



Bray Park Weir Tidal Protection Project

PROJECT REFERENCE GROUP REPORT TO TWEED SHIRE COUNCIL

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Prepared for: Tweed Shire Council

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**Southern Cross
University**

School of Business & Tourism

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Front cover photograph:

Bray Park Weir with concrete blocks and sandbags ready to be deployed before potential overtopping events. Murwillumbah, NSW. Pascal Scherrer.

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EXECUTIVE SUMMARY

The Tweed District Water Supply is a run-of-river supply augmented by releases from Clarrie Hall Dam. Raw water is drawn from upstream of Bray Park Weir, effectively a salt water barrage, in the Tweed River. On 21 and 22 August 2017, the weir was overtopped, causing the raw water to be contaminated by salt water. As a consequence, the raw water for the Bray Park Water Treatment Plant was contaminated by salt resulting in a water-quality incident. Research commissioned by Tweed Shire Council (TSC) highlights that the occurrence of such incidents is predicted to increase in frequency and severity.

Due to the risk to the Tweed District Water Supply, the impact on landowners adjoining the weir pool and industries within Tweed Shire that rely on a safe and secure water supply, TSC established the Bray Park Weir Tidal Protection Project. In May 2018, a Project Reference Group (PRG) was established for the Bray Park Weir Tidal Protection Project to assist TSC in identifying ways to mitigate the risk of salt water contamination of the Tweed District Water Supply. The PRG consists of twelve members of the Tweed Shire community, including two elected members of TSC. Interests represented include neighbouring rural property owners; neighbouring residential property owners; Upper Weir Property Association; Lower Oxley Land Owner Group; Landowners south of Slippery crossing; Tweed Canegrowers; farmers; recreational river users; recreational fishers; fish habitat conservation; critical water users and the Tweed Shire electorate.

Over a series of five facilitated workshops, the PRG defined the problem, identified issues and constraints and proposed a number of potential solutions for further evaluation. Evaluation criteria and their relative weightings were determined. An external consultant to TSC, Hunter H20 (HH20), was then engaged to further develop those options and provide commentary against the criteria which incorporated financial, social and environmental impacts. HH20 also nominated additional options for consideration.

Three further workshops then served to consider the HH20 report and prioritise the options through a scoring process. During this process, several options were identified as exclusions (not suitable to pursue), standalone options (suitable as replacement of current situation) or combination options (suitable as part of a suite of mitigation measures, but not sufficient on their own). Both the standalone and the combination options were then scored and ranked in order of preference.

The PRG recommends to TSC to consider the following preferred options (in order of preference) for detailed investigation as solution to the problem of salt water contamination of the Tweed District water supply:

Standalone options:

- 1 Hinged barrier across whole weir (Option 8A in HH20 report)
- 2 Optimised present practice - Blocks only (Option 1A in HH20 report)
- 3 Narrowing of the weir and passive/automatic temporary barrier (Combination of Options 8B & 8C in HH20 report) - *Note that this option should only be considered if it has demonstrated net benefits over a barrier across the whole weir.*

Combination options:

- 1 Interconnection with Gold Coast and or SEQ Water (Option 11 in HH20 report)
- 2 Weir sump pump. Passive (Option 3B in HH20 report)
- 3 Bray Park WTP bypass. Active (Option 2 in HH20 report)
- 4 Weir sump pump. Active (Option 3A in HH20 report)
- 5 Move inlet out of contamination area Byangum Bridge (Option 9A in HH20 report)
- 6 Move inlet out of contamination area 3.4Km upstream (Option 9B in HH20 report)

This report to TSC serves to summarise the process and the resulting recommendations by the PRG. The next step is for TSC to consider the PRG's advice and to decide on a preferred way forward.

1 INTRODUCTION

In May 2018, a Project Reference Group (PRG) was established by Tweed Shire Council (TSC) to assist them in identifying ways to mitigate the risk of salt water contamination of the Tweed District Water Supply. The PRG consists of twelve members of the Tweed Shire community, including two Councillors. Since their first meeting on 25 May 2018, the PRG worked to identify a preferred option or suite of measures. This report by the PRG serves to advise Council of its findings to assist them in their consideration of mitigation measures.

2 CONTEXT

The Tweed District Water Supply is a run-of-river supply augmented by releases from Clarrie Hall Dam. Raw water is drawn from upstream of Bray Park Weir, effectively a salt water barrage, in the Tweed River.

On 21 and 22 August 2017, the weir was overtopped, causing the raw water to be contaminated by salt water. As a consequence, the raw water for the Bray Park Water Treatment Plant was contaminated by salt resulting in a water-quality incident.

Prior to the event, in June 2017, Council had engaged Water Research Laboratory (WRL) to determine the risk to the Tweed District Water Supply posed by the combination of sea level rise and lower river flows at Bray Park Weir due to climate change. The reason for the August 2017 overtopping was a combination of low flow in the Tweed River, high tides and a sea level anomaly. As a result of the overtopping events in August 2017, the risk arising from sea level anomalies was added for consideration.

The WRL Report dated 23 August 2017 indicates an increasing frequency of Bray Park Weir being overtopped by estuarine water, increasing frequency of flows insufficient to hold back the salt water coming up the river and increasing magnitude and extent of overtopping over time. Since then, Council has also become aware of a further risk to the Tweed District Water supply: meteotsunamis. Meteotsunamis are waves caused by a rapid change in atmospheric pressure resulting in the propagation of waves, which may travel up rivers to barrages.

In summary, the Bray Park Weir pool, which services the Tweed District Water Supply, irrigators and those drawing water from the weir pool for stock and domestic purposes is predicted to be contaminated with salt water more frequently and more severely into the future.

