N O T I C E   O F   M E E T I N G

W A T E R ,   W A S T E   A N D   S E W E R   A D V I S O R Y   C O M M I T T E E   M E E T I N G

A Water, Waste and Sewer Advisory Committee Meeting of Byron Shire Council will be held as follows:

Venue	**Council Chambers, Station Street, Mullumbimby**
Date	**Thursday, 13 April 2017**
Time	**2.00pm**

Phil Holloway
Director Infrastructure Services

I2017/450
Distributed 06/04/17

CONFLICT OF INTERESTS

What is a "Conflict of Interests" - A conflict of interests can be of two types:

Pecuniary - an interest that a person has in a matter because of a reasonable likelihood or expectation of appreciable financial gain or loss to the person or another person with whom the person is associated.

Non-pecuniary – a private or personal interest that a Council official has that does not amount to a pecuniary interest as defined in the Local Government Act (eg. A friendship, membership of an association, society or trade union or involvement or interest in an activity and may include an interest of a financial nature).

Remoteness – a person does not have a pecuniary interest in a matter if the interest is so remote or insignificant that it could not reasonably be regarded as likely to influence any decision the person might make in relation to a matter or if the interest is of a kind specified in Section 448 of the Local Government Act.

Who has a Pecuniary Interest? - a person has a pecuniary interest in a matter if the pecuniary interest is the interest of the person, or another person with whom the person is associated (see below).

Relatives, Partners - a person is taken to have a pecuniary interest in a matter if:

- The person's spouse or de facto partner or a relative of the person has a pecuniary interest in the matter, or
- The person, or a nominee, partners or employer of the person, is a member of a company or other body that has a pecuniary interest in the matter.

N.B. "Relative", in relation to a person means any of the following:

(a) the parent, grandparent, brother, sister, uncle, aunt, nephew, niece, lineal descends or adopted child of the person or of the person's spouse;

(b) the spouse or de facto partners of the person or of a person referred to in paragraph (a)

No Interest in the Matter - however, a person is not taken to have a pecuniary interest in a matter:

- If the person is unaware of the relevant pecuniary interest of the spouse, de facto partner, relative or company or other body, or
- Just because the person is a member of, or is employed by, the Council.
- Just because the person is a member of, or a delegate of the Council to, a company or other body that has a pecuniary interest in the matter provided that the person has no beneficial interest in any shares of the company or body.

Disclosure and participation in meetings

- A Councillor or a member of a Council Committee who has a pecuniary interest in any matter with which the Council is concerned and who is present at a meeting of the Council or Committee at which the matter is being considered must disclose the nature of the interest to the meeting as soon as practicable.
- The Councillor or member must not be present at, or in sight of, the meeting of the Council or Committee:
  (a) at any time during which the matter is being considered or discussed by the Council or Committee, or
  (b) at any time during which the Council or Committee is voting on any question in relation to the matter.

No Knowledge - a person does not breach this Clause if the person did not know and could not reasonably be expected to have known that the matter under consideration at the meeting was a matter in which he or she had a pecuniary interest.

Participation in Meetings Despite Pecuniary Interest (S 452 Act)

A Councillor is not prevented from taking part in the consideration or discussion of, or from voting on, any of the matters/questions detailed in Section 452 of the Local Government Act.

Non-pecuniary Interests - Must be disclosed in meetings.

There are a broad range of options available for managing conflicts & the option chosen will depend on an assessment of the circumstances of the matter, the nature of the interest and the significance of the issue being dealt with. Non-pecuniary conflicts of interests must be dealt with in at least one of the following ways:

- It may be appropriate that no action be taken where the potential for conflict is minimal. However, Councillors should consider providing an explanation of why they consider a conflict does not exist.
- Limit involvement if practical (eg. Participate in discussion but not in decision making or vice-versa). Care needs to be taken when exercising this option.
- Remove the source of the conflict (eg. Relinquishing or divesting the personal interest that creates the conflict)
- Have no involvement by absenting yourself from and not taking part in any debate or voting on the issue as if the provisions in S451 of the Local Government Act apply (particularly if you have a significant non-pecuniary interest)

RECORDING OF VOTING ON PLANNING MATTERS

Clause 375A of the Local Government Act 1993 – Recording of voting on planning matters

(1) In this section, **planning decision** means a decision made in the exercise of a function of a council under the Environmental Planning and Assessment Act 1979:
  (a) including a decision relating to a development application, an environmental planning instrument, a development control plan or a development contribution plan under that Act, but
  (b) not including the making of an order under Division 2A of Part 6 of that Act.

(2) The general manager is required to keep a register containing, for each planning decision made at a meeting of the council or a council committee, the names of the councillors who supported the decision and the names of any councillors who opposed (or are taken to have opposed) the decision.

(3) For the purpose of maintaining the register, a division is required to be called whenever a motion for a planning decision is put at a meeting of the council or a council committee.

(4) Each decision recorded in the register is to be described in the register or identified in a manner that enables the description to be obtained from another publicly available document, and is to include the information required by the regulations.

(5) This section extends to a meeting that is closed to the public.

BUSINESS OF MEETING

1. APOLOGIES

2. DECLARATIONS OF INTEREST – PECUNIARY AND NON-PECUNIARY

3. ADOPTION OF MINUTES FROM PREVIOUS MEETINGS

3.1 Water, Waste and Sewer Advisory Committee Meeting held on 2 March 2017

4. STAFF REPORTS

Infrastructure Services

STAFF REPORTS - INFRASTRUCTURE SERVICES

Report No. 4.1	**Questions Raised by Committee Member Regarding Ocean Shores and Brunswick Valley STPs**
Directorate:	Infrastructure Services
Report Author:	Peter Rees, Manager Utilities
File No:	I2017/365
Theme:	Community Infrastructure Sewerage Services

Summary:

Various questions have been asked by a Committee member in relation to Ocean Shores and Brunswick Valley STPs. The information is contained in this report.

RECOMMENDATION:

That Council note the information provided to the Water, Waste and Sewer Advisory Committee regarding the Ocean Shores and Brunswick Valley Sewage Treatment Plants.

Report
Various questions have been asked by a Committee member in relation to Ocean Shores and Brunswick Valley STPs. The information is contained in this report.

Ocean Shores STP (OS STP) and Brunswick Valley STP (BV STP)

1. the transfer of sewage from OS STP to BV STP is costed at 2.74 million dollars more expensive than upgrading OS STP.

Project costs need to include whole of life costs and not just initial capital costs. The $2.74 million dollars is stated in section 11.1.4 and needs to be read in the context of the discussion in section 11.1.4. The project lifecycle costing for each project configuration are contained in sections 11.3.2 and 11.3.3 of the report.

2. wet weather storage at BV STP is actually storing raw sewage. Why is this necessary?

The proposed wet weather storage is intended to store wet weather flows. As shown by the flow figures for March 2017, the wet weather flows can be diluted with stormwater inflow by up to 17 times.

3. is the construction of a wetlands at BV STP really necessary? BV STP and West Byron STP (WB STP) were designed to supply a quality of effluent suitable for reuse.

The wetlands were a part of the original project scope for the BVSTP. Council's experience is that wetlands provide ancillary benefits to the community by providing habitat as well as effluent polishing beyond EPA licence requirements. They are also a significant source of recycled water reuse.

The BBSTP has 2 recycled water streams – one for rural reuse and one for urban reuse. The BVSTP has one recycled water stream only for rural reuse.

4. GHD has given an estimate of 30 million dollars to upgrade OS STP. This seems extremely expensive.

Agreed – it is staff's opinion this does not impact on the project recommendation. There are also significant environmental and construction risks associated with construction a new treatment works on the existing site that warrant the estimate.

5. BV STP is being hydraulically overloaded during rain periods. Should this not be addressed and resolved before any upgrades or augmentations take place?

The Brunswick Valley STP is hydraulically designed to take a peak instantaneous flow of 314 l/s and a peak day flow of 22 ML/day. It is currently not hydraulically overloaded during rain periods.

The proposed project of transferring OSSTP flows to BVSTP includes provision to construct the originally planned wetlands and storm overflow / effluent storage pond, which will assist in controlling the largest rain events anticipated.

6. the use of solar power needs to be investigated as to running plants and used in supplying reuse.

Solar power projects are currently being scoped.

7. urban reuse should have been investigated and put in place by now that would consume all of the Shire's reuse and take the load of potable water

Council's experience with the BBSTP Urban Recycled water scheme is that while providing benefits to the community, they are not capable of consuming all of the Shire's effluent. Council's experience in operating recycled water schemes is that rural reuse schemes, such as plantations and wetlands, are the most benefit.

8. what efforts have been made to find a company willing to buy the Bio Solids from the STPs?

An expression of interest process was run 5 - 8 years ago that identified the current farmers who utilise the biosolids output in the Shire. No one was willing to pay Council for the privilege at the time.

9. a. what treatment was the leachate receiving at OS STP before being transferred to the STP?

Aeration, chemical dosing and settlement.

b. what effect did the leachate have on the COD load on the OS STP?

I am unable to find any analysis reports.

c. when was a wetlands constructed at OS STP?

I understand the wetlands were last century, in approximately 1991.

Financial Implications

Nil

Statutory and Policy Compliance Implications

Nil

Report No. 4.2	**Inflow and Rainfall - Brunswick Valley STP, March 2017**
Directorate:	Infrastructure Services
Report Author:	Peter Rees, Manager Utilities
File No:	I2017/366
Theme:	Community Infrastructure Sewerage Services

Summary:

This report is to provide information requested by a Committee member regarding daily inflow and rainfall for March 2017 for the Brunswick Valley STP.

RECOMMENDATION:

That Council note that the Water, Waste and Sewer Advisory Committee was provided with daily inflow and rainfall figures for March 2017 for the Brunswick Valley STP.

Report

This report is to provide information requested by a Committee member regarding daily inflow and rainfall for March 2017 for the Brunswick Valley STP.

			Flows	Flows
			BVSTP EPA P5	**Rainfall**
Date	Sampling Site	Location	kL/day	mm
1/03/2017	Flows	BVSTP	2207.1	1.2
2/03/2017	Flows	BVSTP	1378.8	0
3/03/2017	Flows	BVSTP	1320.7	0
4/03/2017	Flows	BVSTP	1309.4	1.4
5/03/2017	Flows	BVSTP	1283	0.8
6/03/2017	Flows	BVSTP	1310.3	6
7/03/2017	Flows	BVSTP	1285.8	0
8/03/2017	Flows	BVSTP	1177	0
9/03/2017	Flows	BVSTP	1189.1	0
10/03/2017	Flows	BVSTP	1166.8	0
11/03/2017	Flows	BVSTP	1148.8	0
12/03/2017	Flows	BVSTP	1179.4	0
13/03/2017	Flows	BVSTP	1144.9	0
14/03/2017	Flows	BVSTP	1094.4	48
15/03/2017	Flows	BVSTP	4504.5	129
16/03/2017	Flows	BVSTP	16153.5	82
17/03/2017	Flows	BVSTP	8070.1	0
18/03/2017	Flows	BVSTP	4083	6.6
19/03/2017	Flows	BVSTP	7483.3	71
20/03/2017	Flows	BVSTP	13073.6	50.2
21/03/2017	Flows	BVSTP	14160.5	27.2
22/03/2017	Flows	BVSTP	7467.9	6.6
23/03/2017	Flows	BVSTP	6326.3	11.8
24/03/2017	Flows	BVSTP	10916.1	42
25/03/2017	Flows	BVSTP	6753.4	5.4
26/03/2017	Flows	BVSTP	4426.2	0
27/03/2017	Flows	BVSTP	3475	2.8
28/03/2017	Flows	BVSTP	2903.9	0
29/03/2017	Flows	BVSTP	2503.5	0
30/03/2017	Flows	BVSTP	3502.8	71
31/03/2017	Flows	BVSTP	18012.7	362

Financial Implications

Nil

Statutory and Policy Compliance Implications

Nil

Report No. 4.3 **Ocean Shores to Brunswick Valley STP Transfer Feasibility Study**
Directorate: Infrastructure Services
Report Author: Peter Rees, Manager Utilities
File No: I2017/449
Theme: Community Infrastructure
Sewerage Services

Summary:

At the Committee's meeting held 02/03/17 it was requested that an extra meeting be held to discuss the Feasibility Study.

The existing Ocean Shores STP (OSSTP) was originally built in the 1980s, with the last significant upgrade being in ca. 1995. The capacity of the existing Intermittently Decanted Extended Aeration (IDEA) process has been assessed at around 1.1 ML/d average dry weather flow (ADWF). The current ADWF treated at OSSTP is in the order of 1.3 ML/d, meaning that it is potentially operating slightly over its assessed capacity.

Council commissioned GHD (2014-15) to undertake a planning study to investigate the augmentation requirements for OSSTP. The planning study found that the plant could be upgraded at a cost in the vicinity of $30 Million.

The purpose of this Study was to examine the feasibility of transferring raw wastewater from the Ocean Shores catchment to the Brunswick Valley Sewage Treatment Plant (BVSTP). The ultimate objective of this strategy is to consolidate the treatment of wastewater at BVSTP from the combined catchments of Mullumbimby, Brunswick Heads and Ocean Shores and avoid the required short term upgrade of OSSTP.

The study concluded the Ocean Shores – BVSTP transfer strategy has the potential to reduce the whole of life NPV of the required Ocean Shores STP upgrade project by approximately $12.6 million as well as allowing the construction of the originally proposed wetlands and effluent storage ponds for the Brunswick Valley Sewage Augmentation scheme.

Council engaged MWH to provide an independent Peer review to provide a professional opinion, based on the information provided in the GHD Feasibility Study. The peer review found the study is sound and provides a valid justification that Council should proceed with a planned closure of the OSSTP, transfer the flows to the BVSTP and upgrade BVSTP as required.

RECOMMENDATION:

That the Committee note the report.

Attachments:

1 GHD Finalised Report - Ocean Shores to Brunswick Valley STP Transfer Feasibility Study Nov 2016, E2016/102321 , page 11⇩
2 Finalised Peer Review Report of Ocean Shores to Brunswick Valley STP Transfer Feasibility GHD Report (MWH, Feb 2017), E2017/9096 , page 263⇩

Report

The existing Ocean Shores STP (OSSTP) was originally built in the 1980s, with the last significant upgrade being in ca. 1995. The capacity of the existing IDEA process has been assessed at around 1.1 ML/d average dry weather flow (ADWF). The current ADWF treated at OSSTP is in the order of 1.3 ML/d, meaning that it is potentially operating slightly over its assessed capacity.

Council commissioned GHD (2014-15) to undertake a planning study to investigate the augmentation requirements for OSSTP. The planning study found that the plant could be upgraded at a cost in the vicinity of $30 Million.

Further to the GHD (2014-15) planning study, Council indicated the need to investigate other alternatives to the augmentation of capacity at OSSTP. Some of the underlying drivers included:

- The significant capital cost of around $30 M for OSSTP upgrade
- Population growth projections
- The Brunswick Valley STP (BVSTP) being located relatively nearby to the OSSTP (less than approximately 3 km) and is the newer of the two plants, having been built in 2009-10.
- Anticipated economies (in both capital and operating costs) can be achieved by consolidating treatment at BVSTP and potentially ceasing (or minimising) operations at OSSTP
- Previous work by Council identified an easement for a pipeline from OSSTP to BVSTP to transfer treated effluent, for water recycling purposes (Council Resolution 06-759) of which only one section of easement remains to be acquired at this point in time.

All of the options proposed for the Ocean Shores- BVSTP transfer offer lower whole-of-life (NPV) costs than the alternative strategy of retaining both STPs and upgrading OSSTP as per a previous planning study for that the Ocean Shores plant.

If the Ocean Shores-BVSTP transfer strategy is be implemented, the biggest opportunity to reduce capital costs (indicatively within the next 20 years) and reduce whole-of-life cost (NPV) comes from deferring the BVSTP capacity augmentation for major process components until no later than 2035-36 (i.e. Option 4 identified in this Study). This Option 4 has the potential to defer up to $22.7 Million in capital (until 2035-36) and reduce NPV by approximately $12.6 Million.

The Peer Review (attached) concluded that the majority of assumptions, approaches, outcomes and conclusions of the GHD Feasibility Study are justified. Whilst some minor discrepancies between the capital cost estimates for BVSTP and OSSTP are noted in the Peer Review, if addressed these will not change the GHD Feasibility Study recommendations.

