UUWR_14

PR24 Draft Determination: UUW Representation

Area of representation: Reservoirs

August 2024

This document outlines the UUW response to the draft determination for UUW_CAC_001 “Reservoirs and Dam Maintenance”.

Reference to draft determination documents: PR24-DD-W-Reservoir-safety

United Utilities

Water for the North West

1. Key points

- **United Utilities submitted a cost adjustment claim, for a total of £186.49m. Ofwat has made an allowance of £57.422m:** This business case was comprised of three parts, 1) historic MITIOS costs due to UUW having higher than average levels of reservoirs, 2) future increase MITIOS costs due to post Balmforth increase in actions, and 3) PRA pro-active risk reduction costs that have increased as a result of changes in EA flood maps and the application of regulations post the Toddbrook reservoir incident. Ofwat rejected Part 1, and assessed Parts 2 and 3 as enhancement rather than a cost adjustment claim. Part 2 was rejected as being base expenditure inappropriate for enhancement, and Part 3 was subject to a 50% downward adjustment.
- **We request that Ofwat re-assess part 2 of our claim as it was presented as a botex Cost Adjustment claim:** Ofwat rejected Part 2 on the basis of it being base expenditure. We agree it is base expenditure, and hence we made a botex cost adjustment claim. We request that Ofwat re-assess the claim as a Cost Adjustment, as originally intended. Ofwat suggested that the increased costs are due to a cyclical increase in the rate of inspection. In Section 4.2 we show that there has been no change to the rate of inspection, but that there has been a significant increase in actions issued per inspection, and hence an increase in absolute numbers of actions overall. The cost of delivering safety actions has increased by 77% since the Toddbrook incident.
- **Our costs have increased substantially as a result of changes to the way that reservoir safety regulations are implemented**: (more safety actions, and more expensive actions being imposed upon us), with an increase of £65.151m. In Sections 4.1 and 4.2 we demonstrate that increasing numbers of (and increasingly expensive) MITIOS actions are new costs that will not be reflected in historic cost models. We request that the full £65.151m increase is reinstated.
- **We provide additional evidence to support Part 3 of our claim, and request Ofwat to re-assess that part of the claim as enhancement:** In Sections 4.3 to 4.8 we provide additional evidence regarding the necessity of PRA spend, and evidence of the drivers that are leading to an increase in cost in this area of activity. We provide evidence regarding why this spend is required in 2025-30, and why the proposed spend is efficient. This spend is a regulatory obligation, that we have been delivering since AMP5, and we have industry leading experience in this area. The recent changes to technical guidance (EA flood maps), and the imposition of risk assessments by independent Inspecting Engineers makes this investment critical. We provide detailed evidence of the risk assessment methods employed, and the site by site optioneering of the AMP8 programme, all of which were flagged as omissions by Ofwat at Draft Determination. We request that Ofwat re-assess this element of the claim with the new evidence provided, and reinstate the full £114.843m.
- **Terms used in this document:** MITIOS = Matters In The Interests Of Safety, a specific action issued to a dam operator by an independent Inspecting Engineer. Under the Reservoir Act 1975 these actions are regulatory obligations, backed by law. PRA = Portfolio Risk Assessment, the process by which United Utilities demonstrates compliance with Part 3 of the Health and Safety at Work Act 1974 (risks to persons who are not employed by the duty holder).

2. UUW's PR24 proposal

UUW evidenced that reservoir sources cost more to operate than borehole sources, due to the costs of complying with regulatory safety requirements arising from the Reservoirs Act 1975 and the Health and Safety at Work Act 1974. We considered that difference in costs is not reflected in the Ofwat cost allocation models. UUW is disadvantaged due to having a comparatively large fleet of reservoirs, and therefore a higher proportion of un-accounted costs.

The higher costs associated with meeting the regulations associated with the Reservoir Act have increased significantly since the implementation of the Balmforth Report into the Toddbrook reservoir incident.

A change to Environment Agency reservoir flood maps (in 2022) indicated that a higher population was exposed to dam risk, than was previously believed. This means that UUW will have to undertake additional PRA interventions in order to ensure compliance with the Health and Safety at Work Act. This is an additional cost driver which is not reflected in Ofwat models, and which will disproportionately affect companies like UUW which have a comparatively large reservoir fleet.

3. Draft determination position

Our claim was structured in 3 parts. Part 1 was backward looking excess (and un-modelled) costs associated with a large reservoir fleet (£36.573m). Part 2 was comprised of post-Balmforth costs in complying with regulatory safety actions (£65.151m). Part 3 was the PRA pro-active risk reduction element (£114.843m). Minus implicit allowance (-£30.077m). Giving a total of the claim (£186.49m).

Ofwat rejected part 1 of the claim on the basis that it considers there is no need for investment.

Ofwat stated that it believes that Parts 2 and 3 of the claim are actually enhancement rather than base, and assessed these elements of the claim as such.

Ofwat rejected part 2 of the claim on the basis that ITIOS has historically been met from base expenditure, and should continue to be so. Ofwat accepted part 3 of the claim, however the claim was then subject to a series of gateway assessments.

Ofwat identified some concerns regarding the need for investment, the best option for customers, and cost efficiency. As a result of these concerns, Ofwat applied a downward adjustment of -50% to the PRA element of the claim, leaving an allowance of £57.422m.

Ofwat has specifically invited UU to respond to their concerns at DD representation. "There are differences in our view and the company's view of costs across all areas of water enhancement. We are challenging United Utilities to provide additional evidence for its business plan proposals in the following key areas:" *PR24 Draft Determinations: Total expenditure allowances – by company Page 46, section "water"*

A PCD has been proposed by Ofwat, directing us to deliver PRA interventions at 18 reservoirs (the full AMP8 programme in the business plan), by the end of the AMP. A penalty rate of £3m+ per reservoir intervention not delivered, would apply as part of this PCD.

4. Issues and implications

MITIOS spend has increased, and continues to do so. United Utilities believes that this increase in costs cannot be sustained from the current botex allowance, and that base allowances should be amended in accordance with this growth.

Our PRA programme is our way of managing our regulatory obligations under the Health and Safety at Work Act. Changes to the implementation of this Act (post the Balmforth review recommendations) and changes to Environment Agency flood maps (the source of the input for the consequence element of our risk calculations) has led to an increase in PRA related expenditure.

The substantial downward adjustment applied by Ofwat to the PRA element of our claim would pose a significant challenge to the delivery of this regulatory obligation.

Detail is provided below regarding the additional evidence that we make available to Ofwat to enable a re-assessment of parts 2 and 3 of our CAC claim.

4.1 MITIOS is base expenditure and should be assessed as a cost adjustment

In the PR24 Draft Determination, document PR24-DD-W-Reservoir Safety.xlsx, worksheet "NWT", cell C15, Ofwat stated; "*We conclude, based on the company's submission and assertions, that these elements are more relevant to potential enhancement (and future requirements), rather than maintaining base service levels (even though the company submit them as part of a base cost adjustment claim).*"

We do not agree with this statement. The requirements discussed in the claim are central to the maintenance of a safe dam fleet, one that is compliant with relevant regulations. These regulations have been in force since the amended Reservoir Act was introduced in 1975, but we have noticed a step change in the associated volume of statutory actions since the release of the Balmforth Report in 2021. MITIOS will feature in companies' historical base costs but our argument is that the step-change in statutory actions **per inspection** since the Balmforth Report means historical costs do not reflect the additional activity we now undertake.

In the PR24 Draft Determination, document PR24-DD-W-Reservoir Safety.xlsx, worksheet "NWT", cell C15, Ofwat stated; "*We consider that the forecast MITIOS spend (£65.151 million) overlaps significantly with base expenditure as it appears to be general maintenance. The company does not identify clear drivers for this expenditure. Most reservoir safety expenditure in previous periods has been delivered in base expenditure. The company's claim of an increasing trend of MITIOS due to increased inspection post Balmforth appears to reflect the change in the number of statutory inspections undertaken each year rather than any increase due to Balmforth. We also find that the company's base water resources control spend over 2020-25 on reservoirs (infrastructure costs used as proxy) is low compared to the water supply (distribution input) delivered by these assets.*"

We agree that MITIOS spend is base maintenance expenditure. This is why we submitted a Cost Adjustment Claim, to adjust botex to accommodate for increased base maintenance costs (arising post Balmforth and post EA flood map changes), that are not reflected in cost allocation models which use historic spend levels.

As such, we request that Ofwat assesses the MITIOS element of our claim as a cost adjustment. We do not dispute the assessment of PRA expenditure as an enhancement case.

4.2 The driver of additional MITIOS expenditure is action and investigation per inspection

It is incorrect to suggest that the number of inspections is increasing

Ofwat suggests that an increasing number of inspections is driving additional costs. Specifically, in its response to OFW-IBQ-UUW-025, Ofwat says:

"The company's claim of an increasing trend of MITIOS due to increased inspection post Balmforth appears to reflect the change in the number of statutory inspections undertaken each year rather than any increase due to Balmforth"[1]

This misunderstands the nature of the inspection regime.

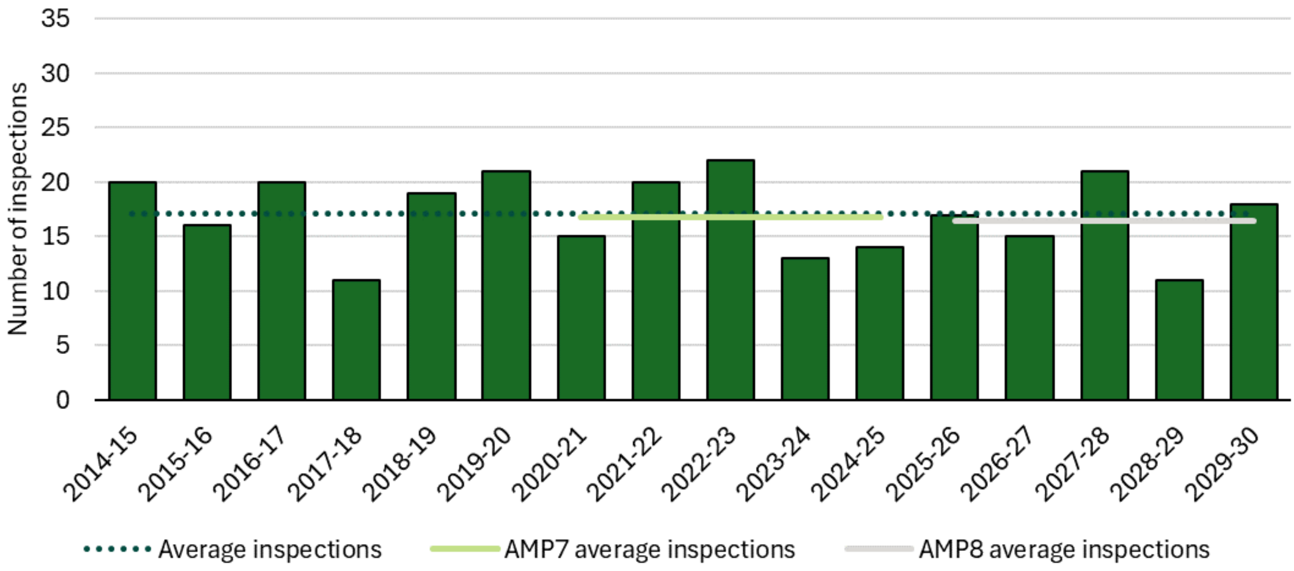
Independent safety inspections carried out under Section 10 of the Reservoir Act 1975 generally take place every 10 years, unless the inspection is brought forward. The typical reason for an inspection to be brought forward, is if the dam in question is being subject to major engineering works. Engineering works on registered large raised reservoirs can only be carried out under the supervision of an independent Inspecting Engineer, and their final 'sign off' of completion of the works includes a safety inspection of the entire dam. This can effectively 're-set the clock', starting the 10 yearly cycle anew. In addition, there is convenience (and economies) to be achieved by having adjacent dams inspected on the same day. We do not therefore have exactly 1/10 of our reservoir fleet inspected every year. However whilst there is some small variation in inspection numbers, these are not

[1] OFW-IBQ-UUW-035

significant, and there has been no significant change to the schedule or frequency of inspection since the Balmforth Report, as Ofwat has suggested in the Draft Determination.

There has been no meaningful change in the number of inspections, nor is any expected within AMP8. This is illustrated in Figure 1, which shows that expected inspections in AMP8 are in line with inspections received in AMP7 and since 2014-15.

Figure 1: There is no discernible trend in inspection numbers over time



Source: UUW records of historic S10 inspections, and schedule of future inspections

Based on Figure 1, it is unclear how Ofwat has concluded that: "*The number of statutory actions has been increasing in recent years but so has the number of reservoir inspections.*"[2]

There is no discernible trend over the period illustrated in the model. We are clear that we expect to receive a similar number of inspections in AMP8 relative to previous AMPs and we consider this should be clear in Figure 1.

The key driver of expenditure is the number of actions per inspection

Our key argument is that **the number of MITIOS actions issued per Section 10 inspection has increased since the publication of the Balmforth Report**, due to the more cautious approach now being taken by independent Inspecting Engineers carrying out regulatory safety inspections under Section 10 of the Reservoir Act 1975. This driver for expenditure is further discussed in detail in Section 3.5 of the document UUW_CAC_001 Reservoir and Dam Maintenance[3].

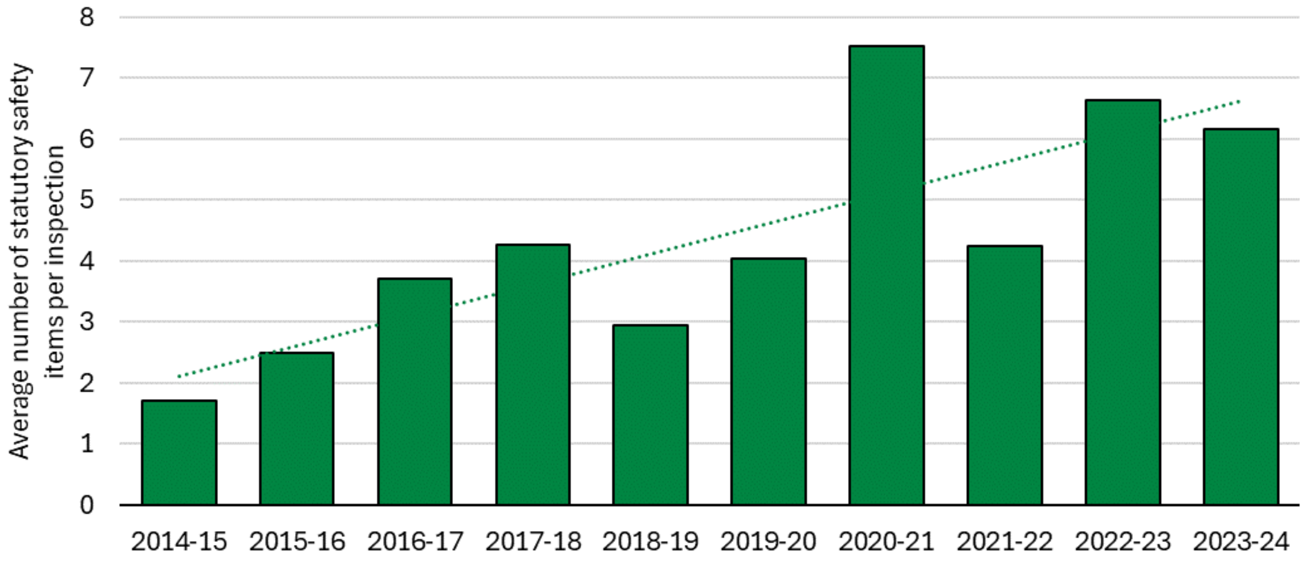
We are clear that the number of MITIOS actions arising per inspection is the key cost driver. Ofwat appears to have concluded that the change in the number of MITIOS actions received post 2019, was because of an increase in the number of statutory Section 10 inspections being undertaken. This is not correct, as discussed above.

Figure 2 shows the number of statutory safety items we have received per inspection. There is a clear increasing trend. This, combined with the static trend in inspection numbers over time identified in Figure 1, demonstrates clearly that increased inspection numbers are not driving additional costs – it is the number of actions required because of each individual inspection. Section 4.3 below evidences that the time lag between actions being received and capital work beginning means that the increase in actions illustrated below will start to increase costs towards the end of AMP7 and the start of AMP8.

[2] Ofwat Inbound query: OFW-IBQ-UUW-035

[3] Figure 14, on Page 27 of the document UUW_CAC_001 Reservoir and Dam Maintenance showed that there had been an increase in absolute numbers of statutory safety actions received by United Utilities, an increase that coincided with the increased caution of Inspecting Engineers following the Toddbrook incident.

