SWT Full Council

Monday, 27th January, 2020, 6.15 pm

The John Meikle Room - The Deane House

Somerset West and Taunton

Members: **Hazel Prior-Sankey (Chair), Simon Coles (Vice-Chair), Ian Aldridge, Benet Allen, Lee Baker, Marcus Barr, Mark Blaker, Chris Booth, Paul Bolton, Sue Buller, Norman Cavill, Dixie Darch, Hugh Davies, Dave Durdan, Kelly Durdan, Caroline Ellis, Habib Farbahi, Ed Firmin, Andrew Govier, Roger Habgood, Andrew Hadley, John Hassall, Ross Henley, Marcia Hill, Martin Hill, John Hunt, Marcus Kravis, Andy Milne, Richard Lees, Sue Lees, Libby Lisgo, Mark Lithgow, Janet Lloyd, Dave Mansell, Chris Morgan, Simon Nicholls, Craig Palmer, Derek Perry, Martin Peters, Peter Pilkington, Andy Pritchard, Steven Pugsley, Mike Rigby, Francesca Smith, Federica Smith-Roberts, Vivienne Stock-Williams, Phil Stone, Andrew Sully, Nick Thwaites, Anthony Trollope-Bellew, Ray Tully, Terry Venner, Sarah Wakefield, Alan Wedderkopp, Danny Wedderkopp, Brenda Weston, Keith Wheatley, Loretta Whetlor and Gwil Wren**

Agenda

1. Apologies

To receive any apologies for absence.

2. Declarations of Interest

To receive and note any declarations of disclosable pecuniary or prejudicial or personal interests in respect of any matters included on the agenda for consideration at this meeting.

(The personal interests of Councillors and Clerks of Somerset County Council, Town or Parish Councils and other Local Authorities will automatically be recorded in the minutes.)

3. Public Participation - To receive only in relation to the business for which the Extraordinary Meeting has been called any questions, statements or petitions from the public in accordance with Council Procedure Rules 14,15 and 16

The Chair to advise the Committee of any items on which members of the public have requested to speak and advise those members of the public present of the details of the Council's public participation scheme.

For those members of the public who have submitted any questions or statements, please note, a three minute time limit applies to each speaker and you will be asked to speak before Councillors debate the issue.

4. To receive any communications or announcements from the Chair of the Council

5. To receive any communications or announcements from the Leader of the Council

6. To receive only in relation to the business for which the Extraordinary Meeting has been called any questions from Councillors in accordance with Council Procedure Rule 13

7. Environment Bill (For Information Only) (Pages 5 - 12)

This document is for information only.

8. Somerset West and Taunton Meeting Timetable (Pages 13 - 14)

The attached document presents the meeting dates for the new municipal year, 2020-21.

9. East Quay Wall (Pages 15 - 44)

This matter is the responsibility of Executive Councillor for Asset Management and Economic Development, Councillor Marcus Kravis.

This report sets out the current situation with the East Quay wall, Watchet and the options that the Council have to maintain this asset into the future. It does not seek approval of a permanent solution for the repair at Splash Point, this will be dealt with separately once possible design options have been established, but does request financial approval of the design work for this permanent repair.

10. Access to Information - Exclusion of the Press and Public

During discussion of the following item(s) it may be necessary to pass the following resolution to exclude the press and public having reflected on Article 13 13.02(e) (a presumption in favour of openness) of the Constitution. This decision may be required because consideration of this matter in public may disclose information falling within one of the descriptions of exempt information in Schedule 12A to the Local Government Act 1972. The Executive will need to decide whether, in all the circumstances of the case, the public interest in maintaining the exemption, outweighs the public interest in disclosing the information.

Recommend that under Section 100A(4) of the Local Government Act 1972 the public be excluded from the next item of business on the ground that it involves the likely disclosure of exempt information as defined in paragraph 3 respectively of Part 1 of Schedule 12A of the Act, namely information relating to the financial or business affairs of any particular person (including the authority holding that information).

11. Housing Revenue Account Acquisitions (Pages 45 - 64)

This matter is the responsibility of Executive Councillor for Housing, Councillor Francesca Smith.

12. Taunton Business Improvement District (Pages 65 - 76)

This matter is the responsibility of Executive Councillor for Asset Management and Economic Development, Councillor Marcus Kravis.

JAMES HASSETT
CHIEF EXECUTIVE

Please note that this meeting will be recorded. At the start of the meeting the Chair will confirm if all or part of the meeting is being recorded and webcast. You should be aware that the Council is a Data Controller under the Data Protection Act 2018. Data collected during the recording will be retained in accordance with the Council's policy. Therefore unless you are advised otherwise, by entering the Council Chamber and speaking during Public Participation you are consenting to being recorded and to the possible use of the sound recording for access via the website or for training purposes. If you have any queries regarding this please contact the officer as detailed above.

Members of the public are welcome to attend the meeting and listen to the discussions. There is time set aside at the beginning of most meetings to allow the public to ask questions. Speaking under "Public Question Time" is limited to 3 minutes per person in an overall period of 15 minutes. The Committee Administrator will keep a close watch on the time and the Chair will be responsible for ensuring the time permitted does not overrun. The speaker will be allowed to address the Committee once only and will not be allowed to participate further in any debate. Except at meetings of Full Council, where public participation will be restricted to Public Question Time only, if a member of the public wishes to address the Committee on any matter appearing on the agenda, the Chair will normally permit this to occur when that item is reached and before the Councillors begin to debate the item.

If an item on the agenda is contentious, with a large number of people attending the meeting, a representative should be nominated to present the views of a group. These arrangements do not apply to exempt (confidential) items on the agenda where any members of the press or public present will be asked to leave the Committee Room. Full Council, Executive, and Committee agendas, reports and minutes are available on our website: www.somersetwestandtaunton.gov.uk

The meeting room, including the Council Chamber at The Deane House are on the first floor and are fully accessible. Lift access to The John Meikle Room, is available from the main ground floor entrance at The Deane House. The Council Chamber at West Somerset House is on the ground floor and is fully accessible via a public entrance door. Toilet facilities, with wheelchair access, are available across both locations. An induction loop operates at both The Deane House and West Somerset House to enhance sound for anyone wearing a hearing aid or using a transmitter. For further information about the meeting, please contact the Governance and Democracy Team via email: governance@somersetwestandtaunton.gov.uk

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Environment Bill introduction policy paper

1. Why we need the Environment Bill

The case for tackling biodiversity loss, climate change and environmental risks to public health is clear. The accelerating impact of climate change in this country and around the world is of profound public concern, as is the damage to nature with species loss, habitat erosion and the disappearance of cherished wildlife. The Government has already taken action to address climate change by setting a target to reach net zero emissions, leading the way amongst major economy as the first to do so.

The Environment Bill is part of the government response to the clear and scientific case, and growing public demand, for a step-change in environmental protection and recovery.

Acting as one of the key vehicles for delivering the bold vision set out in the 25 Year Environment Plan, the Environment Bill brings about **urgent and meaningful action to tackle the environmental and climate crisis we are facing**. It sets a **new and ambitious domestic framework for environmental governance** as we maximise the opportunities created by leaving the European Union and helps to **deliver on the government's commitment to be the first generation to leave our environment in a better state**.

The Environment Bill helps to manage the impact of human activity on the environment, **creating a more sustainable and resilient economy**, and **enhancing well-being and quality of life**. It will **engage and empower citizens, local government and businesses to deliver environmental outcomes** and **create a positive legacy for future generations**.

The Environment Bill has been prepared through consultations with the public on numerous measures in the Bill, including: environmental governance; the clean air strategy; biodiversity net gain; trees; conservation covenants; extended producer responsibility for packaging; recycling; deposit return schemes and water.

In addition to public consultations, extensive and continued collaboration has been undertaken with the Scottish and Welsh Governments and the Northern Ireland Civil Service. This has enabled us to bring forward a number of measures that we expect to see adopted outside of England. These joined up measures will help us **manage the environmental challenges we are facing together across the UK**.

2. Environmental Governance

The government is already taking strong action to protect the environment, as set out in our 25 Year Environment Plan. We have laid legislation to reach net-zero carbon emissions by 2050 and will be hosting the COP26 in 2020. The Environment Bill builds on this strong foundation, and maximises the opportunities created by leaving the European Union, underpinning our goal of delivering a Green Brexit.

We will transform our environmental governance by creating a new system which is built on international best practice and tailored specifically to a UK context. It **embeds environmental principles in future policy making** and takes the essential steps needed to **strengthen environmental oversight and improve on the way things have been done in the past**. The new system will be clear and accessible, providing certainty to businesses and citizens. Coherent and clear purposes underpinning key measures will collectively help to ensure that the protection and improvement of the environment is at the heart of this new system.

Environmental principles will work together to **protect the environment from damage** by making environmental considerations central to the policy development process across government. The Bill **legally obliges policy-makers to have due regard to the environmental principles policy statement when choosing policy options, for example by considering the policies which cause the least environmental harm.** The principles are: 1) environmental protection should be integrated into policy-making principle; 2) the preventative action to avert environmental damage principle; 3) the precautionary principle; 4)

environmental damage should as a priority be rectified at source principle and 5) the polluter pays principle.

A new statutory cycle of target setting, monitoring, planning and reporting will help deliver significant, long term environmental improvement and ensure government can be held to account for its actions. Statutory Environmental Improvement Plans (EIPs; the first being the 25 Year Environment Plan) and a new framework for setting long term legally binding targets will be integral to this cycle. We will set new legally binding targets in four priority areas of the natural environment: air quality; waste and resource efficiency; water and nature. The EIPs and legally binding targets will be reviewed on a five-yearly basis and together they **will drive action to significantly improve the natural environment and provide much-needed certainty for businesses and stakeholders**.

In order to **strengthen environmental accountability**, the Environment Bill will establish a new public body – the Office for Environmental Protection (OEP) – as our own independent, domestic watchdog. Through its scrutiny and advice functions, the OEP will **monitor progress in improving the natural environment** in accordance with the government's domestic environmental improvement plans and targets. It will be able to provide government with written advice on any proposed changes to environmental law.

Through its complaints and enforcement mechanisms, the OEP will replace the role of the European Commission, taking a proportionate approach to managing compliance issues relating to environmental law. Failures by public authorities to implement environmental law will no longer be considered through European enforcement processes and instead the OEP will engage with public authorities to reach a solution. Legal proceedings will only be taken as a last resort or in truly urgent cases.

To **ensure the UK continues to drive forward ambitious action to tackle climate change as we leave the EU.** We are bringing all climate change legislation (including carbon budgets) within the enforcement remit of the OEP, replacing the role of the European Commission, and **ensuring there is no governance gap in relation to climate change legislation**. The OEP will work closely alongside our world-leading Committee on Climate Change on these issues, ensuring that their individual roles complement and reinforce each other.

3. A new direction for resources and waste management

Material resources are at the heart of our economy, and we consume them in large quantities. We have already been successful in reducing the amount of harmful environmental waste we create. Since 2015 the government has introduced a 5p charge on single use carrier bags, reducing big supermarkets plastic bag sales by 90%; introduced a ban on microbeads in cosmetic and personal care products; and announced a ban on plastic straws, drinks stirrers, and plastic stemmed cotton buds in England (which comes into force from April 2020), following overwhelming public support.

The resources and waste measures in the Bill will help **move our economy away from the 'take, make, use, throw' system to a more circular economic model.** Our ambition is to **keep resources in use for longer and ensure that we extract the maximum value we can from them.**

The Environment Bill introduces a series of measures that will fundamentally change the way government, businesses and individuals produce and consume products.