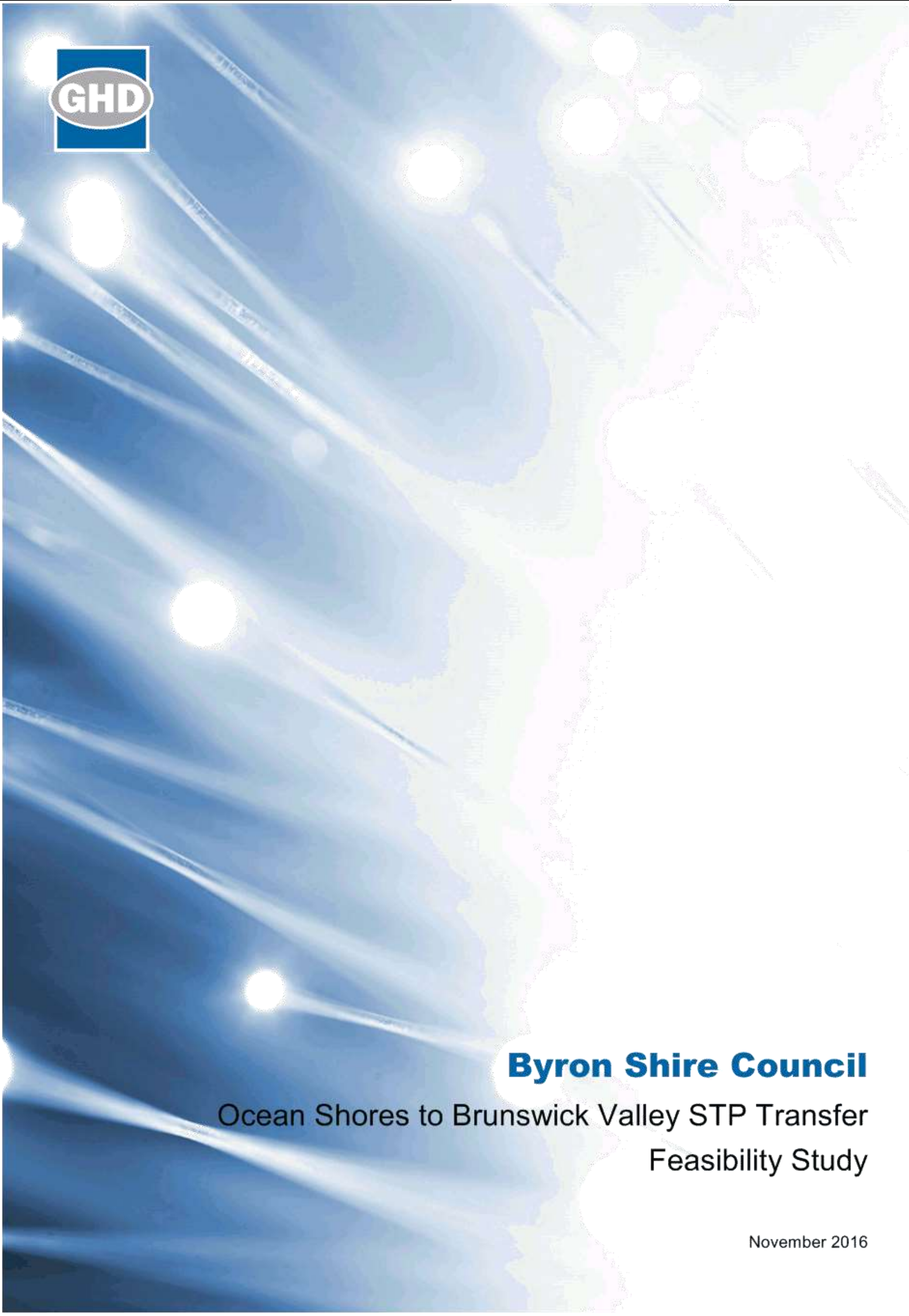
The Peer Review agrees that the BVSTP upgrade approach is quite conservative, and therefore there is significant potential to defer capital spend at BVSTP and/or optimise the upgrade approach.

Financial Implications

The financial implications of the proposed project are the potential to defer up to $22.7 million in capital expenditure and reduce the Net Present Value of the project by approximately $12.6 million.

Statutory and Policy Compliance Implications

Compliance with EPA licences 784 (Ocean Shores Sewage Treatment system) and 13266 (Brunswick Valley Sewage Treatment System).



Byron Shire Council

Ocean Shores to Brunswick Valley STP Transfer Feasibility Study

November 2016

Executive summary

This report is subject to, and must be read in conjunction with, the limitations set out in Section 1.4 and the assumptions and qualifications contained throughout the Report.

The purpose of this Study was to examine the feasibility of transferring raw wastewater from the Ocean Shores catchment to the Brunswick Valley Sewage Treatment Plant (BVSTP). The ultimate objective of this strategy is to consolidate the treatment of wastewater at BVSTP from the combined catchments of Mullumbimby, Brunswick Heads and Ocean Shores. In this strategy, the existing Ocean Shores STP (OSSTP) will be decommissioned and the upgrade of OSSTP (identified as being required in the near future) will be avoided. This Study examined the feasibility of the proposed transfer, particularly from a process and financial point of view.

The population projections adopted for this Study were based on the latest estimates in the *Byron Shire Strategic Business Plan*[1] *(2016)*.

This Study found that it is technically feasible to transfer the wastewater flows and loads from Ocean Shores directly to BVSTP for treatment. The transfer will require a 3.25 km common rising main to be extended, from immediately upstream of the existing OSSTP inlet, to BVSTP. This extension would make use of an easement that has been provisionally identified by BSC in previous work for the transfer of treated effluent from OSSTP to the Mullumbimby recycled water scheme (Council Resolution 06-759). Only one section of easement remains to be acquired.

Two sewage pump stations (SPS) currently transfer all wastewater from the Ocean Shores catchment to OSSTP. Of these, the larger (SPS 5009) has sufficient capacity to pump via the extended rising main to BVSTP. The smaller pump station (SPS 5004) will require a pump upgrade in order to meet requirements for the transfer to BVSTP. The SPS 5004 wet well will also require upgrading to accommodate the larger pumps. It is noted that an upgrade of SPS 5004 is currently planned by BSC as part of its asset renewal program and to meet operational requirements.

Other transfer options, including potential preliminary treatment (screening and grit removal) and dry weather flow balancing at OSSTP, followed by re-pumping to BVSTP, were considered. On a balance of factors, including anticipated least operational complexity and lower long-term costs, the direct raw wastewater transfer option from Ocean Shores to BVSTP is preferred.

The existing BVSTP does not have sufficient hydraulic capacity to treat current or future peak wet weather flows capable of being delivered to the plant from the combined Ocean Shores and existing connected catchments of Mullumbimby and Brunswick Heads. Consequently, for the Ocean Shores transfer to be feasible, the minimum required capacity upgrade at BVSTP must include additional hydraulic capacity at the inlet structure and inlet works, and a suitably sized lagoon-type wet weather flow storage facility. A constructed wetland is also recommended to provide an environmental 'buffer' for effluent 'polishing'. The wetland system would also treat any surplus wet weather flow discharged from the proposed wet weather storage facility. The proposed wetland will also have aesthetic value (e.g. as a bird habitat). It is recommended that alignment be sought between the licence requirements for BVSTP and those for Byron STP, which already includes a wetland.

In terms of mainstream treatment capacity, average dry weather flow (ADWF) estimates based on population projections indicate that the existing BVSTP design capacity (ADWF 3.8 ML/d)

[1] Prepared by Hydrosphere Consulting (Sept., 2016)

would likely be reached by 2025 on peak days (including adopted allowances for tourists), assuming the Ocean Shores transfer is implemented by that time. However, non-peak day ADWF estimates (nominally excluding tourists) for the combined catchments indicate that the existing BVSTP design capacity would be reached considerably later, indicatively in 2035-36. Peak day ADWF by 2035-36 was projected to be 4.3 ML/d (i.e. 15% over the existing design capacity). Therefore, in terms of dry weather flow treatment capacity, there is an opportunity to defer major capital works for process capacity augmentation at BVSTP by up to twenty years (to no later than 2035-36). However, this opportunity is subject to a number of risks associated with operating the existing plant close to its design capacity in the medium term (<20 years). Further study is recommended to enable BSC to better quantify, understand and evaluate these risks, assuming that deferment of capital expenditure for STP treatment capacity augmentation is a key issue.

Given that capital expenditure is likely to be constrained in the medium term (<20 years), the recommended option with lowest capital and whole-of-life costs (NPV) identified in this Study is Option 4. This option involves the transfer of wastewater from Ocean Shores to BVSTP and provision of an immediate minimum upgrade to deliver hydraulic, inlet works and wet weather flow handling requirements, as well as a tertiary wetland. The capacity augmentation of the major process units at BVSTP (i.e. bioreactor and clarifiers) will be deferred. Based on the current low-growth population projections for all three catchments (Mullumbimby, Brunswick Heads and Ocean Shores), a major capacity augmentation at BVSTP can be deferred until ca. 2035-36 at the latest. By then, the loading on the plant will reach 115% of design loads on peak days (including tourist loads) or close to 100% on non-peak days (excluding tourists). This deferral option carries an increased risk profile, which is expected to be acceptable to BSC, subject to further study for confirmation. It will entail a reduced capital budget of $10.6 M, within an indicative timeframe of less than four years (i.e. by 2020-21). This estimate includes the cost of the raw wastewater transfer pipeline from Ocean Shores and includes $3.75 M for project overheads, risk and contingencies. The capital cost (in 2015 dollars) deferred until 2035-36 will be $22.7 M. The Net Present Value (NPV) of Option 4 is estimated to be $35.9 M, which represents a significant saving of $12.6 M in whole-of-life terms, compared with the base case (lowest risk) option.

The base case option identified in this Study (Option 1) is the implementation of the transfer of raw wastewater from Ocean Shores and full capacity augmentation at BVSTP. This option has the lowest risk profile and includes provision of wet weather storage, a tertiary constructed wetland and sufficient hydraulic and process treatment capacity for at least the next 30 years (until beyond 2045), based on current adopted population and flow projections. This option will require an estimated capital budget of $33.2 M, within a timeframe of less than four years (indicatively by 2020-21). This estimate includes the cost of the raw wastewater transfer from Ocean Shores as well as an allowance of $11.8 M for project overheads, risk and contingencies. The Net Present Value (NPV) of Option 1 is estimated to be $48.5 M. Option 1 is not recommended unless the risks associated with other options (involving deferral of a portion of the capital costs for BVSTP capacity augmentation) are found to be unacceptable.

The proposed STP consolidation strategy (Option 4) was compared with the alternative strategy (i.e. retaining both STPs and upgrading Ocean Shores STP with provision for future treated effluent transfer from the latter to Brunswick Valley for water recycling purposes). For all options considered at BVSTP, the proposed strategy had the lowest whole-of life cost (NPV). Depending on the preferred option (i.e. extent to which capital investment for capacity augmentation at BVSTP is deferred) and related assumptions, the proposed strategy has the potential to save between $5 M and $18 M in NPV terms, compared with the alternative strategy.

This Study makes a number of additional recommendations, relating to aspects such as: future environmental licence requirements; assumptions regarding future water recycling; and the need to better understand key project risks. These recommendations should be given due consideration prior to (or as part of) the implementation of any project arising from this Study.

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Disclaimer

This report: has been prepared by GHD for Byron Shire Council and may only be used and relied on by Byron Shire Council for the purpose agreed between GHD and the Byron Shire Council as set out Sections 1.3 and 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than Byron Shire Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The inclusion of safety in design principles within legislation means that it is no longer sufficient to assume that compliance with a code or standard is enough. Safety in design is only addressed on a high level as part of this planning study.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer to Sections 1.4 and 1.5). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared the preliminary cost estimates set out in Section 11 of this report ("Cost Estimate") using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD. These assumptions include but are not limited to the use of information from previous project experience, escalation based on information in the public domain and equipment price estimates from suppliers, some of which may be subject to exchange rate fluctuations.

The Cost Estimate has been prepared for the purpose of planning, including budget setting, and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the project can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

1. Introduction

1.1 Background

The existing Ocean Shores STP (OSSTP) was originally built in the 1980s, with the last significant upgrade being in ca. 1995. Since that time the plant has had only minor capital works improvements, including the installation of one steel grit tank. The capacity of the existing IDEA process has been assessed at around 1.1 ML/d average dry weather flow (ADWF), excluding the original Pasveer channel, which is currently not used for mainstream treatment[2]. The current ADWF treated at OSSTP is in the order of 1.3 ML/d, meaning that it is potentially operating slightly over its assessed capacity. The current equivalent population (EP) loading is estimated to be in the range of approximately 5,600 to 6,500 EP (based on ADWF (2012-14) and depending on unit flow assumptions) or around 5,800 EP from the latest population estimates (BSC, 2012). This compares with a nominal original design EP rating for the IDEA process of 6,500 EP. However, there are a number of operational issues at the plant that constrain capacity, including solids removal from the 'Catch Pond' after the Intermittent Aeration Tank (IAT), disinfection of by-pass flows from the tertiary lagoons/wetlands and limiting capacity of the existing sludge lagoons. Further background information is contained in a recent report for the OSSTP (GHD. 2014a).

Byron Shire Council (BSC) commissioned GHD (2014-15) to undertake a planning study to investigate the augmentation requirements for OSSTP. The planning study (GHD, 2014b) found that the plant could be upgraded at a cost in the vicinity of $30 M, to provide capacity for 10,700 equivalent persons (EP). The proposed upgrade would align OSSTP with Council's STPs at (West) Byron and Brunswick Valley in terms of effluent quality and 'modern' treatment technology standards. The underlying population projections provided by BSC to GHD (2014-15) at the time indicated that a loading of 10,700 EP could be reached, indicatively, by 2040.

1.2 Need for further investigation

Further to the GHD (2014-15) planning study, BSC has indicated the need to investigate other alternatives to the augmentation of capacity at OSSTP. Some of the underlying drivers include:

- A capital cost of around $30 M for OSSTP capacity augmentation would be significant and will need to be justified against a background of other alternatives having been assessed;
- Population growth in the Ocean Shores catchment has been re-assessed. Compared with those provided to GHD (2014-15) as the basis for the recent planning study, current population projections are similar in the medium term (next ten years), and slightly lower in the longer term (next thirty years). According to the latest information available to BSC, the projected population served by OSSTP might reach approximately 7,800 EP by 2025 and 9,100 by 2045 (compared with approx. 8,000 EP by 2026 and 10,700 EP by 2040 in the earlier projections used by GHD at a compound growth rate around 2% pa).
- The Brunswick Valley STP (BVSTP) is located relatively nearby to the OSSTP (less than approximately 3 km, subject to route) and is the newer of the two plants, having been built in 2009-10. There is sufficient space at the BVSTP site to provide additional treatment capacity by augmentation of the existing process. The questions of timing and ultimate

[2] The Pasveer channel is currently used to co-treat waste sludge from the Mullumbimby Water Treatment Plant (WTP) and leachate from the Myocum landfill. The use of the Pasveer channel for these purposes is under review by BSC. The channel is structurally in poor condition.

capacity of an augmented plant would need to be re-assessed in terms of actual vs. projected population growth.

- It is anticipated that economies (in both capital and operating costs) can be achieved by consolidating treatment at BVSTP and potentially ceasing (or minimising) operations at OSSTP in the long term. Careful consideration of the feasibility and costs of transferring sewage from Ocean Shores to BVSTP will be required.
- Previous work by BSC identified an easement for a pipeline from OSSTP to BVSTP to transfer treated effluent, for water recycling purposes (Council Resolution 06-759). The potential transfer of raw wastewater from OSSTP to BVSTP would replace the transfer of treated effluent but could utilise the same easement previously identified.

1.3 Purpose of this report

This report documents the outcomes of a feasibility assessment investigating the technical and cost implications of transferring wastewater from the Ocean Shores catchment to BVSTP. The report is intended to be used for planning purposes to assist BSC with strategic decisions around future capital works and management of its sewerage and wastewater treatment operations in the medium to long term.

1.4 Scope and limitations

Included in the scope of work for this Study are the following:

- Considerations around BVSTP treatment capacity augmentation requirements, including those for treating wet weather flows;
- Considerations around effluent (or raw wastewater) storage
- Considerations around tertiary wetlands prior to river discharge
- Definition and assessment of options for OS-BVSTP transfer pipeline aligned with BVSTP upgrade or capacity augmentation requirements (as defined in Sections 8.1 and 8.2 below)
- Capital and operating cost estimates (concept level) at sufficient level of details for comparison of options and preliminary budget-setting purposes
- Comparison of options on a Net Present Value basis
- One report (this document) to summarise the study, with recommendations

This report has been based on the latest population and flow projections provided by BSC in the form of the Byron Shire Developer Contributions Plan[3] (2012) and Council's Strategic Business Plan[4] (2016). The data provided has been interpreted and applied in consultation with BSC officers responsible for Utilities management and Water Infrastructure Services Planning. However, GHD is not able to verify the information provided by BSC and does not warrant that the information is correct.

This report has been based on additional information provided by BSC, including the existing plant data collated and summarised in Sections 2, 4 and 5. Whilst every effort has been made to ensure that the information used is consistent with GHD experience from similar projects, GHD is not able to check the information. GHD does not warrant that the information supplied is correct.

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[3] Incorporating Section 94 Contribution Plan and Section 94A Plan

[4] Hydrosphere (2016). *Strategic Business Plan* prepared for Byron Shire Council by Hydrosphere Consulting, Sept. 2016, Table 5, p5.