Figure 2: Number of statutory safety items per independent inspection



Source: UUW records of statutory safety items and inspections

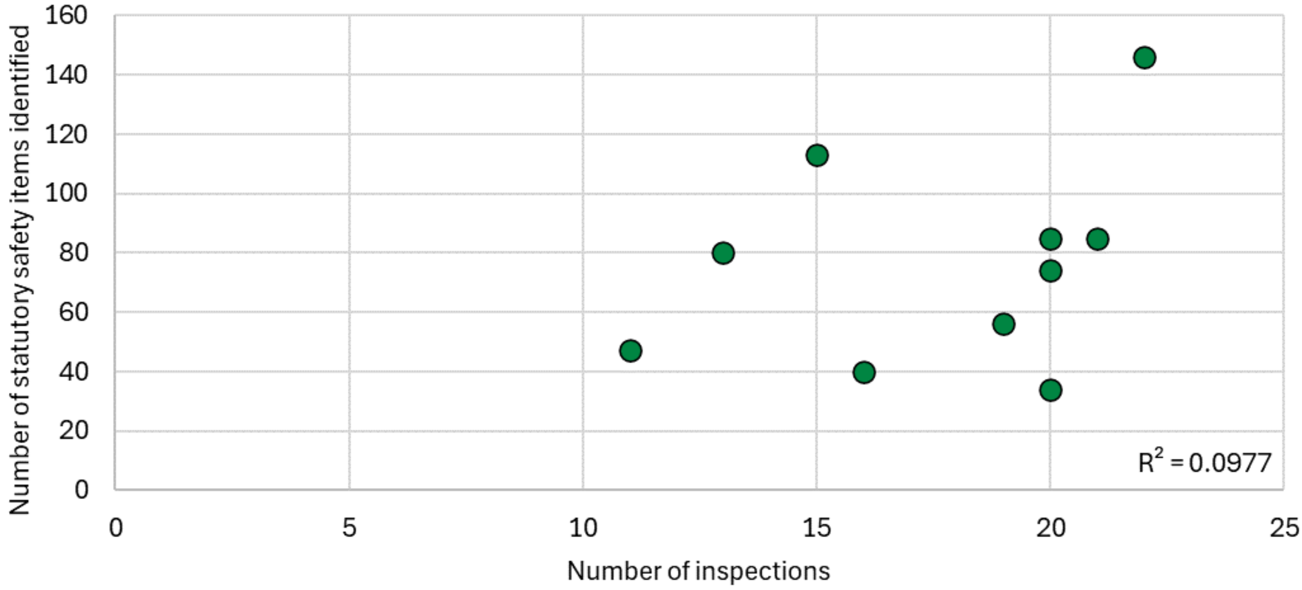
It is inaccurate to suggest there is a correlation between inspections and actions

Ofwat also says:

"The number of statutory actions has been increasing in recent years but so has the number of reservoir inspections. This correlation is as would be expected."[4]

The number of actions depends upon the assessment at each individual reservoir, which is informed by wider factors such as changes in section standards (e.g. due to the Balmforth Report). This means that it wrong to expect a correlation between inspection numbers and statutory actions. Figure 3 provides additional evidence that there is no meaningful correlation between the inspections received in a year and the number of statutory actions received in that year as a result (each data point reflects one year).

Figure 3: There is no clear correlation between number of inspections and number of actions



Source: UUW records of statutory safety items and inspections

[4] Ofwat Inbound query: OFW-IBQ-UUW-035

We therefore continue to assert that the increase in MITIOS actions being received by United Utilities (and the associated costs) are not a reflection of a change in inspection frequency, but as a result of increasing numbers of MITIOS actions being issued per inspection.

Figure 14, on Page 27 of the document UUW_CAC_001 Reservoir and Dam Maintenance showed that there had been an increase in absolute numbers of statutory safety actions received by United Utilities, an increase that coincided with the increased caution of Inspecting Engineers following the Toddbrook incident.

Similarly, Table 7 on page 41 of UUW_CAC_001 Reservoir and Dam Maintenance showed that the unit rate of statutory safety actions had increased by 77% between the period pre to post Toddbrook. Again, the combination or more absolute numbers of action, more actions per inspection, and higher costs per safety item, have all driven an increase in costs for United Utilities to meet MITIOS requirements.

We consider that this provides clear evidence that there is a clear step-up in statutory requirements delivered through base expenditure. As such, we continue to consider that a cost adjustment is necessary to enable us to meet our future obligations under the Reservoir Act 1975.

4.3 Costs are incurred with a lag to the inspection date

In the PR24 Draft Determination, query response OFW-IBQ-UUW-035 document, Ofwat states *"The number of statutory actions has been increasing in recent years but so has the number of reservoir inspections. This correlation is as would be expected. We note that based on the reservoir inspection cycle, 2022-23 is a peak, with the number of planned inspections much lower over 2025-30. We found no conclusive evidence that the number of MITIOS per inspection has increased for United Utilities or other companies, or that will be the likely trend going forwards."*

Section 4.2 provided evidence that the in-year total of inspections is not the primary cost driver but rather, the number of actions per inspection is. This section provides evidence that Ofwat's observation that 2022-23 is a peak year is valid but does not undermine the legitimacy of our statement that maintenance expenditure is expected to increase going forward.

When a MITIOS action is received by a reservoir owner, it is often in the form of an initial investigation or study, the purpose of which is to remove any uncertainty or doubt regarding the need for engineering works, and to develop the scope and extent of any works that are needed. We set out the substantial increase in investigation actions since the publication of the Balmforth Report in Figure 15, Section 3, Page 28 of our document UUW_CAC_001 Reservoir and Dam Maintenance. The receipt of an investigation MITIOS leads to one or more years of comparably modest spending, as the investigation takes place. If the investigation concludes that major engineering works are required, there may then be a further year or more of design phase (often involving environmental surveys which must take place across four seasons). The result of this phased approach is that there is often a lag of up to three years between the original receipt of a MITIOS action, and the bulk of the investment required to deliver that action.

Table 1 below shows the time lag for a number of major projects, between MITIOS receipt and the peak of spend associated with those projects.

Table 1: There is a time lag between MITIOS actions being received, and the majority of the investment associated with that action

Inspection date	Reservoir	2020-21	2021-22	2022-23	2023-24	2024-25	AMP8	Total
24/03/2023	[✂]				14,100	1,963,437	467,929	**2,445,465**
16/02/2022	[✂]				32,727	252,559	1,921,252	**2,206,538**
03/08/2021	[✂]				12,955	776,982	6,554,877	**7,344,815**
13/05/2021	[✂]			37,639	1,011,642	1,022,622	15,375	**2,087,278**
13/04/2021	[ ]				47,347	114,229	2,138,972	**2,300,548**
10/02/2021	[✂]			90,912	2,883,385	1,189,866	13,977	**4,178,141**
29/04/2020	[✂]		77,690	2,353,156	1,414,794	37,374		**3,883,013**
26/11/2019	[✂]	58,258	1,467,599	3,446,891	283,338	14,021		**5,270,107**
23/08/2019	[✂]		1,610,559	2,468,203	288,106	6,861		**4,373,729**
05/07/2019	[✂]	1,246,008	50,124	34,316	90,844			**1,139,356**
12/07/2018	[✂]	930,800	2,138,977	59,278	24,824	14,450		**3,168,328**

Source: UUW records of selected project costs

This clearly evidences the time lag between the inspection date and the year in which a company begins to incur significant capital costs. For example, Stocks was inspected in 2021-22 but will incur the majority of additional expenditure within AMP8. As such, the higher number of statutory actions **per inspection** received since Balmforth is likely to result in increased spend within AMP8. To see this, consider Ofwat's observation that 2022-23 was a year with an atypically high number of inspections (although as evidenced above, this is in the context of a steady rate of inspections over time). Based on the data set out in Table 1 it's reasonable to assume that the associated capital expenditure will be incurred in AMP8 i.e. with a two-year lag to 2022-23.

Ofwat further states in the same document "*We also find that the company's base water resources control spend over 2020-25 on reservoirs (infrastructure costs used as proxy) is low compared to the water supply (distribution input) delivered by these assets*". According to Ofwat, this raises the risk that additional allowances for MITIOS activities in AMP8 will result in customers paying twice for base reservoir maintenance.

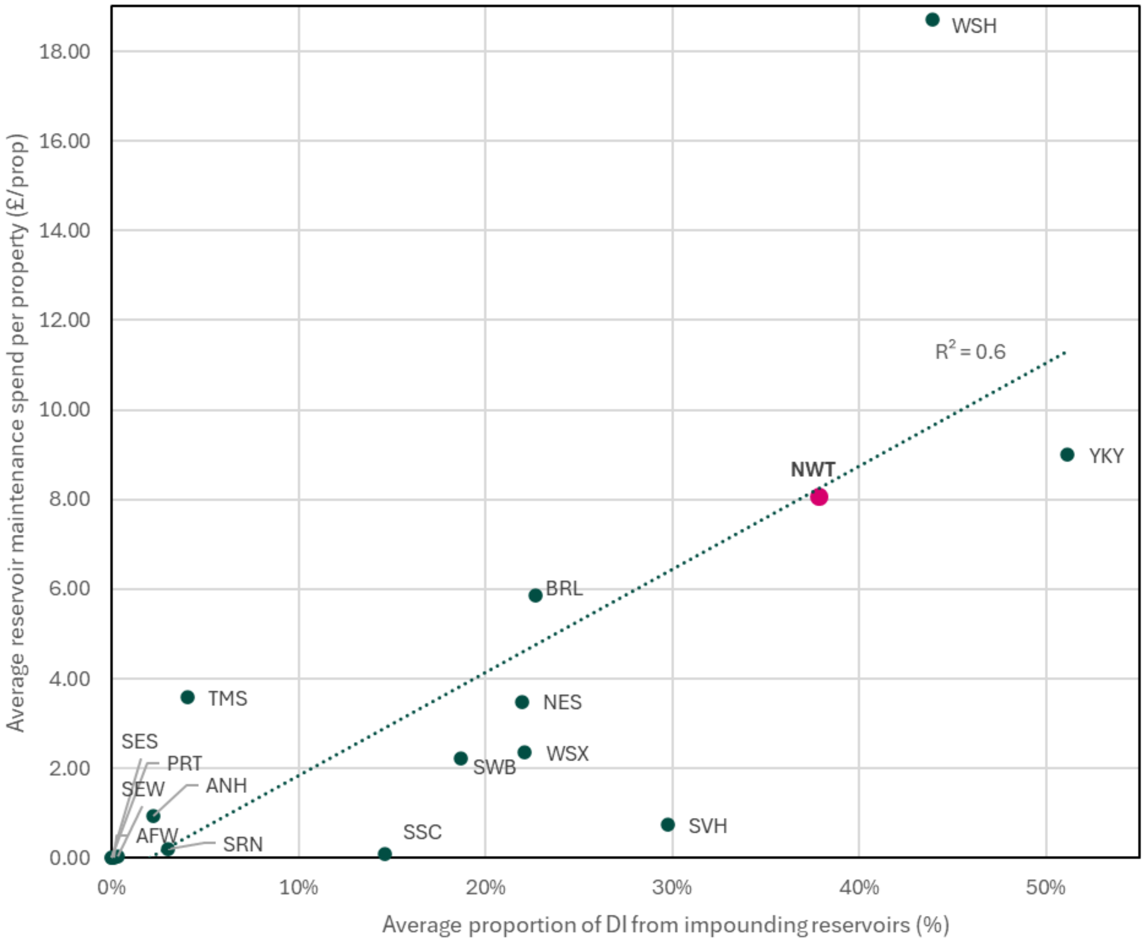
We are clear that our historic reservoir dam maintenance activity has been appropriate. We consider that Ofwat's argument is not well evidenced. Ofwat appears to be implying that there should be a 1:1 relationship between the share of reservoir distribution input (DI) and between the share of reservoir maintenance spend. However, this assumption appears to have little logical basis – if, for instance, a company was exclusively reliant on reservoirs (so that reservoir DI accounted for 100% of water supplied) we would not expect infrastructure maintenance costs to account for 100% of water resources expenditure. Ofwat claims that UUW's share of reservoir maintenance cost is low, but does not specify what would constitute an appropriate level of spend.

A more intuitive way to assess whether base maintenance levels are appropriate is to compare reservoir maintenance costs across different companies. This comparison is shown in Figure 4, which depicts average reservoir maintenance spend[5] (per property) between 2011-12 and 2022-23 against the share of reservoir DI. There is a relatively strong relationship between these two variables, with an R-squared of 0.6. Thus, the line of best fit can be interpreted as denoting the appropriate level of reservoir maintenance spend, depending on the share of reservoir DI. United Utilities is located exactly on the line, indicating that our maintenance expenditure aligns with what would be expected from a company with a share of reservoir DI such as ours. We note that Welsh Water appears to be an outlier in terms of reservoir maintenance expenditure – however, this it to be

[5] Here, the sum of Water Resources "Renewals expensed in year (Infrastructure)" and "Maintaining the long term capability of the assets – infra" is used as a proxy for reservoir maintenance expenditure.

expected, given that Welsh Water received an additional allowance for improving reservoir maintenance at PR19.[6]

Figure 4: Reservoirs maintenance per property compared to share of DI from reservoirs



Source: UUW analysis of APR data

4.4 Our PRA programme is well scoped and no regrets enhancement investment

In the PR24 Draft Determination, document PR24-DD-W-Reservoir Safety.xlsx, worksheet "NWT", cell C15, Ofwat stated; "*The remaining investment is related to more certain drivers and which could result in significant infrastructure interventions. This includes changes to EA flood risk maps (2022) which result in updated risks for its reservoirs as identified by its Portfolio Risk Assessment (PRA). However, for the residual £114.843 million we make a further 20% cost challenge as the company has not provided sufficient and convincing evidence that all the investment will be necessary (e.g. as a result of PRA rather than specific changes to technical guidance) and why it is all enhancement rather than base maintenance and that it is definitely required in 2025-30.*"

We agree and acknowledge that the drivers of change in relation to dam safety will result in significant structural interventions, and that these drivers are beyond the control of an individual dam operator.

Ofwat particularly notes the 2022 changes to the Environment Agency reservoir flood inundation maps. These indicated that since their first iteration (in around 2010) there has been both a change in the population distribution in the North West, and an increase in the Environment Agency's understanding of where flood flows

[6] Ofwat (2019), *PR19 final determinations: Dŵr Cymru final determination,* p.5.

would travel, in the event of a dam breach. Both factors combine to show more people living in areas at risk of dam breach floods, than was previously thought to be the case.

United Utilities has reviewed the impact of the changes to the flood maps, in relation to our individual condition based, dam risk assessments. The Environment Agency updated flood maps for dam operators from many industrial sectors, and for private dam owners. The update was based on observations from dam breaches which had occurred across the globe, and an increase in computational power available to the Agency to carry out flood flow modelling.

Ofwat's statements could be interpreted to suggest that PRA is an optional process, which does not carry the weight of technical guidance or regulation. This is not the case. The Portfolio Risk Assessment (PRA) is the United Utilities term for our process of assessing risk (dam breach probability and consequence) as part of a pro-active process of risk management. The values (for probability and consequence) generated by the PRA are compared against the technical guidance "Reducing Risks Protecting People" 2001 published by the UK Health and Safety Executive. This technical guidance is the official interpretation of Part 3 of the Health and Safety at Work Act 1974, the regulation which places duties on operators of industrial processes which have the potential to cause off-site consequences.

Abiding by Part 3 of the Health and Safety at Work Act is not optional, nor is it dependent upon the risk appetite of the organisation involved. All industries that have the capacity to cause off-site consequences (such as a flood following dam failure) are obliged to take action to manage the risks associated with their activity.

PRA is therefore our way of delivering and demonstrating our compliance with Health and Safety at Work regulations. Whilst the Health and Safety at Work Act has not itself changed (not a specific change to technical guidance), the changes to the EA flood maps changed individual dams' level of risk, when measured against the requirements of the Act.

In the PR24 Draft Determination, document PR24-DD-W-Reservoir Safety.xlsx, worksheet "NWT", cell C15, Ofwat stated "*the company has not provided sufficient and convincing evidence that all the investment will be necessary (e.g. as a result of PRA rather than specific changes to technical guidance)*".

Whilst there has not been a specific change to technical guidance, the change in the Environment Agency flood maps (leading to a change in our understanding of the population exposed to risk) fundamentally changes our risk position, as calculated through the PRA process. The PRA process is how we demonstrate compliance with the Health and Safety at Work Act, a regulation with equal weight in law as the Reservoir Act. In essence then, it is wrong to suggest that PRA activity may not be necessary, as the PRA is the approach we have used for many years to ensure compliance with a key regulation.

Finally in regard to PRA, Professor David Balmforth, in his 2021 independent report "Independent Reservoir Safety Review", on page 6 states "*I have therefore recommended that in future the assurance of reservoir safety should be managed on the basis of risk, and that the amount of effort (and cost) associated with that process should be in proportion to that risk*." As a result of this recommendation, independent Inspecting Engineers have, since 2021, widely included a requirement to carry out risk assessments (PRA in United Utilities terminology) as part of the MITIOS actions issued to dam operators..

Ofwat enquires as to why this spend is required in the 2025 to 2030 time period. The reason is that it is expected that unacceptable risks (as defined through "Reducing Risks Protecting People" 2001 published by the UK Health and Safety Executive), should be managed and addressed as soon as practicable.

United Utilities has been undertaking some pro-active risk reduction interventions before the recent changes arising from the Toddbrook incident and Balmforth Report. In 2009, United Utilities wrote to the Health and Safety Executive to clarify the expectations around the "as soon as practicable" expectation. At that time, the HSE replied that *"a five year period would not be inconsistent with "as soon as reasonably practicable", given the civil engineering and continuity of supply constraints which UU would have to address"*.