3 THE BRAY PARK WEIR TIDAL PROTECTION PROJECT

Due to the risk to the Tweed District Water Supply, the impact on landowners adjoining the weir pool and industries within Tweed Shire that rely on a safe and secure water supply, Tweed Shire Council established the Bray Park Weir Tidal Protection Project. A Project reference group (PRG) was established and an independent facilitator was engaged to work with the PRG over a series of workshops through the definition of the problem and draw out issues and constraints, leading to the identification of potential solutions and the selection of preferred options and mitigation measures¹. The project website (<https://www.yoursaytweed.com.au/BrayParkWeir>) provides a publicly accessible repository of information considered by the PRG as well as meeting minutes.

The PRG identified a number of potential options for further evaluation, established a series of evaluation criteria and determined relative weightings of these criteria. Hunter H20 (HH20), an external consultant to TSC, was then engaged to further develop those options and provide commentary on the options against the criteria which incorporated

¹ Note that during the project, TSC implemented the following two procedural changes discussed by the PRG: a) automatic shut-down of raw water in-take in the event of elevated salinity levels; and b) leaving concrete blocks in place on the weir during no-flow periods (sought to reduce costs associated with block installation/removal and reduce OHS risks while not imposing deleterious impacts on landowners, aquatic species or the environment).

financial, social and environmental impacts. After consideration of the HH20 report, the PRG proceeded to prioritise the options through a scoring process. During this process, several options were identified as exclusions (not suitable to pursue), standalone options or combination options. Both the standalone and the combination options were then scored and ranked in order of preference. This report to TSC summarises the process and the resulting recommendations by the PRG. The next step is for TSC to consider the PRG’s advice and to decide on a preferred way forward.

4 THE PROJECT REFERENCE GROUP (PRG)

The PRG consists of twelve members of the Tweed Shire community, including two Councillors (Figure 1). To date, PRG members jointly contributed at least 500 volunteer hours to the Bray Park Weir Tidal Protection Project. All participants cooperatively worked through the process to find a solution that is cost effective whilst having minimal negative impact on the river and associated environment and property owners.



Figure 1. Project Reference Group members: (l-r): Pryce Allsop, Katie Milne, Peter Robson, Brett Sander, Glenn Jones, Nic Cornish (for James Perrin), Pascal Scherrer (Facilitator), Neil Baker, Corey Crosthwaite, Simon Fitzpatrick, Michael McDonald and Ken Baker. Absent: Peter Tomsett. (Photos: Brenda Hannigan)

The PRG is meant to be representative of a broad cross-section of the Tweed Shire community. Table 1 below outlines the members and the interests that they represent.

Table 1. List of Project Reference Group (PRG) members and the interests they represent

<i>Name</i>	<i>Representing/Interests*</i>
Ken Baker	Farmers; Neighbouring landowners
Peter Robson	Engineer; Recreational river users
Brett Sander	Engineer; Residential property owners
Corey Crosthwaite	Farmers; Upper Weir Property Association
Neil Baker	Farmers; Upper Weir Property Association
Glenn Jones	Farmers; Landowners south of Slippery Crossing, along Solomons Road to Old Lismore Road south
Peter Tomsett	Retired engineer; Lower Oxley Land Owner Group
James Perrin	Critical water users
Simon Fitzpatrick	Recreational fishers; Fish habitat conservation
Michael McDonald	Tweed Canegrowers
Katie Milne	Councillor – Mayor; Tweed Shire electorate
Pryce Allsop	Councillor; Tweed Shire electorate

Key interests represented through PRG members include: neighbouring rural property owners; neighbouring residential property owners; Upper Weir Property Association; Lower Oxley Land Owner Group; Landowners south of Slippery crossing; Tweed Canegrowers; farmers; recreational river users; recreational fishers; fish habitat conservation; critical water users; Councillors.

Notable interests that were not represented include: water resources department (NSW DPI); water transporters; Aboriginal perspectives; health industry; future population; high-volume treated-water users; conservation perspective (EPA/OEH). The PRG was gender imbalanced with eleven male and one female representatives.

Relevant TSC staff and invited experts also attended meetings throughout the course of the project to provide council updates, issue specific information and offer expert advice. These include:

Tweed Shire Council Staff

- Rob Siebert - Coordinator: Strategy & Business Management - Water & Wastewater Unit
- Brenda Hannigan - Stakeholder Engagement & Communications (Engineering)
- Peter Haywood - Water / Wastewater Operations Coordinator
- Michael Wraight - Water and Sewer Capital Works Engineer
- Elizabeth Seidl - Engineer Water Efficiency and Connections
- Sandra Freeman - Administrative Officer: Project Support

Guest Experts

- Jonathan Yantsch - Aquatic Ecosystems (North Coast, Wollongbar) Aquatic Environment, Primary Industries NSW
- Anne-Marie Turnbull - Hunter H2O Consultant: Project Manager
- Matt Bloomfield - Hunter H2O Consultant

5 APPROACH & TIMELINE

The PRG met for eight facilitated sessions and a start-up meeting with Hunter H2O between 25 May 2018 and 25 February 2020 as outlined in Figure 2 below.