This Study did not include a condition assessment of the existing BVSTP and related equipment.

This Study did not include a condition assessment or a review of the capacity of the existing BVSTP effluent outfall pipeline and/or related infrastructure.

No geotechnical investigation was undertaken for any of the sites (STP and proposed transfer pipeline route). For this Study it was assumed that expansion of the BVSTP site with additional infrastructure would be feasible for a treatment plant of similar design to that existing at this site. A detailed geotechnical investigation will be required prior to any detailed design or implementation of the project.

No additional site survey investigation was carried out as part of this Study. The site survey information used (STP and existing or proposed pipelines) was sourced from existing drawings provided by BSC.

This Study has focussed on BVSTP process capacity and its ability to absorb additional flows and loads from Ocean Shores. Hydraulics issues were addressed only in relation to the ability of this plant to treat wet weather flow from its existing catchments (i.e. Mullumbimby and Brunswick Heads) plus the proposed transfer from Ocean Shores. A detailed review of BVSTP internal hydraulics was not included in the scope of work for this Study.

No investigation of the urban and site reuse systems for recycled water from the STPs was undertaken as part of this Study

1.5 Assumptions

This Study was based on the following assumptions:

- Population projections as per the latest Strategic Business Plan[5] (2016), as provided by Byron Shire Council
- Previous population projections obtained from studies in the period ca. 2003-2012, as listed in Section 2.1.1
- Unit flows per population equivalent as explained in Section 2.2.1
- Information from existing STP design reports and as-built drawings (Fulton Hogan/Cardno, 2010)
- Information on easement for previously proposed OSSTP-BVSTP effluent transfer pipeline and associated survey (conducted by B & P Surveys, 2012)
- Data and information collected from previous studies (GHD, 2014& b) for OSSTP
- Additional plant operating data supplied by BSC
- Existing environmental licence requirements (notably for BVSTP effluent quality) will remain unchanged in future, and that a renewed licence with the same effluent quality requirements will be issued by the NSW Environment Protection Authority (EPA) for a plant with expanded treatment capacity at Brunswick Valley.

[5] Hydrosphere (2016). *Strategic Business Plan* prepared for Byron Shire Council by Hydrosphere Consulting, Sept. 2016, Table 5, p5.

2. Population and flow projections

2.1 Population

2.1.1 Approach for population projections

Population projections were adopted from a combination of sources provided by BSC, namely:

- GHD (2003) *Brunswick Area Sewerage Augmentation Concept Design and Detailed Investigations*. This report also formed the wastewater characterisation design basis (GHD, 2007) for the Brunswick Valley STP
- GHD (2008a) *Brunswick Area Sewerage Augmentation Scheme Schematic Design Report*, May 2008
- Byron Shire Council (2010) *Population Projection for Mullumbimby and Brunswick Heads Water & Sewer Model*. BSC internal document (June 2010)[6]
- Byron Shire Council (2010) *Population Projection for Ocean Shores Sewer & Water Model* BSC internal document (July 2010)[7]
- Byron Shire Developer Contribution Plan (2012) – Incorporating a Section 94 Contribution Plan and a Section 94A Plan

Byron Shire Council *Strategic Business Plan*[5] (2016)The GHD (2008a) *Brunswick Area Sewerage Augmentation Scheme Schematic Design Report* made reference to a flow re-assessment and adoption of lower unit flow rates (per resident population or population equivalent) than those originally adopted in the GHD (2003) concept design investigations. These lower unit flow rates (290 L/EP/d) from the GHD (2008a) report were adopted here for the Low Growth scenario (see below) and the original (GHD, 2003) unit flow rates for the High Growth scenario (see below) for a more conservative estimate, allowing for high infiltration/ inflow (I/I).

The more recent Developer Contribution Plan (2012) had lower growth rates projected for the Ocean Shores catchment than the previous projections (in 2010) that formed the basis for the Ocean Shores Planning Study (GHD, 2014 a,b). Similarly, the previous population projections (GHD, 2003; 2007) had higher numbers of permanent residents than those from the more recent Developer Contribution Plan (2012). However, the Developer Contribution Plan (2012) did not give specific provision for tourists (overnight guests and day trippers) required to make up the peak season population estimates in the forward projections.

The most recent growth projections are sewerage system equivalent tenements (ET) taken from BSC's Strategic Business Plan (2016). These projections are from 2015 to 2045, being Council's current planning horizon. It was assumed[8] that the ET projections in the Strategic Business Plan were based on peak populations, including tourists.

Accordingly, for the purposes of this Study, revised projections for the combined catchments were compiled using the following approach:

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[6] BSC Internal Technical Note: Ref. 24.2010.17.1/ENG703300/#977886

[7] BSC Internal Technical Note 24.2010.17.1/ENG703300/#989427

[8] The notes provided by Hydrosphere (2016) in the Strategic Business Plan (section 1.2) indicate a peak population of 34,500 people for 2014/15 (referencing DPI-Water, 2016a). The corresponding Sewerage ET adopted for 2015 (Section 1.2.1, Table 5 of the same report) was 15,148 ET (all areas), which gives approximately 2.3 persons/ ET. Since this ratio is a reasonable number, the assumption of peak population being included in the ET growth projections was considered to be reasonable. The permanent population for 2014/15 was stated as 20,500 people (i.e. a significantly lower figure).

- **Mullumbimby and Brunswick Heads catchments:**
  - Peak population projections based on ET projections from the Strategic Business Plan (2016) and an assumption[9] of 2.46 Equivalent Persons (EP) per ET.
  - Tourist population numbers adopted as a median of high and low growth projections from previous estimates (GHD, 2003; BSC, 2010) – see references above. The tourist population numbers were assumed to be included in the population estimates derived from the Business Plan (2016) projections (see above), and only subtracted for the purpose of estimating non-peak day population numbers, excluding tourists (overnight and day trippers).
- **Ocean Shores catchment:**
  - Population projections based on ET projections from the Strategic Business Plan (2016) and an assumption of 2.46 Equivalent Persons (EP) per ET.
  - An assumption of negligible tourist (overnight guests or day trippers) contributions to loads for the Ocean Shores catchment[10].
- **Combined catchments:**
  - By summation of the above for projection purposes when estimating the future STP upgrade requirements for the combined catchments.

2.1.2 Results of population projections for combined catchments

For the purposes of this Study, and in consultation with BSC[11], the *peak* population projections derived from the Strategic Business Plan (2016) were adopted (refer to Section 2.1.1). The adopted total population projections for the combined catchments are given in Figure 1. A further breakdown is given in charts and tables in Appendix A. Previous projections from a combination of sources (including the Developer Contribution Plan, 2012; and other earlier studies) are also given for comparative purposes.

2.1.3 Results of population projections for Ocean Shores catchment

If the catchments are not combined (i.e. sewage is not transferred from Ocean Shores to BVSTP, then OSSTP will need to be upgraded. A previous planning study (GHD, 2014a,b), followed by an Addendum report (GHD, 2016) to this Study, examined high and low population projections for the Ocean Shores catchment. The previous planning study (2014b) recommended a plant upgrade to a capacity of 10,700 EP, based on higher growth projections, compared with an upgrade to 7,100 EP based on lower growth projections in the draft Addendum report (GHD, 2016).

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[9] The EP/ET ratio of 2.46 was derived from 240 L/EP/d (design basis for Byron Bay STP) and the current BSC planning guideline of 590 L/ET/d (BSC, D Baulch email communication to GHD, 11 June 2015).

[10] BSC (Dean Baulch) email communication to GHD (D de Haas, 10-11 June, 2015) – refer also to previous Planning Study for Ocean Shores STP, (GHD, 2014a,b). This assumption is not critical in that the exact location of tourist contributions to the three catchments (OS, BH & M) is not important from a planning perspective, following the transfer of combined flows from Ocean Shores to BVSTP, provided that the summed allowance for tourist numbers is appropriate.

[11] BSC (D Baulch (meeting with GHD (D de Haas) on 6 October 2016 in BSC offices.

Referring to Figure 2, it can be seen that the most recent population projections for Ocean Shores from the Strategic Business Plan (2016, see above), are higher than the original high growth projections (GHD, 2014a) in the short-medium term (up to ca. 2025) but follow a mid-trajectory in the longer term (2025 to 2045). Some further work might be required to resolve the discrepancies between current OSSTP flows and the previous and most recent population short-term projections. For planning purposes in this Study, the OSSTP upgrade strategy proposed in the GHD (2014b) planning study was considered to be appropriate, being a close match to the adopted population projections (from Strategic Business Plan, 2016).

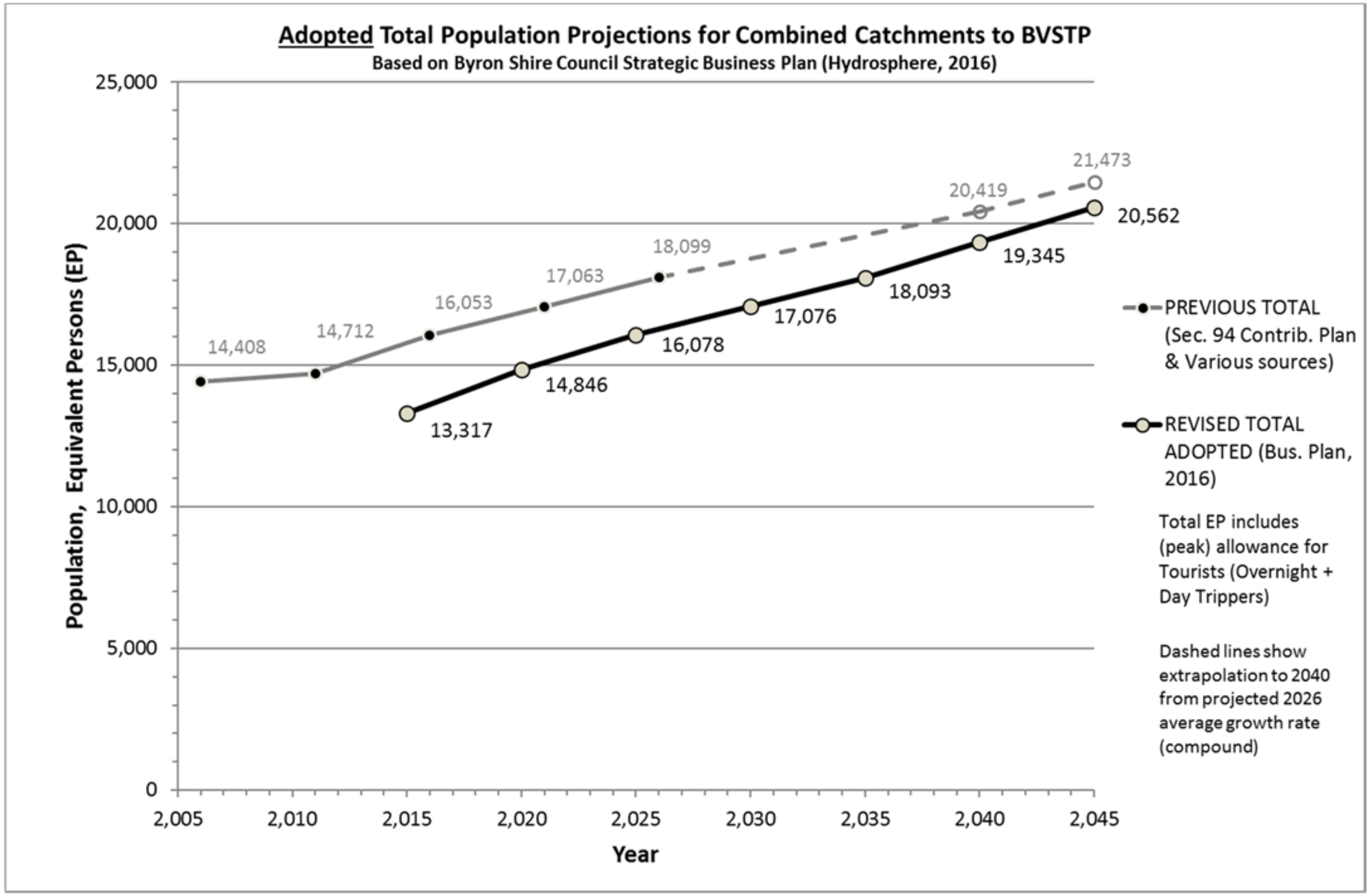

Figure 1 Adopted Total Population Projections - combined catchments of Brunswick Heads, Mullumbimby and Ocean Shores

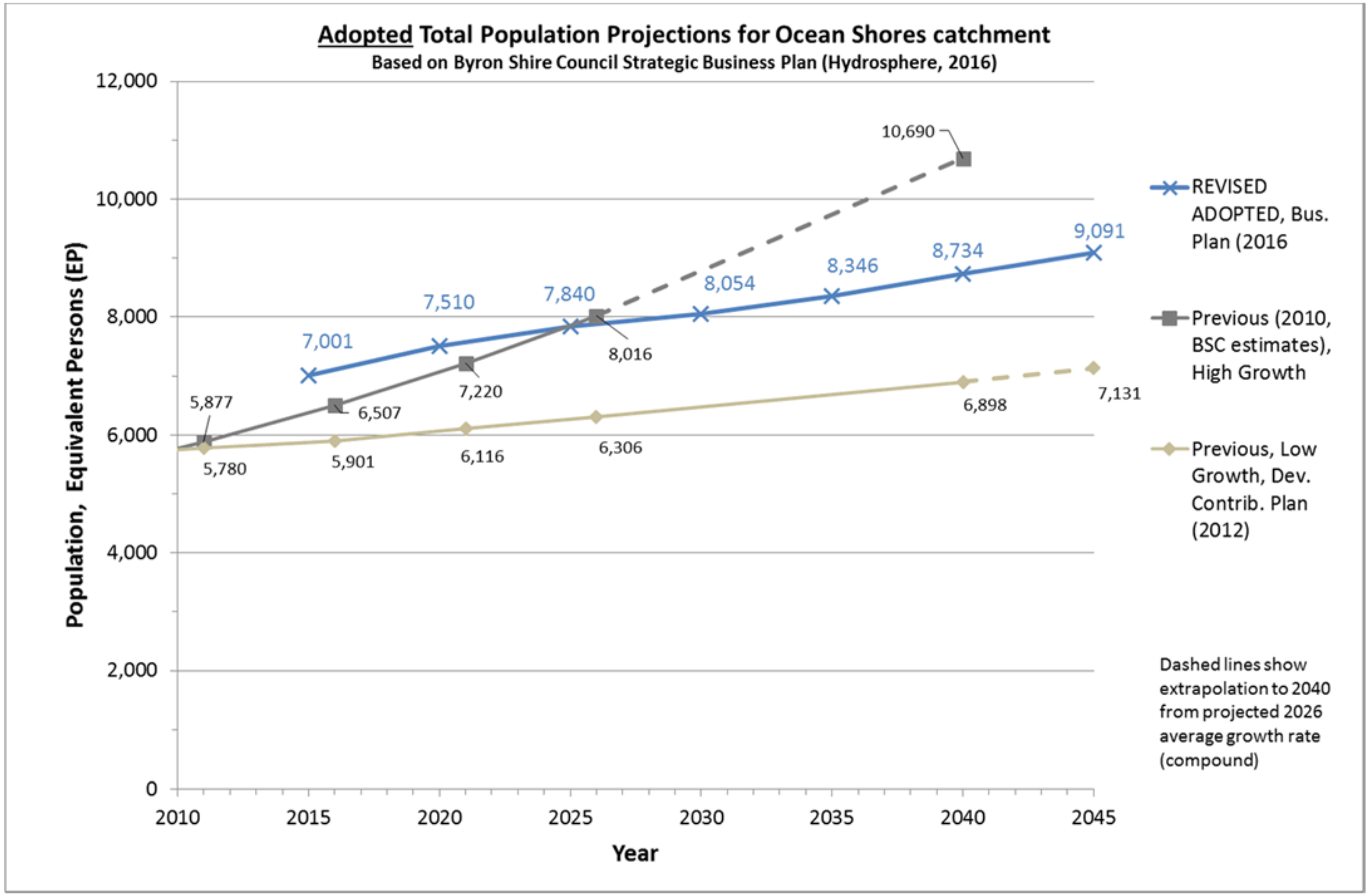

Figure 2 Adopted Population Projections for Ocean Shores catchment

2.2 Dry weather Flow

2.2.1 ADWF from population projections

Average dry weather flow (ADWF) projections were carried out using the adopted unit flow allocations per equivalent population, as given in Table 1.