New government powers to set resource-efficiency standards for products will help **drive a shift in the market towards products that can be more easily recycled**, as well as **products that last longer and which can be re-used and repaired more easily**. Powers in the Environment Bill to introduce new extended producer responsibility schemes will enable us to reform our existing producer responsibility arrangements and introduce new schemes in the future. Extended producer responsibility schemes seek to **make producers responsible for the full net costs of managing their products at end of life**. The powers provide for

modulated fees that incentivise, producers **to design their products with re-use and recycling in mind**, as those that make their products easier to recycle will pay less.

We will also modernise the government's existing powers to set producer responsibility obligations, extending them to prevention and redistribution of waste.

To continue tackling plastic pollution across the country, the Environment Bill will enable the creation of new charges for other single-use plastic items, similar to the carrier bag charge, which will **incentivise a shift towards the use of more reusable items.** We are also taking powers to establish deposit return schemes that **further incentivise consumers to reduce litter and recycle more**.

The Environment Bill **helps consumers to make purchasing decisions that support the market for more sustainable products**. It contains powers to introduce clear product labelling, which will enable consumers to identify products that are more durable, reparable and recyclable and will inform them on how to dispose of used products.

The Bill also takes steps to tackle illegal waste activities, which costs the UK economy around £600 million per year[1]. We will improve the management of waste and reduce the risk of economic, environmental and social harm that illegal activity often causes. These measures will help level the playing field by ensuring all **businesses are adopting legitimate waste management practices**, including through powers to introduce an electronic waste tracking system. It will also **ensure regulators and local authorities can work more effectively to combat waste crime**, with better access to evidence, improved powers of entry and the ability to keep fixed penalty notices at an appropriate level. The Bill also includes measures that will allow us to introduce producer responsibility obligations on waste prevention and redistribution.

To support citizens' efforts to recycle more, the Environment Bill stipulates a consistent set of materials that must be collected from all households and businesses, including food waste. This will help make services more consistent across the country.

The Environment Bill also helps deliver commitments in the 2017 Litter Strategy to promote proportionate and effective enforcement against littering. It will provide powers to issue legal guidance to litter authorities and extending government's existing powers to impose conditions to be met by those authorised to carry out enforcement activity.

4. Improving the air we breathe

Everyone has a role to play in changing the way we act in order to ensure we have a cleaner, healthier environment. The Environment Bill aims to **maximise health benefits** by tackling poor air quality, which is the greatest environmental risk to our health. Poor air quality shortens lifespans and damages quality of life for many people. Pollution also has major impacts both on the natural world and the state of the economy.

The UK has long been determined to improve air quality. Having adopted legally binding international targets to reduce overall national emissions of five key air pollutants by 2020 and 2030. Our tough regulatory frameworks have yielded significant progress to date. For example, direct action on nitrogen dioxide has led to emissions falling by almost 27% between 2010 and 2016 and they are now at their lowest level since records began. And in January we published our Clean Air Strategy, which was commended by the World Health Organisation. However, we still need to go further, which is why we are taking forward ambitious measures through the Environment Bill.

The Environment Bill makes a clear commitment to set a legally binding target for the pollutant with the most significant impact on human health, fine particulate matter. Reductions in this

[1] Rethinking Waste Crime

pollutant will deliver **significant benefits to public health and technological advancements, resulting in benefits for the economy.**

The Bill also **strengthens the ability for local authorities to tackle air quality issues**. At a local level, the legislative framework for air quality in England was in need of updating. Both the Environment Act 1995 and Clean Air Act 1993 provide mechanisms for local authorities to address local air quality, however these duties to act and the powers to enable action were often misaligned. While responsibility sits with local authorities, often the levers to take action sit with other bodies.

The Environment Bill updates, simplifies and strengthens the local air quality management framework (LAQM). In particular it ensures that **responsibility for tackling air pollution is shared across local government structures and with relevant public bodies.**

We are also introducing measures to **reduce emissions from the single largest contributor of fine particulate matter emissions** – domestic solid fuel burning. The Bill creates a simpler mechanism for local authorities seeking to tackle smoke emissions within their areas.

Finally, the Bill introduces a new power to **compel vehicle manufacturers to recall vehicles for environmental non-conformity or failure**, in the case that a manufacturer refuses to issue a voluntary recall.

5. Delivering sustainable water resources

Managing water sustainably is essential if our environment is to thrive; to benefit people and wildlife. In recent years we have improved our management of this vital resource; deaths from water pollution have reduced from over 500 per year in the early 1990s to 57 in 2016; the Water industry since privatisation have invested around £140 billion, equivalent to around £5 billion annually, and the government is investing £2.6 billion from 2015 to 2021 in flood and coastal defence projects, from which already 147,000 out of a total of 300,000 homes are better protected.

There is more to be done. Our changing climate is associated with more extreme weather; higher risks of drought and an increase in flooding which seriously affects people's lives and assets.

The water measures in the Environment Bill will help to secure long-term, resilient water and wastewater services, **making sure that we have a cleaner, greener and more resilient country for the next generation**. Water companies and other users of water may over-abstract and deprive rivers of the very basic resource they need to survive: water. The Bill reforms elements of abstraction licensing to link it more tightly to our 25 Year Environment Plan goal of **restoring water bodies to as close to natural state as possible.**

The Bill enables the environmental regulator to propose the variation or revocation of abstraction licences without liability for compensation. This is established based on two conditions: 1) if they are causing, or risk causing, considerable environmental damage and / or 2) if they consistently abstract less water than their licensed volume**.**

The Environment Bill **introduces additional requirements for Water Company planning for future water supply and wastewater and drainage networks,** enabling more resilient solutions to drought and flooding.

In a changing climate, **these measures will ensure the water regulator has the powers it needs to respond to changing priorities.** The framework for licence modification in other utility sectors has evolved over time, to create a more flexible and transparent process. In order to strengthen Ofwat's (the economic water regulator) ability to improve the way water and sewerage companies operate to meet current and future demand for water, the Environment Bill amends the process for modifying the conditions of companies' licences to operate.

The 25 Year Environment Plan committed to delivering clean and plentiful water. The Environment Bill creates a power to update the lists of substances and their respective standards which are potentially harmful to surface waters and groundwater. This will ensure regulations protecting water quality are keeping pace with scientific and technical knowledge.

The Bill also creates a power to amend the governance arrangements in the Solway Tweed river basin district, which straddles the border between England and Scotland. **This will bring greater efficiency for Scottish and English environment agencies and better reflect devolved competence.**

This Bill will **enhance flood and coastal erosion risk management** by addressing a current barrier to the expansion of existing, or creation of new, internal drainage boards. Internal drainage boards undertake important work around managing local water levels and flood risk management. To fund this work, internal drainage boards charge the communities they serve. The Bill amends the Land Drainage Act 1991 to enable certain valuation calculations to be provided for in secondary legislation, so that necessary updates to the calculations (including data sources) can be readily made.

Internal drainage boards use these valuation calculations to correctly apportion their expenses between agricultural land owners (via drainage rates) and local authorities (via the special levy). The powers will enable the government to address the issue posed by the unavailability of certain valuation data, whilst also future proofing the legislation, by enabling any future updates to other aspects of the valuation calculations to be made in secondary legislation as necessary. Since internal drainage boards are funded locally the government will only establish them where there is local support.

6. Restoring and enhancing nature and green spaces

Our natural environment is in decline. In recent years the government has taken action to reduce this environmental decline. We have strengthened protections for ancient woodlands, veteran trees and other irreplaceable habitats in the revised national planning policy framework and provided almost £6 million to the new Northern Forest. In the 25 Year Environment Plan we pledged to plant 11 million new trees and one million urban trees.

Many ecosystems have been degraded and biodiversity has fallen significantly in recent decades. For too long, we haven't been able to reverse this downward trend and now urgent action is needed to drive necessary change.

This government is determined to create a step-change for our natural environment and work towards its recovery. To achieve this the Environment Bill introduces new measures to support lasting action for our natural environment. The Bill will drive continual improvement by changing the way we plan, invest and live to **maximise the health and social benefits of nature**.

Many environmental issues naturally have distinct local elements and responding to challenges at a local level allows not only for bespoke and more appropriate responses but also drives the potential for innovation. The Bill supports and enables action on the ground through working together, including with land owners and managers, developers, local government and conservation organisations to **create or restore wildlife rich habitats to enable wildlife to recover and thrive**. This will improve the way that environmental effects are measured in planning and development, **providing greater certainty for both developers and local communities.**

The Environment Bill introduces mandatory biodiversity net gain, to ensure that new developments **enhance biodiversity and help deliver thriving natural spaces for communities.** Integrating biodiversity net gain into the planning system will provide a step change in how planning and development is delivered. The Bill will **provide new opportunities for innovation as well as stimulating new economic markets**. This is

expected to result in the creation and the avoidance of loss of several thousands of hectares of habitat for wildlife each year, which represents **annual natural capital benefits of around £1.4 billion.** This will increase the public benefits of ecosystems, such as **improvements in air quality, water flow control, outdoor recreation and physical activity.**

Net gain requirements do not undermine existing protections for protected sites or irreplaceable habitats. In relation to protected sites, net gain will only be enforceable following a planning decision which will consider the existing legal and planning policy requirements for protected sites in the usual way. Net gain requirements will not undermine the existing range of protections, in planning policy and legislation, for irreplaceable habitats and protected sites.

The Environment Bill also introduces provisions requiring the development of Local Nature Recovery Strategies (LNRSs) across England. These are tools that will support **better spatial planning for nature recovery**, by setting out priorities and opportunities for protecting and investing in nature within a local area. They will include a map of existing nature assets including protected sites and wildlife-rich habitats and will identify key opportunities for enhancement.

LNRSs will help local authorities and other public bodies identify priorities and opportunities for conserving and enhancing nature. These tools will also support strategic planning for housing and infrastructure and help **direct net gain investment** so that it has the greatest benefit for local wildlife and people. Whilst government will provide data, guidance and support for LNRSs, each one will be produced locally ensuring local ownership and knowledge is embraced, and strategies are consistent and link together across England.

These spatial strategies will underpin the ability for key stakeholders to help deliver Nature Recovery Networks (NRNs). All members of society have a role to play, and these tools will help all parties work together more effectively to help deliver **meaningful environmental improvement.**

Maximising benefits for our natural environment should not just be for the short term. The Environment Bill enables landowners to make long term commitments to conservation. A conservation covenant is a private, voluntary agreement between a landowner and a 'responsible body', such as a conservation charity or public body, to fulfil conservation objectives and **ensure the delivery of wider health and social benefits for communities** for the public good. Covenants will be voluntary but legally binding.

The Natural Environment and Rural Communities (NERC) Act 2006 places a duty on public authorities to 'have regard' to conserving biodiversity in the exercise of their functions. With the environmental challenges we are currently facing, the current duty needs to be strengthened in order to **ensure public authorities play their part in enacting meaningful change.** The Environment Bill strengthens the duty to cover the enhancement, as well as the conservation, of biodiversity, and **requires public authorities to actively carry out strategic assessments of the actions they can take to enhance and conserve biodiversity**. Designated public authorities will also be required to produce a five-yearly report on the actions taken to comply with the new duty. Together, these measures provide an important driver for the effective implementation of LNRSs, providing an effective way to embed consideration of biodiversity across the public sector.