The changes to Environment Agency flood maps were published in 2022. United Utilities took time to review this data, and to repeat the probability of failure assessments for those dams which newly fell within the unacceptable risk categories (as defined by the HSE). The highest risk dams were immediately subject to an engineering intervention, funded through AMP7 base expenditure. Slightly lower risk (but still unacceptable category) dams were scheduled for interventions in AMP8, and borderline risk dams were subject for further investigation, and intervention in AMP9. This timescale was provided in Table 24, on Page 81, of the document UUW_CAC_001 Reservoir and Dam Maintenance, and we consider that this timescale discharges our regulatory obligations against the "as soon as reasonably practicable" clause.

The rate or timescale of dam risk reduction interventions (PRA activity to ensure compliance with HSWA) cannot practicably be accelerated. It takes time and resources to develop engineering solutions to dam failure risks, including extensive geophysical surveys and core material samples, or modelling of spillways for flood derived modes of failure. The development of solutions takes some time (hence why MITIOS actions usually have a 3 year timescale attached). In addition, the delivery of risk reduction engineering interventions often involves a water level draw-down, the temporary partial emptying of a reservoir to provide safe working area for engineers working on the dam. We could not simultaneously draw-down all of our reservoirs requiring a risk-based intervention, as this would threaten the water resources position and continuity of customer supplies. The balance of engineering solutioneering, risk and continuity of supply, all prevent significant acceleration of the programme.

Similarly United Utilities cannot postpone risk based interventions to future AMPs. Postponing interventions would mean that we would no longer be in accordance with the "as soon as reasonably practicable" clause. Furthermore, as discussed earlier, risk assessment and risk reduction interventions are now standard parts of a Section 10 independent safety inspection.. The risk of such an approach is that the independent Inspecting Engineer will inevitably focus on the reservoir which is the subject of their inspection at that time, and will issue a MITIOS notice for risk assessment and risk reduction, regardless of where that reservoir sits in a ranked priority order for United Utilities. We would end up having to intervene based on the risk appetite of individual Inspecting Engineers, rather than on a risk ranked basis, whilst also losing our ability to effectively plan outages (reservoir draw downs) to minimise the risk of impact to supplies. We have built the cost estimates for our PRA programme with the assumption that that will be the route through which we deliver risk-reduction interventions (we have not built those costs into our forecast MITIOS programme).

4.5 UUW has a track record of managing historic reservoir safety risk within base allowances

In the PR24 Draft Determination, document PR24-DD-W-Reservoir Safety.xlsx, worksheet "NWT", cell C15, Ofwat stated; "*This includes why part of the risk associated with these investments includes that it could have been proactively managed via previous base allowances, noting again that base water resources spend on reservoirs appears low.*"

Previous base allowance has been used to manage dam safety risks. Appendix 1 shows how historic base expenditure has been used to address dam safety risks as they have become known to us. The considerable increase in risk (that arose from increased exposure revealed through the 2022 flood map changes) means that baseline Botex allowances require adjustment in order to accommodate the scale of the investment required.

United Utilities has been undertaking risk based interventions on its fleet of dams since AMP5. Previous base allowances have been used to address the highest ranked risks pertaining at that time. The risks (and costs) that are highlighted for the AMP8 dam safety programme (shown in Table 24, on Page 81, of the document UUW_CAC_001 Reservoir and Dam Maintenance), arose from the 2022 changes to the Environment Agency flood maps, and the 2021 (post Balmforth) link between MITIOS and risk assessment activity. We could not have used previous base allowances (prior to 2022) to address these risks, as they were not known prior to 2022. The highest risks identified have been addressed through the AMP7 base allowance.

4.6 UUW has carried out dam breach investigations

In the PR24 Draft Determination, document PR24-DD-W-Reservoir Safety.xlsx, worksheet "NWT", cell C15, Ofwat stated; "*The risk of failure in the company's proposal is based on the type of the dam construction rather than its current condition, the company has not undertaken its own breach studies (to validate the risks) and there is no* *deadline for compliance (it is not currently linked to Reservoirs Act requirements). The company has therefore not provided sufficient and convincing evidence this proposed investment is required.*"

United Utilities has carried out a dam breach risk assessment for every dam in its fleet. This assessment, (the assessment of probability of failure) is **entirely based upon the condition of the dam**. Whilst different types of dam construction may have different specific technical risk assessment steps applied, those assessments are nonetheless entirely focussed on dam condition. We use industry recognised methods to assess the condition of our dams, and these are set out in Section 6.2 of the document UUW_CAC_001 Reservoir and Dam Maintenance. These condition based assessment methods provide us with a probability of failure for each of our dams.

Risk is determined by the probability of failure, multiplied by consequence, in this case the number of people exposed to high velocity flooding in the event of a dam breach. This consequence (exposure) element of the risk is determined by the Environment Agency. The Environment Agency is the responsible agency in England for determining flood risk exposure, and that agency has the funding and technical expertise to use world leading techniques to calculate population exposure to flooding of various kinds (including coastal, river, rainfall and dam and canal failure flooding).

It would not be appropriate for United Utilities to waste customers' money on replicating the official Environment Agency calculations of exposure to flood risk, in the event of dam breach. There are no better or more advanced techniques (to those used by the EA) readily available that would give a different answer. If we undertook an in-house assessment of exposure to dam safety risk and found a different answer, we would nonetheless be obliged to use the official EA values for all regulatory activity (such as assessment of dam category by the Inspecting Engineer), in any regard.

We consider that the use of our condition based engineering assessments of failure probability, and the Environment Agency assessments of consequence, to be the most effective way of measuring risk in relation to our fleet of dams. The results of our condition based assessment are shown in Appendix 2 to this representation, on a dam by dam basis, for every reservoir in the AMP8 programme.

In terms of deadlines, we are working to the guidance specifically provided to us by the Health and Safety Executive regarding "as soon as reasonably practicable", and in regard to the link to the Reservoirs Act, that link arises from the requirement for risk assessments to be carried out as part of statutory inspections, as recommended by Professor David Balmforth to the Inspecting Engineer community. For clarity and the avoidance of doubt, recommendation 5 (page 94) from Professor Balmforths' 2021 "Independent Reservoir Safety Review Report" is reproduced below:

"RECOMMENDATION 5. The Periodic Inspection of Reservoirs by Inspecting Engineers should be systematic, detailed and impartial, and their findings and requirements communicated in a clear and evidence-based manner: a) As part of their inspection of a reservoir, ***Inspecting Engineers should identify all the potential failure modes of the dam and other reservoir structures. They should determine the significance and credibility of each of these and then evaluate each to understand the overall likelihood of failure****. On the basis of this they should require any measures in the interest of safety (MIOS) or amendments to the RSMP. b) Where an Inspecting Engineer considers that further investigations are needed, an interim report should be issued together with any associated MIOS or precautionary measures pending the completion of the investigation and the issuing of a final report and requirements for further measures, where required. c) For class 1 and 2 reservoirs, Inspecting Engineers should undertake or update, as necessary, a risk assessment for the reservoir (see recommendations 1 and 10).* ***Where MIOS are required as a result of a risk assessment, these should be specified so as to reduce risk to ALARP, and evidence should be provided to demonstrate that****. d) Appropriate and clearly defined timescales should be attached to each MIOS depending on the urgency of implementation. In assessing the condition of the reservoir, the Inspecting Engineer should not rely on visual observations alone, but should make use of the data and information collected during routine surveillance activities, previous reports from Inspecting and Supervising Engineers and records of the reservoir's design and construction. In any report they should express their findings, recommendations and requirements in a clear and evidence-based manner. e) Where precautionary measures may compromise the beneficial use of a reservoir, their implementation should be determined on the basis of managing the risk to be ALARP"*

This recommendation is being implemented in full by independent Inspecting Engineers when carrying out their inspections under Section 10 of the Reservoirs Act. Risk assessment is now required as part of the safety inspections carried out under the Reservoir Act. This is the link to Reservoir Act requirements.

4.7 We have appropriately optioneered our PRA programme

In the PR24 Draft Determination, document PR24-DD-W-Reservoir Safety.xlsx, worksheet "NWT", cell C23, Ofwat stated; "*Company optioneering focuses on options for significant works. Given the overall aim of this investment is reducing risk, the options considered are relatively limited with options such as improved drainage and increased surveillance are only considered as temporary measures.*"

We concur that this investment is intended to address risk.

Dams are exposed to the living environment, and are built across uncontrolled, free flowing natural rivers. Dams must be able to accommodate any extreme environmental condition that could be experienced. Extreme conditions can destroy dams that are in a poor condition within a few hours. As these extreme conditions could occur at any time, dams must be able to passively deal with any environmental risk, without intervention from dam operators.

This need to manage extreme conditions without human intervention drives us to change the fundamental engineering characteristics of the dam.

We acknowledge that our options regarding risk reduction are limited. Any engineering alteration that we make to a dam must be made under the supervision of an independent Inspecting Engineer (a QCE under the terms of the Reservoir Act). Part of the inherent purpose of an independent Inspecting Engineer is to be naturally conservative, and risk averse. Our ability to innovate or use non-standard methods is constrained by the need to secure Inspecting Engineer approval. The entire dam safety 'industry' relies upon known, successfully demonstrated, low risk techniques. We would not be permitted to install risk reduction solutions that had a high degree of uncertainty or that were unproven.

We concur that drainage and surveillance are temporary measures, as they are not 100% effective, nor are they operable on a 24 / 365 basis, passively under all conditions. Drainage and surveillance are temporary mitigation measures whilst a dam is awaiting its' permanent risk reduction intervention. Drainage and surveillance do not form part of our permanent solution options for our PRA programme.

Drainage relies on being able to discharge the flows associated with internal erosion, in a manner that prevents water retaining core material from being washed away. By its nature, internal erosion affects the water retaining core, at the centre of the dam (see section 2.3 of UUW_CAC_001 Reservoir and Dam Maintenance). This makes the phenomenon hard to map, and flow pathways regularly change and evolves as the erosion take place. Drainage then buys time, and enables better monitoring, but does not resolve the root cause, and so is a temporary mitigation not a solution. A well-drained dam can still fail due to internal erosion in a matter of hours.

Our solution for internal erosion risks is the grouting up of leakage pathways (arresting the flow), or installing slurry trenches (to prevent core material being washed away). In contrast to drainage, these are permanent fixes that prevent the issue from ever progressing to a point where the core integrity could be compromised.

Similarly, surveillance is a temporary mitigation, and not a solution. Surveillance assumes that a problem can be identified, and that heroic intervention will be successful. Surveillance attempts to buy more time for such intervention. Surveillance does not resolve the problem, and nor does it prevent a problem from occurring in the first place. As per the Toddbrook dam emergency, (where the armed forces, two police forces, national fire service assets, and two large water companies all responded to the emergency) even heroic intervention will not necessarily save the asset and leave it in an operable condition (whilst it might save the community at risk). Surveillance, then, is not a solution to dam risks.

4.8 We provide additional evidence of site-specific optioneering

In the PR24 Draft Determination, document PR24-DD-W-Reservoir Safety.xlsx, worksheet "NWT", cell C23, Ofwat stated; "*The company has presented a series of standard options, which are largely capital intensive, and a high-level flow chart for how they are arriving at the option. There is no site-specific optioneering and no analysis setting out the extent to which the option proposed addresses the risk of being in the unacceptable risk zone. Sufficient and convincing evidence of optioneering was not provided for the proposed works.*"

We have previously explained why standard options have been used, and why these are capital intensive engineering options rather than drainage or surveillance, in Section 4.6 of this report. However, we acknowledge our omission in not providing site specific optioneering details. A complete optioneering flowchart for each dam in the AMP8 programme is therefore provided in Appendix 3 to this document. We are happy to provide further information, if that is required.

4.9 We provide additional evidence on our approach to managing capital projects to support cost efficiency

In the PR24 Draft Determination, document PR24-DD-W-Reservoir Safety.xlsx, worksheet "NWT", cell C31, Ofwat stated; "*We have minor concerns whether the investment is efficient. While the company provides evidence on its cost estimation approach, benchmarking and external assurance, there are limits and gaps in some of those areas.*"

In addition to our cost estimation approach, our drive towards greater efficiency will continue into the tender process and contract award phases of the project. A detailed statement on United Utilities approach to managing capital investment and engineering procurement is provided in Appendix 4.

Our forecast costs are representative of actual costs being incurred. In Section 4, Table 8, Page 44 of UUW_CAC_001 Reservoir and Dam Maintenance we forecast an AMP8 cost per unit for grouting (one of the key solutions likely to be employed in AMP8) of £21,325 per metre. We completed a grouting project at Yeoman Hey Reservoir in 2024, where we incurred a unit rate of £20,954 per metre, very close to our estimate of AMP8 costs. This is indicative that the costs used in the build up of the AMP8 programme are based on realistic real world prices.

4.10 UUW does not dispute Ofwat's proposed PCD

In the PR24 Draft Determination, document Water-resilience-and-security-PCDs.xlsx, worksheet "UUW-reservoirs", cell C9, Ofwat stated; "*Interventions delivered to meet recent legislative changes at each of the 18 reservoir sites with enhancement funding. Deliver improvements to reservoirs identified under companies Portfolio Risk Interventions to include slurry trenching or grouting*".

In cell C10 of the same document Ofwat states; "*Companies should provide assurance on the reported data as per the common requirements.*", and in Cell C11 "*No further conditions apply.*". The document goes on to state a target of 18 PRA reservoirs receiving risk reduction by 2030, with an incentive rate of £3.070m.

United Utilities notes this PCD proposal from Ofwat, but expects that Ofwat will revisit the allowed costs for the reasons already set out in this document.

5. Approach for final determination

United Utilities submitted a cost adjustment claim for additional Botex associated with maintenance of our fleet of impounding reservoirs. The claim was set out in the supplementary business plan document UUW_CAC_001 Reservoir and Dam Maintenance.

Part 2 of the claim (£65.151m) covered the increase in regulatory maintenance activity (such as MITIOS notices) which has grown since the Toddbrook dam emergency in 2019, and the Balmforth independent report into reservoir safety in 2021. **We request that Ofwat re-assess this specific element of our claim as a Cost Adjustment Claim**, with reference to base allowances. **We recommend reinstatement of the full £65.151m to enable us to meet our statutory obligations in this area.**

We further ask Ofwat to consider the additional evidence presented in support of Part 2 of the claim. This can be found in Figure 14, Section 3 of UUW_CAC_001 Reservoir and Dam Maintenance regarding the increases in absolute numbers of statutory safety items, the evidence in Figure 1 regarding the increasing number of statutory safety items per inspection, and the evidence of increasing costs per item, provided in Table 47, Section 4, Page 41 of UUW_CAC_001 Reservoir and Dam Maintenance.

Part 3 of the claim (£114.843m) was in regard to an increase in risk based safety interventions, which have increased as a result of changes to the Environment Agency flood maps published in 2022. These risk based interventions are required to enable us to meet the regulatory requirements of the Health and Safety at Work Act, and are in regard to obligations to reduce non-occupational risk to the community to as low as reasonably practicable.

Part 3 of the claim was assessed an enhancement business case. **We request that Ofwat re-assess this element of the business case, on the basis of enhancement expenditure, taking into account the additional evidence provided.**

With regard to Part 3 of our claim, we ask Ofwat to take regard of the additional evidence in this document, particularly regarding the necessity of undertaking PRA activity in the AMP8 timeframe, and the efficiency of our costs. This evidence can be found in sections 4.6 to 4.9 of this report.

We consider our PRA activity to be a regulatory necessity (see section 4.4), and to have been efficiently optioneered (see Appendix 3) and cost estimated (see Section 6, Page 53 to 63 of UUW_CAC_001 Reservoir and Dam Maintenance). **On that basis we recommend reinstatement of the full £114.843m to enable us to deliver the activity associated with Part 3 of our claim.**

We note the PCD proposed by Ofwat at Draft Determination.

Appendix A Historic dam safety risk reduction achieved through previous AMPs base investment

United Utilities has been operating a Portfolio Risk Assessment (PRA) ranking of its embankment dams since 2007 providing a proactive approach to enable prioritised assessments and expenditure to be undertaken on those reservoirs deemed to be high risk.

This is driven by the requirements of the Health and Safety at Work Act (1974) with a need to understand the risks associated with these assets and ensure appropriate preventative actions are in place. This process has been externally benchmarked, with the last assessment (led by an independent Inspecting Engineer) undertaken in 2023, and deemed to be a regulatory compliant process (see Section 6, Table 26, Page 62 of UUW_CAC_001 Reservoir and Dam Maintenance).

A substantial reduction in the numbers of reservoirs within the unacceptable/intolerable risk profile has been achieved since the PRA approach was adopted (Table 2).