Table 1 Adopted unit flows per equivalent population or tenement

Catchment	Unit Flow per Equivalent Population (L/EP/d)	Approximate Unit Flow per Equivalent Tenement (Note 1) (L/ET/d)	Notes
Ocean Shores	240	**590** to 624	Based on Planning Study (GHD, 2014a, b)
Mullumbimby	240 290	**590** to 624 **713** to 754	Design assumption From GHD (2005)[12], allowing for lower I/I
Brunswick Heads	240 326	**590** to 624 **802** to 848	Design assumption From GHD (2005)[12], allowing for slightly lower I/I
Overnight Tourists	200	**492** to 520	From GHD (2003)
Day Trippers	30	**74** to 78	From GHD (2003)

Note 1: For EP/ET ratio in the range[13,14] 2.46 to 2.6. **The adopted EP/ET ratio was 2.46.**

The calculated ADWF based on peak season[15] population projections is given in Figure 3 below. A breakdown of the projected flows is given in Appendix B. The results suggest that:

- Peak season ADWF from the Mullumbimby (M) and Brunswick Heads (BH) catchments currently connected to the BVSTP, which nominally includes Overnight Tourists and Day Trippers allowances, will reach 2.75 ML/d by 2045 (i.e. about 72% of the existing plant design ADWF of 3.8 ML/d), assuming a design unit flow rate of 240 L/EP/d. If additional allowance in the unit flow rate is made for Infiltration/Inflow (I/I in the lower range 290 to 326 L/EP/d for the M and BH catchments, refer to Table 1), then the peak season ADWF is projected to reach 3.51 ML/d by 2045 (i.e. 92% of the existing design ADWF for BVSTP).
- Assuming the transfer of wastewater from Ocean Shores, as proposed in this Study is implemented, peak season ADWF from the combined Mullumbimby, Brunswick Heads and Ocean Shores catchments will reach 4.93 ML/d by 2045 at the adopted deign unit flow rate of 240 L/EP/d, or approximately 5.69 ML/d by the same date if additional I/I flow allowance is included for the M + BH catchments (see above).

[12] The GHD (2005) reassessed flows using lower I/I values formed the basis of the plant design (GHD, 2007).

[13] An EP/ET ratio of 2.46 from 240 L/EP/d (design basis for Byron Bay STP) and current BSC planning guideline of 590 L/ET/d.

[14] An EP/ET ratio of 2.6 from previous (BSC, 2010) population projections (see to reference in Section 2.1.1)

[15] Peak season is taken as total adopted population estimates, including the full quota of Overnight Visitors and Day Trippers.

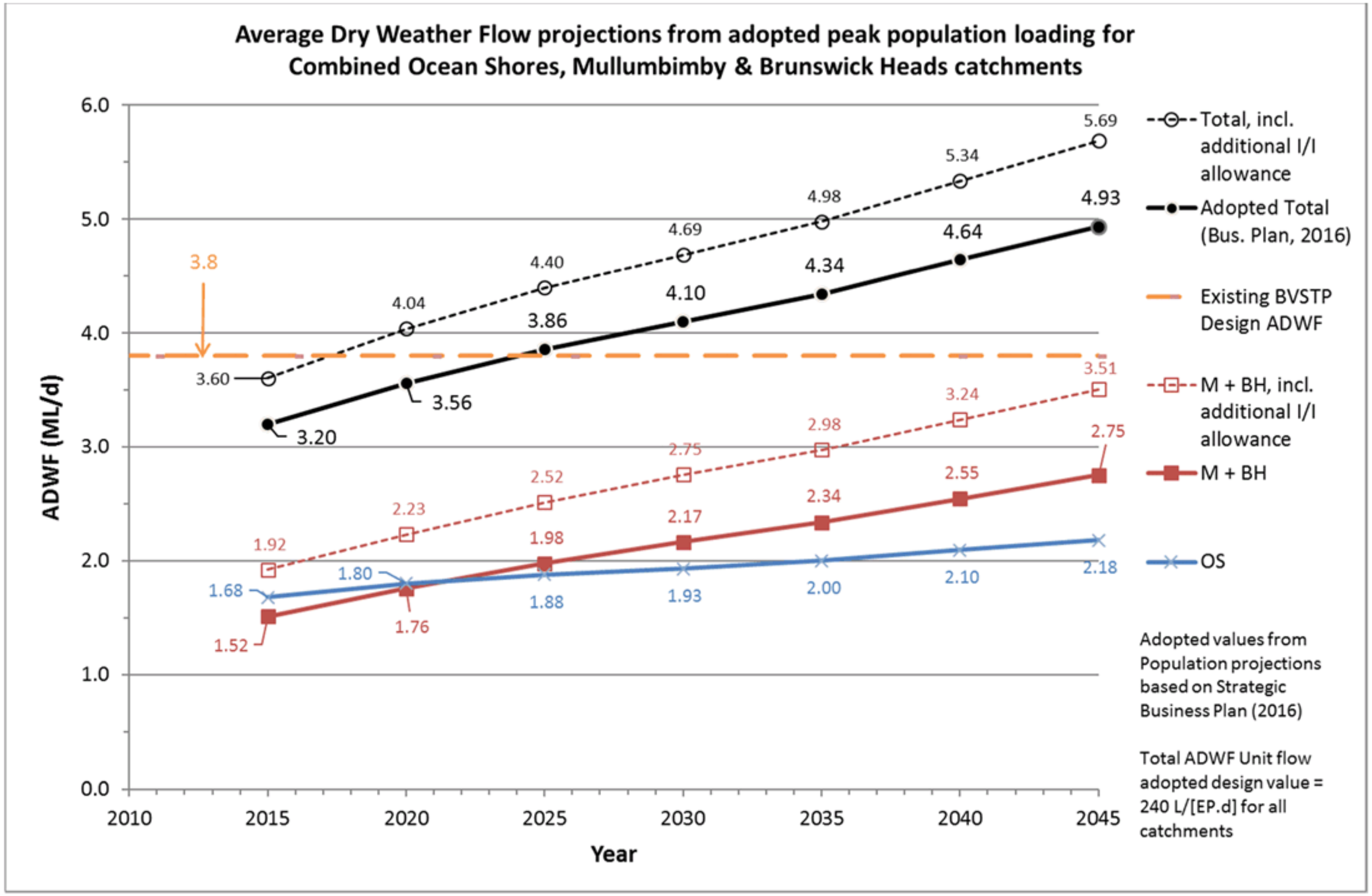

Figure 3 Average dry weather flow projections based on population projections and adopted design unit flow

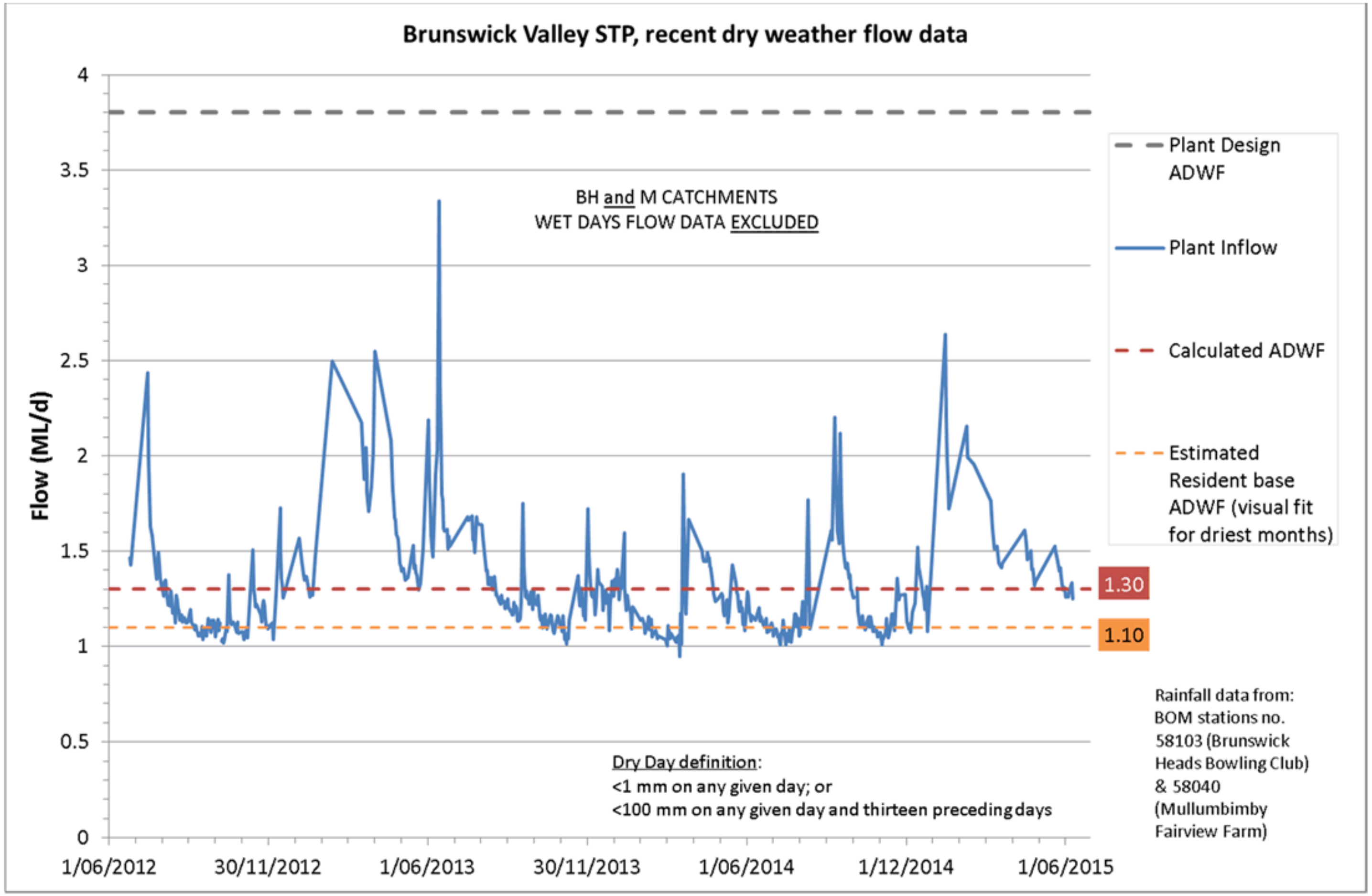

Figure 4 Recent (2012-15) dry weather flows received at BVSTP, based plant and rainfall records

2.2.2 Current plant ADWF

The current ADWF to the Ocean Shores STP (as assessed by GHD, 2014a) is approximately 1.3 ML/d (2014 data).

The current ADWF to the BVSTP was estimated based on recent (June 2012- June 2015) daily total flows recorded at the plant[16] and matching rainfall records[17] for the Mullumbimby and Brunswick Heads. Dry weather flow data was derived by filtering the data set to exclude wet days[18]. The results are shown in Figure 4 above. The data suggests that:

- ADWF on peak days during tourist season periods (typically mid-summer months, indicatively December-February) currently typically range[19] approximately 1.5 to 2.0 ML/d. This agrees reasonably well with the estimates from population projections for the corresponding period, depending on the assumptions for I/I allowance (e.g. approximately 1.5 to 1.92 ML/d for 2015 – refer to Figure 3 above).
- Outside of peak season (see above), ADWF typically ranges approximately 1 to 1.5 ML/d, and on the lower end of that range (1.0 to 1.3 ML/d) during the driest months – refer to Figure 4). This matches reasonably well with the flow estimates for resident population only of the two catchments (M + BH, data not plotted in Figure 3 – refer to Appendix B), excluding tourists and without additional I/I allowance (i.e. subtracting flow allowances of 0.43 ML/d and 0.07 ML/d respectively for Overnight Tourists and Day Trippers respectively from the projected ADWF of 1.51 ML/d derived from peak population projections and the adopted design unit flow rate of 240 L/EP/d). Therefore, it can be concluded that the projected ADWF based on adopted population and unit flow estimates are reasonable and reflective of typical conditions in the catchment in terms of average I/I allowance. Lower base dry weather flows would likely occur during the driest months, which are typically in the winter-spring period (Jul-Nov) when peak day contributions from tourists are also lowest.
- The coupling of flow projected from higher population projections and higher I/I allowance seems unlikely, based on the comparison between the projections for Mullumbimby and Brunswick Heads population numbers (refer to Appendix B), and current dry weather flows (Figure 4). However, the available data[20] suggest that peak single-day flows (nominally in dry weather) currently range from approximately 2.0 to 3.3 ML/d (i.e. approximately 1.3 to 2.2 times ADWF from population projections for 2015). Elevated plant daily flow totals in this range are likely due to lingering I/I effects from wet weather that were not effectively 'filtered out' of the dataset using the adopted definition of dry weather (refer to footnote[14]). The M and BH catchments are known to have significant on-going I/I issues. It would therefore be prudent for the design of BVSTP (upgrade including OS transfer under review in this Study) to make a conservative allowance for clarifier capacity to handle peak wet weather flows (refer to Section 2.3), as well as lingering I/I effects on daily peak flows on dry days following wet weather.

[16] Data supplied by BSC for the two plant inflow flow meters (i.e. one each on the two rising mains into the plant)

[17] Bureau of Meteorology daily rainfall data for stations located at Fairview Farm (Mullumbimby) and Brunswick Heads Bowling Club respectively for the two catchments.

[18] A wet day was defined as any day on which >1 mm was recorded in either of the two catchments, or any day on which the cumulative rainfall on that day plus the thirteen preceding days was >100 mm. The relatively long preceding period (thirteen days) applied was selected because of known Infiltration/ Ingress issues in the catchments (particularly Mullumbimby) and the associated 'tapering off' of flows to the sewers following significant rainfall events.

[19] Ignoring peak day flows >2.5 ML/d that are probably due to lingering wet weather effects.

[20] Excluding one peak day flow (3.3 ML/d) that occurred in the dataset during Jun-2013 and appeared to be an outlier.

2.3 Wet Weather Flow

2.3.1 Design Peak Wet Weather Flows

Mullumbimby and Brunswick Heads

According to GHD (2008a), there are two existing main pump stations[21] that deliver flow to the BVSTP in its current form, namely:

- PS 4000 serving the Mullumbimby sewerage scheme; and
- PS 2000 serving the Mullumbimby sewerage scheme

The design assumptions for these pump stations are summarised in Table 2.

Table 2 Design Information for Sewage Pump Stations delivering to BVSTP

Catchment served	Pump Station number	Design maximum flow rate, L/s (instantaneous or peak wet weather)	Wet well volume (kL) From Pump Stop Level to:	Notes
Mullumbimby	SPS 4000	156 L/s	Start (min.): 7 Start (max.): 14 Standby: 15.5 Alarm: 17 TWL: 23.2	Based on projected 2025 PWWF (130 L/s or 7ADWF) pumped over 20 hours in a 24-h period
Brunswick Heads	SPS 2000	158 L/s	Start (min.): 7 Start (max.): 14 Standby: 15.5 Alarm: 17 TWL: 27.6	Based on projected 2025 PWWF (132 L/s) pumped over 20 hours in a 24-h period
Total	(to BVSTP)	314 L/s 27.13 ML/d	-	-

Source: GHD (2008a)

The design flows in Table 2 match the instantaneous peak flow rates given in the design report for the BVSTP (Fulton Hogan, 2010), namely:

- Rising Main 1 ("Brunswick Raw Sewage"): 158 L/s
- Rising Main 2 ("Mullumbimby Raw Sewage"): 156 L/s
- Sub-total Raw Sewage: 314 L/s (or 7.1 times ADWF where ADWF = 3.8 ML/d)
- Return Activated Sludge (RAS included in flow via Inlet Works): 150 L/s
- Inlet Works (Total peak flow including peak RAS): 314 + 150 = 464 L/s

[21] Both PS 4000 and PS 2000 were new pump stations, proposed and built at the same time as the new BVSTP (GHD, 2008)

The existing BVSTP is designed for (full) biological treatment at a sustained peak raw wastewater inflow rate of 5.8 times ADWF (255 L/s or 22 ML/d), subject to assumptions relating to the clarifier design (refer to discussion in Section 6.4.2 below). The (instantaneous) peak hydraulic raw wastewater capacity of the plant is 314 L/s.

Ocean Shores

According to the recent GHD (2014a,b) planning reports, the existing sewerage scheme for Ocean Shores has two pump stations that deliver wastewater to the Ocean Shores STP (OSSTP). These are listed in Table 3, along with the current rated capacity of these pump stations.