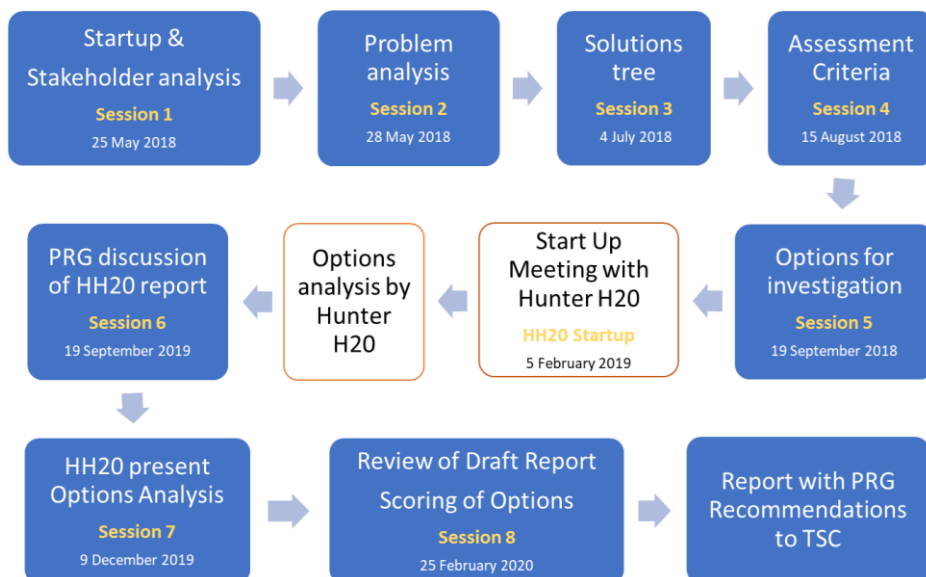


Figure 2. Overview of the PRG workshop sessions and the approach leading to the recommendation report to TSC.

The facilitator guided the PRG through a stakeholder analysis, a problem analysis and the development of a solutions tree with identification of a suite of mitigation options or measures and the development of assessment criteria for the evaluation of those options. A selection of options was then presented together with the assessment criteria to HH2O for detailed analysis and evaluation. The resulting report by HH2O was then reviewed by the PRG before the options were scored for ranking in order of preference.

5.1 Problem & Solutions Trees

The problem analysis involved the development of a problem tree identifying the problem, the causes of the problem and the effects of the problem as outlined in Figure 3 below (click [here](#) for further information on problem tree analysis). Through this process, a range of climatic, physical and engineering/operational causes were identified. Similarly, effects arising from the problem were examined across the economic, environmental and social dimensions.

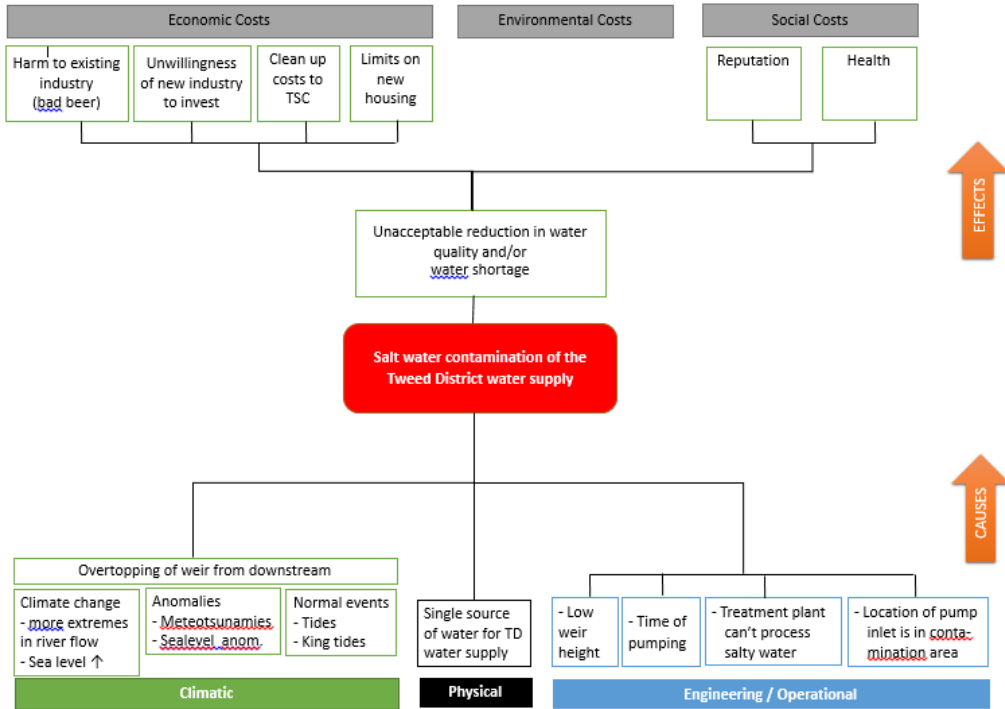


Figure 3. Initial problem tree compiled by the PRG at the 28 May 2018 workshop (Session 2).

The problem tree was then flipped into a solutions tree whereby the problem was reframed as a solution, each cause was considered with view to that solution and the positive effects therefrom were mapped (see Figure 4 below).