Trees bring nature to the heart of our communities, help clean and cool the air, reduce flooding, and improve people's physical and mental health. Urban trees in particular play a pivotal role in **creating healthy and economically successful communities and places for people and wildlife to live**. The Environment Bill introduces 'Duty to Consult' which will give the public the opportunity to understand why a street tree is being felled and express any concerns regarding this. The Bill also introduces Forestry Enforcement Measures which strengthens the Forestry Commission's power to **tackle illegal tree felling across England**, ensuring the Commission has the powers to continue to protect and maintain our forests.

7. Chemicals regulation (REACH)

The Environment Bill gives the Secretary of State the power to amend two pieces of legislation regulating the use of chemicals in the UK. The REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) Regulation regulates the manufacture, placing on the market and use of chemicals. The REACH Enforcement Regulations 2008 set out how the requirements of the REACH Regulation are enforced. Both pieces of legislation are retained EU law under the European Union (Withdrawal) Act 2018.

This will allow the Secretary of State to take further steps where necessary to ensure a smooth transition to a UK chemicals regime following the UK's exit from the EU. It will also make it possible to keep the legislation up to date and respond to emerging needs or ambitions for the effective management of chemicals.

8. Delivering environmental ambition at the local level

Local government has an essential role to play responding to challenges at a local level, leading specific and locally appropriate responses and driving innovation. Local authorities - as local experts, place-shapers, and conveners of their communities – must be empowered to play a fundamental role in delivering the environmental action needed in local areas.

The Bill bolsters the role of local leaders on tackling environmental issues by providing additional powers and flexibilities to deliver action. This Bill delivers this through:

- **Improved and increased powers to take more effective action** to tackle the challenges in each local area;
- **Greater certainty through the planning system** on how to plan effectively for the local environment;
- **Providing more certainty and simplicity for developers** by mandating biodiversity net gain, and ensuring that all new developments enhance biodiversity and help deliver thriving natural spaces for communities;
- **Ensuring that producers can be held responsible** for the full net costs of managing products at end of life, reducing local authorities' financial burdens from waste management, including litter collection;
- **Stronger abilities to improve health and social outcomes** for local citizens; and
- **Supporting local authorities as place shapers** through new tools and data for effective spatial planning.

The Bill creates a framework in which strong local government leadership will be enhanced to drive the necessary, and once in a lifetime environmental improvements to reverse decades of biodiversity loss, improve air quality.

Government will fully fund all new burdens on local authorities arising from the Bill in order to make our ambition a reality. We are committed to working in partnership with local government, businesses and wider stakeholders on the implementation of these measures, to identify and secure the capacity and skills to deliver a cleaner, greener and healthier environment.

COUNCIL MEETING TIMETABLE 2020 – 2021

	MAY (2020)	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY (2021)	FEBRUARY	MARCH	APRIL	MAY (2021)
MON		**1**								**1** Member Briefing TBC	**1**		
TUES		**2** ENPA			**1** ENPA Member Briefing TBC			**1** ENPA		**2** ENPA	**2** ENPA		
WED		**3** Scrutiny 6.15pm (DH)	**1** Scrutiny 6.15pm (DH)		**2** Scrutiny 6.15pm (DH)			**2** Scrutiny 6.15pm (DH)		**3** Scrutiny 6.15pm (WSH)	**3** Scrutiny 6.15pm (DH)		
THUR		**4** Planning 1pm (TBC)	**2**		**3**	**1**		**3**		**4** Planning 1pm (TBC)	**4**	**1**	
FRI	**1**	**5**	**3**		**4**	**2**		**4**	**1 Bank Holiday**	**5**	**5**	**2 Bank Holiday**	
SAT	**2**	**6**	**4**	**1**	**5**	**3**		**5**	**2**	**6**	**6**	**3**	**1**
SUN		**7**	**5**	**2**	**6**	**4**	**1**	**6**	**3**	**7**	**7**	**4**	**2**
MON	**4** Annual Council 6.15pm (DH)	**8** Audit, Governance and Standards 6.15pm (WSH)	**6**	**3**	**7** Audit, Governance & Standards 6.15pm (DH)	**5**	**2**	**7** Audit, Governance & Standards 6.15pm (WSH)	**4**	**8**	**8** Audit, Governance & Standards 6.15pm (DH)	**5**	**3 Bank Holiday**
TUES	**5** ENPA	**9**	**7** ENPA Full Council 6.15pm (DH)	**4** ENPA	**8**	**6** ENPA	**3** ENPA Member Briefing TBC	**8** Member Briefing TBC	**5** Member Briefing TBC	**9**	**9**	**6** ENPA	**4** ENPA
WED	**6**	**10** Member Briefing TBC	**8**	**5** Scrutiny 6.15pm (WSH)	**9**	**7** Scrutiny 6.15pm (DH)	**4** Scrutiny 6.15pm (WSH)	**9**	**6** Scrutiny 6.15pm (DH)	**10**	**10**	**7** Scrutiny 6.15pm (DH)	**5**
THUR	**7** PCC Elections	**11**	**9**	**6** Planning 1pm (TBC)	**10**	**8** Planning 1pm (TBC)	**5**	**10**	**7**	**11**	**11**	**8** Planning 1pm (TBC)	**6**
FRI	**8 Bank Holiday**	**12**	**10**	**7**	**11**	**9**	**6**	**11**	**8**	**12**	**12**	**9**	**7**
SAT	9	**13**	**11**	**8**	**12**	**10**	**7**	**12**	**9**	**13**	**13**	**10**	**8**
SUN	**10**	**14**	**12**	**9**	**13**	**11**	**8**	**13**	**10**	**14**	**14**	**11**	**9**
MON	**11**	**15** Licensing 6.15pm (DH)	**13**	**10** Member Briefing TBC	**14** Licensing 6.15pm (WSH)	**12** Member Briefing TBC	**9**	**14** Licensing 6.15pm (DH)	**11**	**15**	**15** Licensing 6.15pm (WSH)	**12**	**10**
TUES	**12**	**16**	**14**	**11**	**15**	**13**	**10**	**15** Full Council 6.15pm (DH)	**12** ENPA	**16** Full Council 6.15pm (DH)	**16** Member Briefing TBC	**13**	**11** Annual Council 6.15pm (DH)
WED	**13** Scrutiny 6.15pm (WSH)	**17** Executive 6.15pm (WSH)	**15** Executive 6.15pm (DH)	**12**	**16** Executive 6.15pm (WSH)	**14**	**11**	**16** Executive 6.15pm (WSH)	**13**	**17**	**17** Executive 6.15pm (WSH)	**14**	**12**
THUR	**14** Planning 1pm (TBC)	**18**	**16** Planning 1pm (TBC)	**13**	**17** Planning 1pm (TBC)	**15**	**12**	**17** Planning 1pm (TBC)	**14** Planning 1pm (TBC)	**18**	**18** Planning 1pm (TBC)	**15**	**13**
FRI	**15**	**19**	**17**	**14**	**18**	**16**	**13**	**18**	**15**	**19**	**19**	**16**	**14**
SAT	**16**	**20**	**18**	**15**	**19**	**17**	**14**	**19**	**16**	**20**	**20**	**17**	**15**
SUN	**17**	**21**	**19**	**16**	**20**	**18**	**15**	**20**	**17**	**21**	**21**	**18**	**16**
MON	**18** Member Briefing TBC	**22**	**20** Member Briefing TBC	**17**	**21**	**19**	**16**	**21**	**18**	**22** Member Briefing TBC	**22**	**19** Member Briefing TBC	**17**
TUES	**19**	**23**	**21**	**18**	**22** Member Briefing TBC	**20**	**17**	**22**	**19**	**23** Full Council (Res)	**23**	**20**	**18**
WED	**20** Executive 6.15pm (DH)	**24**	**22**	**19** Executive 6.15pm (DH)	**23**	**21** Executive 6.15pm (DH)	**18** Executive 6.15pm (DH)	**23**	**20** Executive 6.15pm (DH)	**24** Executive 6.15pm (DH)	**24**	**21** Executive 6.15pm (DH)	**19**
THUR	**21**	**25** Planning 1pm (TBC)	**23**	**20**	**24**	**22**	**19**	**24**	**21**	**25** Planning 1pm (TBC)	**25**	**22**	**20**
FRI	**22**	**26**	**24**	**21**	**25**	**23**	**20**	**25 Bank Holiday**	**22**	**26**	**26**	**23**	**21**
SAT	**23**	**27**	**25**	**22**	**26**	**24**	**21**	**26**	**23**	**27**	**27**	**24**	**22**
SUN	**24**	**28**	**26**	**23**	**27**	**25**	**22**	**27**	**24**	**28**	**28**	**25**	**23**
MON	**25 Bank Holiday**	**29**	**27**	**24**	**28**	**26**	**23** Member Briefing TBC	**28 Bank Holiday**	**25**		**29** Member Briefing TBC	**26**	**24**
TUES	**26**	**30** Member Briefing TBC	**28**	**25**	**29** Full Council 6.15pm (DH)	**27**	**24**	**29**	**26**		**30** Full Council 6.15pm (DH)	**27**	**25**
WED	**27**		**29**	**26**	**30**	**28**	**25**	**30**	**27**		**31**	**28**	**26**
THUR	**28**		**30**	**27** Planning 1pm (TBC)		**29** Planning 1pm (TBC)	**26** Planning 1pm (TBC)	**31**	**28**			**29** Planning 1pm (TBC)	**27**
FRI	**29**		**31** Special Audit, Governance & Standards 1pm (DH)	**28**		**30**	**27**		**29**			**30**	**28**
SAT	**30**			**29**		**31**	**28**		**30**				**29**
SUN	**31**			**30**			**29**		**31**				**30**
MON				**31 Bank Holiday**			**30**						**31 Bank Holiday**
TUES													
WED													

School Holidays are highlighted in yellow. References to ENPA are Exmoor National Park Authority Planning Committees. DH = Deane House WSH = West Somerset House TBC = To Be Confirmed Timetable as 29/11/2019

Report Number: SWT 30/20

Somerset West and Taunton Council
Full Council – 27 January 2020

East Quay Wall, Watchet - Maintenance

Report of Localities Manager – Chris Hall
(This matter is the responsibility of Executive Councillor Marcus Kravis)

1. Executive Summary

This report sets out the current situation with the East Quay wall, Watchet and the options that the Council have to maintain this asset into the future. It does not seek approval of a permanent solution for the repair at Splash Point, this will be dealt with separately once possible design options have been established, but does request financial approval of the design work for this permanent repair.

For the East Quay wall survey works have identified that the wall is not at imminent risk of failure but would benefit from maintenance with some reinforcing in the central and northern sections to ensure that operations can continue here into the future, and that a programme of monitoring be put in place for the entire length of the wall. The report challenges the economic advantage of undertaking the reinforcing work to the northern section and proposes alternative options.

The East Quay wall serves as part of the structure to create the marina, protects Watchet as a sea defence, and stabilises the East Quay itself. This area is used for boat storage, as a lifting facility for the marina, and a tourism offering.

The timing of this report is unrelated to the granting of the lease to the Onion Collective as the report identifies that this development has a negligible impact on the wall structure and no works to the wall are required to enable the development.

The report identifies a budget need for design work and a maintenance solution, therefore a budget request is made for £740k to design a permanent solution to the Splash Point failure and reinforce the central section of the East Quay wall with the associated professional costs.