Table 2: Summary of numbers of reservoirs within the unacceptable/intolerable risk

Year of assessment	Unacceptable – individual *	Unacceptable – societal*	Unacceptable - total
2007	46	22	68
2015	23	25	48
2022	5	24	29
2030 target	0	10	10
2035 target	0	0	0

Appendix B Results of condition based risk assessment

Table 3: Results of condition based risk assessment for every dam in the AMP8 programme

Reservoir	Probability of failure due to flood risk	Probability of failure due to slope instability	Probability of failure due to seismic instability	Probability of failure due to internal erosion	Total condition based probability of failure	Public exposure from 2022 EA flood map	Total risk (condition based POF x exposure)
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[ ]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[ ]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[ ]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[ ]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[ ]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[ ]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[ ]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[ ]	[✂]
-]	[✂]	[✂]	[✂]	[✂]	[✂]	[ ]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[ ]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[ ]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[ ]	[✂]
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[ ]	[✂]

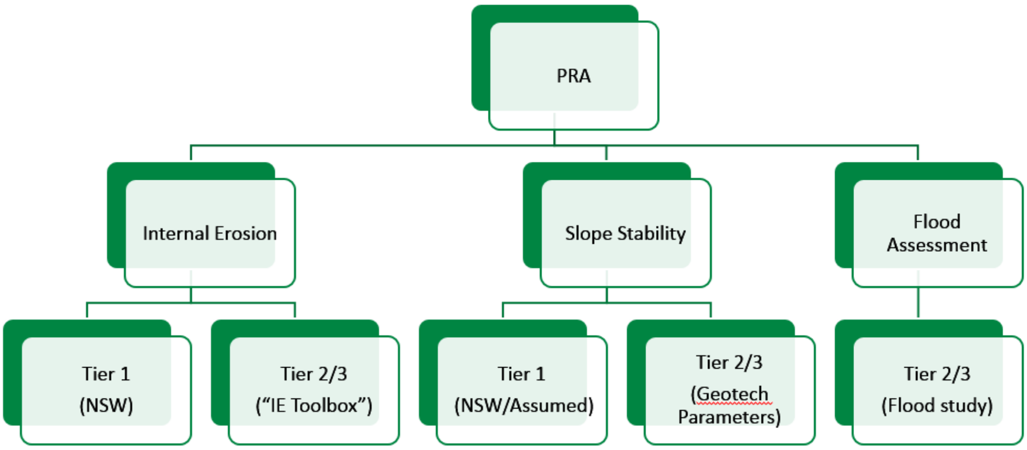
The annual probability of failure for each statutory reservoir is determined in the UU Portfolio Risk Assessment (PRA) process by assessing the following dominant risks:-

- Internal Erosion
- Slope Instability (including seismic risk)
- Flood Risk

A ‘Tier 1’ high level qualitative assessment for each of the main risks was undertaken on all of UU portfolio of embankment dams in 2007 to determine initial prioritisation.

Based on this risk approach the high priority reservoirs were investigated further and studies undertaken to allow ‘Tier 2/3’ qualitative and quantitative assessments to be completed (Figure 5).

Figure 5: United Utilities approach to PRA prioritisation and assessment



In 2013 the Environment Agency published the Guide to Risk Assessment for Reservoir Safety Management (RARS). The risk assessment methodology adopted by UU predates publication of RARS but uses similar techniques across all three Tiers, at different stages of the risk assessment.

RISK ASSESSMENT PROCESS

Slope assessment

Tier 1 – Stanford Method
For all embankment dams a high level assessment (Tier 1) is carried out using the Stanford method (McCann et al 1985). This quantitative method is based on historical frequency of dam failures by slope instability of 1.1E-05 and is adjusted using descriptions based on whether the embankment is considered 'poor', 'neutral' and 'good'. The descriptions are included in Table 5.1 below along with the adjusted probability of failure for each scale.

Tier 2 – Detailed Slope Stability Study
Driven by either a PRA Prioritisation where low factors of safety (FoS) were identified, or S10 measures a (Tier 2) detailed slope stability assessment is carried out using computer software used to determine the FoS for the embankment adopting a Eurocode 7 (Case 3) approach.

Site specific investigations are undertaken including ground investigations and topographical surveys to complete the assessment to determine appropriate geotechnical parameters. The assessment is carried out by UU Ground Engineering team and typically under the guidance and direction of a QCE and Supervising Engineer(SupE) for the reservoir.

Once the FoS is determined for the embankment an associated probability of failure is inferred based on the Stanford Evaluation scale (Table 4).

Table 4: Slope Stability Stanford Evaluation Scale

Evaluation Scale	Description	Frequency of Failure	Assumed Factor of Safety
1	Good condition of dam. No unanticipated movements or performance. Mild operating conditions and climate.	1.10E-06	1.80
2	Good condition of dam, but dam subjected to extreme weathering or drawdown cycles are likely.	2.80E-06	1.70
3	Minor erosion of slope face.	3.30E-06	1.60
4	Evidence of weak material or organic matter.	5.90E-06	1.50
5	Evidence of minor erosion and weak material.	9.20E-06	1.45
6	Excessive erosion or undercutting of side slopes.	1.30E-05	1.40

Evaluation Scale	Description	Frequency of Failure	Assumed Factor of Safety
7	Poor compaction of embankment, steep side slopes with a low calculated factor of safety.	2.10E-05	1.34
8	No unusual surface movement, but evidence of high pore pressures (if available).	3.70E-05	1.25
9	No tension cracks, but evidence of settlement and misalignment, or ruptured conduits. Unusual and sudden change in pore pressure instrumentation	4.80E-05	1.20
10	Longitudinal tension cracks at crest along with misalignment, sloughing, and bulging of embankment or tilting of roadway, sideway, or inlet structures. Sinkholes.	1.50E-04	1.00

Seismic assessment

The impact of seismic assessments formed part of a detailed study undertaken by UU in 2000, overseen by an expert panel of QCEs. This concluded that seismic risk could be excluded from assessment where stability was shown to have a > 1.3 factor of safety. The finding were published in Rigby et al (2002), “A Methodology for Site Investigation and Analysis of Dams in the UK”.

The only exception is where potential for liquefaction is identified, and further assessment is undertaken by the Ground Engineering team.

Internal erosion

Tier 1 – University of New South Wales Method
For all UU dams a high level assessment (Tier 1) has been carried out using the University of New South Wales (UNSW) method developed by Foster et al (1998). A similar approach to the Stanford slope stability method the UNSW approach is a quantitative method starting with an historical frequency of dam failures (depending on the embankment dam type) and is adjusted for descriptions associated with the following failure mechanisms.

- Piping through the Embankment
- Piping through the Foundation
- Piping from the Embankment into the Foundation

Tier 2 – IE Toolbox
Driven by either a PRA Prioritisation or S10 measures a (Tier 2) assessment is carried out using a quantitative risk analysis for piping and internal erosion failure modes (i.e., Piping Toolbox) for embankment dams.

The Toolbox was developed by United States Department of the Interior, Bureau of Reclamation (Reclamation) and the United States Army Corps of Engineers (USACE). These methods are closely related to those developed at the University of New South Wales and used in practice in Australia by URS and other consultants. This approach was initially adopted by UU in 2006 and has been subject to review and updates in line with best practise since that time.

In order to complete the assessment a desk study is carried out to review all existing ground investigation, historical records and other pertinent information relating to the site. If considered necessary additional investigations are carried out prior to completing the “toolbox” assessment.

The assessment is determined by a Risk Estimating Team (RET) comprising at least the Reservoir Safety Manager, an All Reservoirs Panel Engineer (ARPE), SupE and a project Geotechnical Engineer. The process is facilitated by the UU ground engineering team.

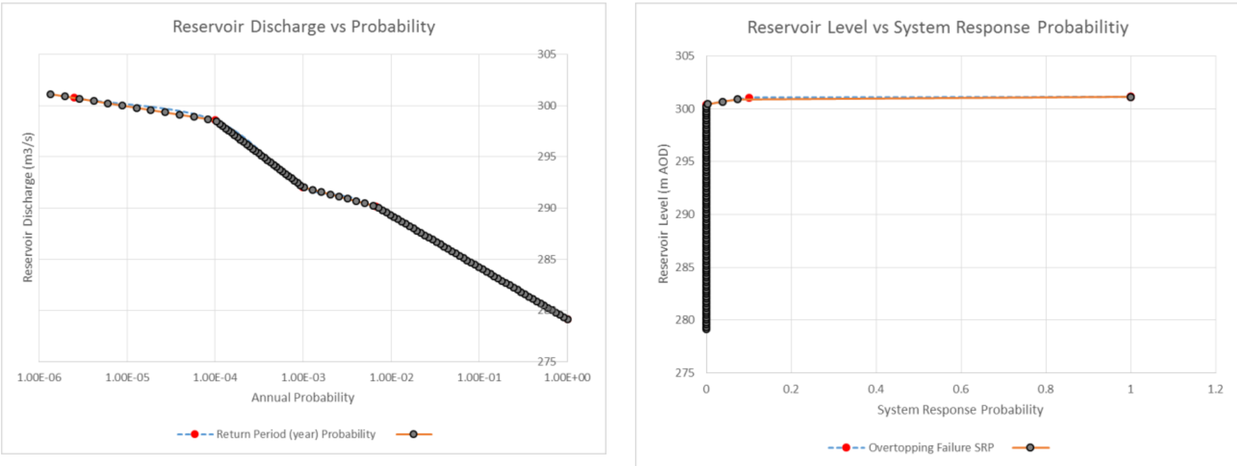
Flooding

UU Flood Risk Parameters

The assessment requires the use of a Risk Estimating Team and depending on the complexity input from UU hydraulics team to review and determine the System Response. The process is facilitated by the UU ground engineering team.

An example of UU Flood Risk outputs for Staged Discharge Curves; Embankment System Response are shown below.

Figure 6: Examples of flood response and probability of failure



For each scenario the risk is determined using the following equation

$$\int_{L=0}^{L=1} Probability\ of\ Flood\ Event_{t=x} \times System\ Response\ at\ Reservoir\ level\ _{t=x}$$

Where L is the corresponding reservoir level at a flood return period, t = x with a system response less than 1.

The approach uses an event tree approach to combine all possible/plausible failure modes associated with flooding (overtopping, spillway plugging, spillway failure causing erosion and failure of the embankment)

Appendix C Site by site optioneering results

In Section 6, Figure 21, Page 57, of the document UUW_CAC_001 Reservoir and Dam Maintenance, United Utilities provided an example of the optioneering flow chart used to identify solutions for risk based safety interventions. In the PR24 Draft Determination, document PR24-DD-W-Reservoir Safety.xlsx, worksheet “NWT”, cell C23, Ofwat requested site specific optioneering details. The following pages provide worked optioneering flowcharts for each of the dams in the AMP8 programme.

The main driver for remedial solution at the sites relates to either

Internal Erosion – Considers a poorly compacted or highly permeable layer in the embankment

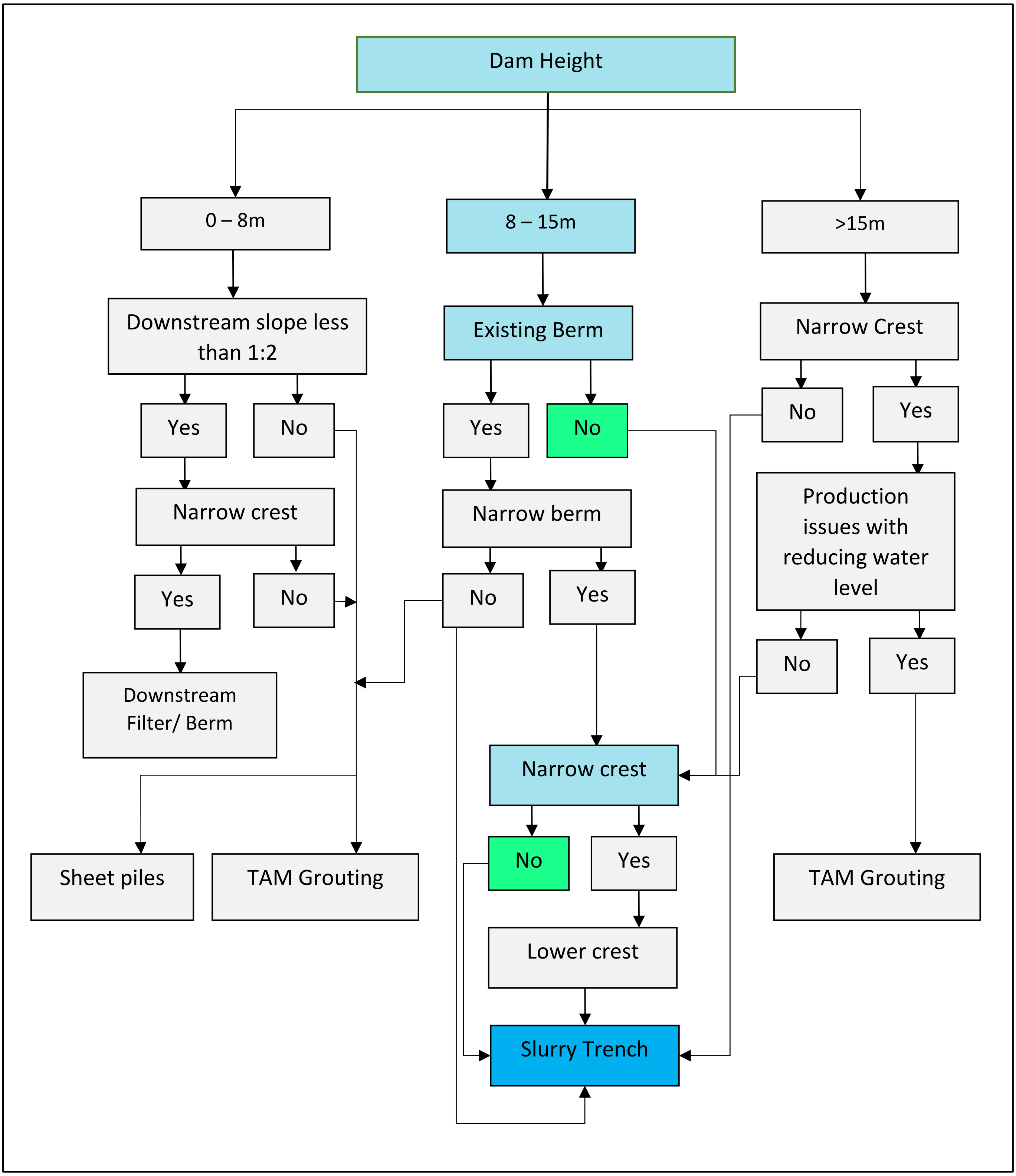
Slope stability requirements on several of the dams based on high level slope stability assessments

The high level optioneering and solution development approach was reviewed in conjunction with Constructability, Environmental, Customer and Stakeholder impacts and constraints. The high level approach optioneering for each dam is included in Appendix A and a summary of the proposed fixes is summarised in Table 5. Solution optimisation will be undertaken following the completion of the Tier 3 studies.

Table 5: Summary of viable high level solutions per dam

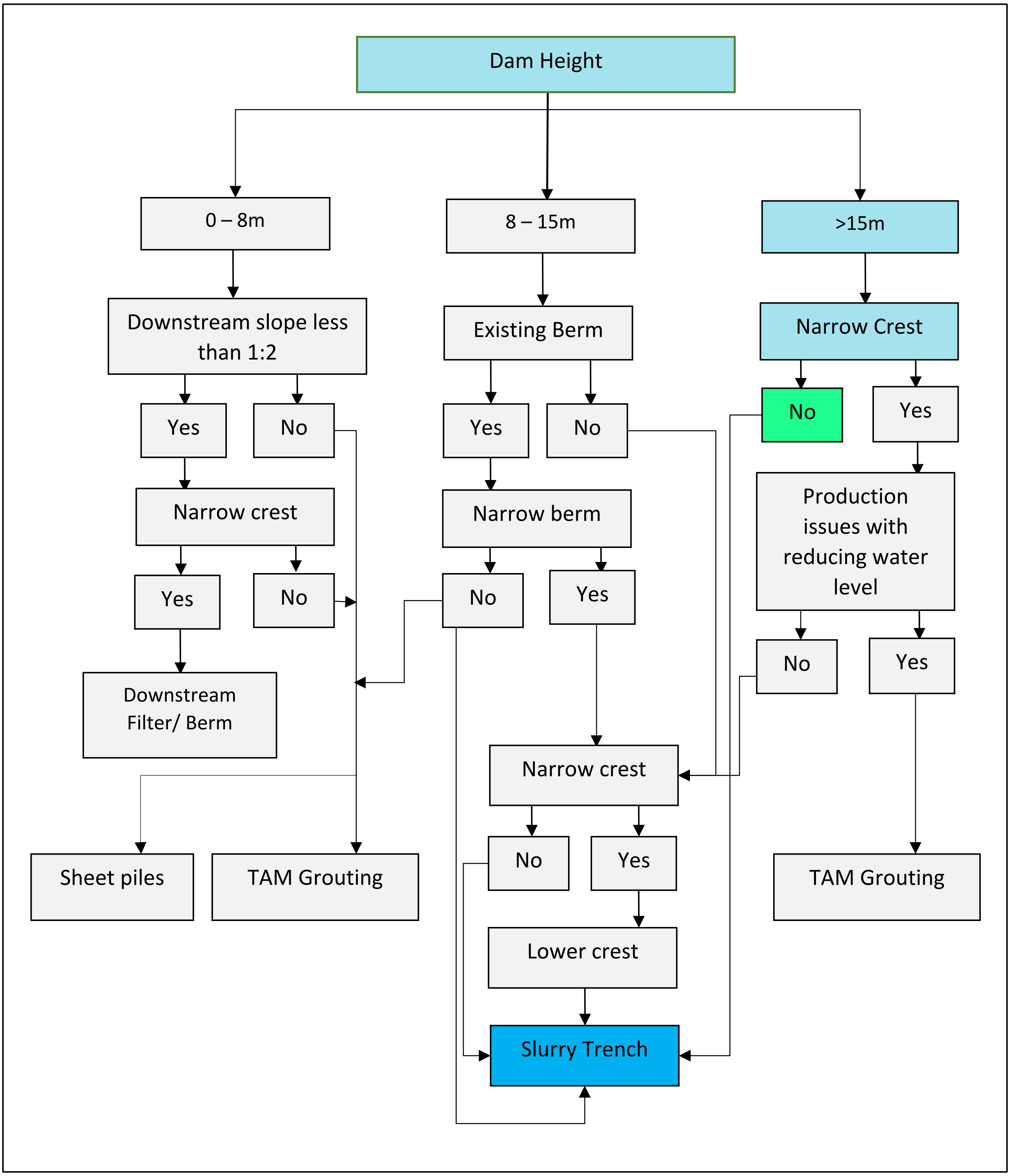
	High Level Solution
[✂]	Slurry trench from crest
[✂]	Filter Collar around tunnel (grouting) and slurry trench from crest
[✂]	Slurry trench from crest
[✂]	Slurry trench from crest
[✂]	Slurry Trench from crest
[✂]	Slurry Trench from crest
[✂]	Slurry trench from crest
[✂]	Slurry Trench from crest
[✂]	Slurry Trench from crest
[✂]	Slurry Trench from crest
[✂]	Slurry trench from crest
[✂]	Slurry Trench from crest
[✂]	Slurry trench from crest
[✂]	Three rows of TAM grouting - 1m centres offset by 0.5m
[✂]	Filter on downstream face
[✂]	Three rows of TAM grouting - 1m centres offset by 0.5m
[✂]	Slurry trench from crest
[✂]	Slurry Trench from crest
[✂]	Slurry Trench from crest