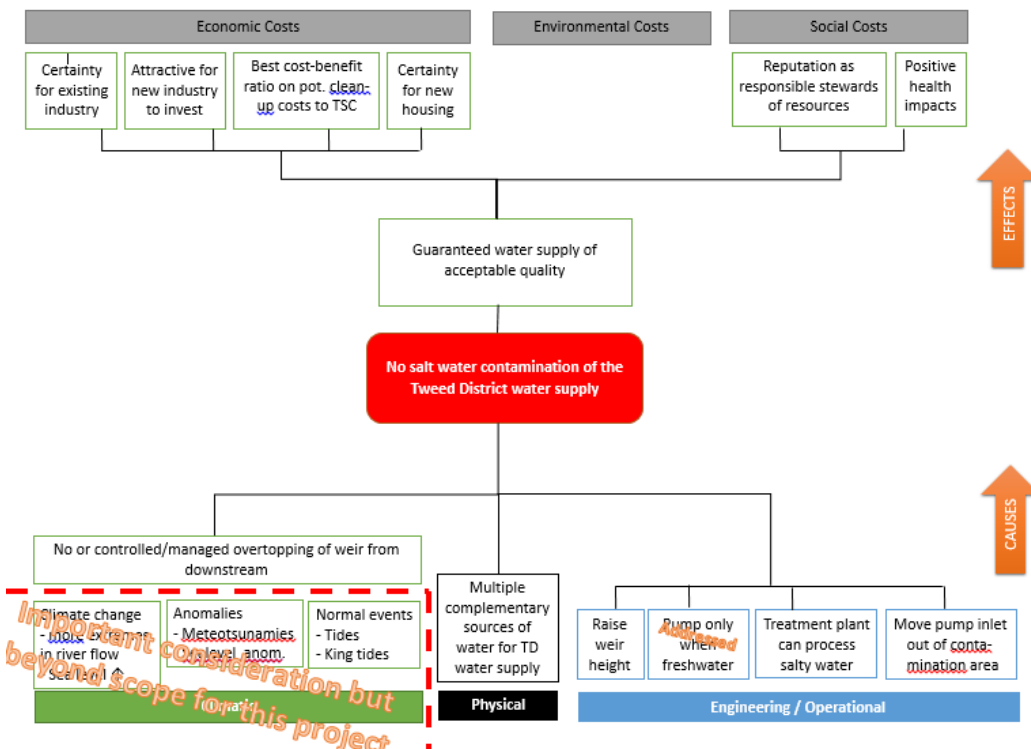


Figure 4. Initial solutions tree compiled by the PRG at the 4 July 2018 workshop (Session 3).

6 IMPORTANT CONSIDERATIONS FOR SOLUTIONS

Throughout sessions 1 to 3, a range of values and considerations of importance to PRG members were identified and compiled (see Table 2 below). Additional contributions from email communications with TSC and posts on the Your Say Tweed project site were also incorporated. This list then formed the basis for the development of the evaluation criteria for potential solutions.

Table 2. Important considerations for solutions compiled from Sessions 1-3, emails and Your Say Tweed.

CATEGORY	CONSIDERATIONS FOR FUTURE SOLUTIONS
Environmental	<ul style="list-style-type: none"> • Suitable with regards to flooding (e.g. must not retard flood flows; increase upstream flood heights; no permanent lifting of weir) • Effect on normal river flows • Ready for increase in severity, variability and unpredictability of extreme events (floods & droughts) • Ready for increase in conditions contributing to overtopping (periods of low river flow & rise in sea level) • Neutral or positive conservation outcomes (e.g. ensure fish passage/aquarian migration at weir; maintain environmental flows) • Potential impacts on environment of river related to fresh/salt water balance/boundary • Impact on salinity of water table • Apply precautionary principle • Bank stability / erosion control • That any environmental impact is minimal • Potential for increase in flooding magnitude • A more environmentally sensitive water supply option that does not include a weir with all its impacts on the environment of the Tweed River
Evidence-based	<ul style="list-style-type: none"> • Taking into consideration best available data
Financial	<ul style="list-style-type: none"> • Acceptable cost to ratepayers • Cost effective • Best cost-benefit ratio • Cost of solution must not exceed the do nothing cost
Fit for purpose	<ul style="list-style-type: none"> • Is it a suitable solution for providing good quality safe drinking water for everyone • Acceptable water quality (and community assurance thereof) • What is acceptable level of water quality?
Operational	<ul style="list-style-type: none"> • Feasibility • Reliability • Ease of implementation • Ease of operation (including reliance on operational resources for deployment) • Level of reliance on human monitoring • Resilience: solution strong enough to survive tough ongoing conditions including flooding or removable if necessary • TSC has a water quality target never to exceed 400ppm. Target 130ppm • Weir: temporary long-term solution best fit for occasional not constant threat? • Weir: for temporary solution, cost and time requirement for deployment • What level of risk is TSC prepared to take? • Provides buffer • Threat of overtopping is occasional, not constant • Compliant with relevant regulations (e.g. Weir: Fisheries and Management Act 1994 sections 218-219)
Social	<ul style="list-style-type: none"> • Fair & equitable • Respectful of 1980s agreement between Council and the Upper Weir Property Owners Association • Good outcome for those whose livelihoods depend on it • Acceptable to all stakeholders • Landowners upstream are concerned about potential impacts on flooding from any changes either via higher floods or access to properties over bridges • Impact on farmland viability (consider potential issues of future inundation & salinity of water table) • Population growth (growing water demand, condensed living, development) • That any modifications do not affect the frequency of inundation to either Old Lismore Road residents or the private bridges on the Oxley River • Must not exacerbate flooding in current approved DA areas

Sustainable	<ul style="list-style-type: none"> • Durable solution • Sustainable with regards to the socio-cultural, socio-economic and environmental dimensions • What is the weir lifespan into the future and how do studies by Council show long-term a function or role of the Weir • Longevity of solution (future proofing) • Must be resilient against flood flows (Not easily damaged during a flood) • Should be capable of a river height of 1.6m AHD. When tidal datum shows a permanent datum increase of 0.2m, revisit the solutions like alternate water supplies and or pipeline from Clarrie Hall Dam
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7 ASSESSMENT CRITERIA

From the above considerations (Table 2), a set of criteria for evaluating and comparing potential solutions was developed and endorsed by the PRG as follows:

Water Quality: Individual and suitable combinations of options are to be assessed on their impact on water quality. In general, options are not to cause a reduction in water quality to a level below the long-term average water quality. Where a reduction in quality may occur, that reduction and impact of the reduction are to be quantified.