2. Recommendations

2.1 It is recommended that Full Council approve the following additions to the Capital Programme, which will be funded through borrowing:

i) Add the following to the Capital Programme for 2019/20
   a. The sum of £100k be allocated to the wall design works at Splash Point and
   b. The sum of £100k be allocated to the wall design works at East Quay

ii) Add the following to the Capital Programme for 2020/21
   a. The sum of £500k be allocated to reinforce the East Quay wall in the central section and
   b. The sum of £40k for project management resource to deliver this project to its conclusion.

3. Risk Assessment

Risk Matrix

Description	Likelihood	Impact	Overall
Risk: Failing to maintain the East Quay in a timely fashion could result in deterioration with greater costs at a later date	Possible (3)	Moderate (3)	Medium (9)
Mitigation: Investigations and proposals presented in this report seek approval to undertake improvement works in the central section with limited restrictions to operations in the northern section.	Unlikely (2)	Moderate (3)	Low (6)
Risk: The wall fails unexpectedly resulting in a risk to public and greater costs in reacting to this as an emergency.	Possible (3)	Moderate (3)	Medium (9)
Mitigation: Survey and modelling identify a theoretical risk area in the central section, the construction type here would likely lead to a bend in the structure rather than a collapse. Recommendation is to reinforce this section.	Unlikely (2)	Moderate (3)	Low (6)
Risk: Failing to maintain the asset to meet the terms of the lease to the Marina Operator. Breach of these terms could place the council at risk of challenge, or at least place further strain on the relationship	Possible (3)	Moderate (3)	Medium (9)
Mitigation: The Marina operator has been provided with report on condition and offered a meeting to discuss its content. We do not consider any of the restriction options to have a negative impact on their operation.	Unlikely (2)	Moderate (3)	Medium (6)
Risk: Reinforcing the wall will remove a small amount of space from the Marina and increase, by that same amount the side of the East Quay, this additional land will increase the cost of the roadway surfacing which is a responsibility of the OC development. If there is an identifiable increase in cost we would anticipate the OC seeking a contribution from the council for this.	Possible (3)	Minor (2)	Low (6)

Mitigation: Whilst there may be an increased area for surfacing there may be less sub base construction works needed in creating the roadway reducing the costs. Council officers will negotiate the cost changes and seek to offset OC savings on the roadway against any increased cost for surfacing.	Unlikely (2)	Minor (2)	Low (4)
Risk: In order to expedite delivery of the works Members are being asked to approve a project based on estimates of costs, there is a risk that these could be incorrect once put to market	Moderate (3)	Possible (3)	Medium (9)
Mitigation: Member approval would allow the project team to undertake the design works and go to market with a tender, this will only then be converted into a contract where the overall costs of the project fall within the estimates. Should they not then a revised report will be provided for Members to reconsider.	Moderate (3)	Possible (3)	Medium (9)

4. Project Governance

4.1 The Project was initially being managed under the Commercial Investment functional area but with such close links to Localities, the operations of the Marina, and the Onion Collective, the Localities Manager is now overseeing this with initial project management support being provided through Localities.

4.2 The Project Team is made up of internal and external contributors. The internal Project Manager is Steve Hughes, with a range of others providing their technical support as required. Pick Everard and Crouch Waterfall have been providing specialist survey works and modelling.

4.3 The likely scale of spend and complexity of the works means that we will continue to need engineering expertise to design and potentially support the procurement process.

5. Background

5.1 This report does not attempt to resolve the issues that have recently been encountered with the wall at Splash Point, there are a range of options at that location that require further consideration before a design can be put to market. Therefore a budget is requested to undertake the design works at Splash Point. The design options for East Quay are less variable with the likely solution being a sheet piled front to reinforce the existing wall. However to meet our obligations under the Construction Design and Management Regulations 2015 a principle

designer still needs to be appointed and a solution drawn up by competent engineers.

5.2 The Authority has responsibility for the East Quay wall which has been repaired in different places at a different times over its life. There have been concerns raised about the structural integrity and the lifecycle for maintenance. In response the council commissioned a range of surveys from specialists in the industry.

5.3 The survey response from Pick Everard was presented to the Asset Management Group of West Somerset Council back in 2018. It was clear at this point that whilst there was no immediate risk to the public from the wall its maintenance needs to be planned for and its current condition better understood.

5.4 The council had previously undertaken a procurement activity to seek a contractor to deliver a maintenance scheme in advance of the OC development. The rationale for this was to complete any work necessary and be off site prior to the OC work starting, it was felt that this would minimise complexity. In reality contractors considered that this posed increased challenges in the timeframe available. It was also apparent that contractors needed additional information on the wall construction which was not available at that time.

5.5 Officers commissioned surveys to establish the condition of the wall ties and finite material analysis. Both of these would support the design of the maintenance scheme required as well as provide a greater understanding of the current factor of safety. These surveys were undertaken and the outcomes of these provide the most up to date information available, further reducing concerns over the East Quay wall structure.

5.6 The British Standard minimum factor of safety is 1.25. This means meeting the basic requirements for the wall for pedestrians, vehicles movements, and crane operations with a safety factor of 0.25 or 25%. Therefore any score below 1.25 is a fail.

5.7 A quay wall would normally be built to take activities with a loading of 10 kilopascals (kpa), kilopascals being a common measure of pressure. Due to the lease with the marina operator and their known use of the crane this has been increased to 20 kpa to ensure that our factor of safety relates to the known activities on site.

5.8 The Onion Collective's project does not include maintenance of the wall but it is clear that we will need to work with the OC and Watchet Harbour Marina Ltd to ensure that each parties operational needs are met when works are underway. Undertaking the work after the development may result in damaging the new surfaces put down by them, this could invalidate any warranties that they have for the buildings. This could also impact on warranties for the provision of the roadway which is being provided at OC's cost but will remain an asset of the council, their warranty for this is therefore to the benefit of SWaT. Reputational damage could also occur for the council where newly laid surfaces need to be lifted (or are damaged) for the wall maintenance.

5.9 Information that is pertinent to the OC's development has been shared with their engineers, to help inform their design and working practices. Their contractors are required to consider this information and undertake their own assessment to inform their design. The assessment of the OC engineers have been provided to the council.

5.10 As a point of clarity the council are not undertaking these repairs to enable the Onion Collectives development, the wall is the responsibility of the council and it serves as a structure that not only creates the East Quay, which is also part leased by the Marina Operator, but is also a sea defence for Watchet.

5.11 There has been no historical programme of monitoring or maintenance in place and only reactive works have been undertaken. Regardless of any recommendations to make repairs or reinforce sections a monitoring and maintenance programme must be put in place.

6. Survey works

6.1 A range of surveys have been undertaken over a period of time, these include but are not limited to core hole sampling, wall tie condition, location of dead man's anchors, and finite materials analysis. The Surveyors have also looked at wall construction and repairs, and life expectancy of the materials. These have all provided information for the modelling assessments.

6.2 The modelling has considered the likely means of failure of the wall and provided a factor of safety (fos) on each of these. These include bend moments, wall slip from the toe and overturning of the head. All results in table 1 are represented as the lowest factors of safety from any of this analysis, i.e. worst case scenarios.

6.3 The surveys undertook a range of modelling based on a sectional analysis of the wall. These sections were derived by the construction type and therefore the loadings required to achieve failure. This is then converted into a factor of safety with fos of 1.25 being the minimum needed for the activities and loading that are undertaken. Crane operations have the greatest weight impact on the wall exerting 20 kpa in close proximity to the wall. All outcomes assume the greatest weight loading unless stated otherwise.

6.4 A key message from the survey works, and one of the reasons the council were comfortable in signing off the lease to the Onion Collective, is that the surveys identify a negligible impact of the development on the wall. Therefore development, or no development, the factor of safety for the wall is unaffected. This is due to the distance of the development from the wall edge.

6.5 The wall for the purposes of the report is considered in the three sections. The southernmost section which adjoins The Esplanade, the central section which is the steel piled area, and the northernmost section beyond the steel piles but before the pier. These can be seen in appendix A, a diagram of the East Quay

6.6 In all scenarios modelled by the consultants the **southernmost** section **exceeds** the minimum factor of safety of 1.25. This may come as a surprise as visually it

looks to be in the worst condition, however due to its lower height, and a number of other factors, the wall here is stable and has the highest factor of safety rating of the three sections.

6.7 At high tide the **central** section of the wall **exceeds** the minimum factor of safety of 1.25. However at low tide the wall **fails** to meet the minimum requirements, this means that in theory the wall should fail but in practice it has shown no signs of doing so. Due to the construction of this section failure would most likely be seen by a bending of the sheet piles rather than a collapse. The modelling gave a range of factors of safety based on assumptions about the sheet pile types and their embedment into the bedrock. The table below takes the worst case scenario and it is therefore possible that the assumptions are predicting a situation that is worse than reality. It is nevertheless recommended to Members that this section is reinforced.

6.8 It is clear from the site investigation works that the central part of the structure is nearing the end of its life and were there to be no maintenance then it will inevitably fail at some point in the future.

6.9 With the current mud and silt level the **northern** section of the wall **exceeds** the minimum factor of safety of 1.25 at high and low tide for pedestrian and vehicle traffic, but **fails** for crane operations at **low tide only**. Officers will be advising the marina operator of this however in practice with the current marina mud levels crane operations would not occur at low tide anyway.

6.10 The council have a choice to reinforce this section of wall, or place a restriction on crane operations at low tide, or restrict any future dredging operation within this immediate area. The cost of including the northernmost section in the procurement is estimated to be in excess of £400k it is therefore economical to look at alternatives. It is recommended that this is excluded from the reinforcing programme and officers are instructed to work with the marina operator to limit the impact of this decision.

6.11 Results of the modelling shown in Table 1 below differ between low and high tide. This is caused by the volume of water at high tide placing a positive pressure on the wall front and increasing the factor of safety.

Table 1: Factor of Safety Outcomes.

No	**Surcharge**	**kpa loading**	**Northern section**		**Central section**		**Southern section**	
			Low Tide	High Tide	Low Tide	High Tide	Low Tide	High Tide
1	Current	10 kpa	1.3 (1.1 with silt removed)	4.0	0.7	2.7	1.8	10+
2	Current inc. crane	20 kpa	1.06	2.5	0.7	2.7	1.4	4.0
3	Current + OC	60 kpa	Outside of OC development area		Negligible effect of OC development so not modelled		1.8	10+
4	Crane + OC	70 kpa					1.4	4.0

6.12 As part of the analysis we sought to understand if water that entered into the structure of the East Quay at high tide washed out material as the tide fell. This finite element modelling identified no loss of fine material being washed out from the rear of the wall. In terms of the wall integrity this is a good result as it reduces the opportunity for voids to be created behind the wall.

7. The Maintenance options

7.1 From the survey information provided it is clear that the southern section requires no substantial maintenance works, however a plan for monitoring is required.

7.2 It is recommended that the central section is reinforced to allow for vehicle movements into the boat storage area and crane operations which are a condition of the lease to the marina operator. These can continue at high tide but advice will be provided to the marina operator and Onion Collective concerning low tide. Undertaking this work will also provide for longer term stability for the operation of the marina.

7.3 It is recommended that the northern section is excluded from the reinforcing programme and officers are instructed to work with the marina operator to limit the impact of this decision.

8. Procurement process

8.1 The Authority will undertake a robust procurement activity to ensure that the best options and value are established. We recommend to Members that we further instruct specialists to create the necessary engineering designs for both Splash Point and the central section of East Quay.

8.2 We then recommend that the design is put to market with a minimum lifespan requirement. With this quality aspect already set we can then run a procurement activity weighted in favour of price.

8.3 Upon approval of the recommendations the design and procurement will begin, with works being undertaken on site in 2020 / 21, and completed to a timeline that avoids further disruption on site following the conclusion of the OC development.