Figure 7: [✂]



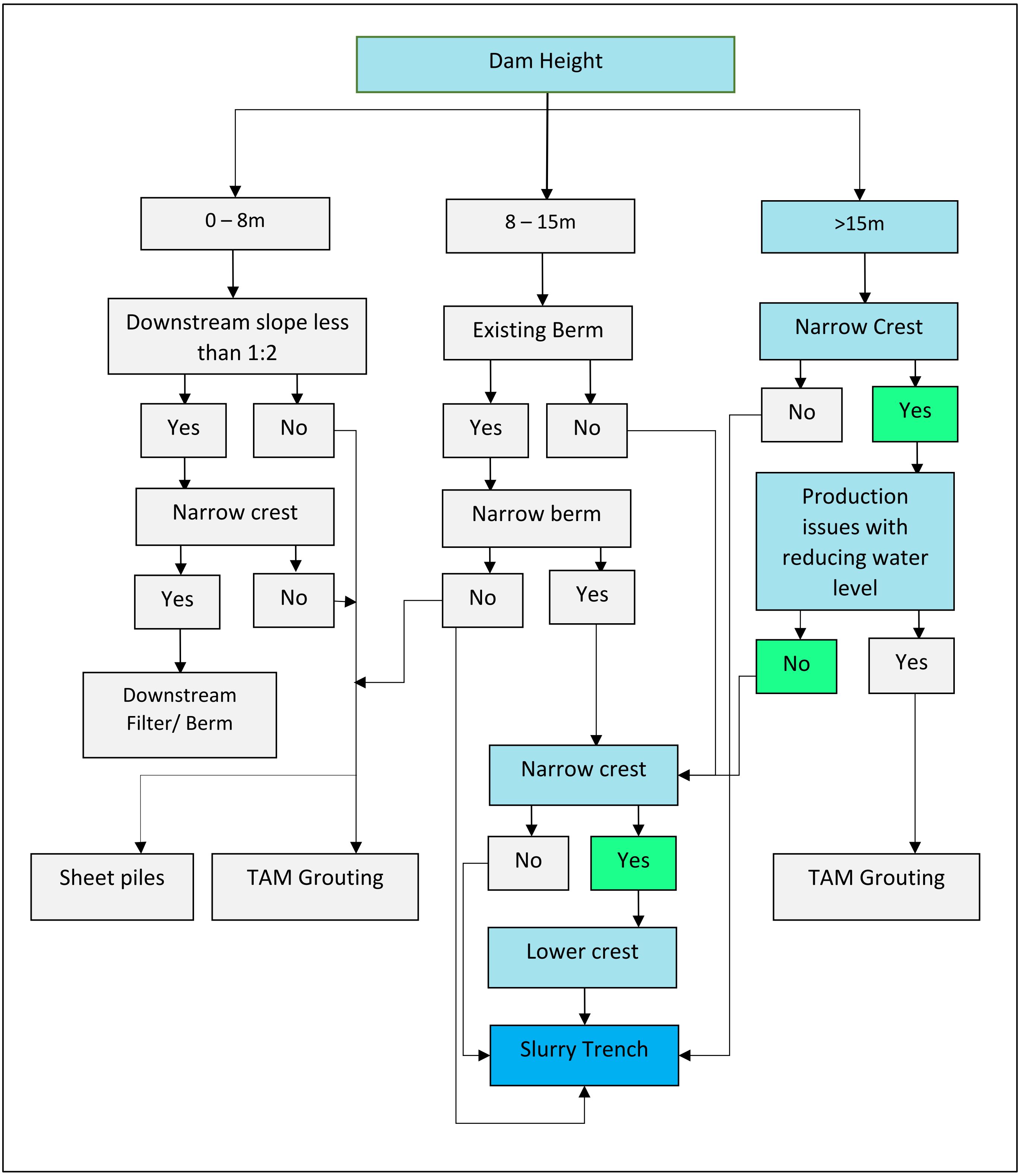
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 8: [✂]



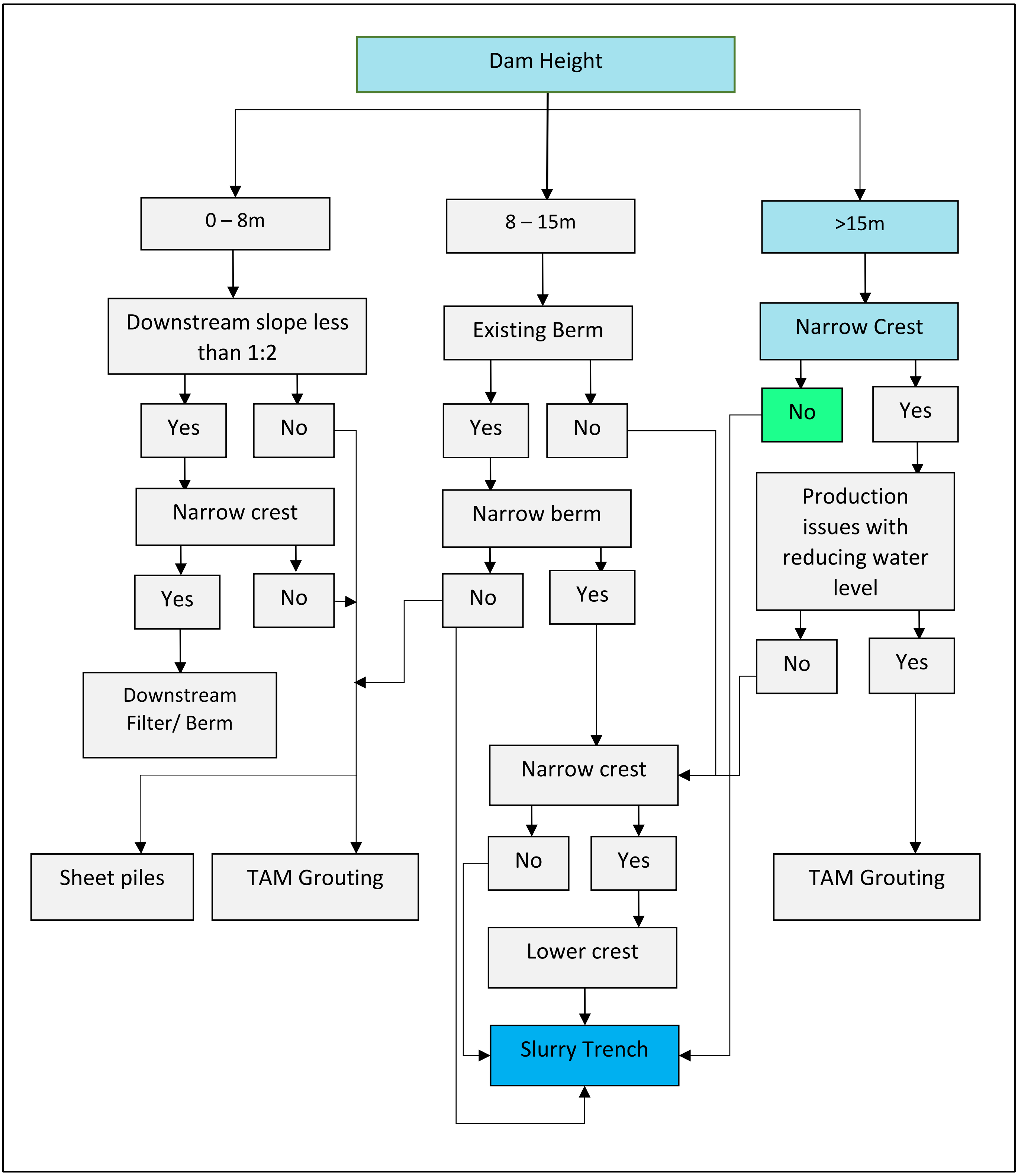
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 9: [✂]



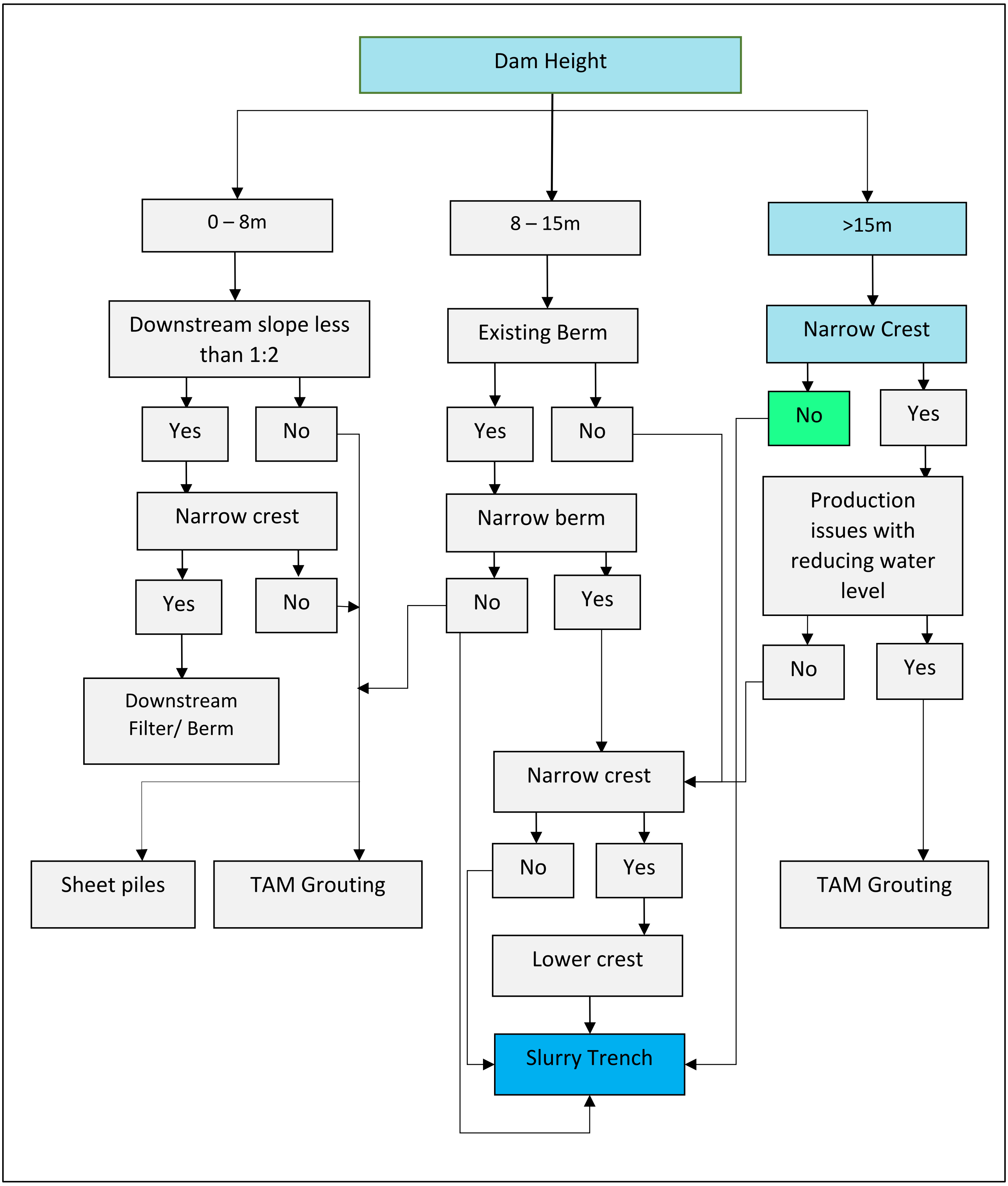
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 10: [✂]



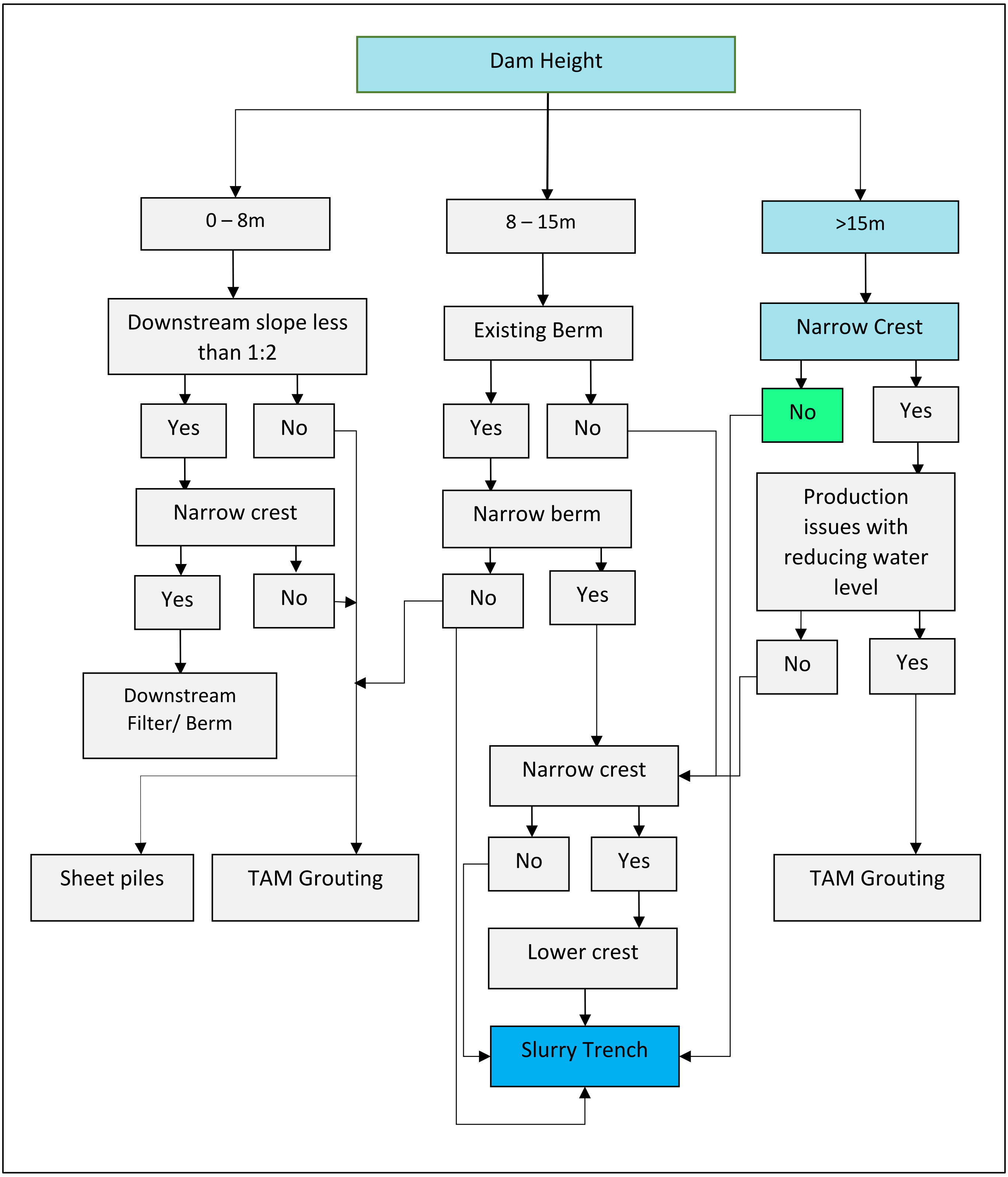
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 11: [✂]