Water Security: Individual and suitable combinations of options are to be assessed on their impact on secure yield. In general, options are not to cause a reduction in secure yield. Where a reduction in secure yield may occur, that reduction and the impact of that reduction are to be quantified. Where potential for increase in secure yield is evident, that increase and the impact of that increase should be quantified.

Longevity: Individual and suitable combinations of options are to be assessed on longevity/lifespan, that is how long into the future the option would guarantee Tweed District water supply of acceptable quality. Staged options and combinations of approaches are to be considered also. The assessment is to include advice on "trigger points", that is the parameter by which the option longevity or staging is assessed.

Cost: Individual and suitable combinations of options are to be assessed on capital cost, probable operational costs per year and Net Present Value so that options of different longevities can be compared. The options are also to be assessed using Equivalent Annualised Annuity calculations.

Resilience: The resilience of each individual and suitable combinations of options is to be assessed. The assessment is to include consideration of: durability; robustness and ability to withstand extreme events including flood, drought and earthquake; ease of operation; and reliability.

Environmental Impact: The environmental impacts of individual and suitable combinations of options are to be qualitatively assessed. The assessment is to include consideration of: flooding, including extreme events; fish passage and the current standards required by the NSW Department of Fisheries; riparian vegetation; bank stability and erosion (the existing bank stability and erosion (baseline) and the bank stability and erosion which may occur for each option, soil type, saturation and other factors that influence the bank stability and erosion are to be considered in these assessments); effects on the water table; and effects on river flows.

Social Impact: The social impacts of individual and suitable combinations of options are to be qualitatively assessed. The assessment is to include consideration of: diminution or otherwise of property values; impact on farming and other practices within the impacted areas; impact on properties upstream from the weir pool, including neighbouring properties that may be impacted by a raising of the weir; property access; property damage/loss due to flooding; recreational activities; and acceptability to stakeholders.

Risk: Options are to be assessed on the residual risk, that is: the probability of failure of the option to guarantee Tweed District water supply of acceptable quality (e.g. by preventing salt water contamination); and the consequence of that failure; the risk to the public accessing the area of the Bray Park weir and weir pool; the risk of staff absences during an event or emergency; and the risk of failure due to human involvement in operation or tampering.

Legal: The legal impacts of individual and suitable combinations of options are to be qualitatively assessed. The assessment is to include consideration of: the 1980 Legal Agreement with property owners; whether the option would constitute a permanent raising of the weir; relevant state and Commonwealth legislation such as, but not exclusive to, the EP&A Act and Fisheries Management Act.

The PRG proceeded to assign weightings to the criteria as outlined in Table 3 below.

Table 3. Weightings assigned by PRG to assessment criteria.

Criteria	Weightings
Water Quality	Y/N ¹
Water Security/Secure Yield	20.1
Time for Implementation	4.0
Longevity (Scalability)	8.5
Cost	31.8
Resilience	17.5
Environmental Impact	11.4
Social Impact	6.7
Risk	Y/N ¹
Legal	Y/N ¹

¹ non-weighted items as deemed either acceptable (Y) or not (N)

8 OPTIONS IDENTIFIED BY PRG FOR FURTHER EVALUATION

Through the process outlined in Section 6, the PRG identified a range of options to be assessed and examined in further detail by an external consultant. The options were split into two groups being those that can be readily implemented and those that may be part of a longer-term solution.

Readily Implemented Options

- 1) **Continue present practices.** This is a continuation of present practices.
- 2) **Optimised present practices.** After a review of the present practices, and the undertaking of an optimisation of the present practices, develop an Optimised Present Practice option for assessment. This will be considered as the base case for comparison with other options.
- 3) **Bray Park Water Treatment Bypass.** This option consists of the continuous monitoring of the TDS of the raw water (in the pipeline) being pumped from the river to the Bray Park Water Treatment Plant. If the TDS exceeds a pre-set limit, the water is diverted into a pipe which drains downstream of the weir. Once the TDS drops below a pre-set threshold (250ppm), the diversion is closed and water continues to flow to the Treatment Plant. It should be noted that with this option the continued supply of water to consumers will be dependent on storage within the system and higher flow rates or longer operation may be required to make up for the depletion of storage.
- 4) **Weir Pool Sump.** This option consists of using the depressions in the bottom of the weir pool to capture and hold salt water ingress prior to it being pumped out or removed through pipework drawing from the lowest point in the depression and discharging – with or without pumping – through or over the weir during low tide intervals. This option could also consist of an engineered sump or underwater barrage or weir to contain the salt water.
- 5) **Bray Park Water Treatment Plant Pumping Protocol.** This option is to alter the pumping protocol to cease drawing water from the weir pool approximately six hours before a potential overtopping event. The aim of this option is to maximise flow over the weir to hold back salt water and reduce the TDS of water downstream if it does overtop.
- 6) **Pipeline from Clarrie Hall Dam.** This option is the installation of a pipeline from Clarrie Hall Dam to the Water Treatment Plant (WTP) so water can be drawn directly from the dam in the event of an overtopping and salt water contamination. When the event is over and salt water removed from the weir pool, pumping from the weir pool would recommence.