Table 3 Design Information for Sewage Pump Stations delivering to OSSTP

Catchment served	Pump Station number	Design maximum flow rate, L/s (instantaneous or peak wet weather)	Wet well volume (kL) From Pump Stop Level to:	Notes
Ocean Shores (northern, Kiah Close)	SPS 5009	252 (original pumps) 136 L/s for current pump installed (single pump) (Up to approx. 165 L/s for dual pump operation)	Start (speed 1): 12.9 Start (speed 2): 16.1 Start (speed 3): 19.3 Standby: 22.5 Alarm: 29.0 TWL: 64.4	Variable speed, Duty BEP from pump curve
Ocean Shores (southern, Rajah Rd)	SPS 5004	48 (single pump) (Approx. 62 L/s for dual pump operation)	Start: 2.8 Standby: 3.9 Alarm: 5 TWL: 11.2	Fixed speed, single Duty pump BEP from pump curve. Duty-assist operation is possible
Total	(to OSSTP)	300 (original pumps) Up to approx. 227 L/s for current pumps installed, with dual pump operation		Sum of design Duty BEPs from pump curves

Source: Flygt pump curves (Best Efficiency Point, BEP)

The nominal peak hydraulic capacity of OSSTP inlet works (as assessed by GHD, 2014a,b) is at least 270 L/s. However, this assessment noted that:

- The estimated peak capacity of 270 L/s is conservative, assuming that all the flow travels via by-pass weir and manual screen and allows for 232 L/s peak raw inflow[22] plus 38 L/s of in-plant recycles. In practice, a higher capacity may be possible with some portion of the combined flow passing through the mechanical screen (partially blinded as a worst case scenario).
- The original inlet works (as built in 1996) was subsequently modified by installation of one vortex grit tank. The original inlet works (without grit removal) was rated for an instantaneous PWWF of 156 L/s (for a design ADWF of 1.92 ML/d or 8,000 EP), with the potential to ultimately double the treatment plant capacity to 16,000 EP. The ultimate design peak hydraulic capacity of the plant was not clearly defined in the original plant documentation, but presumably would be close to 312 L/s.

The limited dataset[23] used in the GHD (2014a,b) assessment of wet weather flows suggested that the cumulative maximum flow received over a defined period at the STP (i.e. sum of SPS 5009 and 5004 combined) was as follows:

- Cumulative maximum flow averaged over 24 h: 55.8 L/s
- Cumulative maximum flow averaged over 3 h: 106.0 L/s
- Cumulative maximum flow averaged over 2 h: 121.1 L/s
- Cumulative maximum flow averaged over 1 h: 135.6 L/s

2.3.2 Current Peak Weather Flow

Brunswick Valley STP

Figure 5 shows recent totalised daily flow data for BVSTP, including wet weather, with rainfall plotted on the same chart. It can be seen from this chart that:

- The plant is quite susceptible to high wet weather flows. This is a known issue[24] due to relatively high I/I, particularly in the older parts of the Mullumbimby and Brunswick Heads catchments.
- Sustained (i.e. daily total) flows have exceeded the plant design PWWF (sustained) for full biological treatment (22 ML/d), once during the three-year period observed here (i.e. 23.4 ML/d on 5/4/2013).
- Daily total flows during wet weather have exceeded approximately 4 times ADWF (15.2 ML/d) on at four days during the three-year period observed here (refer to Figure 5).
- Daily total flows have not exceeded the instantaneous peak design flow rate of the plant (27.1 ML/d) during the three-year period observed here.

Instantaneous flow data (from SCADA) during the period 22/6/2015 to 30/6/2015 (a minor wet weather event) did not exceed 180 L/s (15.55 ML/d). Refer to Appendix D.

Ocean Shores STP

Plant flow and rainfall data recorded at OSSTP in the period 2010-2014 is shown plotted in Figure 6. This figure shows that sustained (i.e. daily total) flows at OSSTP in this period during

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[22] Based limited flow meter data (GHD, 2014a) for the rising mains at the STP (SCADA data from 25/08/2014 to 28/08/2014), the maximum pump rates were found to be 62 L/s and 170 L/s for SPS5004 and SPS5009, respectively.

[23] Based limited flow meter data (GHD, 2014a) for the rising mains at the STP (SCADA data from 25/08/2014 to 28/08/2014), the maximum pump rates were found to be 62 L/s and 170 L/s for SPS5004 and SPS5009, respectively.

[24] Discussions with BSC Water & Sewerage technical staff (May 2015) indicate that the I/I issues in the older parts of the catchments are unlikely to improve significantly in the near future but new developments are less likely to suffer from the same degree of I/I.

wet weather did not exceed 13.5 ML/d (156 L/s). Average dry weather flow was assessed[25] in the range 1.3 to 1.4 ML/d for the 2010-14 period (GHD, 2014a).

Recent (2014) limited SCADA data showing instantaneous flow rates for SPS 5009 and 5004 are shown in Figure 7 and Figure 8 respectively (taken from GHD, 2014a). The data suggests that SPS 5009 achieved its full design capacity at maximum speed (on VSDs) during this period for the currently installed pumps, peaking at 170 L/s (compared with up to 165 L/s rated maximum capacity from the existing pumps, with dual pump operation, and theoretical system curves). SPS 5004 briefly recorded a peak of 61 L/s, which compares well with the rated maximum capacity of 62 L/s for dual pump operation.

[25] Dry weather definition: any day on which the cumulative total rainfall for that day and six preceding days (i.e. 7-day cumulative) was <2 mm.

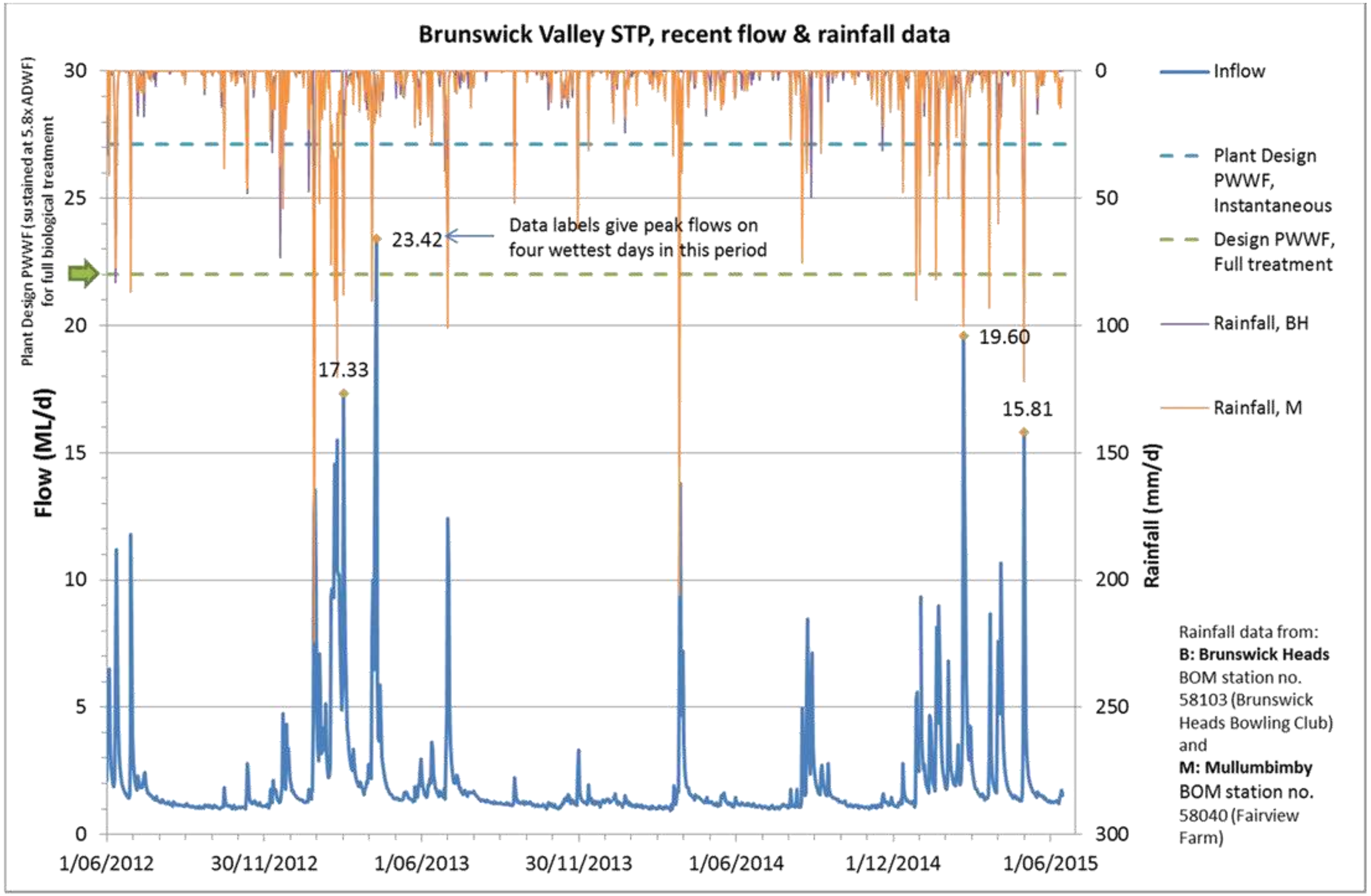

Figure 5 Recent (June 2012 to June 2015) daily total flow and rainfall data for BVSTP

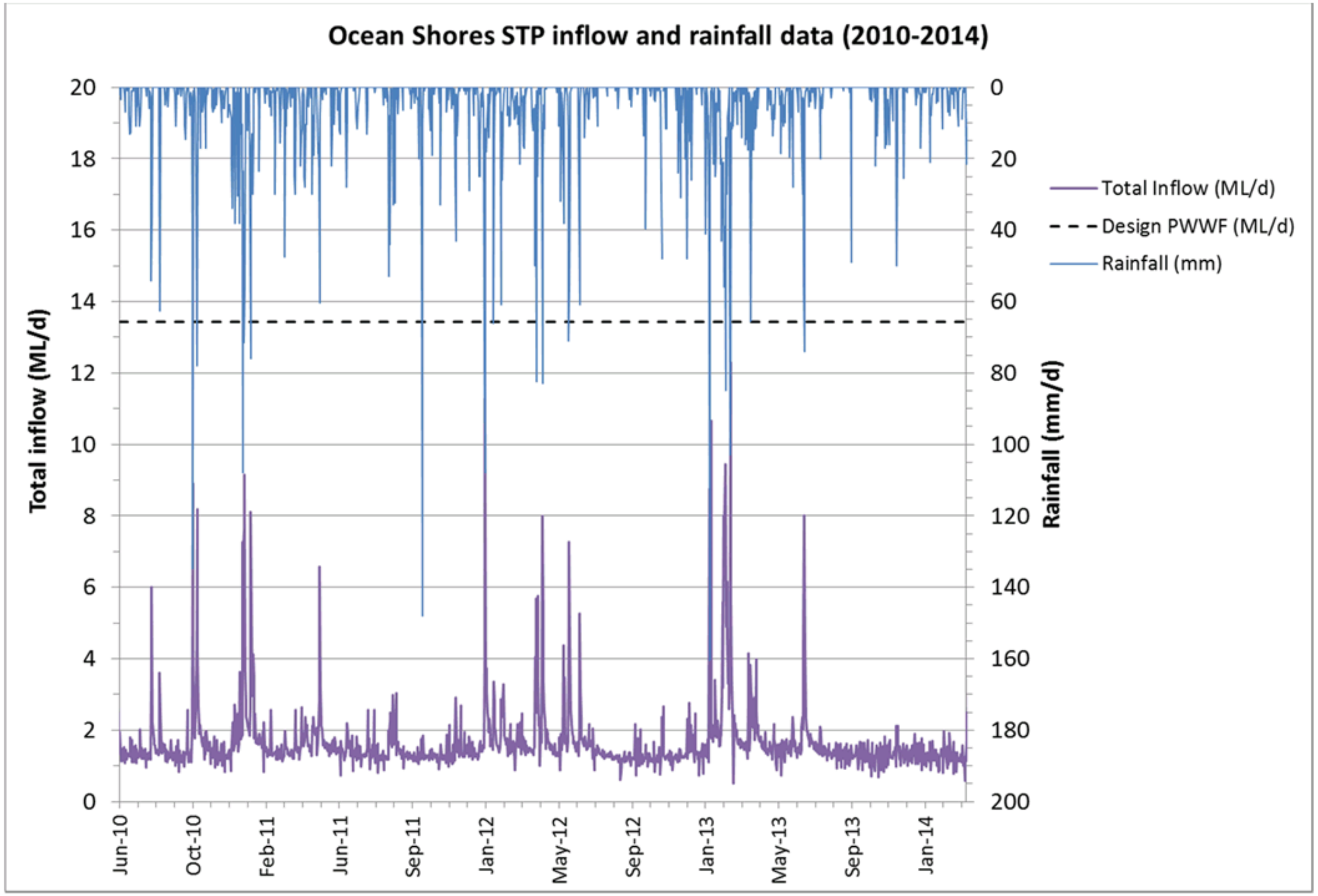

Figure 6 Daily total flow and rainfall data (June 2010 to Mar 2013) for OSSTP

Source: GHD (2014a)

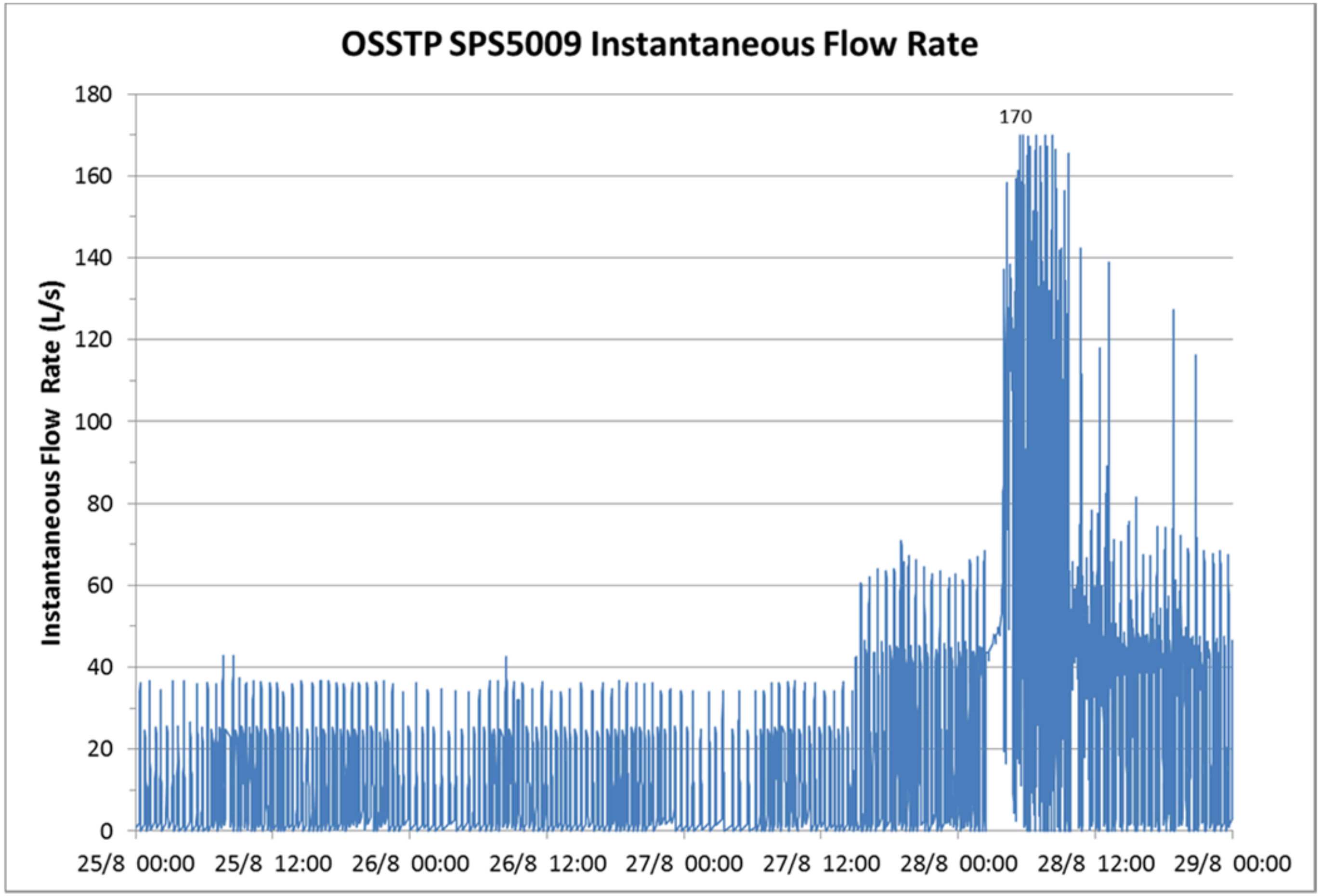

Figure 7 Instantaneous flow data (limited period 25-28 Aug. 2014) for Ocean Shores Sewage Pump Station 5009

Note: Design flow rate for this pump station (from pump curves) is 252 L/s (pumps equipped with variable speed drives)