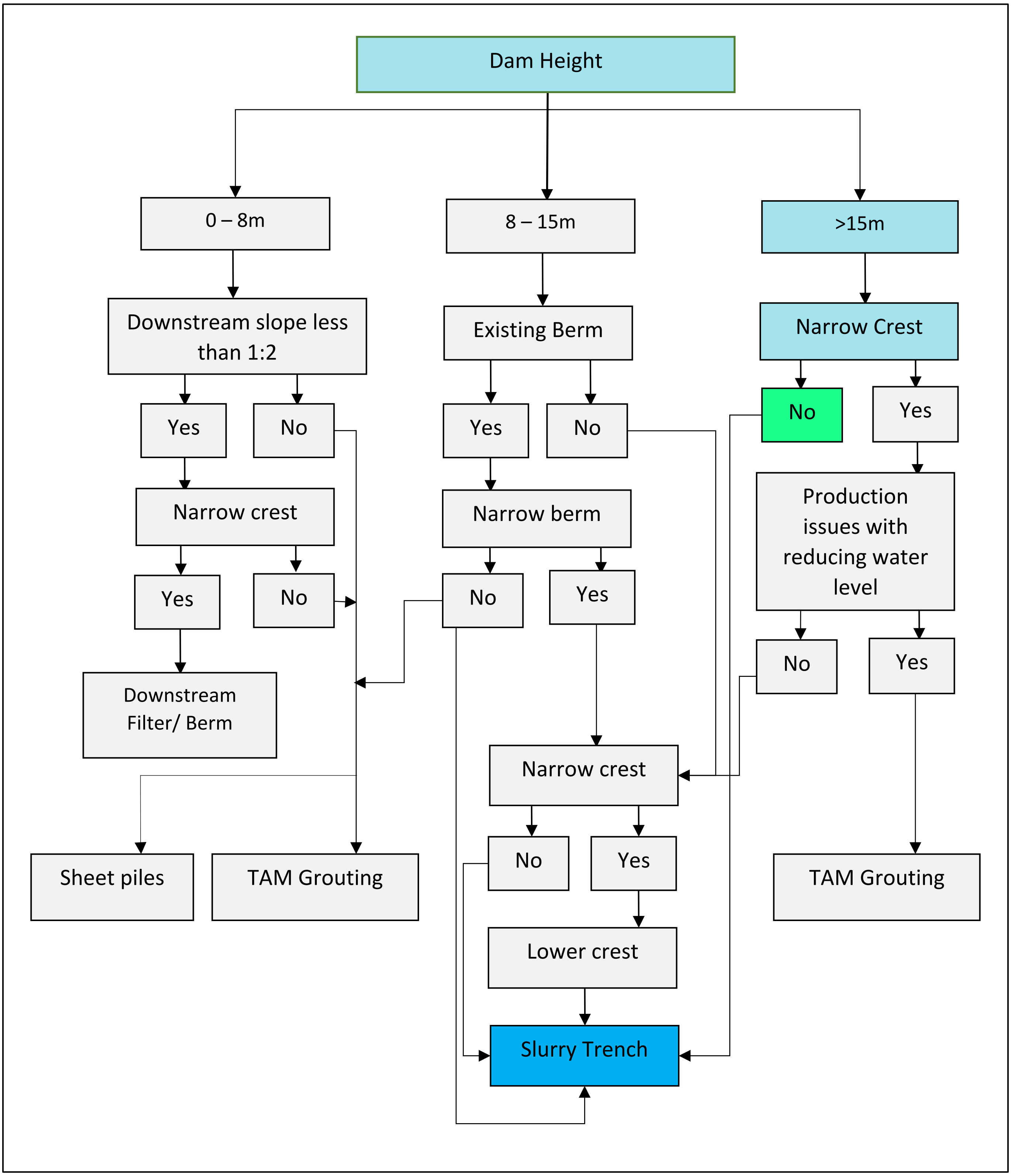
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 12: [✂]



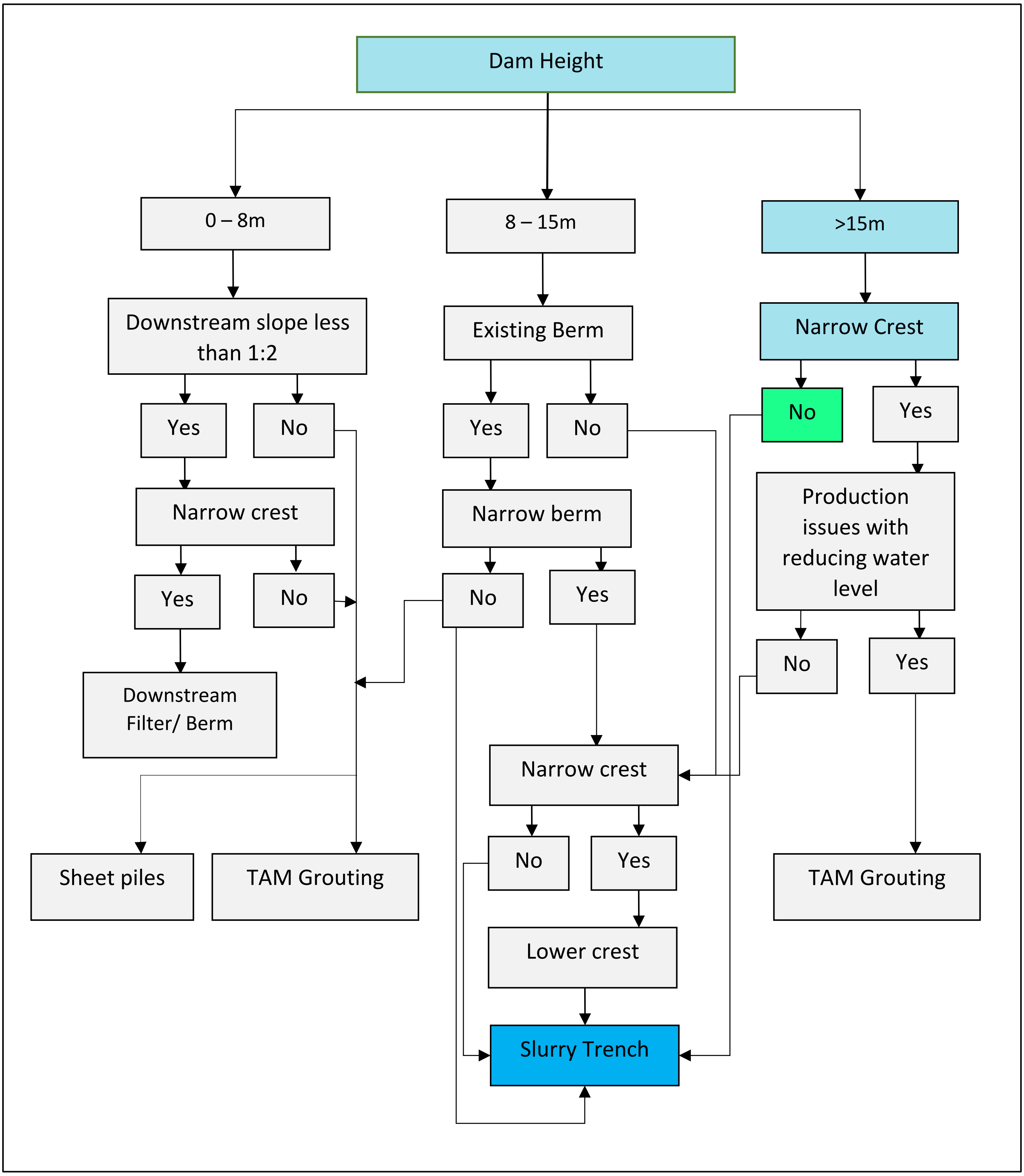
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 13: [✂]



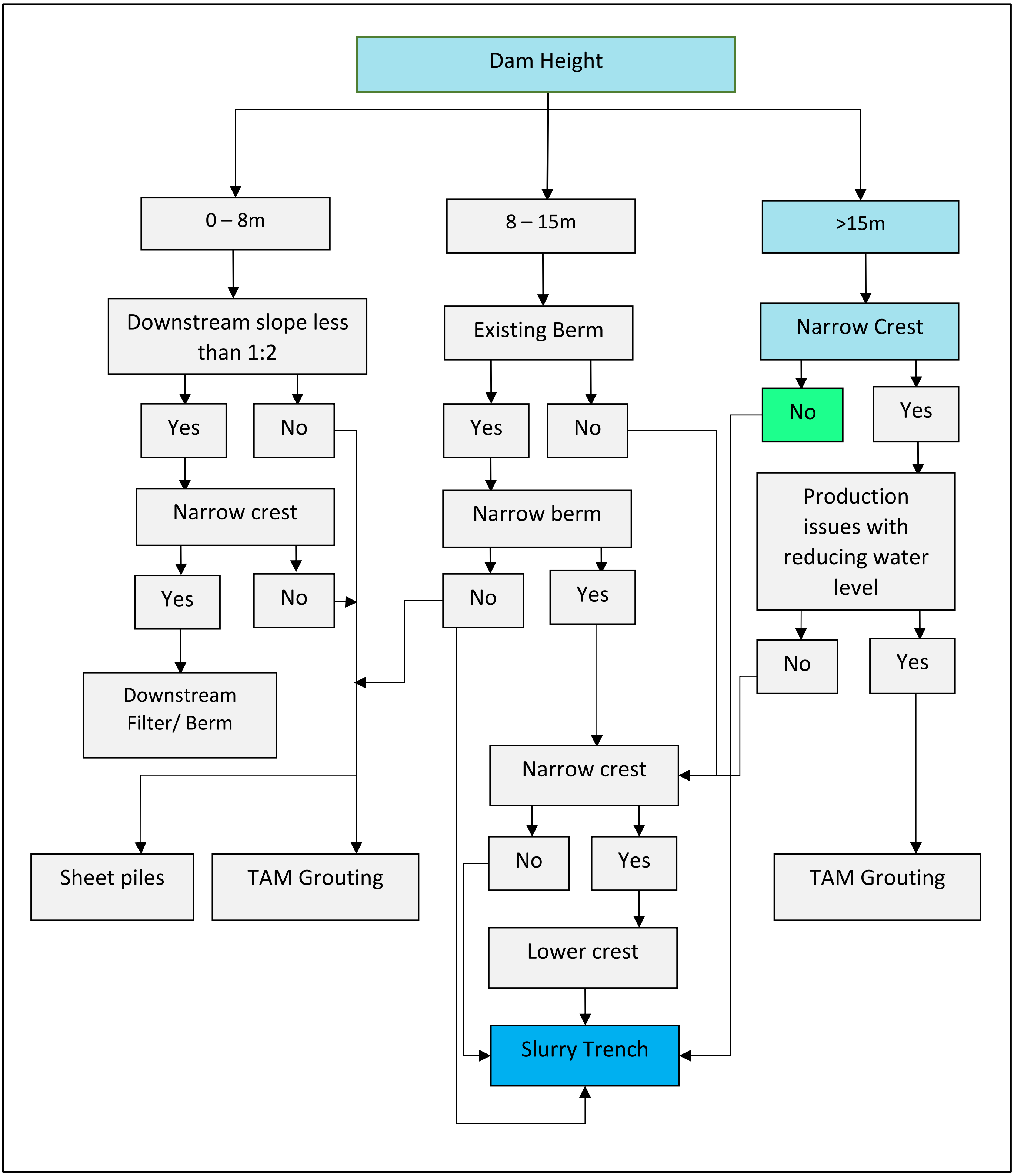
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 14: [✂]



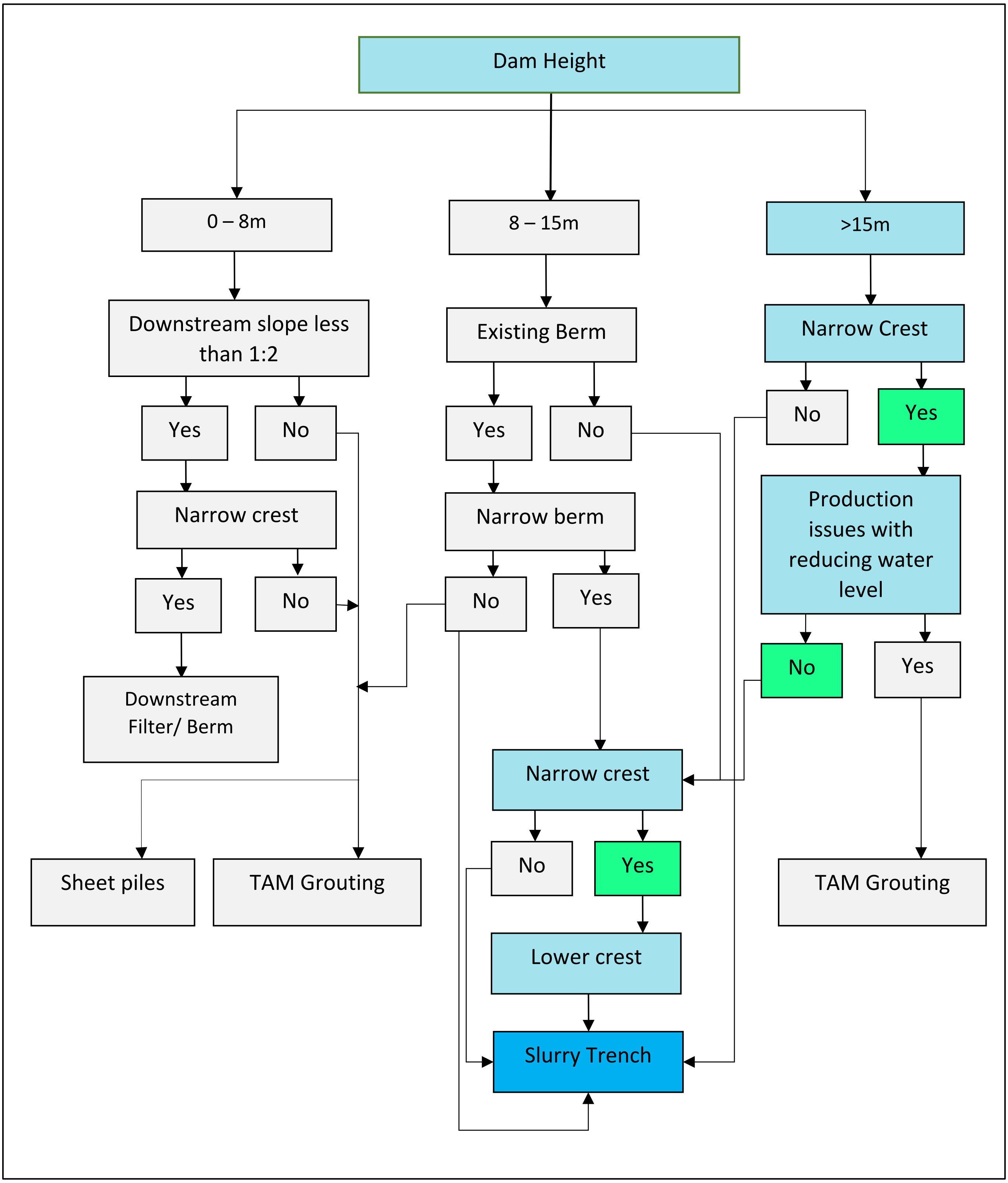
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 15: [✂]



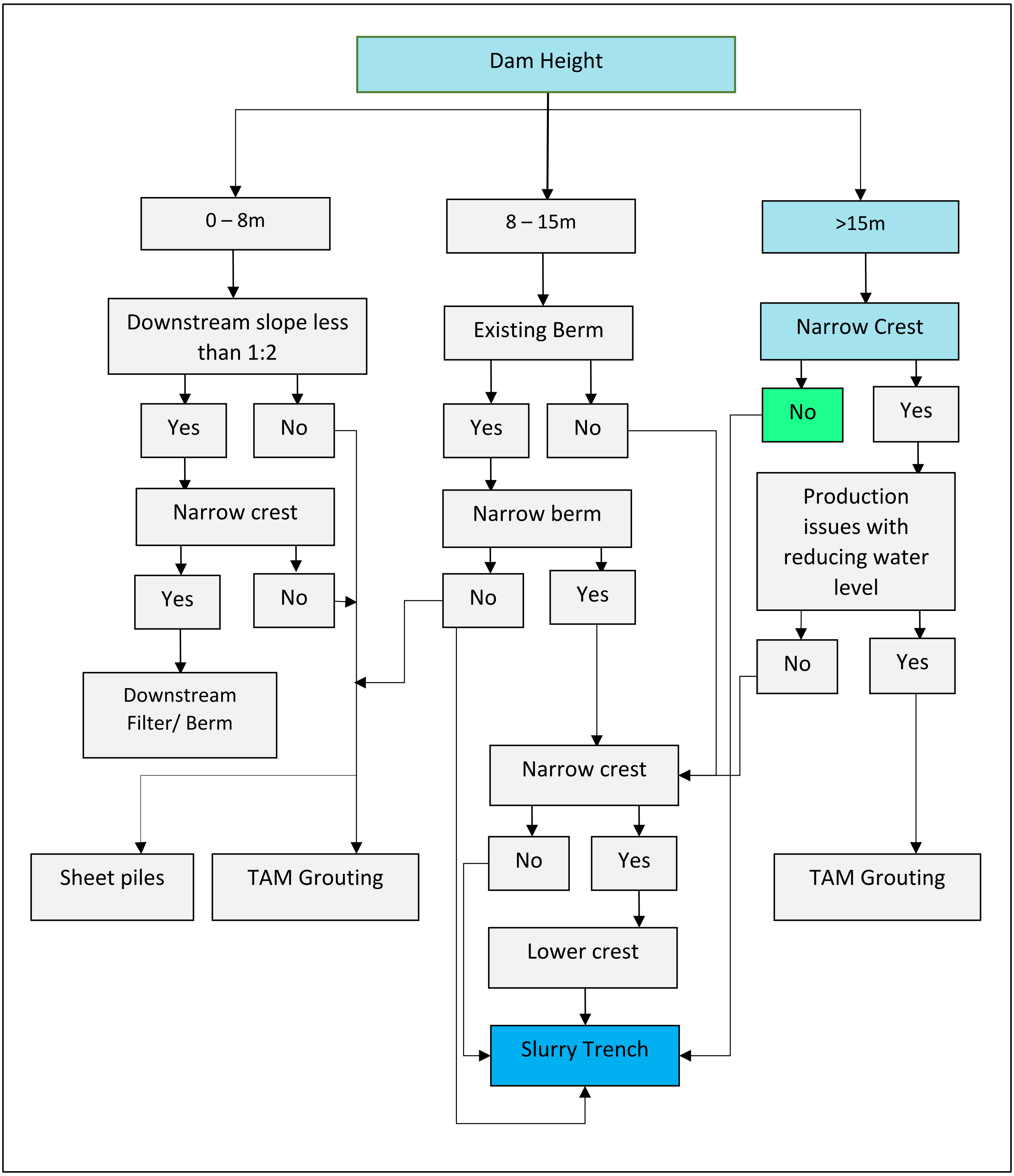
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 16: [✂]