9. Financial resource implications

9.1 The financial requests of this report are currently based on estimates and cannot therefore be considered as fixed, this creates a risk in terms of the known costs, however the councils responsibility for delivery are unchanged by the costs of the project. Any further changes to the costs will be reported through the budget monitoring process.

9.2 The total cost requested to be added to the Capital Programme is £740k, which will

be funded from borrowing, with a revenue cost of £44k per annum to be included in the budget from 2021/22 onwards.

10. Legal Implications

10.1 The council have a responsibility to maintain the assets at Splash Point and East Quay, any failure of the asset caused by the council's negligence would likely expose the council to challenge and financial risk.

10.2 Any failure of the asset caused by the negligence of others would expose that party to challenge and financial risk and the Council would take action against them to recover all associated costs.

10.3 Any restrictions imposed for the northern section of the wall are not considered to be unreasonable given the known operating restrictions caused by the marina's mud.

12. Environmental Impact

12.1 There are no detrimental implications associated with supporting the recommendations of this report. Environmental implications could exist where Members are unable to support the necessary maintenance of this asset. With no maintenance the asset could fail in time creating pollution within the Harbour.

12.2 It is anticipated that an Environmental Impact Assessment will be required making reference to the reinforcing solutions proposed by contractors.

13. Safeguarding and/or Community Safety Implications

13.1 There are no implications resulting from the recommendations of this report being approved.

14. Asset Management Implications

14.1 The Asset Management Team have been involved throughout the process and support the recommendations of this report. A programme of monitoring would fall to this team to manage.

15. Data Protection Implications

15.1 There are no identified implications of this report on data protection.

16. Consultation Implications

16.1 There has been and will continued to be a need for close working with the Onion

Collective and Watchet Harbour Marina Ltd, although there is no formal consultation process.

17. Equalities Impact

17.1 There are no detrimental impacts on any of the protected groups as a result of this report and its recommendations.

18. Partnership Implications

18.1 There are no formal partnerships impacted by the content of this report.

19. Climate Change implications

19.1 Climate change will impact on the sea levels in the coming years. This report does not evaluate the effects of rising sea levels but does seek to secure funding to maintain the integrity of the sea wall for the foreseeable future.

20. Comments from Executive

20.1 At the time of writing this report the Executive committee had not met, a verbal update will be provided for Full Council summarising the questions and responses, and their recommendations.

Democratic Path:

- ~~**Executive – 22nd January 2020**~~
- **Full Council – 27th January Date 2020**

Reporting Frequency: One off

Appendicies:

A) Plan of the East Quay, Watchet
B) Site investigations report

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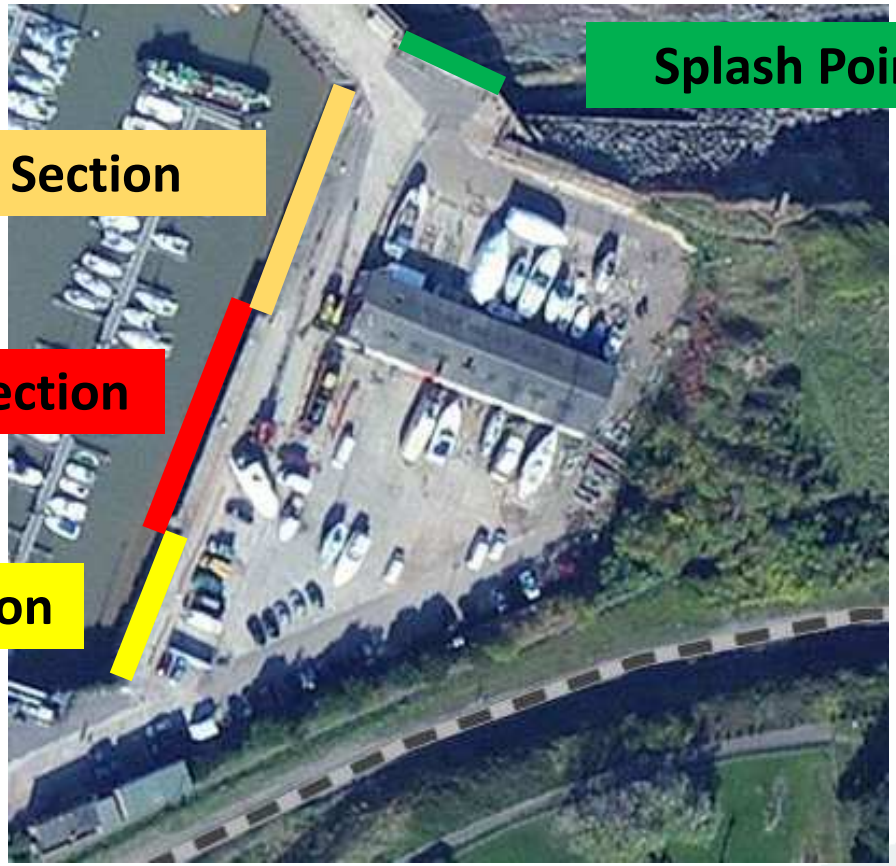
Risk Scoring Matrix

Likelihood	5	Almost Certain	Low (5)	Medium (10)	High (15)	Very High (20)	Very High (25)
	4	Likely	Low (4)	Medium (8)	Medium (12)	High (16)	Very High (20)
	3	Possible	Low (3)	Low (6)	Medium (9)	Medium (12)	High (15)
	2	Unlikely	Low (2)	Low (4)	Low (6)	Medium (8)	Medium (10)
	1	Rare	Low (1)	Low (2)	Low (3)	Low (4)	Low (5)
			1	2	3	4	5
			Negligible	Minor	Moderate	Major	Catastrophic
			Impact				

Likelihood of risk occurring	**Indicator**	**Description (chance of occurrence)**
1. Very Unlikely	May occur in exceptional circumstances	< 10%
2. Slight	Is unlikely to, but could occur at some time	10 – 25%
3. Feasible	Fairly likely to occur at same time	25 – 50%
4. Likely	Likely to occur within the next 1-2 years, or occurs occasionally	50 – 75%
5. Very Likely	Regular occurrence (daily / weekly / monthly)	> 75%

East Quay Watchet



Somerset West and Taunton

PICK EVERARD

CROUCH WATERFALL

WATCHET HARBOUR

GEOTECHNICAL ANALYSIS REPORT

CLIENT:	PICK EVERARD
DOCUMENT REFERENCE:	19-272B-REP-001 – WATCHET HARBOUR – GEOTECHNICAL ANALYSIS REPORT
REVISION:	ISSUE 06
ISSUE DATE:	DECEMBER 2019

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02	6 November 2019	Issue 1
03	8 November 2019	Issue 2
04	22 November 2019	Issue 4
05	29 November 2019	Issue 5
06	09 December 2019	Issue 6

Contents

Executive Summary

The report summarises a modelling exercise carried out on the existing harbour wall at Watchet Harbour; this exercise has been undertaken to gain an understanding of the effect of loading on the existing structure as a result of various scenarios.

The east quay harbour wall at Watchet, West Somerset comprises three distinct sections of wall:

- Northern section – masonry/concrete wall;
- Central section – sheet pile wall supported by deadman anchors;
- Southern section – masonry/concrete wall;

Each section of the harbour wall has been modelled using various tidal loading scenarios, detailed below:

- High tide with harbour silt;
- Low tide with harbour silt;
- Low tide with harbour silt removed (dredged);

Due to the proximity of Hinkley Point (located 14km to the east) to the site, the tide levels for Hinkley have been adopted for Watchet Harbour (from the UK National Tidal & Sea Level Facility).

Surcharge loading scenarios have been detailed by the Client, as per the following:

- A **10kPa** load is placed over a 10-wide strip immediately behind the wall. This simulates a generic load for day-to-day use of the quay/harbour wall – it represents the 'current' situation;
- A **20kPa** load replaces the 10kPa load mentioned above. This 20kPa load is applied over a 10m-wide strip immediately behind the wall and simulates the operation of a mobile crane used to lift boats in to/out of the marina;
- Static (dead) load of **50kPa** imposed by the proposed new development, located 14.5m (minimum) away from the harbour wall;

Load combinations have been analysed for all three sections of the wall and all tidal situations as follows:

Load Scenario 1: 10kPa loading – 'current' situation;
Load Scenario 2: 20kPa loading – potential crane loading;
Load Scenario 3: 10kPa + 50kPa loading – 'current' load + development load;
Load Scenario 4: 20kPa + 50kPa loading – crane load + development load

<u>Northern Section – Masonry Wall</u>

Analysis of the northern section of wall has concluded that, under 'current' marina conditions (ie: silt present), using Load Scenarios 1 and 2, the wall has a minimum Factor of Safety of 1.06. This figure, albeit greater than 1.0, already represents a reduced Factor of Safety, as the minimum acceptable FoS was set at 1.25. Analysis was carried out to SLS conditions of the Eurocode for gauging of the current condition of the wall. This being said, should the silt be dredged from the base of the marina then the Factor of Safety drops below 1.0.

<u>Central Section – Sheet Piled Wall</u>

Detailed sensitivity analysis has been completed on Larssen 22 and Larssen 25 sheets with varying thicknesses (as requested by the Client) and steel grades. This has given some insight into how much degradation/loss of section is required, at differing steel grades, before the Factor of Safety falls below 1.25. Determination of the steel grade (through chemical testing) would give valuable insight into predicting the performance of the sheet piles.

Load Scenarios 1 and 2 have been determined as having significant impacts on the harbour wall, enough to reduce the FoS to <1.0. Based on the Limit Stage analysis, the addition of the development surcharge (Load Scenarios 3 & 4) is not deemed significant enough to affect the harbour wall.

The fact that the model predicts failure but the wall remains standing is believed to be (partly) due to the cyclical nature of the tides and the limited length of time that the wall is left exposed to excessive bending moments. Once the tide starts rising again, so returns the stabilising force of the high tide, and thus the Factor of Safety rises in turn.

Southern Section – Masonry Wall

Analysis of the southern section of wall has concluded that, under 'current' marina conditions (ie: silt present), using Load Scenarios 1 and 2, the wall has a minimum Factor of Safety of 1.4. This Factor of Safety remains unchanged should the silt be dredged from the marina.

When the development load is applied to the wall, the Factor of Safety does not change, suggesting that the development has little to no effect on this section of the harbour wall.

Summary of East Quay Harbour Wall Scenarios, Watchet Harbour

			North Section		Central Section				South Section	
Load Scenario	Surcharge	Loading (kPa)	Low Tide + Silt	High Tide + Silt	Low Tide + Silt		High Tide		Low Tide + Silt	High Tide + Silt
					Larssen Sheet Pile* Equivalent – Bending Moment FOS - in mms					
					22mm	25mm	22mm	25mm		
1	Current Loading	10kPa	1.3 - 7	4 - 10+	0.7	1.1	2.7	4.1	1.8 - 10+	10+
2	Crane Loading	20kPa	1.06 - 1.3	2.5 - 10+	0.7	1.1	2.7	4.1	1.4 - 6	4 - 10+
3	Current + OC Building	10kPa + 50kPa	No impact on Northern wall from development.		As there were no changes from Load Scenario 1 to Load Scenario 2 it is concluded that there will be no further changes as a result of Load Scenarios 3 and 4.				1.8 - 10+	10+
4	Crane + OC Building	20kPa + 50kpa							1.4 - 6	4 - 10+

Assumed Onion Collective development to generate 50kPa sited 14.5m+ from the edge of the Central and Southern Harbour Walls. No impact on Northern wall section hence discounted from calculations.