- 7) **Increase Temporary Storage near WTP.** This option is to allow the cessation of pumping when salt water enters the weir pool. Pumps would be turned off and temporary storage used to maintain supply. When the event is over and salt water removed from the weir pool, pumping from the weir pool would recommence.
- 8) **Dilution at Intake by Mixing with Fresh Strata.** This option is to enable the mixing of the heavier salt water strata with the freshwater upper layer. The result would therefore provide two alternatives: a) allow the heavier salt water layer to be diluted and which may bring the raw water TDS level under Council's maximum TDS level for processing; or b) alternately, if the layer is mixed effectively, a release from Clarrie Hall may allow the Bray Park weir pool to be flushed with a discharge of water from Clarrie Hall Dam.
- 9) **Temporary Barrier or Raising of the Weir.** This option is to install tilt-able (say 600mm) high panels on the top of the weir on the downstream side. The panels could be raised to prevent the ingress of salt water when the risk of overtopping was imminent either mechanically, hydraulically or by a flotation lift system. When not required, the panels are lowered flat in a downstream direction below the weir crest, thus not impacting the environment, flooding, inundation etc. The lowered panels would then protect any lifting mechanism from flood damage. This option involves the temporary raising of the weir when salt water incursion events are predicted. The method of temporary raising may be something fixed to the weir or readily deployable. It may be a fixed structure or an installation such as a "pillow", which can be inflated or filled with water as required.
- 10) **Move pump inlet out of contamination area.** This option consists of moving the pumping extraction point a few kilometres upstream of the weir or to the upstream end of the weir pool, between Byangum and Dum Dum, past the Guinea's Fruit stall. This option is based on a premise that any salt water entering the weir pool will not contaminate water that far upstream of the weir.

Longer-term Options

- 11) **Byrrell Creek Dam.** It is not known whether the construction of the Byrrell Creek dam would in some way mitigate the risk of salt water contamination of the water supply. The option is to be considered in a conceptual sense only with environmental, legislative and cost assessment, so that it can be determined whether it warrants further consideration.
- 12) **Inter connection with Gold Coast Water or South East Queensland Water Grid.** Council is presently pursuing this option as a contingency supply in the event of a gross failure of the Tweed District Water Supply. The interconnection may be considered in conjunction with other options to provide mitigation against salt water contamination of the Tweed District Water Supply.
- 13) **Equip Bray Park WTP to treat salty water.** It is understood this option would provide a long-term solution to the problem but the cost may be prohibitive. The option is to be considered in a conceptual sense only, with indicative costing, so that it can be determined whether it warrants further consideration.

The consultant was also invited to identify further individual and suitable combinations of options that will mitigate the risk of salt water contamination of the water supply.

9 OPTIONS ASSESSED BY CONSULTANT

An external consultant (HH20) was engaged by Tweed Shire Council to further examine the options identified by the PRG. At the start-up meeting with HH20 on 5 February 2019, HH20 was provided the opportunity to engage with the PRG and TSC to clarify the brief provided.

The resulting report by HH20 was discussed by the PRG in Session 6 on 19 September 2019. At that meeting, additional clarification was requested by the PRG on some issues which resulted in addenda to the initial report. On 9 December 2019, HH20 then presented their options evaluation to the PRG in Session 7 which allowed for further discussion, questions and clarification between the PRG and HH20. Table 4 below provides an overview of the considered options as evaluated by HH20 in their report.

Table 4. Options presented in HH20 analysis

Option #	Option name	Description (by HH20)
1A	Optimised present practice - using the concrete blocks	The current predictive model would be improved to optimise the number, arrangement and duration of blocks required during each deployment. Real time conductivity monitoring downstream of the weir would be incorporated into the model. Costs could be reduced through engaging external contractors, optimising the location of stockpiled blocks and/or the staff time required during deployments.
1B	Optimised present practice - using an alternative barrier	The optimised practice presented in option 1A would be modified by replacing the concrete blocks with a demountable flood barrier which could be installed on top of the weir when required. The barriers do not require heavy machinery to install and allow for greater mitigating potential, as the height of the barriers can be adjusted.
2	Bray Park Water Treatment Plant bypass - active	The existing Bray Park Raw Water Pump Station pumps would be used to remove salt water contamination from the weir pool. When salt water concentrations exceed a pre-set threshold, supply to Bray Park Water Treatment Plant would cease. The pumps would then pump the salt water from the depression around the intake structure to a discharge location downstream of the weir. Pumping to remove salt water would occur during a short window, with supply to customers maintained from existing storage within the network. Any salt water ingress remaining trapped in depressions immediately upstream of the weir pool, would be removed by natural flushing.
3A	Weir sump pump. Active	A dedicated pumping station would be built to remove salt water contamination from the deep depression immediately upstream of the weir. An allowance has also been made for a submerged weir downstream of the WTP inlet works, with a bubble curtain to help contain any salt water ingress. The pumping station is proposed to be located on the eastern side of the weir next to existing access road with a suction pipe weighted down to sit along the river bed. The pump would discharge to a location downstream of the weir. During pumping, monitoring of salt water concentrations at the existing raw water intake would occur to ensure raw water quality is not compromised.
3B	Weir sump pump. Passive	<i>*not assessed in original report* - addressed in addendum</i>
4	Bray Park WTP pumping protocol	A pumping protocol would involve ceasing operation of raw water extraction to increase discharge over the weir in an attempt to 'hold back' potential ingress. This option was determined to be not feasible as the mitigating impact of ceasing pumping is negligible. Instead it was assumed ceasing pumping would be combined with significant and prolonged releases from Clarrie Hall Dam to 'hold back' potential ingress events.
5	Pipeline from Clarrie Hall Dam	A pipeline would be constructed from Clarrie Hall Dam to the Bray Park Water Treatment Plant (WTP). A 15.5 km, minimum DN900 pipeline would be capable of supplying the maximum capacity of the Bray Park WTP (i.e. 100 ML/d). During an ingress event, the pipeline would provide 100% of supply until salt water concentrations in the weir pool return to normal. A method to remove salt water from the weir pool has not been defined for this option, however it is acknowledged that for the option to be feasible this would need to be part of the final solution. It is also likely that the pipeline would be used more frequently as salt water concentrations in the weir pool increase over time if natural flushing does not occur.
6	Increase temporary storage near WTP	Temporary storages would be constructed to provide a backup supply when pumping from the weir pool is ceased during a salt water contamination event. A 30 ML treated water storage tank and a 120 ML raw water storage lagoon has been assessed. This would provide Council a dual back-up storage. During an ingress event, these temporary storages would be used to maintain customer supply. A method to remove salt water from the weir pool has not been defined for this option, however it is acknowledged that for the option to be feasible this would need to be part of the final solution. It is also likely that the storages would be used more frequently as salt water concentrations in the weir pool increase over time if natural flushing does not occur.
7	Dilution at intake and mixing with fresh strata	Salt water contamination in the weir pool would be mixed. Instead, mixing would be coupled with significant and prolonged releases from Clarrie Hall Dam. Mixing and flushing of the weir pool would involve careful monitoring of salt water concentrations with fresh water to either dilute the water column to allow pumping to Bray Park WTP to continue, or flush the weir pool with releases from Clarrie Hall Dam.
8A	Temporary barrier or raising of the weir - tilting across whole weir	A hinged tilting barrier would be constructed across the entire length of the weir. The barrier would sit flush along the weir surface and deploy to a vertical position during ingress from downstream. The barrier employs a passive flotation system that activates when the downstream water level overtops the weir.
8B	Narrowing of the weir and passive/automatic temporary barrier	To reduce the length of hinged tilting barrier required in option 8A, the wing walls on either side of the weir would be extended across the weir and a hinged tilting barrier would be constructed across a section of the weir. The effective length of the weir would be narrowed. The barrier would sit flush along the weir surface and deploy to a vertical position during ingress from downstream. The barrier employs a passive flotation system that activates when the downstream water level overtops the weir.
8C	Narrowing of the weir and manual temporary barrier	<i>*not assessed in original report* - addressed in an addendum and later combined by PRG with 8A&B</i>