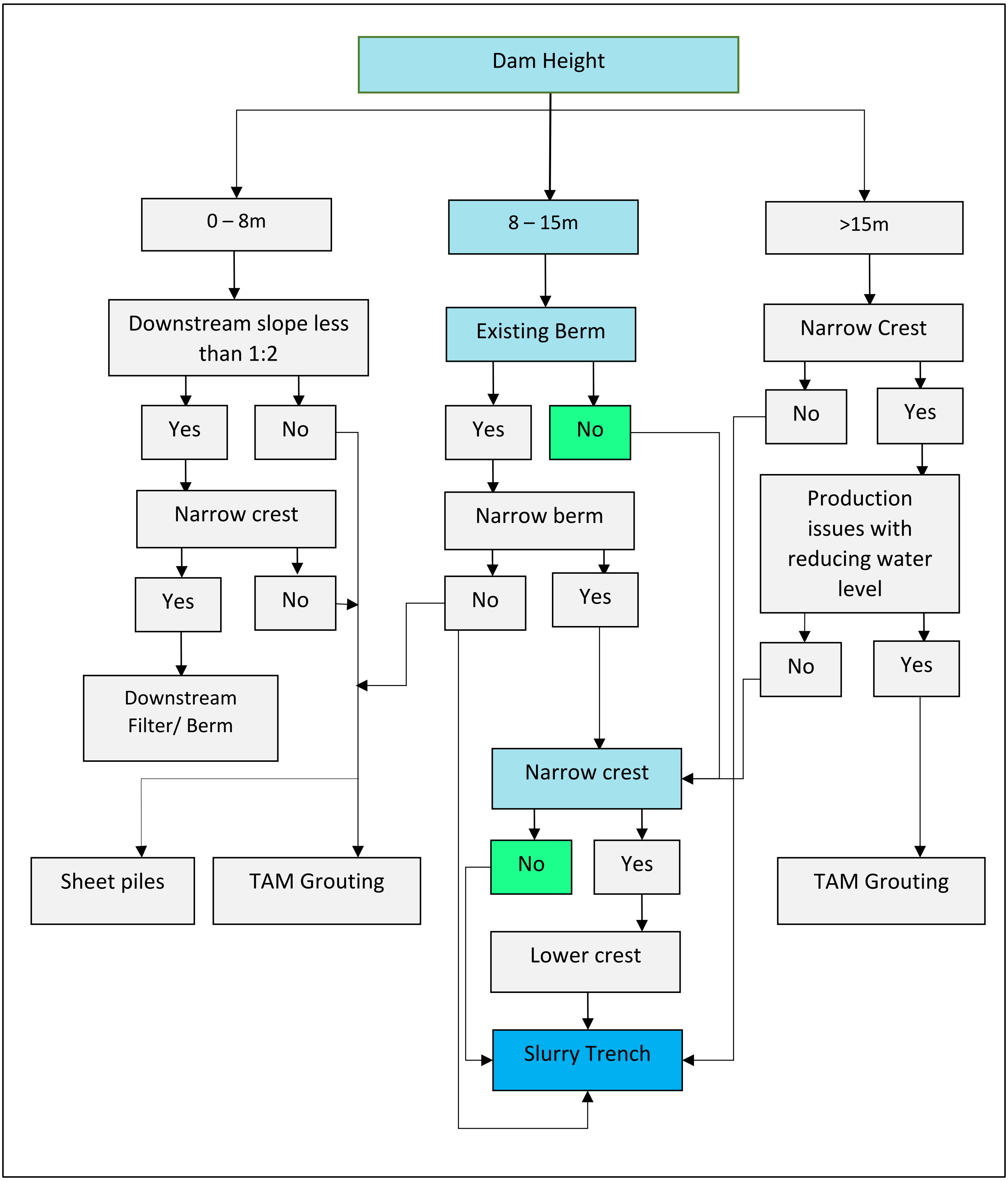
This solution is designed to reduce the annual probability of failure of the dam [✂].

Figure 17: [✂]



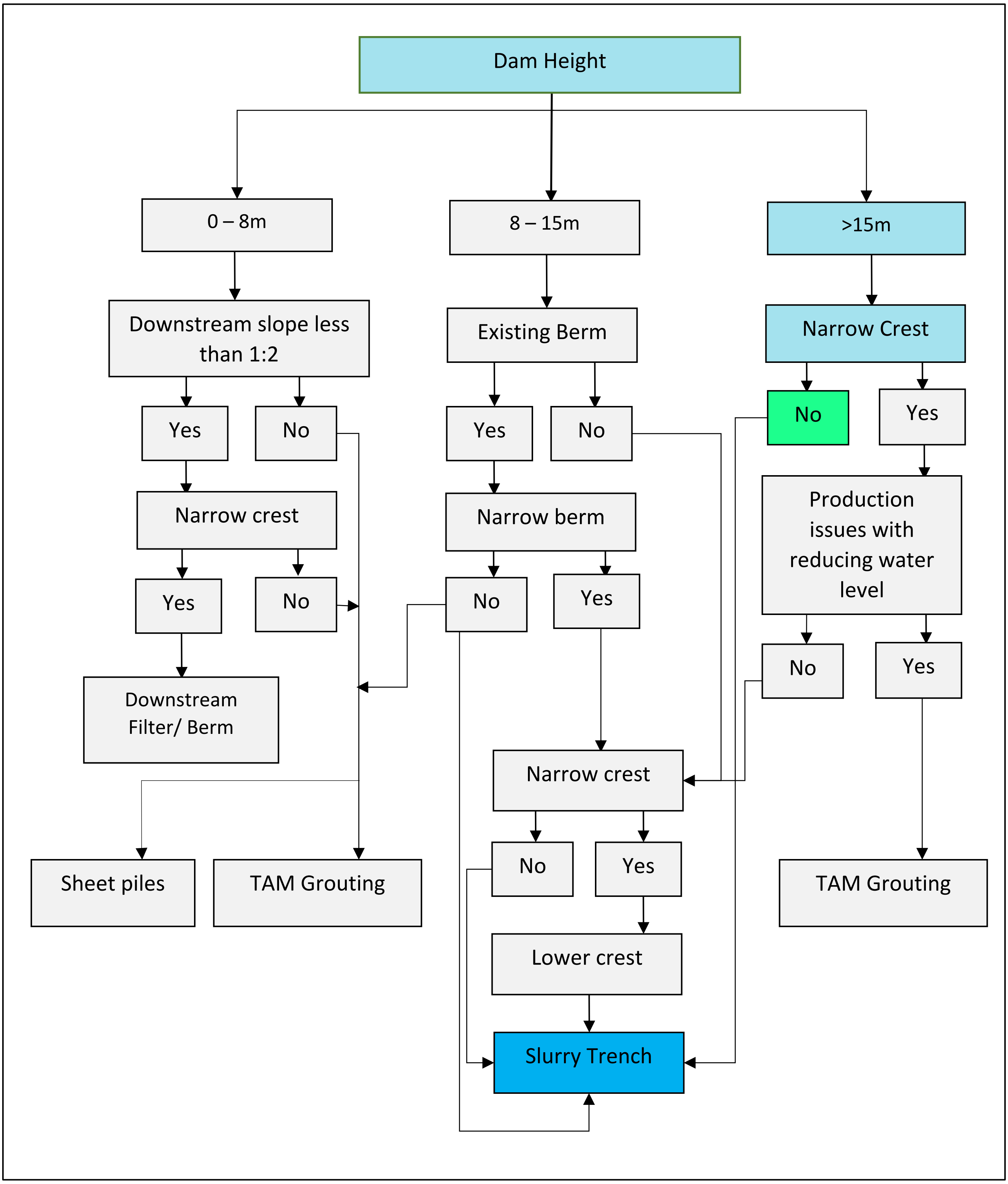
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 18: [✂]



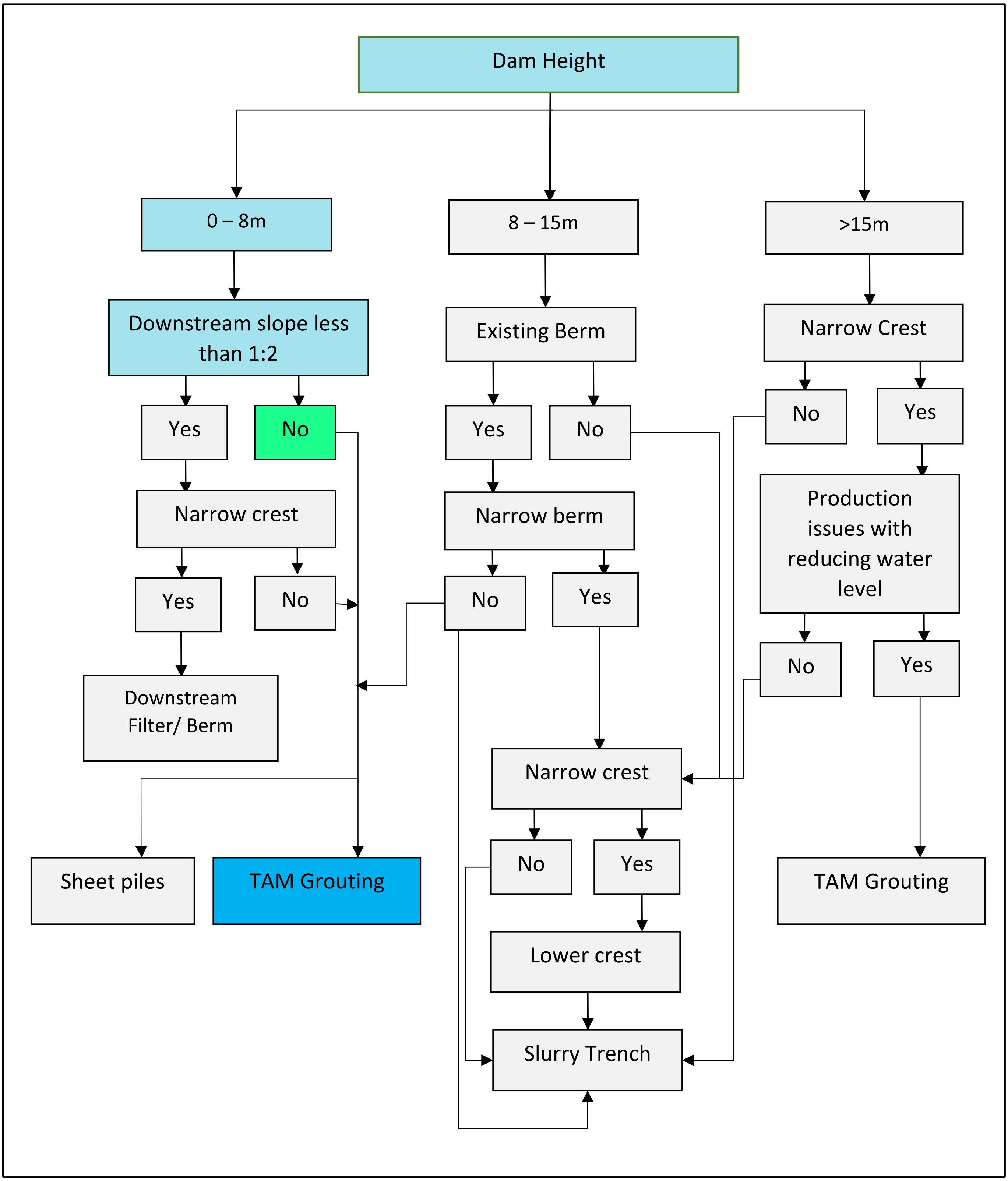
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 19: [✂]



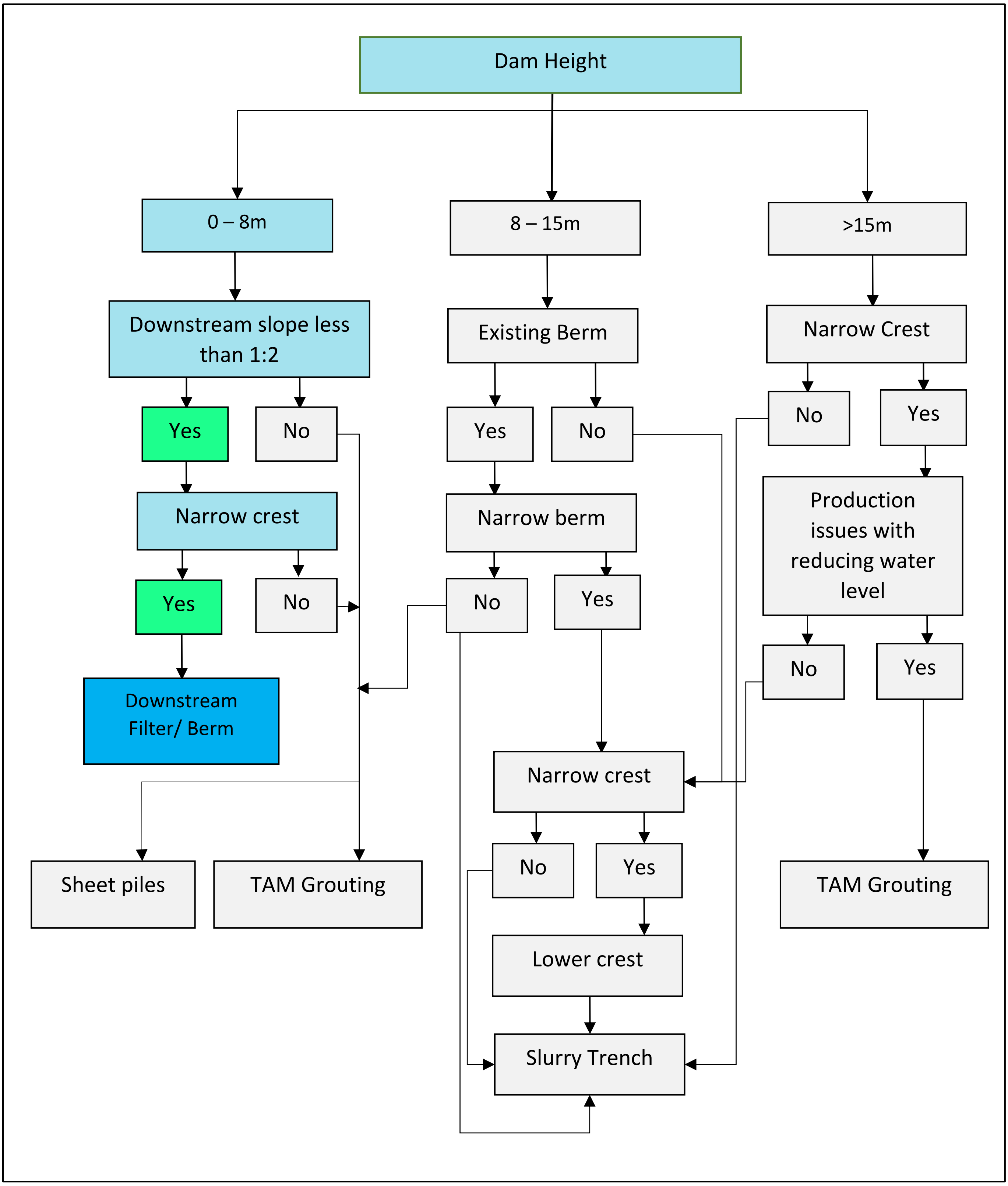
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 20: [✂]