All numbers are Factor of Safety (FoS) numbers. FoS = 1.25 is the minimum required by British Standards. As this is an existing structure it has not been analysed against Eurocode 7 partial factors.

Central Section assumed 240 MPa Yield Strength Steel – weakest

Megapascal (MPa) is the mega-unit used to measure the intensity of pressure. MPa in these works can be summarised as the capacity of a material, such as a structure or ground, to 'resist pressure' – the higher the number, the more resistance.

The overall Factor of Safety for each scenario should be taken as the lowest figure for the pile and tidal situation. Numbers in red fail the Factor of Safety assessment or fall outside the margin of safety required.

**Larssen 22/25 are the types of sheet piles at Watchet Harbour – modelling has been done on equivalent sheets to estimate likely current performance depending on the grade of steel (this is unknown at this stage).*

1. Introduction

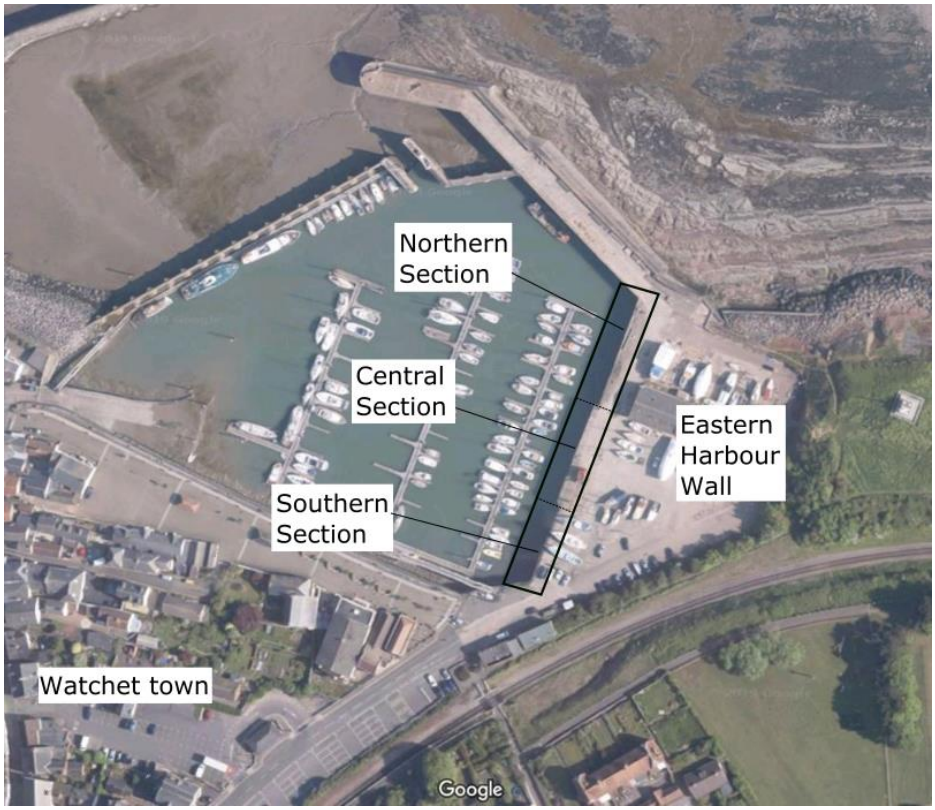
Crouch Waterfall have been commissioned by Pick Everard ('the Client') to undertake detailed geotechnical analysis of the existing east quay wall ('the asset') at Watchet Harbour, West Somerset, TA23 0AQ. The ultimate client and owner of the harbour and quay is Somerset West & Taunton Council.

The town of Watchet is located in south-west England, on the northern Somerset coast, 15 miles to the west of Bridgwater. The town is home to a marina which is contained by a combination of concrete/masonry and sheet piled harbour walls to the north and east, with the town of Watchet lying to the south (see Figure 1 of Watchet Harbour, below).

The eastern harbour wall backs onto the east quay which is currently used as a boat park and storage area. The east quay fulfils a number of functions including flood defence for the town and a working quay for the marina (including boat parking and storage area). It is proposed to redevelop this area with a community arts centre that will lie 14.5m from the harbour wall at its closest point. The proposed redevelopment will be serviced by an access road from the Esplanade, that runs immediately behind the edge of the harbour wall. The proposed development is to be designed and constructed by others.

The focus of this report is to look in detail at the make-up of the eastern harbour wall along its length and attempt to determine the state of this asset and how it might react to proposed future loading scenarios.

Figure 1: Overview of Eastern Harbour Wall, Watchet



2. Existing Information

2.1. Report References

The following reports were supplied by the Client and used during the analysis:

- Scope Document, issued by Pick Everard, June 2019, JRBB/MGA/190315/17-3/R102 Issue 1;
- Assessment of Potential Lateral Loads on the Quay Wall due to Raft Loads, issued by Red Rock Geo, June 2019, RP7090/C001;
- Watchet Harbour – Sea Wall Investigation, issued by Henderson Thomas Associates, December 2018, L/1748/18/WDT Rev 2;
- Quay Wall Survey – Watchet Marina, issued by Marine & Civil Solutions, November 2018;
- Geotechnical and Geoenvironmental Assessment of Watchet Harbour, issued by South West Geotechnical, January 2019, Ref 10501 Issue 2;

2.2. Eastern Harbour Wall

The eastern harbour wall comprises two distinct forms of construction, as per Figures 2-4, and summarised in Table 1 (levels/thicknesses taken from dive survey report provided by the Client) below:

- Stone masonry / in-situ concrete (believed to be unreinforced);
- Sheet piles supported by deadman anchors;

The stone masonry / in-situ concrete make up the northern and southern sections of the harbour wall, with the sheet piles located in the central section.

A thickness of soft silt has built up over the base of the marina. The thickness of this silt was found to fluctuate along the line of the harbour wall, varying from 1.55m to 3.35m at the time of the survey. The variation in thickness of silt deposits within the marina is predominantly believed to come from the proximity to the marina entrance: i.e.: thickest in the north which is closest to the marina entrance. Other factors might include tidal scour from an outgoing tide. In addition to these, Watchet Harbour Marina have proposed dredging the silt from the marina, in order to increase the draft under boats that use the marina.

TABLE 1: EASTERN HARBOUR WALL DETAILS

Section ID & Make-up	Full wall height (excl. embedment)	Thickness of silt
Northern – masonry/concrete	10.05m	3.35m
Central - sheet pile circa 1970's High level ties/northern half	9.70m	3.1m
Central - sheet pile circa 1950's Low level ties/southern half	9.70m	3.1m
Southern – masonry/concrete	8.45m	1.55m

Figure 2: Indicative Cross-Section through Northern Section of Harbour Wall

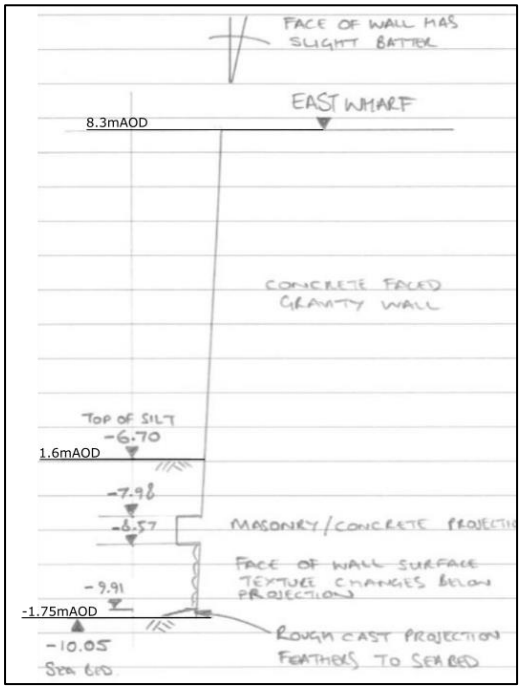


Figure 3: Indicative Cross-Section through Central Section of Harbour Wall

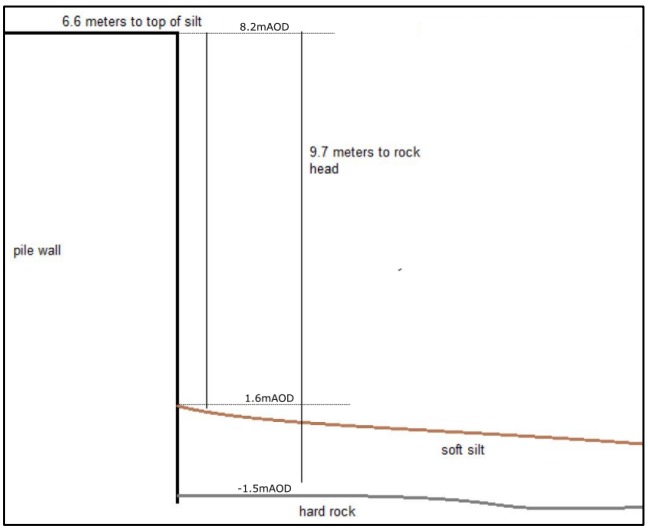
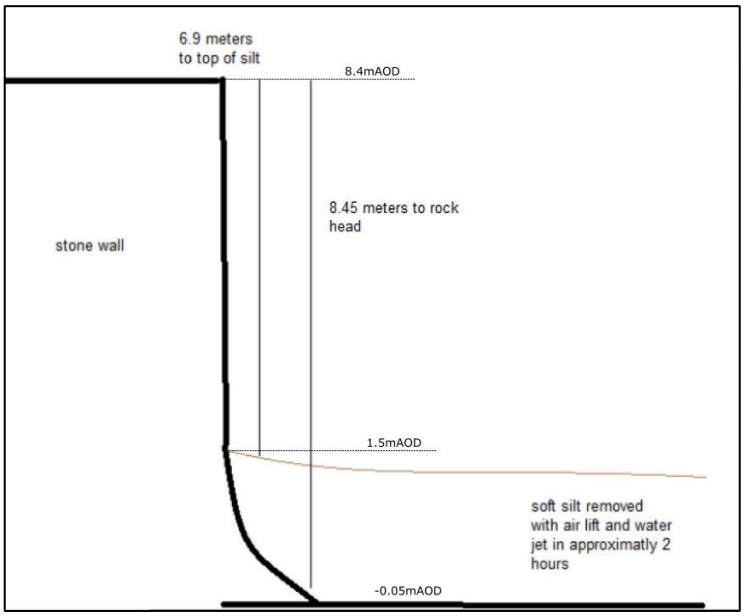


Figure 4: Indicative Cross-Section through the Southern Section of Harbour Wall



2.2.1. Central Section – Sheet Piled Wall

It is understood that the sheet piles were installed on two separate occasions: the first in the 1950s and the second in the 1970s. Installation of sheet piles on both occasions is believed to have been as a result of collapse or failure of the masonry wall, but no as-built information or details of the construction methodology has been made available. These two separate installations can be identified by the anchor heads located at two distinct levels: the 1970s installation having high-level anchors (located in the northern half of the central section), and the 1950s installation using low-level anchors (located in the southern half of the central section).

The selection of the sheet-pile sections is based on measured/estimated dimensions. Larssen 22 sheets have been identified in the northern half of the Central Section (installed in 1970s), utilising high level anchor ties. Larssen 25 sheets are believed to be present in the southern half of the Central Section (installed in 1950s), utilising low level anchor ties.