9A	Move inlet out of contamination area 1.4 km upstream (at Byangum Bridge)	The pump inlet would be relocated approximately 1.4 km upstream of the existing intake, near the Byangum Bridge. This option allows the WTP to access supply from both the Tweed and Oxley river catchments. At this location the water depth is approximately 5 to 6 m, which is slightly greater in depth than the existing river intake (approximately 5m deep). However, there is uncertainty around the extent of salt water intrusion at this location, with further study and modelling required. To maximise yield the new pumping station would only be utilised when salt water prevented the existing pumping station being used. A method to remove salt water from the weir pool has not been defined for this option, however it is acknowledged that for the option to be feasible this would need to be part of the final solution.
9B	Move inlet out of contamination area 3.4Km upstream	The pump inlet would be relocated approximately 3.5 km upstream of the existing intake, near the Kyogle Road and Boulder Close intersection. This location is likely to be sufficiently far upstream to avoid salt water impacts for some time as it is above a natural rock bar in the river. At this location however, the river is very shallow, so construction of a river pumping station will involve extensive excavation. This location also restricts the catchment to the Tweed River only, significantly reducing secure yield. To maximise yield the new pumping station would only be utilised when salt water prevented the existing pumping station being used. A method to remove salt water from the weir pool has not been defined for this option, however it is acknowledged that for the option to be feasible this would need to be part of the final solution.
9C	<i>Move inlet out of contamination area with 2 inlets upstream - one in Oxley and one in Tweed</i>	<i>*not assessed in original report* - discussed by PRG at the final scoring meeting</i>
10	Byrrill Creek Dam	The impact of construction of the Byrrill Creek Dam was considered in mitigating salt water ingress at the Bray Park WTP. Three options have been considered for the construction of the Byrrill Creek Dam, a 16,300ML dam approximately the same size as Clarrie Hall Dam, a large 36,000ML dam or a staged option.
11	Interconnection with Gold Coast and or SEQ Water	Network infrastructure would be required to connect the Tweed District Water Grid to the South East Queensland Water Grid. Investigations are currently underway by Council, with the scheme assumed to have a capacity of 20 ML/day (MWH, 2010). During an ingress event, supply from the SEQ water grid would be switched on until salt water contamination of the weir pool is removed. A method to remove salt water from the weir pool has not been defined for this option, however it is acknowledged that for the option to be feasible this would need to be part of the final solution.
12	Equip Bray Park WTP to treat salty water	Bray Park WTP would be upgraded to treat salt water. A 'bolt on' Reverse Osmosis train could be constructed at the existing plant. As each overtopping event would result in varying salt concentrations in the weir pool, the design would be complex and staff would be required to carefully manage the treatment train to ensure effective treatment.
13	Bores to supplement supply	Bores would be constructed to provide a backup supply for the Tweed District Water Supply during a salt water contamination event. Previous studies identified two sites upstream of Bray Park and estimated a bore field comprising up to 7 bores, each 20 m deep may yield around 4.3 ML/day (MWH, 2010). In the event of salt water ingress in the Bray Park Weir Pool, supply would need to be supplemented with an additional source to meet system demand. For the purposes of this study, it was assumed that additional bores could be constructed providing a total yield of 30 ML/d. Further study would be required to confirm the viability of this yield. A method to remove salt water from the weir pool has not been defined for this option, however it is acknowledged that for the option to be feasible this would need to be part of the final solution.
14	Permanent raising of weir	Permanently raising the Bray Park weir would involve construction of either an extension to the existing weir or a replacement weir. A staged approach could be adopted whereby the weir is raised incrementally in height over time. The raised weir would provide a barrier to prevent future salt water ingress into the weir pool. <i>Note:</i> This option directly conflicts with the Tweed Shire Council's 1980 Legal Agreement with the Upper Weir Property Owners Association.
15	Mobile desal plants	Mobile desalination units would be deployed to treat salt water contamination in the weir pool. Mobile desalination units are an alternative to equipping Bray Park WTP to treat salt water. Mobile units however have limited treatment capacities and require significant lead time to procure and deploy. In the event of salt water ingress in the Bray Park Weir Pool, supply would need to be supplemented with an additional source to meet system demand. Upon investigation, this option was found to not be feasible unless combined with other options.
16	Raw water pump station surface / high level intake	Construction of a new intake or modification to the existing intake would be made to take advantage of stratification in the weir pool. The modified intake would allow capture of water from the top 200 – 300 mm of the weir pool. Following an ingress event, pumping from the weir pool would be able to continue through use of a high level or surface intake taking water from the top 200 mm – 300 mm, in combination with releases from Clarrie Hall Dam which were found in the August 2017 event to 'skate over' the salt water. A method to remove salt water from the weir pool has not been defined for this option which increases the risk of failure.