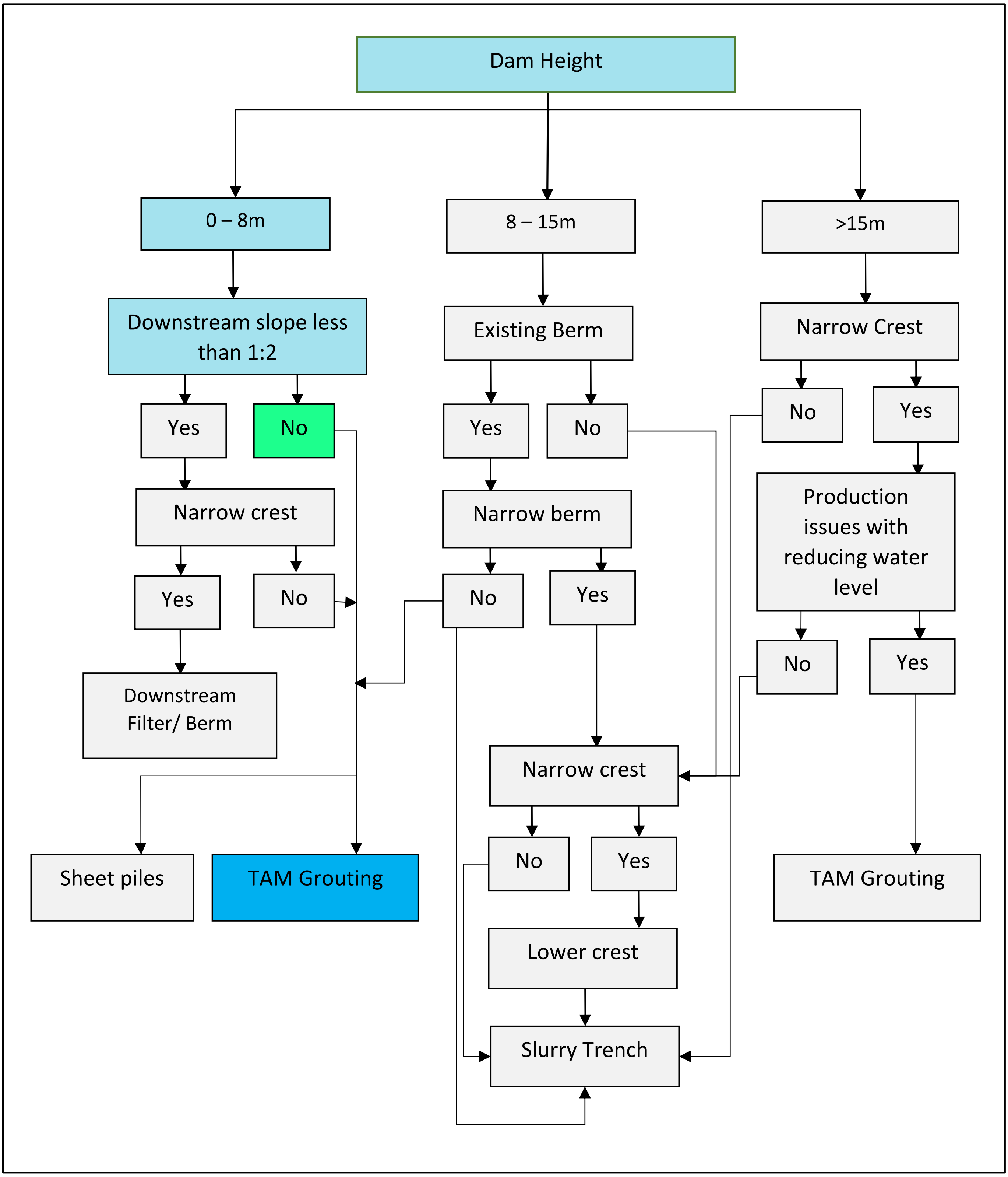
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 21: [✂]



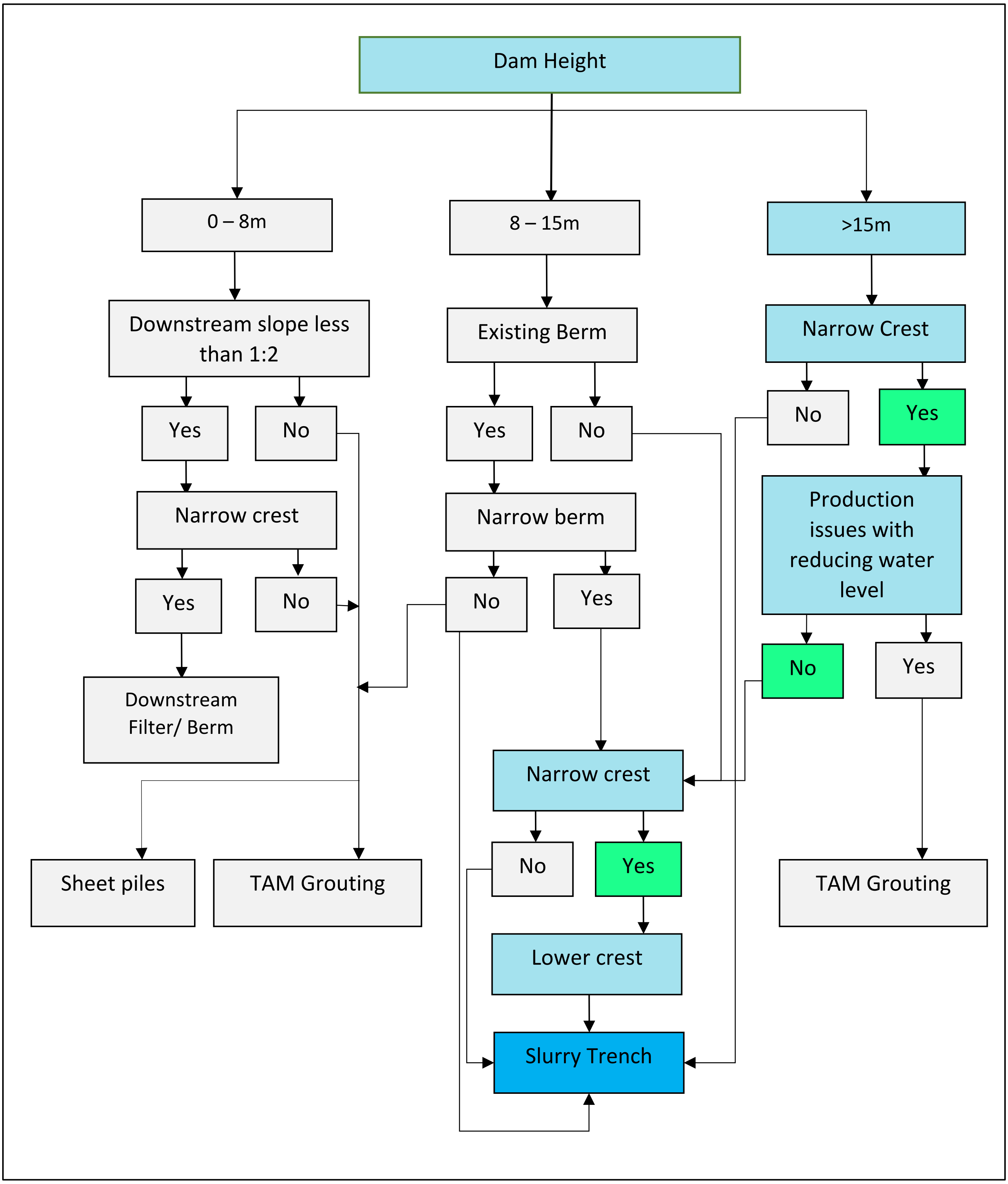
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 22: [✂]



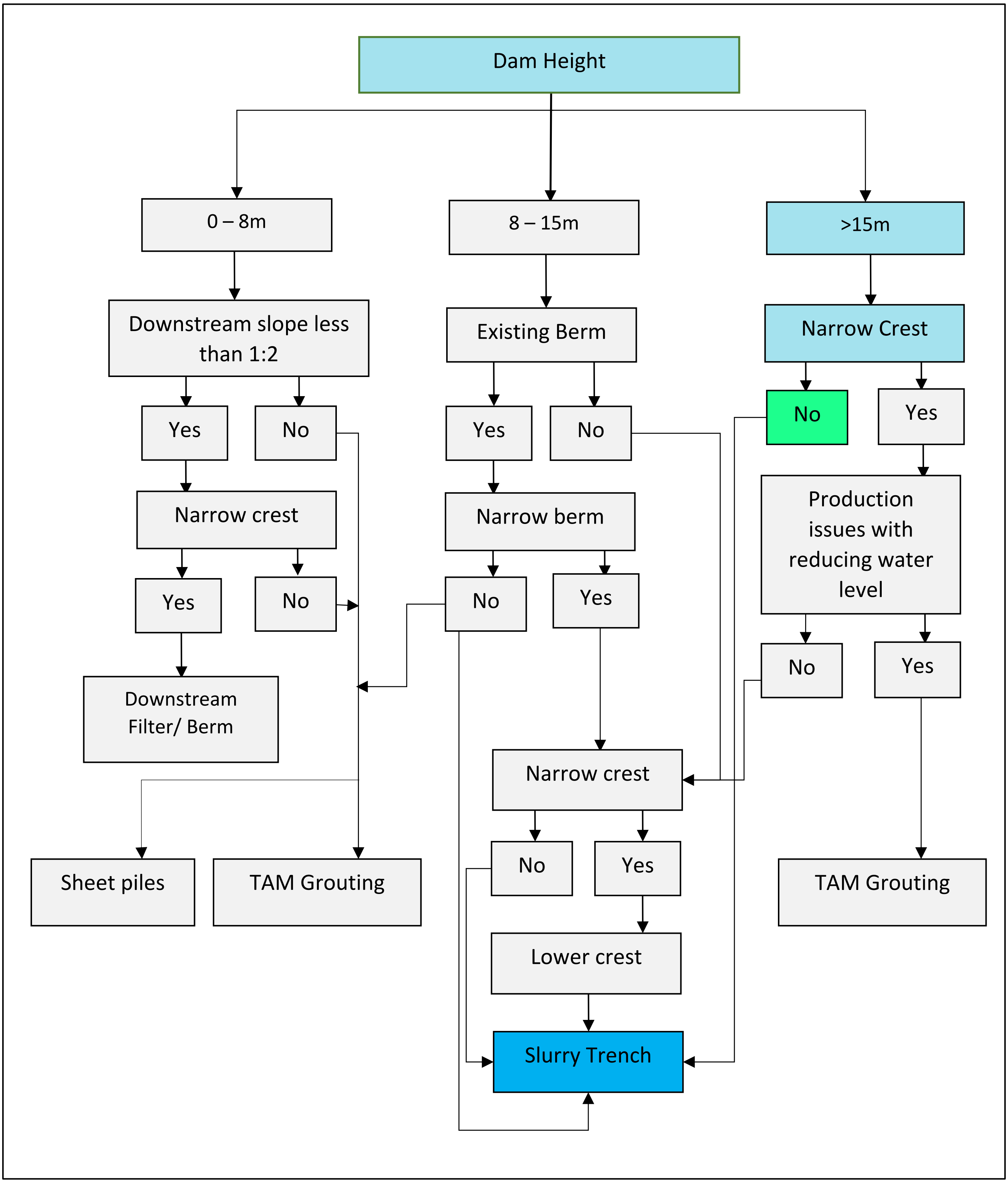
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 23: [✂]



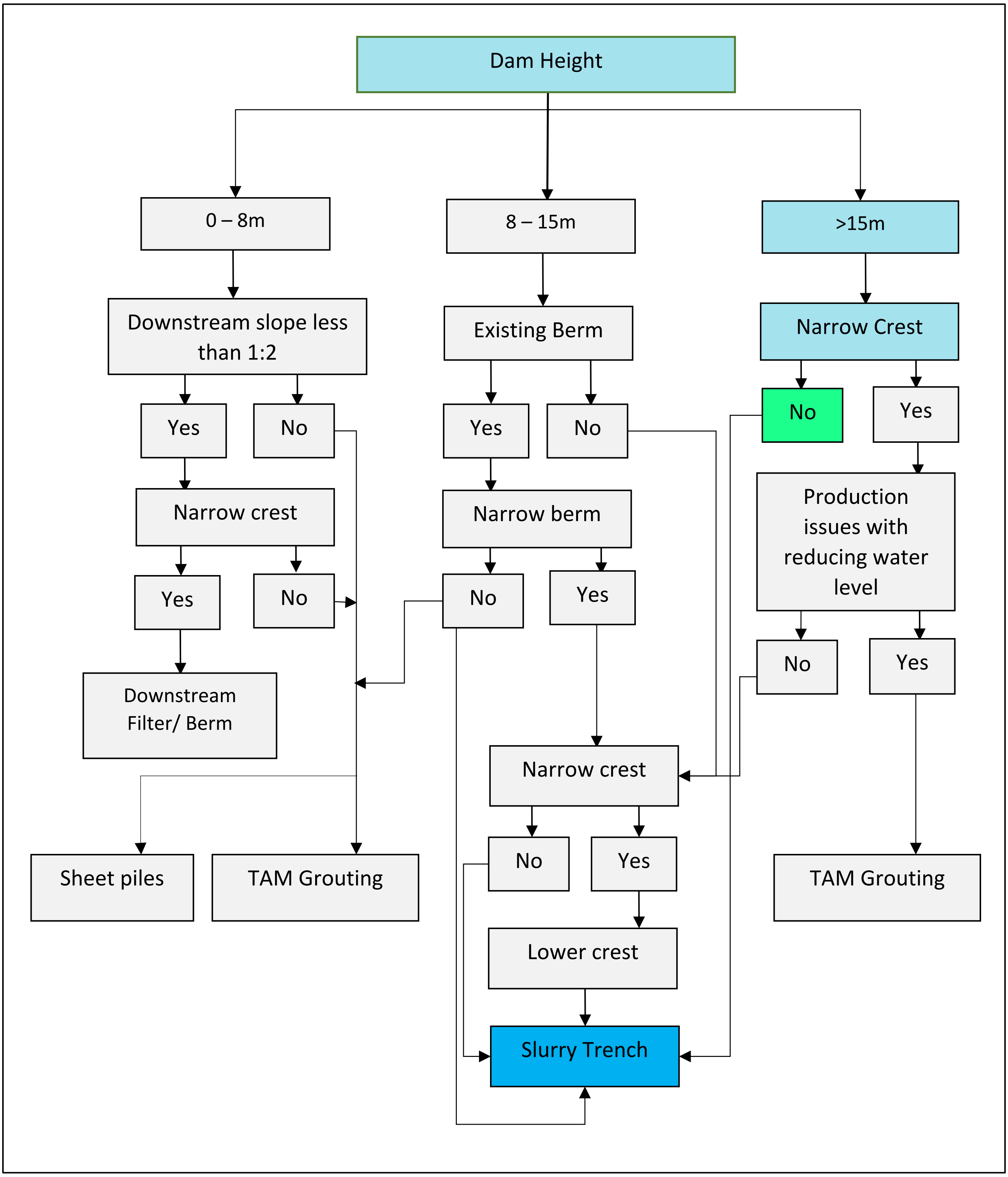
This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 24: [✂]



This solution is designed to reduce the annual probability of failure of the dam to [✂].

Figure 25: [✂]



This solution is designed to reduce the annual probability of failure of the dam to [✂].

Appendix D United Utilities approach to capital investment

At Price Review stage, the United Utilities Commercial, Engineering and Capital Delivery department will review the capital investment programme to determine the typical type, size, value and complexity of solutions required for the assets to be renewed or maintained across the water and wastewater infrastructure and non-infrastructure programme to ensure the procurement strategy is fit for purpose to deliver an efficient programme.

We will then review the procurement strategy to determine what type of commercial construction, supply, engineering and consultancy frameworks need to be procured to ensure that UU has the most appropriate partners in place to deliver the capital programme below budget and to the right timescales .

Each framework will go through a rigorous procurement process so that each of the bidders commercial/value, technical, health and safety, relevant experience and staff CV's can be assessed and scored, to ensure that the Framework partners chosen will have demonstrated through a competitive process, their proven technical expertise and efficient commercial pricing.

In addition, when these framework partners are utilised, dependent on the need, then they will either undergo a further mini-competition through the framework or they will price a single source solution, but in either approach their pricing levels will be in accordance with their competitive framework pricing levels, and they will be checked and validated against the UU independent internal estimate, and challenges will be made as necessary to ensure commercial value is maximised and technical compliance.

If the framework approach is not appropriate for any project, UU also procures direct to the market where it seeks competitive tenders from a range of suppliers/contractors and allows market forces to ensure a competitive price is obtained. These are also validated against the UU independent internal estimate.

Once the Contract has been awarded to the successful bidder, the contract is rigorously managed by the UU project team in accordance with the Contract. The UU Project Manager, Quantity Surveyor, Construction Supervisor and Engineering representative will ensure that any additional variations are kept to a minimum and valued appropriately, all costs and payments are in accordance with the contract and the contractor is being monitored on site to ensure efficient delivery of construction plant and equipment and to UU specification and standards.

Each project will be audited by UU's cost assurance consultants to ensure that only legitimate costs are paid.

Final accounts at the end of each project are agreed timely and there is a clear escalation process to deal with any disagreements or disputes by use of senior representatives.

UU continuously seeks lessons learnt to improve efficiency in future processes and seeks innovation to continuously improve leaner solutions and ways of working.