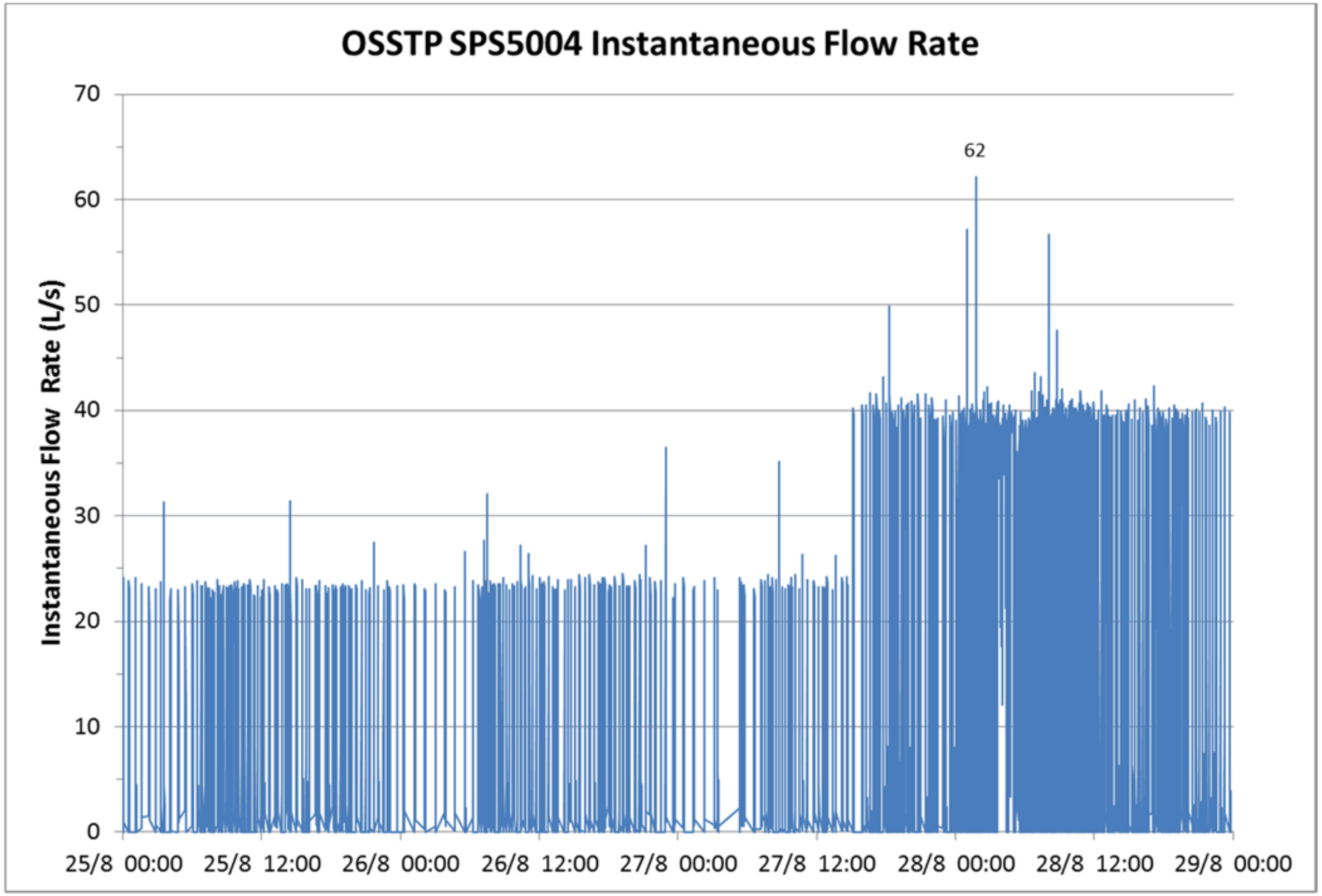

Figure 8 Instantaneous flow data (limited period 25-28 Aug. 2014) for Ocean Shores Sewage Pump Station 5004

Note: Design flow rate for this pump station (from pump curves) is 48 L/s for single pump operation (2 no. fixed speed pumps, duty-assist)

2.4 Average annual flow

Average annual flows[26] recorded at BVSTP during the period 1 June 2012 - 16 June 2015 are given in Table 4.

Table 4 Average BVSTP annual flows (1 June 2012 – 16 June 2015)

Parameter	Value	Unit
Total flow	2 305.3	ML
No. of days in recording period	1 107	Days
Average annual flow (AAF)	761	ML/year
Average annual flow (daily basis)	2.08	ML/d
Total dry weather27 flow	765.2	ML
No. of dry days in recording period	590	Days
Average dry weather flow (ADWF, daily basis, from above)	1.30	ML/d
Ratio AAF/ADWF	1.60	-

[26] Based on BVSTP raw inflow meters on rising mains from PS1 (SPS2000) and PS2 (SPS4000) serving the plant

[27] Refer to definition in Section 2.2.2

3. Licence requirements

A copy of the NSW Environmental Protection Authority Environment Protection Licence (Version date 11 February 2013; or 'Licence') for the Brunswick Valley STP is provided in Appendix C. Key points are summarised below.

3.1 Flow limits

The licence is limited to a maximum flow of 22.04 ML/d to be discharged to water (or solids or liquids applied to the area). This equates to 5.8 times current design ADWF capacity (3.8 ML/d) refer to Section 4. Peak pumping capacity into the plant (refer to Section 2.3.1) is higher than this, equating to 7.1 times design ADWF. If the peak pumping capacity is sustained over one or more days, then the licence flow limit will be exceeded. To date, such a high flow event is not known to have occurred[28].

If Ocean Shores wastewater flows are transferred to BVSTP, the maximum daily (total) flow is likely to increase by at least 12 ML/d for the existing catchments (refer to 2.3.2). A new Licence will need to be negotiated for the BVSTP.

For this report, it was assumed that BSC will negotiate a new future licence for the plant, if and when required. For the purposes of this Study, it was assumed that the plant will be upgraded in a manner that is similar to the current design philosophy for BVSTP as a conservative starting position. The maximum daily flow limit for the new licence would need to be revised to at least 5.8 x 5.7 ML/d (33 ML/d) to consistent with the existing plant design philosophy.

For this Study, it was assumed that in future, a peak (instantaneous) hydraulic capacity (or flow limit) will be designed to accommodate the revised peak raw wastewater pumping capacity, including Ocean Shores. The combined peak pumping capacity of the four raw wastewater pump stations feeding the consolidated upgraded BVSTP (i.e. serving Ocean Shores, Mullumbimby and Brunswick Heads catchments - refer to Section 2.3.1) may be up to 614 L/s (refer to Sections 2.3.2 and 8.1.1). This amounts to seven times design ADWF if BVSTP dry weather capacity is nominally doubled to 7.6 ML/d. A lower design ADWF capacity (e.g. 5.7 ML/d) is likely to be sufficient at current population growth rates. This means that the apparent ratio of peak wet weather flow to design ADWF is likely to be higher (around 9 times ADWF). The plant upgrade strategy and peak wet weather flow management is discussed in Section 7.

3.2 Load limits

The annual mass load limits shown in Table 5 apply to the BVSTP effluent.

[28] The highest flow event (daily total flow) in the most recent period for which data was examined in this Study (refer to Section 2.3.2) was 23.42 ML/d on 5/4/2013. Prior to that, during the two-year Process Proving Period (26 Feb. 2011 to 11 Jan 2013) following plant commissioning, the maximum daily flow recorded was 13.8 ML/d.

Table 5 Brunswick Valley STP existing licence mass load limits

Assessable Pollutant	Annual Load Limit (kg)	Equivalent Average Concentration (mg/L) at:			
		ADWF = 3.8 ML/d	AAF = 6.08 ML/d (Note 1)	ADWF = 5.7 ML/d	AAF = 9.12 ML/d (Note 1)
BOD	15,818	11.4	7.1	7.6	4.8
Total N	15,818	11.4	7.1	7.6	4.8
Total P	475	0.34	0.21	0.23	0.14
Total Suspended Solids	23,726	17	11	11	7
Oil & Grease	3,163	2.3	1.4	1.5	<1

Note 1: Values for estimated Annual Average Flow (AAF) assuming AAF = 1.6 * ADWF (based on 2012-14 data), refer to Section 2.4.

Except for Oil & Grease (O&G), the concentrations of pollutants back-calculated from the load limits are within the envelope of licence/design concentrations and/or current plant performance (refer to Sections 3.3 and 4 below). In the case of O&G, the back-calculated concentration limits are lower than the tabulated concentration licence and design limits (refer to Table 6 and Section 4). This appears to be an anomaly. The back-calculated concentration limits (Table 5) imply that final effluent O&G will need to be at or near typical detection limits for this parameter.

It is noted from Table 5 that to meet current licence load limits, the required concentrations decrease in future as plant population loads and flows increase. Alternatively, a new licence with increased load limits will need to be negotiated.

3.3 Concentration limits

The concentration limits tabulated in Table 6 apply to the BVSTP effluent.

Table 6 Brunswick Valley STP existing licence concentration limits

Pollutant	Units	90th percentile concentration limit	100th percentile (Maximum) concentration limit
BOD	mg/L	10	15
Faecal coliforms	cfu/100 mL	200	600
Ammonia	mg/L as N	2	4
Total N	mg/L as N	10	15
Oil & Grease	mg/L	5	10
pH	pH units	-	6.5 (Min.) to 8.5
Total P	mg/L as P	0.3	1
Total Suspended Solids	mg/L	15	30

Note: Tabulated values from the licence apply to the effluent discharge to receiving waters i.e. discharge pipe on eastern arm of western billabong of Brunswick River (Licence 'Point 1').

3.3.1 Note on disinfection requirements

A constructed wetland (downstream of secondary effluent UV disinfection) has been included in the proposed concept for BVSTP upgrade associated with the transfer of flow from Ocean Shores in this Study (refer to Section 8.2.14). The requirement for additional (tertiary) disinfection downstream of the proposed wetland is uncertain and subject to NSW EPA requirements for licensing of the upgraded plant, including the proposed transfer.

Depending on the outcome of future EPA licence requirements, it might be necessary provide tertiary disinfection downstream of the proposed wetland. However, for the purposes of this Study, it was assumed that this will not be necessary and no inclusion for this has been made in the costs estimates (Section 11). It was assumed that the future (new) Environmental Protection Licence (EPL) requirement for the BVSTP plant will be similar to the existing EPL for the Byron STP, where the point of compliance for effluent quality (including bacteriological quality i.e. faecal coliforms) is at the discharge to the wetland (i.e. downstream of secondary treatment effluent UV disinfection but upstream of the wetland).

3.4 Biosolids limits

The licence requires that biosolids at the premises must be stored, treated, processed, classified, transported and disposed in accordance with the (NSW) 'Biosolids Guidelines' (Use and Disposal of Biosolids Products), or as otherwise approved in writing by the EPA.

3.5 Odour

The licence does not identify a 'potentially offensive odour' (or odour source) at the STP. However, the licence notes that Section 129 of the NSW Environment Operations Act (1997) provides that BSC ('the licensee') must not cause or permit the emission of any offensive odour from the premises. Provisions are also made for cases where an odour is identified as being 'potentially offensive' and the odour was 'emitted in accordance with the conditions of a licence directed at minimising odour'. An example would be failure of odour mitigation or odour control systems at the plant, in which case BSC would be required to make a defence to the EPA.

4. Existing plant capacity

4.1 Design loads

The BVSTP is designed for loadings as summarised in Table 7.

Fulton Hogan (2010) noted the following for the adopted design loadings

- Nutrient ratios (i.e. TKN/COD or TP/COD) are typical or 'average' for (domestic) sewage
- The sewage is 'well fermented' in the sewers with a (relatively) high biodegradable COD content that is favourable for biological nutrient removal
- Estimated sulphide concentrations are (relatively) high, presenting both odour and corrosion risks that need to be controlled.

Table 7 Design loadings for existing BVSTP

Parameter	Value		
50%ile Loads:	**Load**		**Concentration**
Flow (ADWF)	3.8 ML/d		---
COD	2050 kg/d		540 mg/L
TKN	205 kg/d		54 mg/L
TP	38 kg/d		10 mg/L
TA	---		230 mg$CaCO_3$/L
SO_4	---		37 mg/L
Sulfide (estimated generation in sewage rising mains at 19-24-29 degC)	---		2-5-9 mgS/L
Peaking Factors (x 50%ile):	**90%ile**	**Peak Rate**	**Diurnal Peak**
Flow:			
Hydraulics			
Sustained	---	5.8	---
Instantaneous	---	7.1	---
Process	1.3	7.1	2
COD mass load	1.3	---	2.5
Peak flow rate:			
Sustained	255 L/s; 920 m3/h; 22 ML/d		
Instantaneous	314 L/s; 1120 m3/h; 27 ML/d		
50%ile Sewage Characteristics:			
COD/BOD	2.4		
Unbiodeg soluble COD / total COD, fus	0.05		
Unbiodeg particulate COD / total COD, fup	0.20		
RBCOD / CODtotal, fbs	0.15		
TKN/CODtotal	0.100		
TP/CODtotal	0.019		
Unbiodegradable soluble N fraction, fnus	0.035 (raw, decreased by alum dosing)		
ML Temperature (min-ave-max)	19-24-29 degC		

Source: Fulton Hogan (2010) Design Report

4.2 Hydraulic capacity

The STP is capable of simultaneously receiving the maximum instantaneous pump flow rates from both the Mullumbimby and the Brunswick Heads sewage systems as follows (refer to Table 2 and Section 2.3.1):

- Mullumbimby: 156 L/s
- Brunswick Heads: 158 L/s
- TOTAL: 314 L/s

The hydraulic capacity of Brunswick Valley STP augmentation is based on the following criteria:

The inlet works is designed to accept a flow of 7.1 x ADWF and provides mechanical screening and degritting of this flow. A full flow bypass channel around the mechanical screens, with manually raked screen, is provided.

The biological treatment stage (oxidation ditch and clarifiers) is designed for 7.1 x ADWF hydraulic instantaneous peak flow, or 5.8 x ADWF sustained peak flow, is designed for reduction of nitrogen and phosphorus.

The UV disinfection stage is designed to provide effective reduction of effluent coliforms at a flow of 3 x AWDF, and the hydraulic capacity of the UV disinfection stage is 7 x ADWF.

The plant hydraulic profile shows that:

- Return Activated Sludge (RAS) is recycled to the upstream end of the inlet works, presumably to provide for screening of the RAS. This is somewhat unusual; no additional RAS screen is provided and the hydraulic gradeline through inlet works includes the peak RAS flow allowance of 150 L/s.
- There is no by-pass facility around the bioreactor to the clarifiers[29] (i.e. if peak flows into the plant exceed 5.8 x ADWF on a sustained basis, these flows will continue to flow via the bioreactor to the clarifiers and will potentially cause solids loading 'stress' on the clarifiers (beyond their design sustained solids loading rate). Similarly, short-term instantaneous peak flows (>5.8 x ADWF) will increase short-term solids loading rates on the clarifiers beyond the design sustained solids loading rate.
- The differential top water level between the feed channel downstream of inlet works and the bioreactor (oxidation ditch) outlet channel is 0.16 m (i.e. <0.2 m). This is very limited with little or no opportunity for the potential retrofit of a bioreactor by-pass channel as described above. Furthermore, in the current arrangement, any by-pass from the downstream end of inlet works will include RAS, thereby defeating the purpose of the by-pass. A raw wastewater reactor by-pass (without RAS) would be required to reduce solids loading rate on the clarifiers. This would require modification of the hydraulic profile with a new splitter structure upstream of the existing inlet works with additional considerations around the question of screening by-pass flows.
- Flow gravitates out of the plant from the clarifier launders, via the UV disinfection system, then to the plant outlet manhole and effluent discharge pipeline. It is ultimately discharged to the 'oxbow lake' in the Brunswick River. Total head loss from the clarifier launder to the UV outlet overflow channel is approximately 1.16 m, and from the UV outlet overflow channel to the effluent outfall pipeline to river (at average high tide) is approximately 2.62 m. The UV and outfall systems have been designed to take into account prevailing flood levels on the site (refer to Section 4.3). For example, the UV reactor top-of-concrete level

[29] The (West) Byron STP (BSTP) plant, by comparison, has a by-pass facility from inlet works directly to the clarifier feed for flows >3 ADWF (adjustable weir), which reduces clarifier feed solids concentration and loading rates during PWWF events. In other respects the BVSTP and BSTP designs are similar.

is at Reduced Level (RL) 6.100 m Australian Height Datum (AHD), which allows for a freeboard of +2.8 m above the 100-year Average Recurrence Interval (ARI) flood level. However, the effluent outlet manhole and discharge pipeline are below this flood level and expected to be inundated in such a flood condition.

4.3 Flood levels

According to the Fulton Hogan (2010) design report, all buildings, critical facilities and tankage are designed to be protected from a 100 year ARI flood level of RL 3.30 m AHD and with a freeboard of not less than +1.0 m generally and +1.2 m for electrical equipment.

The design report further stated that the specification for the plant required the cross sectional area of the new STP to be limited to 50% of the area above existing ground level and ARI 100 flood level of 3.3 m. The plant layout exceeded 50% of the cross sectional area. Byron Shire Council arranged for a new flood model to be prepared to determine the effect of the plant layout on the flood level at Mullumbimby. The model determined that the plant layout had no measurable effect on the flood level.