Based on dive survey findings, a 3.1m-thick layer of silt was encountered in front of the sheet pile wall. The diver was not able to tell how far the piles penetrated into the underlying bedrock. The length of the sheet piles, to the point where they enter the bedrock, have been measured at 9.7m.

The thickness of the existing sheet piles has been estimated based on the published parameters of the Larssen 22/Larssen 25 sheets. However, from dive surveys commissioned by the Client, it is understood that the sheets have developed large areas of rust, and therefore the loss of thickness due to corrosion is uncertain and could be significant.

Following a ground investigation, the two different sets of anchors were discovered lying at 2.0m/6.2mAOD (northern half, installed in 1970s) and 3.5m/4.7mAOD (southern half, installed in 1950s) below the top of the sheet pile wall. The horizontal spacing of the anchors has been estimated at 0.77m-1.0m based on photographs provided by the Client. The anchor bars have been measured at 14.3m to 14.4m long and 63.5mm diameter. The anchor ends are set into concrete blocks of varying sizes.

2.2.2. Northern & Southern Sections – Concrete/Masonry Wall

The masonry/concrete sections of the harbour wall were surveyed using ground penetrating radar (GPR) as well as cored sections taken from multiple points on the face of the walls. Based on the GPR results the wall thicknesses have been estimated at 1.0m to 1.3m for both sections. However, the cored sections for each of the

walls give varying thicknesses of intact concrete, ranging from 170mm to 1260mm. For the purposes of simplicity in the modelling exercise, the masonry walls have been modelled as 1.0m thick, as per the GPR survey.

The full wall height in the northern section has been measured as 10.05m, with 3.35m of silt at its base. The full wall height in the southern section has been measured at 8.45m, with 1.55m of silt at its base. The foundations for each of the masonry wall sections are unknown. The dive survey did not find any evidence of a shear key binding the wall to the underlying bedrock.

2.3. Ground Model

A ground model has been produced based on the information within the Geotechnical Investigation Report (GIR) produced by South West Geotechnical (Ref. 10501). This investigation comprised 5 No. boreholes, 2 No. plate load tests and assorted lab testing. Individual ground profiles were produced for each of the Northern, Central and Southern sections of the harbour wall, based on the closest boreholes. These are summarised in the tables below.

TABLE 2: NORTHERN SECTION

Level top (mAOD)	Level base (mAOD)	Soil Description	Comments
8.3	2.3	MADE GROUND: clayey GRAVEL	Based on BH101
2.3	1.3	Clayey GRAVEL	
1.3	-4.2	Weak-medium strong Mercia MUDSTONE	

TABLE 3: CENTRAL SECTION

Level top (mAOD)	Level base (mAOD)	Soil Description	Comments
8.2	1	MADE GROUND: clayey GRAVEL	Based on BH103
1	-4.3	Extremely weak Mercia MUDSTONE	

TABLE 4: SOUTHERN SECTION

Level top (mAOD)	Level base (mAOD)	Soil Description	Comments
8.4	3.3	MADE GROUND: clayey GRAVEL	Based on BH105. Limestone bands encountered in BH105 have been ignored in the design
3.3	-2	Very weak Blue Lias MUDSTONE	

In the above tables, the Blue Lias Mudstone and Mercia Mudstone will be treated as one and the same.

A table summarising the ground parameters assigned to these soil types is presented below.

TABLE 5: SOIL PARAMETERS

Soil Type	Unit Weight γ (kN/m³)	Young's Modulus E (MPa)	Poisson's Ratio ν	Angle of Shearing Resistance ϕ (° deg)	Cohesion c' (kPa)
MADE GROUND: clayey GRAVEL	18	16 *	0.4	34 ᐞ	16 ᐞ
Clayey GRAVEL	19	16	0.35	33 ^	1
MUDSTONE	22	30	0.45	0	400 ᵗ
Harbour SILT	18	5	0.3	20	1
Masonry wall FILL	22	100	0.1	-	-

Notes:

** This figure is based upon the results from the 2 No. plate load tests completed on site. Two stiffness values were calculated for the Made Ground material, and the more conservative value has been used in this analysis.*

ᐞ This figure is based on shear-box testing results (Taken from South West Geotechnical GIR, Ref 10501)

^ This value is based upon in-situ SPT testing.

ᵗ This value is based upon the unconfined compressive strength (UCS) laboratory testing. The most conservative test result produced a UCS of 0.8MPa (UCS/2 ≈ c').

Based on the borehole information and particle size laboratory testing, Crouch Waterfall have concluded that the risk of the soils/foundations degrading due to freeze/thaw action is negligible.

2.4. Tide Levels

Historic tide level data was not available for the site at the time of writing; however, long term monitoring has been taking place at Hinkley Point since 1990. Due to the proximity of Hinkley Point (located 14km to the east) to the site, the tide levels for Hinkley have been adopted for Watchet Harbour. The highest and lowest tide levels for the period 2008 – 2026 are listed in the table below (taken from the UK National Tidal & Sea Level Facility https://www.ntslf.org).

It is understood that the marina is partially impounded and therefore never completely empties at low tide (thus ensuring that the boats always remain afloat). This impounded level has been estimated at +1.5mAOD. For the purposes of this modelling exercise, the impounded level (+1.5mAOD) has been used instead of the *actual* low tide level (-6.09mAOD).

TABLE 6: TIDE LEVELS

Scenario	Level (Tidal Datum)	Level (Ordnance Datum mAOD)
High Tide	13.02m	+7.12mAOD
Low Tide	-0.19m	-6.09mAOD
Low Tide - Impounded Level	-	+1.5mAOD

2.5 Assumptions, Exclusions and Caveats

Modelling has been undertaken with due regard to the available information. However, there are significant areas in which information is not available and has had to be assumed for the purposes of modelling, and are as follows:

- Sheet-pile embedment is assumed to be 0.5m;
- Based on investigative surveys completed by the Client, the deadman anchors, supporting the sheet pile wall, are determined to be free from corrosion and are not detrimentally affecting the structural integrity of the harbour wall;
- The presence of a shear key has been discounted;
- The thickness of the masonry wall has been assumed as being 1.0m;
- The masonry and concrete wall is assumed to be unreinforced;
- The steel grade (yield strength) of the sheet pile wall has been assumed as 240MPa;
- Ground strength information is based on available information and published data;
- Accurate limits for the high tide and low tide levels were not available for Watchet Harbour, and so the tide levels have been taken from the nearby tidal measuring station at Hinkley Point power station;

3. Modelling Results and Interpretation

3.1 Introduction

Both finite element modelling (FEM) and limit-state modelling has been carried out on all three structural sections. Initially, FEM modelling has been carried out to gain an understanding of the forces acting on the existing structures. These forces have then been incorporated into limit-state models in order to provide Factor of Safety (FoS) values for the structures.

3.2. Finite Element Modelling

Finite element models for the northern, central and southern sections were produced using the profiles and parameters mentioned above. In addition, three tidal situations were chosen by the Client, namely:

- High Tide with harbour silt present in front of the existing structures;
- Low Tide (impounded) with harbour silt present in front of the existing structures;
- Low Tide (impounded) with the harbour silt dredged/removed to harbour floor level;

Various surcharges to accurately model the possible future development of the quay were chosen by the Client, namely:

- A **10kPa** load is placed over a 10m-wide strip immediately behind the wall. This simulates a generic load for day-to-day use of the quay/harbour wall – it represents the 'current' situation;
- A **20kPa** load replaces the 10kPa load mentioned above. This 20kPa load is applied over a 10m-wide strip immediately behind the wall and simulates the operation of a mobile crane used to lift boats in to/out of the marina.
- Static (dead) load of **50kPa** imposed by the development, located 14.5m (minimum) away from the harbour wall;

Load combinations (as specified by the Client) have been analysed for all three sections of the wall and all tidal situations as follows:

Load Scenario 1: 10kPa loading – 'current' situation;
Load Scenario 2: 20kPa loading – proposed crane loading;
Load Scenario 3: 10kPa + 50kPa loading – 'current' load + proposed development load;
Load Scenario 4: 20kPa + 50kPa loading – crane load + proposed development load

GEO5 Finite Element Modelling (FEM) software was used to perform the analysis for all three sections of the harbour wall.

A detailed drawing showing the layout of the harbour and locations of the crane operating area and proposed development is appended to this report.

3.2.1. Central Section – Reduced Thickness Sheet Pile Wall

Crouch Waterfall were advised by the Client on the types of sheet piles used in the Central section of the wall. However, following the findings of the dive survey, it was necessary to take into account corrosion and subsequent loss of section of the sheet piles. This was completed by following guidance in BS EN 1993-5:2007 Eurocode 3 – Design of Steel Structures – Piling. The following values have been generated following a reduction in the sheet-pile section based on this guidance:

TABLE 7: SHEET PILE - REDUCED THICKNESSES

Sheet Pile ID	Original thickness (mm)	Loss of thickness on Soil Side (mm)		Loss of thickness on Seawater Side (mm)		Reduced Sheet Pile Thickness (mm)	
		After 45yrs	After 65yrs	After 45yrs	After 65yrs	After 45yrs	After 65yrs
Larssen 22	10	0.55	0.75	3.5	5.0	5.95	4.25
Larssen 25	25					20.95	19.25

Following the guidance in BS 1993-5, the corrosion values for the Low Water/Splash Zone have been used as these are most onerous case. It should be noted that if it is assumed that Larssen 22 sheets were installed in the 1970s, then these sheets will be approaching the end of their design life, with potentially only ~6mm of thickness remaining in the most corroded parts of the piles.

In order to model the performance of a 45yr/65yr old Larssen 22 or 25 sheet pile, a sheet pile with the appropriate thickness must be modelled in its place (i.e.: 5.95mm or 4.25mm for a Larssen 22 and 20.95mm or 19.25mm for a Larssen 25). Larssen 25 sheets were replaced with Larssen 605 sheets, with a thickness of 12.5mm. However, a comparable sheet for the Larssen 22 could not be found; therefore, a GU6N pile was used in its place.

Following the application of reduced section values, modelling was undertaken to evaluate the performance of the harbour wall after 45yrs/65yrs of corrosion has reduced the thickness of the piles. In the following sections, only the reduced thickness sheet piles will be analysed (GU6N and Larssen 605) and the original, full thickness sheets (Larssen 22 and 25) have been ignored in the analysis.

3.2.2. Central Section – Sheet Pile Wall

Computations covering the various tidal scenarios and surcharges (Loading Scenarios 1-4) were completed for the central section of the harbour wall. A pile embedment depth of 0.5m into the underlying bedrock was assumed. This figure was chosen following analysis into the minimum embedment depth required to ensure stability of the wall, under the low tide without silt condition. This resulted in a total length of sheet pile of 10.2m. Given the nature of the underlying Mercia/Blue Lias mudstone a maximum embedment value is expected to be in the order of 2.0m. This depth is based on engineering judgement and working knowledge of the Mercia/Blue Lias mudstone.

The following results were achieved:

TABLE 8: SHEET PILED WALL (10.2M LONG SHEETS) – HORIZONTAL DISPLACEMENTS & BENDING MOMENTS

Model	Sheet Pile ID & Section	Max Bending Moment (Capacity) of Sheet (kNm)	Load Scenario 1		Load Scenario 2		Load Scenario 3		Load Scenario 4	
			Disp (mm)	Bending Moment (kNm)	Disp (mm)	Bending Moment (kNm)	Disp (mm)	Bending Moment (kNm)	Disp (mm)	Bending Moment (kNm)
High Tide + Silt	GU6N (6mm)	150	39	87	41	89	51	88	53	90
Low Tide + Silt			42	45	44	47	55	47	56	49
High Tide + Silt	Larssen 605 (12.5mm)	484	31	172	33	178	43	178	45	183
Low Tide + Silt			40	136	41	142	52	142	53	148

Load Scenario 1: This gives some indication as to how the wall is reacting to the 'current' applied load.