It is noteworthy that Option 14 was included by HH20 to ensure full consideration of all potential options, despite the PRG strongly expressing throughout the entire process that the permanent raising of the weir would not be an acceptable solution and would breach the 1980s Legal Agreement with Landholders.

10 SELECTION OF PREFERRED OPTIONS BY PRG

After consideration of the HH20 report, the PRG proceeded to prioritise the options through a scoring process. During this process, several options were identified as exclusions (not suitable to pursue), standalone options or combination options. Both the standalone and the combination options were then scored and ranked in order of preference.

10.1 Exclusions

A number of potential options were excluded from further consideration for reasons outlined in Table 5 below.

Table 5. List of excluded options and reasons.

Option #*	Description	Reason for exclusion
Option 1B	Optimised Present Practice Slats not blocks	Ruled out based on OHS risks
Option 4	Bray Park WTP pumping protocol	Excluded. already implemented
Option 5	Pipeline from Clarrie Hall Dam	Only 10% of catchment as per HH20 report. PRG accepts their recommendation
Option 6	Increase temporary storage near WTP	Excluded. accepted HH20 recommendation as not feasible
Option 7	Dilution at intake and mixing with fresh strata	Excluded. Based on HH20 report
Option 10	Byrrill Creek Dam	Excluded. Not legal
Option 12	Equip Bray Park WTP to treat salty water	Excluded. Based on cost, location of current plant & technical factors associated with TDS variability
Option 13	Bores to supplement supply	Excluded. Based on HH20 report
Option 15	Mobile desal plants	Excluded. Based on HH20 report
Option 16	Raw water pump station surface / high level intake	Excluded. Based on HH20 report

*option number as per the HH20 report

10.2 Standalone options

Standalone options (options that would provide adequate water supply for the TSC in their own right) were evaluated, discussed and scored by the PRG. Table 6 below outlines the preference rankings for the standalone options.

Table 6. Summary of preference rankings by PRG for standalone options.

Rank	Option #	Description
1	8A	Hinged barrier across whole weir
2	1A	Optimised present practice - Blocks only
3*	8B/C	Narrowing of the weir and passive/automatic temporary barrier
4**	14	Permanent raising of weir
5	9C	Move inlet out of contamination area with 2 inlets upstream - one in Oxley and one in Tweed

* the PRG has expressed considerable concerns about potential negative downstream effects such as erosion due to turbulence and changed flow patterns; ** the PRG does not consider permanent raising of the weir as an acceptable solution.

10.3 Combination options

Combination options (options that would not in themselves provide adequate water supply for the TSC but could contribute to a suite of measures) were evaluated, discussed and scored by the PRG as summarised in Table 7 below.

Table 7. Summary of preference rankings by PRG for the combination options.

Rank	Option #	Description
1	11	Interconnection with Gold Coast and or SEQ Water
2	3B	Weir sump pump. Passive
3	2	Bray Park WTP bypass. Active
4	3A	Weir sump pump. Active
5	9A	Move inlet out of contamination area Byangum Bridge
6	9B	Move inlet out of contamination area 3.4Km upstream

11 RECOMMENDATIONS TO TWEED SHIRE COUNCIL

In summary, the Bray Park Weir Tidal Protection Project Project Reference Group recommends that Tweed Shire Council consider the following preferred options (in order of preference) for detailed investigation as solution to the problem of salt water contamination of the Tweed District water supply:

Standalone options:

- 1 Hinged barrier across whole weir (Option 8A in HH20 report)
- 2 Optimised present practice - Blocks only (Option 1A in HH20 report)
- 3 Narrowing of the weir and passive/automatic temporary barrier (Combination of Options 8B & 8C in HH20 report).

Note that the PRG has expressed considerable concerns about potential negative downstream effects from narrowing the weir (3rd ranked option) that would require further investigation and modelling. This option should only be considered if it has demonstrated net benefits over a barrier across the whole weir (1st ranked option).

Combination options:

- 1 Interconnection with Gold Coast and or SEQ Water (Option 11 in HH20 report)
- 2 Weir sump pump. Passive (Option 3B in HH20 report)
- 3 Bray Park WTP bypass. Active (Option 2 in HH20 report)
- 4 Weir sump pump. Active (Option 3A in HH20 report)
- 5 Move inlet out of contamination area Byangum Bridge (Option 9A in HH20 report)
- 6 Move inlet out of contamination area 3.4Km upstream (Option 9B in HH20 report).