4.4 Process units

Process unit details for BVSTP are contained in the Fulton Hogan (2010) design report and have not been repeated here. In summary, the treatment process consists of the following units:

- Mechanical step screen (1 no. 3 mm nominal aperture), with manual by-pass screen (1 no., 25 mm aperture)
- Vortex tank for grit removal (1 no., 3.35 m top diameter air-lift grit pump to 1 no. mechanical classifier)
- Ferric sulphate dosing facilities at inlet works for sulphide (odour and corrosion) control
- Four air extraction and treatment from inlet works (nominal 15 air changes per hour) for odour control via a biofilter (gravel/compost media bed)
- Anaerobic reactor (3 no. compartments in series, 10% overall biological mass fraction)
- Oxidation Ditch (6 m wide, 4 m deep, 139 m circuit length), 21 h nominal HRT, 20 day SRT, with submersible banana-blade mixers for mixed liquor circulation
- Diffused aeration (2 no. duty/1 no. standby positive displacement blowers, each 30 kW and 1005 Nm^3/h nominal maximum airflow rate each; maximum SOTR 175 kg/h; turndown 5:1)
- Clarifiers (2 no. 23 m diameter secondary clarifiers, 3 m side water depth)
- RAS system (2 no. pumps per clarifier, max. total RAS rate 3.5 times design ADWF)
- Waste activated sludge (WAS) to aerobic digester
- Scum pumps from clarifiers to Oxidation Ditch
- UV disinfection
- Effluent systems
  - Site Service Water
  - Off-site reuse (1.9 ML storage tank on site for optional transfer to Mullumbimby – see below)
  - Transfer Pump Station (2 no. pumps, 22 L/s each or 0.5 times design ADWF) to Mullumbimby effluent storage facility (dam)
  - Effluent discharge to Brunswick River

- Biosolids treatment
  - Aerobic Digester (292 kL; 20 day solids retention time)
  - Sludge dewatering via one gravity drainage deck/belt filter press (1.2 m effective belt width; 35 h/week operation at design loading)
  - Filtrate return pump station
  - Ancillary equipment
    - Polymer dosing system
    - Compressor
    - Conveyors
  - Sludge storage (covered area, six bays for up to one month dewatered biosolids storage at design load)
- Chemical dosing equipment
- Site Drainage Pump Station (2 no. pumps, 10 L/s each)

4.5 Clarifier capacity

The existing circular clarifiers (2 no. 23 m diameter) were designed more 'aggressively' than the (West) Byron STP, which has largely the same process configuration as the BVSTP. The main difference lies in the design sludge settleability assumptions – refer to the discussion in Section 5.1.3 below. A summary comparison of the clarifier capacities of the two plants, on a relative basis, is given in Table 8.

Although not outside the design range encountered for secondary clarifiers in general, the BVSTP clarifiers are at the higher end of the range for design peak overflow and/or solids loading rate typically used for biological nutrient removal (BNR) plants. BNR plants tend to have less favourable sludge settleability than some other types of activated sludge systems that tend to have higher organic loading rates and less apparent negative impact from nitrogen removal biological processes on sludge settleability. The sludge settleability at BVSTP is discussed in Section 5.1.3 below and has been found to be worse than expected. It was postulated by Hartley (2013b), that, during the plant process proving period, settleability will improve as the plant approaches design loading. However, this was speculative on the basis that the prevailing dissolved oxygen concentration (evidenced by the ammonia/nitrate ratio as a surrogate measure of anoxic fraction in the oxidation ditch) is the main underlying cause of relative poor settleability. On-going septicity (high dissolved sulphide) of the raw influent at BVSTP is a factor that could be contributing to the poor settleability. This is not likely to change with plant loading, and could, in fact, deteriorate with the transfer of raw wastewater from Ocean Shores (longer rising mains).

For low effluent (total) suspended solids concentrations (<10 mg/L), clarifier design procedures that adopt relatively poor sludge settleability as a design basis, typically suggest peak overflow rates of <1 m/h and <7.5 kg/(m^2.h) including RAS. These values compare with 1.1 to 1.4 m/h and 7.9 to 10 kg/(m^2.h) respectively for BVSTP (refer to Table 8). The more aggressive design for the BVSTP clarifiers is likely to be the reason behind anecdotal operator reports that the plant experiences difficulty with solids loss under peak flow conditions – refer to Section 5.1.3 below.

Therefore, a more conservative approach for the future augmentation of clarifier capacity at BVSTP is recommended.

Table 8 Comparison of design basis for existing Brunswick Valley and (West) Byron STP clarifiers

Design parameter	Units	BVSTP	(W)BSTP	Notes
Number of clarifiers	No.	2	2	
Diameter, each	m	23	33	
Area, each	m2	415	855	
Area, total	m2	831	1711	
Design Stirred SVI, 90%ile	mL/g	59	90	
Design MLSS, Peak (90%ile)	mg/L	4,900	3,900	
Design ADWF	ML/d	3.8	6.95	
Maximum design hydraulic flow (instantaneous)	(xADWF)	7.1	7	
Peak design process flow for full treatment	(xADWF)	5	3	
Mixed liquor by-pass	-	No	Yes	
Max. RAS ratio at peak flow	(xADWF)	3.5	2	
Peak surface solids loading rate at maximum hydraulic loading rate incl. RAS	kg/(m^2.h)	9.9	5.9	Without reactor mixed liquor by-pass operating
	kg/(m^2.h)	N/A	2.5	With reactor mixed liquor by-pass operating (>3 ADWF)
Peak surface solids loading rate for full treatment incl. RAS	kg/(m^2.h)	7.9	3.3	
Peak overflow rate	m/h	1.35	1.19	At max. hydraulic flow rate
	m/h	0.95	0.51	At peak process design flow rate (full treatment)

BVSTP: Brunswick Valley STP

(W)BSTP: (West) Byron STP

5. Existing plant performance

5.1 Previous reports

5.1.1 Overall performance

The performance of BVSTP after commissioning was extensively documented during the process proving/ defects liability period over two years from ca. Feb. 2011 to Feb. 2013. This information has been reported[30] to and saved by BSC.

In summary, these reports showed that the plant achieved very good performance with compliance in most respects relative to contractual (i.e. 'specified') design targets, which were based partly on the Licence requirements at the time. A summary of the results is given in Table 9 and Table 10 below.

It is worth noting that effluent concentration limits for Faecal Coliforms are only listed in the current EPA Licence (refer to Section 3.3) for river discharge, and correspond with those listed in Table 9. The more stringent Faecal Coliform limits listed for "UV effluent" in Table 9 are driven by BSC internal specifications for water recycling (i.e. not listed in the EPA licence).

The results in Table 9 show that actual plant loading during the two-year process proving period was generally within the design specifications. The maximum daily total flow (in wet weather) was 13.8 ML/d (compared with design 22 ML/d) and average flow <2 ML/d (compared with design ADWF 3.8 ML/d). In terms of flow, the plant was therefore only loaded to <52% of its design capacity during this time. The raw wastewater concentrations were close to the adopted design values, with the nutrient ratios (COD/BOD; TKN/COD; and TP/COD) on average being slightly more favourable for nutrient removal than the adopted design values. In COD mass load terms, the plant was operating at only about 42% of its design capacity on average, although the constraints around the accuracy of raw wastewater sampling (for concentrations) makes this estimate less certain.

The results in Table 10 show that the plant was generally compliant with the specified effluent quality design targets. The following effluent quality exceedance issues were noted (figures in red in Table 10):

- Maximum ammonia and Total P limits (for river discharge)
- Maximum Faecal Coliforms limit for river discharge
- Maximum Faecal Coliforms limit for UV effluent
- 90%ile Faecal Coliforms limit for service water

5.1.2 Wet weather event

The reports during the process proving period made reference to one wet weather incident in late January 2013 (when the maximum daily flow of 13.8 ML/d was recorded). During this incident, the plant suffered gross loss of biomass from the clarifiers due to an operational control error (under diurnal control) in which the RAS ratio[31] fell to 0.2. This incident occurred during a non-sampling period and therefore the expected high suspended solids concentration in the effluent was not measured. However, the bioreactor MLSS concentration dropped significantly

[30] Process Report Nos. 1 to 17 and *Process Tuning Guidelines* prepared by Ken Hartley for Byron Shire Council (dated March 2011 to February 2013).

[31] Note: Design RAS ratio (s) as follows: s= 0.6 at sustained PWWF = 5.8 x ADWF; or minimum s=0.49 at instantaneous PWWF = 7.1 x ADWF.

from 3,100 to 2,100 mg/L. To recover, sludge wasting from the bioreactor was suspended for eleven days.

5.1.3 Sludge settleability

The plant clarifiers were designed with the following assumptions:

- 50th percentile (50%ile) Stirred Sludge Volume Index: 55 mL/g with alum dosing
- 90th percentile (90%ile) Stirred Sludge Volume Index: 59 mL/g with alum dosing (equivalent[32] to 103 mL/g unstirred SVI)
- 50th percentile MLSS: 3,800 mg/L (90th percentile MLSS: 4,900 mg/L)
- Clarifier peak overflow (surface loading) rate 1.1 m/h

The failure analysis using flux theory given in the BVSTP design report[32] shows that, at design values of 50%ile MLSS, 90%ile SSVI and max. RAS rate of 154 L/s, the clarifiers (2 no. online) were expected to 'fail' (in terms of clarification performance) at a peak flow of 323 L/s (1163 m^3/h). This peak flow is only slightly over the design instantaneous peak inflow rate for the plant (314 L/s) – refer to Table 2. The inference is that at a prevailing settleability close to SSVI 90 mL/g (design 90%ile), there is little or no factor of safety in the design for the clarifiers to handle the instantaneous peak flow (314 L/s or 7.1 x ADWF). The clarifiers are only rated for a sustained maximum flow rate of 255 L/s (5.8 x ADWF) for full clarification (biological treatment).

The Design Report (Fulton Hogan, 2010) noted that the adopted sludge settleability for BVSTP was based on data from (West) Byron STP (BSTP). This data showed better settleability at BSTP than the original design, namely:

- BSTP actual 50th percentile SSVI = 53 mL/g with alum (c.f. BSTP 50%ile design[33] value 90 mL/g,)
- BSTP actual 90th percentile SSVI = 59 mL/g with alum (c.f. BSTP 90%ile design value not stated)
- BSTP design median (or 50%ile) MLSS = 3,000 mg/L
- BSTP clarifier peak overflow (surface loading) rate[34] = 0.51 m/h at 3 x ADWF

Notes in the Design Report[32] indicate that the BVSTP clarifier design is "*basically a scaled down West Byron (design) with increased SRT and higher MLSS to compensate. The clarifiers can handle the full flow from the reactor because of the improved SSVI (60 c.f. 90 mL/g)*".

During the process proving period (2011-2013), it was shown that settleability at BVSTP was <u>not</u> as good as at the Byron plant. Refer to Figure 9. The long-term SSVI ranged typically 75 to 90 mL/g (i.e. the observed median or 50%ile exceeded the design 90%ile assumption of 59 mL/g). Similarly, the (unstirred) SVI typically ranged typically approximately 150 to 225 mL/g (i.e. significantly higher than the design 50%ile assumption, see above). Therefore, it can be expected that subject to actual sludge settleability and bioreactor MLSS, the BVSTP clarification capacity could be compromised under peak flow conditions. This aspect was discussed in Section 4.5 above.

The final process proving report (Hartley, 2013b) concluded that:

- Sludge settleability was worsened by low plant loading, leading to a low dissolved oxygen (DO) setpoint for operating the oxidation ditch (i.e. a relatively high anoxic fraction or

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[32] Fulton Hogan (2010) Design Report for BVSTP (Appendix B).

[33] Refer to John Holland/ Cardno (2005) Design Report for (West) Byron STP.

[34] The BSTP Design Report (see above) notes that the clarifiers at the Byron plant were conservatively designed in terms of area and surface loading rate for a low effluent suspended solids.

ammonia/nitrate ratio, which was theorised to stimulate growth of filamentous bacteria and 'sludge bulking')

- Under the prevailing load, a minimum SVI of about 170 mL/g (SSVI about 80 mL/g) is achieved at a DO setpoint of 0.3 mg/L
- Sludge settleability would improve as plant loading approaches design load (speculative, based on theory and data presented).

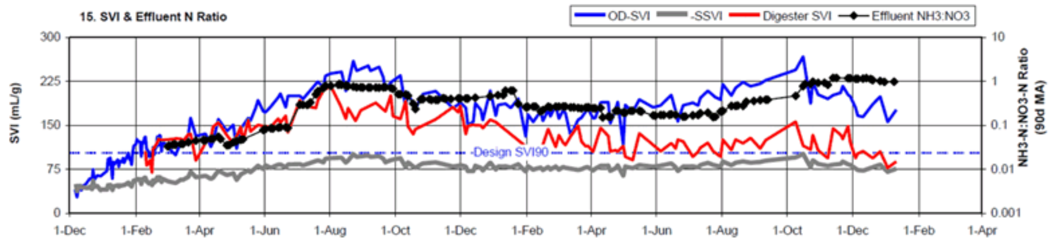

Figure 9 Long-term (2011-2013) settleability data for BVSTP

Source: Hartley (2013b). Note "Design SVI90" (90th percentile SVI) horizontal line plotted at 103 mL/g.

Table 9 Plant loading summary during process proving period (2011-13)

Parameter		Design	Average Load to Date[1]	
			17-Nov-12 to 11-Jan-13	26-Feb-11 to 11-Jan-13
Mass Load				
Rainfall	total mm	---	237	3170
Raindays / total days		---	21 / 56	247 / 686
Flow:				
Mullumbimby	ML/d	---	1.18	1.48
Brunswick Heads	ML/d	---	0.65	0.55
Total[2]	ML/d	ADWF 3.8	1.71	1.99
Maximum day	ML/d	22	4.76	13.8
COD load	kg/d	2050	861	850
Sewage Quality				
COD	mg/L	540	576	495
COD:BOD		2.4	2.04	2.20
TKN:COD		0.10	0.095	0.090
TP:COD		0.018	0.015	0.016
Total alkalinity	mg$CaCO_3$/L	230	263	202
Sulfide soluble:				
Raw sewage	mg/L	2-9 (19-29 degC)	ND	0.5
After Fe dosing	mg/L	3	---	---
VFA	mg/L as acetic	~50 (total RBCOD 80)	61	45

1. Defects liability period start 26-Feb-11. ND = no data
2. Total may not equal sum of inputs due to flow meter differences

Table 10 Effluent summary during process proving period (2011-13)

Parameter	Target/Design Limits[3]			Performance to Date					
				17-Nov-12 to 11-Jan-13			26-Feb-11 to 11-Jan-13		
	50%	90%	Max	50%[4]	90%	Max	50%[4]	90%	Max
Inflow ML/d	3.8	---	22.0	1.71	---	4.76	1.99	---	13.8
Outflow ML/d									
River	3.8	---	22.0	1.63	---	---	1.98	---	---
Reuse	3.8	---	5.7	0.12	---	---	0.17	---	---
Total	3.8	---	22.0	1.76	---	---	2.12	---	---
Effluent Quality (mg/L UNO)									
BOD	---	10	20	1	2	2	1	2	4
SS	5	15	30	3	3	4	2	4	13
Total N									
Specified	4	10	20	1.0	1.7	2.0	1.6	4.0	7.2
EPA	---	10	15						
NH3-N	0.5	2	4	0.10	0.18	0.22	0.08	0.73	4.2
Total P									
Specified	0.3	0.5	1	0.21	0.25	0.25	0.10	0.23	1.4
EPA	---	0.3	1						
O&G	---	5	10	0[6]	0	0	1.0	2.0	5.0
pH (range, units)	---	---	6.5-8.5	---	---	7.6-7.8	---	---	7.0-8.0
F. coliforms: (cfu/100mL)									
UV effluent	2	14	28	ND	ND	ND	3	12	93
River discharge	---	200	600	10	13	14	10	65	21000
Site service[5]	---	10	---	ND	ND	ND	3	25	92

1. ND = no data
2. Any red data are exceedances of 90%ile or maximum limits
3. 90%iles apply to 26 fortnightly samples over each year ending 27-Sep; 50%iles are design values adopted to meet 90%ile and maximum limits
4. Flows are averages; totals may not equal sum of inputs due to flow meter differences
5. Limit shown is Qld Class A (95%ile) for open industrial use & irrigation with unrestricted access
6. 2 no. oil & grease samples

Source for Table 9 & Table 10: Hartley (2013a)

5.2 Recent data

5.2.1 Effluent quality

The recent effluent quality data (since Feb 2013, i.e. post-process proving period) is summarised in Table 11. The results show that the effluent quality is generally compliant with the EPA Licence requirements, except for:

- Ammonia at maximum (presumably due to infrequent under-aeration issues)
- Total P at maximum (presumably due to infrequent alum under-dosing issues)
- Faecal coliforms (presumably due to infrequent issues with the UV disinfection equipment, or possibly infrequently high suspended solids carryover from the clarifiers that might be only partially reflected in the sample results for TSS recorded).