Load Scenario 2: With the addition of the crane load, the sheet pile wall is noted to displace an extra 1-2mm, with minor increases in bending moment.

Load Scenario 3 & 4: Once the development load is added to the 'current' situation, the displacements were noted to increase by ~12mm. The same can be said when the development load is applied in addition to the crane loading.

The significant increase in bending moment for the High Tide with Silt scenario is believed to be due to the increased water pressure acting on the back of the sheet pile wall.

In general terms, Table 8 shows that the sheet piles do not exceed their bending moment capacity in any of the Load Scenarios, despite experiencing some significant horizontal displacements.

3.2.3. Northern & Southern Sections – Masonry/Concrete Wall

Computations covering the various tidal scenarios and surcharges were completed for the northern and southern sections of the harbour wall. Due to the difficulties in accurately modelling a masonry wall in finite element software, only the horizontal displacements have been computed.

The results of the analysis are tabulated below.

TABLE 9: NORTHERN MASONRY WALL - HORIZONTAL DISPLACEMENTS

Scenario	Load Scenario 1	Load Scenario 2
	Horizontal Displacement (mm)	
Low Tide + Silt	41	43
High Tide + Silt	62	66

For the Northern masonry wall analysis, Load Scenarios 3 & 4 were ignored under direction from the Client. The northern masonry wall is located far enough from the proposed development for it to lie outside the zone of influence.

A small increase of 2-4mm is noted in the transition from the 'current' situation (Load Scenario 1) to the addition of the crane load (Load Scenario 2).

As with the Central section, the increased displacements during the High Tide with Silt scenario are believed to be caused by the increased water pressure acting on the back of the masonry wall. It is not clear why this is only evident in the analysis of the Northern section.

TABLE 10: SOUTHERN MASONRY WALL - HORIZONTAL DISPLACEMENTS

Scenario	Load Scenario 1	Load Scenario 2	Load Scenario 3	Load Scenario 4
	Horizontal Displacement (mm)			
Low Tide + Silt	38	39	50	51
High Tide + Silt	32	36	43	47

As with the central sheet pile section above, only minor increases in displacements are noted when moving from Load Scenario 1 to 2. More substantial displacements are noted when the development load is included in Scenarios 3 and 4.

3.3. Limit State Modelling

Limit State models were employed in an to attempt to assess the predicted performance of the harbour wall in terms of a Factor of Safety (FoS) value.

In the following analyses, Eurocode 7 partial factors were ignored, in order to have greater parity with the original British Standard design methods that would have been used at the time.

3.3.1. Central Section – Sheet Pile Wall

The Central section of the harbour wall was modelled using Larssen 22 and Larssen 25 sheet piles with progressively reduced thicknesses (a product of corrosion). In addition to this, a sensitivity analysis was carried out on the effect of steel grade on the performance of the sheet piles. The piles were assigned an embedment depth of 0.5m (total pile length of 10.2m)

In order to complete this analysis, typical sections of Larssen 22 and Larssen 25 sheets were modified to reduce the thickness of the sheet (as though being corroded), and in doing so compute the reduced structural parameters that would accompany the loss of section. A steel grade of 240MPa was chosen for the yield

strength. It should be noted that changing the thickness and grade of steel only affects the Factor of Safety on the bending moment of the sheet piles. The following tabulated results were calculated for Load Scenario 1 (10kPa surcharge behind the wall). The addition of the development load (Load Scenarios 3 & 4) has been determined to have no effect on the Central Section of the harbour wall, due to the location of the development.

The same analysis was completed for Load Scenario 2 (20kPa crane load), and separately, for the Low Tide with silt dredged scenario, but neither of these resulted in a significant change in the bending moment factors of safety shown below, and therefore the results have not been replicated here.

TABLE 11: LIMIT STATE ANALYSIS - 240MPA YIELD STRENGTH STEEL – LOAD SCENARIO 1

Scenario	Sheet Pile ID & Thickness (mm)	Bending Moment FoS	Scenario	Sheet Pile ID & Thickness (mm)	Bending Moment FoS
Low Tide + Silt	Larssen 22 – 6mm	0.7	High Tide + Silt	Larssen 22 – 6mm	2.7
	Larssen 25 – 15mm	1.1		Larssen 25 – 15mm	4.1

In Table 11 above, the bending moment factors of safety have been calculated for both Larssen 22 and Larssen 25 sheet piles, with varying levels of reduced thickness. The calculated factors of safety which fall below 1.25 have been highlighted in red. For the basis of this investigation, a Factor of Safety greater than 1.25 is deemed 'acceptable' (the minimum Factor of Safety required by British Standards is 1.25). The stated thicknesses (6mm for Larssen 22 and 15mm for Larssen 25) were advised by the Client.

3.3.2. Northern & Southern Sections – Masonry/Concrete Wall

The same Limit State analysis was performed for the northern and southern sections of masonry wall. During the analysis, there was a degree of uncertainty around the dimensions of the foundations for the walls, as well as the presence of any kind of shear key. To maintain simplicity of analysis, the foundation dimensions (on the seawater side) that were recorded during the dive survey have been mirrored on the soil side of the wall.

The following Overturning (OVT) and Sliding (SLI) Factor of Safety values were recorded:

TABLE 12: NORTHERN SECTION - LIMIT STATE ANALYSIS – FACTOR OF SAFETY

Scenario	Load Scenario 1		Load Scenario 2	
	SLI	OVT	SLI	OVT
Low Tide + Silt	7	1.3	1.3	1.06
High Tide + Silt	10+	4	10+	2.5

For the Northern masonry wall analysis, Load Scenarios 3 & 4 were ignored under direction from the Client. The northern masonry wall is located far enough from the proposed development for the increased loading to be insignificant.

From the table above it is apparent that under 'current' conditions (Load Scenario 1) the lowest FoS the northern masonry wall might experience is FoS=1.3. Should Somerset West & Taunton council decide to dredge the silt from the marina then this would drop to FoS=1.1. Factors of Safety that are <1.25 have been highlighted in red.

Should the proposed crane be used within the 10m-wide strip immediately behind the northern harbour wall, the FoS drops to FoS=1.06 (under current marina conditions). Again, should Somerset West & Taunton council decide to dredge the marina silt, the FoS drops to less than unity (FoS=<1).

TABLE 13: SOUTHERN SECTION - LIMIT STATE ANALYSIS – FACTOR OF SAFETY

Scenario	Load Scenario 1		Load Scenario 2		Load Scenario 3		Load Scenario 4	
	SLI	OVT	SLI	OVT	SLI	OVT	SLI	OVT
Low Tide + Silt	10+	1.8	6	1.4	10+	1.8	6	1.4
High Tide + Silt	10+	10+	10+	4	10+	10+	10+	4

The southern section of masonry wall is not as tall as the northern section, and this is reflected in the higher Factors of Safety.

Load Scenario 1: The lowest safety factor values produced by the analysis occurred during the low tide scenario (FoS=1.8).

Load Scenario 2: When the crane load was applied to the model, the FoS dropped to FoS=1.4, for the low tide scenario.

Load Scenario 3 & 4: When the development load was applied in Load Scenarios 3 & 4, the FoS did not change, suggesting that the construction of the development will not have an effect on the southern section of masonry wall.

4. Conclusions & Recommendations for Additional Works

4.1. Conclusions

Following detailed geotechnical analysis into the different sections of the harbour wall, and the various loading scenarios / tidal scenarios that are being applied to the wall, it is possible to comment on the 'robustness' of the harbour wall.

Northern (Masonry) Section

Only a minimal increase (1-2mm) in horizontal displacement was recorded during FEM analysis when moving from the current situation (Load Scenario 1) to operating with the crane immediately behind the wall (Load Scenario 2). However, when this analysis was conducted using Limit State methods, this transition from Scenario 1 to 2 resulted in the Factor of Safety falling to FoS=1.06.

Central (Sheet Pile) Section

As with the northern section, only small increases in horizontal displacement were recorded during FEM analysis when moving from Scenario 1 to 2. Larger increases of 10-13mm were recorded when the development load was applied to the model.

In terms of Limit State analysis: calculations were completed on varying thicknesses of both Larssen 22 and 25 sheet piles, for both the high tide- and low tide- with silt scenarios. The factor of safety remained >1.25 for all of the high tide with silt scenarios (ie: both Larssen 22 and 25 sheets). The low tide with silt scenario produced some factors of safety <1.25 for Larssen 22 and 25 sheets, as shown in Table 11. Determining the steel grade and sheet pile thickness would give considerable confidence towards predicting the sheet pile capacity.

It is often difficult to reconcile hypothetical results from analysis of an existing situation, where the analysis predicts failure (FoS<1.0), and yet the structure remains standing. The reasoning behind this is believed to be (partly) due to the continuous, cyclical action of the tides. It is likely that the unstable low tide condition does not last long enough to bring about failure of the sheet piles, before the tide, and the Factor of Safety, start rising again. The excessive bending, and ultimate failure, of the sheet piles, would be a progressive process rather than a singular catastrophic event. It is believed that if the harbour were left dry for any significant period of time then there is a distinct possibility of bending failure of the wall.

Southern Section

Limit State modelling of the southern section did not produce any situations where the Factor of Safety dropped below 1.0. This is believed to be partly due to the fact that the southern wall has the smallest retained height, and therefore the lateral forces are less.

4.2. Recommendations for Additional Works

Whilst every attempt has been made to use realistic assumptions and not impose undue conservatism into the models, there are still some key areas of uncertainty.

4.2.1. Sheet Pile Walls

Several significant uncertainties still surround the central sheet piled section of the harbour wall. These include:

- The sheet piles were modelled as either Larssen 22 or 25 sheets, with reduced (assumed) thicknesses/strength parameters as appropriate due to corrosion.
- Detailed sensitivity analysis has been completed on the effect of reducing the thickness of the sheet and also reducing the grade of steel. If either/both of these parameters could be established, then it would give greater confidence in predicting the behaviour of the sheet pile wall. Determination of steel grade is possible through chemical testing of samples of the steel.
- Depth of embedment into bedrock: this could potentially be achieved through the use of geophysical surveys;

4.2.2. Masonry Walls

- Significant uncertainties surround the base of walls and their foundations: are the foundations embedded to any extent? The thickness/dimensions of the walls is also key to ensuring the existing situation is modelled accurately;
- Based on the investigations completed to date there appears to be some variation over the thickness of the masonry/concrete;

However, notwithstanding the above recommendations there is a strong possibility that further investigation work would **not** necessarily result in significantly better/improved model outputs that reduce the perceived risk to the harbour walls. Therefore, it may be prudent to consider other options that could reduce the impact on the harbour walls, such as: limiting the extent of the crane operating area, effecting repairs, or strengthening the harbour wall.

Consideration must also be given to the fact that theoretical reduction of section as a result of corrosion, coupled with the results of the dive survey, suggests that the sheet-piled section of the development is nearing the end of its working life. While improvements such as propping could be considered to increase the capacity of these structures, this is not seen as a workable solution in the medium – long term.

Drawings

By virtue of paragraph(s) 3 of Part 1 of Schedule 12A
of the Local Government Act 1972.

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