Table 11 Recent BVSTP effluent quality data (for EPA Licence compliance monitoring)

Parameter	Licence			Recent performance (13/2/13 to 27/5/15)		
Limit	**50%ile**	**90%ile**	**Max.**	**50%ile**	**90%ile**	**Max.**
BOD, mg/L	-	10	15	1	3	7
SS, mg/L (TSS)	-	15	30	2	5	12
Total N, mgN/L	-	10	15	1.3	2.6	10.2
Ammonia N, mgN/L	-	2	4	0.2	1.4	9.4**
Total P, mgP/L	-	0.3	1.0	0.11	0.42	2.24**
Oil & Grease, mg/L	-	5	10	0 (ND)	2	3
pH	6.5 to 8.5 (Min. – Max.)			6.9 (Min.)		7.8
Faecal coliforms, cfu/ 100 mL	-	200	600	7	190	5800**

** Denotes licence limit exceedance;

ND: not detected (or below detection limit)

5.2.2 Other operational monitoring parameters

Sludge settleability has not been monitored recently for the plant. The last five values for unstirred Sludge Volume Index (SVI) were recorded in Feb-Mar. 2013, at the end of the process proving period, and ranged from 163 to 194 mL/g (average 177), which is close to the typical range noted by Hartley (2013b) for the current operation (refer to Section 5.1.3 above).

Anecdotal information from the BVSTP operators and BSC managers is that the plant has difficulty retaining MLSS (biomass) under peak wet weather flow conditions (or, as a rough indication, at flows greater than approximately 15 ML/d or 4 times design ADWF).

MLSS is occasionally[35] measured by the operators. The results are shown plotted in Figure 10 along with the four highest wet weather flow events (>4.5 times design ADWF) during the corresponding period (refer also to Section 2.3.2 above). The results in Figure 10 do not show a clear relationship between MLSS and occurrence of high flow events. If significant biomass washout occurred during such events, then a sudden drop in MLSS concentration would have been observed, followed by a slow recovery. However, the low frequency of MLSS sampling by operators might not fully reflect the actual plant behaviour.

An attempt was made to use on-line MLSS instrument[36] data to illustrate the problem. Some examples are shown in Appendix D:

1. For the period spanning the peak flow event on 10/04/2013. However, during this period the instrument produced too much scatter in the data (high-end interference, probably due to probe fouling) to be useful.
2. For the period spanning a recent smaller peak flow event of 26-28/06/2015. During this period, the on-line MLSS instrument operated reliably and showed a transient decrease in oxidation ditch MLSS concentration during the peak flow event. However, the MLSS concentrations recovered quickly (within a few hours). This suggests normal clarifier operation as a portion of the oxidation ditch MLSS inventory was displaced to the clarifier blankets but then recirculated via the RAS. The RAS ratio (relative to inflow) was operated in the range of approximately 1 to 3.5 (:1) i.e. a 'safe' operating condition being higher than the design values (normal 1:1; minimum 0.49:1 relative to peak flow of 3.5 times ADWF).

[35] The MLSS sampling frequency in the dataset by BSC considered here (post-process proving period to date i.e. Jan 2013 to Jun 2015) averaged 23 days but ranged widely from 3 days to 263 days.

[36] Online MLSS instrument fitted to the oxidation ditch after the plant was commissioned (not part of the original design).

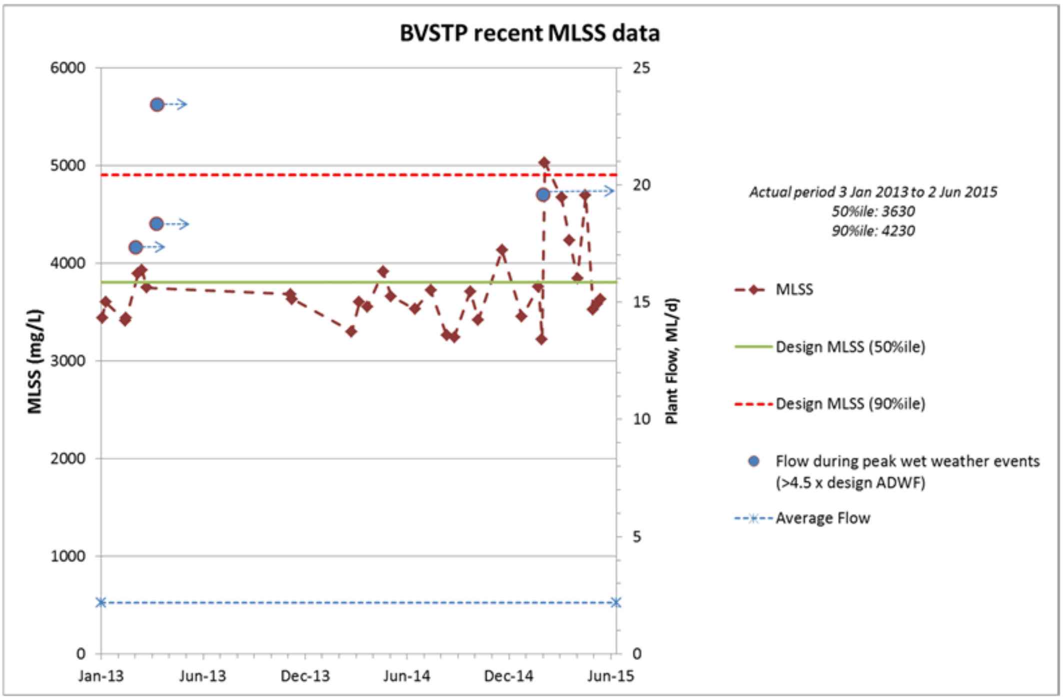

Figure 10 Recent MLSS data for BVSTP in relation to high flow events in wet weather

6. Process modelling

6.1 Model process flow diagram

The process flow diagram for the existing plant was used as the basis for modelling. Refer to Appendix E.

The proposed modified process flow diagram for the plant augmentation (to include Ocean Shores loads) is given in Appendix F.

6.2 Models applied

6.2.1 Activated sludge model

An in-house spreadsheet-based activated sludge model was applied. The basis of this model is similar to that used for the plant design, as documented in Appendix B of the Design Report by Fulton Hogan/Cardno (2010).

6.2.2 Clarifier model

An in-house clarifier model based on modified flux theory (Ekama et al., 1997) was applied. The basis of this model is similar to that used for the plant design, as documented in Appendix B of the Design Report by Fulton Hogan/Cardno (2010).

6.3 Key model inputs

6.3.1 Wastewater characteristics

The design wastewater characteristics for BVSTP and those adopted for planning purposes for OSSTP are given in Table 12 below, along with the combined characteristics. The combined characteristics assume that the plant augmentation makes provision for 1.9 ML/d ADWF from Ocean Shores (compared with predictions in the range 1.7 to 2.2 ML/d from population projections, depending on the growth scenario). Provision is made for 3.8 ML/d ADWF (the existing plant design capacity) from the Mullumbimby and Brunswick Heads catchments combined. Refer to population and flow projections in Section 2.

The OSSTP wastewater composition assumptions made here (from GHD, 2014a) are slightly more conservative than the design values for BVSTP (refer to Table 12). No detailed wastewater characterisation data for OSSTP was available for this Study to confirm these assumptions. It is recommended that a detailed wastewater characterisation program be carried out prior to detailed design to confirm the assumptions made in this section.

6.3.2 Other model parameters

Assumptions for other key model parameters are stated in Table 12. As far as possible, these are consistent with the design assumptions for the existing BVSTP.

Table 12 Adopted raw wastewater characteristics and related parameters for modelling

Parameter	Load (kg/d unless otherwise stated)			Load per EP (g/EP/d)			Concentration (mg/L)		
Value for:	BVSTP	OS	OS + BVSTP	BVSTP	OS	OS + BVSTP	BVSTP	OS	OS + BVSTP
Peak Flow									
Sustained (L/s)	255	140	395						
(ML/d)	22.0	12.1	34.1						
times ADWF	5.8	6.4	6.0						
Instantaneous (L/s)	314	300	614						
(ML/d)	27.1	25.9	53.0						
times ADWF	7.1	6.8	9.3						
50%ile Loads									
Nominal Equivalent Persons (EP) @ 240 L/EP/d	15,833	7,917	23,750						
Flow, ADWF (ML/d)	3.8	1.9	5.7						
COD	2,052	1,140	3,192	129.6	144.0	134.4	540	600	560
TKN	205.2	122.6	327.8	13.0	15.5	13.8	54	64.5	58
TP	38	18.2	56.2	2.4	2.3	2.4	10	9.6	10
Total Alkalinity (as CaCO3)	874	551	1425				230	290	250
Sulfate (SO42-)							37	no data	37
Sulfide (as S) at 19-24-29 degC							2-5-9	no data	2-5-9

Table 12 continued

Factors	BVSTP			OS			OS + BVSTP		
Peaking factors (x 50%ile)	**90%ile**	**Peak**	**Diurnal Peak**	**90%ile**	**Peak**	**Diurnal Peak**	**90%ile**	**Peak**	**Diurnal Peak**
Flow									
Sustained Flow /Process	-	5.8	2	-	6.4	2	-	6.0	2
Instantaneous Flow /Hydraulics	-	7.1	-	-	6.8	-	-	9.3	-
Load									
COD Mass Load	1.3	-	2.5	1.3	-	2.6	1.3	-	2.53
TKN Mass load	-	-	not stated	-	-	3.2	-	-	3.0
TOD Mass load			not stated						2.65
Raw Wastewater Characteristics	**50%ile**						**50%ile**		
COD/ BOD	2.4						2.4		
USCOD/ TCOD, fus	0.05						0.05		
UPCOD/ TCOD, fup	0.20						0.20		
RBCOD/ TCOD, fbs	0.15						0.15		
USTKN/ TKN, fnus	0.035						0.027		
TKN/TCOD	0.1						0.1		
TP/TCOD	0.019						0.019		

Table 12 continued

Other key model parameters	BVSTP			OS			OS + BVSTP		
Mixed liquor temperature (°C)	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.
	19	24	29	no data			19	24	29
Nitrifier kinetics (at 20°C) Note 2									
Max. Specific Growth rate (d^{-1})		1.0						1.0	
Specific Decay rate (d^{-1})		0.04						0.04	
Ammonia half-saturation coefficient (mgN/L)		1.0						1.0	
Notes									
Note 1: Ocean Shores values based on a combination of GHD (2014b) adopted concentrations for OSSTP Planning and population projections from this Study (refer to Section 2.1)									
Note 2: Nitrifier kinetic parameters quoted here are for the steady-state (spreadsheet based) model consistent with that used as the design basis for the existing BVSTP. Biowin™ model parameters (as applied by GHD 2014b) for OSSTP planning were not applied here (Biowin™ model not used).									
RBCOD: Readily biodegradable COD									
USCOD: unbiodegradable COD									
UPCOD: unbiodegradable COD									
TCOD: Total COD									
USTKN: Unbiodegradable soluble TKN (at zero Alum dose; USTKN decreases with Alum dose, based on West Byron STP data)									

6.4 Model results

6.4.1 Activated sludge model

The model results are given in Appendix G.

These may be compared to those given in Appendix B of the Design Report for the existing plant (Fulton Hogan/Cardno, 2010). The results are similar.

6.4.2 Clarifier model

The key model outputs from the flux theory model analysis are given in Table 13.

Table 13 Key outputs from clarifier modelling

	CLARIFIER FLUX CALCULATIONS - KEY OUTPUTS												
			Assuming: Peak month MLSS = 4900 mg/L; SSVI = 59 mL/g (BVSTP design 90%ile)										
Model Case No.	Scenario	Mixed liquor bypass	ADWF (ML/d)	PWWF/ ADWF ratio to clarifiers	PWWF (L/s)	Max. RAS (L/s) per clarifier	No. of Clarifiers	Required Clarifier Total Area (m^2)	Existing Clarifier Total Area (m^2)	Required Clarifier Diameter (m) each	Existing (or proposed) Clarifier diameter (m) each	Approx. spare clarifier capacity (% of total area provided)	Notes
Case 1.1	Current Design at 5.8 ADWF	No	3.8	5.8	255	77	2	622	831	19.9	23.0	25%	Existing clarifiers do not have reactor flow-bypass facilities; RAS is recycled via inlet works for screening
Case 1.2	Current Design at 7.1 ADWF	No	3.8	7.1	312	77	2	834	831	23.0	23.0	0%	Ditto
			Assuming: Peak month MLSS = 4900 mg/L; SSVI = 90 mL/g (approx. BVSTP actual 90%ile; Byron STP design 50%ile)										
Case 2.1	Current Design at 5.8 ADWF	No	3.8	5.8	255	77	2	1283	831	28.6	23.0	-54%	Existing clarifiers do not have reactor flow-bypass facilities; RAS is recycled via inlet works for screening
Case 2.2	Current Design at 7.1 ADWF	No	3.8	7.1	312	77	2	2091	831	36.5	23.0	-152%	Ditto
Case 3.1	Proposed Future Design at 6 ADWF	No	5.7	6.0	396	77	4	1660	1662	23.0	23.0	0%	Proposed 50% ADWF and bioreactor capacity plant augmentation. For consistency with current design, asssume new reactor and clarifiers will also not be equipped with reactor flow by-pass
Case 3.2	Proposed Future Design at 7.1 ADWF	No	5.7	7.1	468	77	4	2170	1662	26.3	23.0	-31%	Ditto

6.5 Summary of modelling

6.5.1 Activated sludge model

A summary of the model results is given in Table 14.

Table 14 Summary results from activated sludge modelling

Process Train	OS+BVSTP (Existing train)			OS+BVSTP (New train)		
Parameter	**Tave**	**Tmin**	**Tmax**	**Tave**	**Tmin**	**Tmax**
Mixed liquor temperature (°C):	**20**	**19**	**29**	**20**	**19**	**29**
Parameter, units	**Value**					
ADWF, ML/d	3.8			1.9		
Sludge age, d	19.5			19.5		
Process Volume (bioreactors total), ML Oxidation ditch channel dimensions, m • Depth (water) • Width • Length (mid-point circuit, 2-pass) • Straight length	3.7 • 4.0 • 6.0 • 139 • 60			1.85 • 3.6 • 3.6 • 128.5 • 58.6		
Average MLSS concentration, mg/L	3786			3785		
Peak month MLSS concentration, mg/L	4922			4921		
Average Actual Total Oxygen demand, kg/d	1445			722		
Average SOTR, kg/h (diffused air)	124	125	122	62	62	60
Maximum SOTR, kg/h (diffused air)	176	176	175	87	87	86
SOTR turndown required (Max./Min.) for airflow	5.8			5.7		
Alum dose, mg/L as dry alum	<= 10			<= 10		
Alkalinity depletion due to alum dosed, mg/L $CaCO_3$	<=4			<=4		
Effluent Ammonia, mgN/L	0.7	0.7	0.6	0.7	0.8	0.6
Effluent Nitrate, mgN/L	0.3	0.3	0.3	0.3	0.3	0.3
Effluent Total N, mgN/L	3.4	3.5	3.2	3.4	3.5	3.2
Effluent soluble P, mgP/L	0.01			0.01		
Effluent Total P, mgP/L	0.21			0.21		
Effluent TSS, mg/L (assumed)	4			4		

The results show that the BVSTP can be feasibly upgraded by adding 50% to the existing bioreactor process capacity. The new (smaller) oxidation ditch bioreactor will be narrower and slightly shallower than the existing oxidation ditch, but a similar length, in order to keep the aeration system design as consistent as possible.

Subject to the confirmation of design wastewater characteristics (refer to Section 6.3.1, particularly for Ocean Shores), the design sludge age for the plant (both existing and new process trains), when subjected to the combined loads of the Mullumbimby, Brunswick Heads and Ocean Shores catchments, can be similar to that for the existing plant (i.e. 19.5 days compared to 20 days for the existing plant). This is expected to produce an operating MLSS (average and peak) that matches the design assumptions for the clarifiers, as discussed in Section 6.5.2).

In terms of aeration, the estimated oxygen requirement (Standard Oxygen Transfer Rate or SOTR – refer to Table 14) for the existing process train (oxidation ditch bioreactor) is projected to be largely within the range of the existing blower and diffused aeration equipment (refer to Section 4.4). However, subject to design wastewater characteristics being confirmed, the maximum SOTR is expected to marginally exceed the design maximum capacity of the existing system (by a negligible margin of about 1 kg O_2/h).

The new process train will also be aerated by means of diffuser air with a similar design to that of the existing plant. Subject to equipment selection, including the diffuser type and number, the efficiency of aeration of the new train will be marginally lower (indicatively 10%) than that of the existing system. This is due to the altered tank geometry (reduced tank depth), to maintain the DO profile required for good biological nitrogen removal performance along the channel length. Such details can be confirmed during detailed design and will make an insignificant difference to cost considerations that form part of this feasibility study.

The effluent quality from the new and existing process trains, after transfer of the Ocean Shores loads to the augmented plant, is expected to be essentially the same as that of the existing process and should meet EPA licence requirements (refer to Table 14 and Sections 3.3 and 5.1.1 above).

6.5.2 Clarifier model

The clarifier model results illustrate the issues discussed in Sections 4.5 and 5.1.3 above. In summary, the following points can be noted:

- The existing clarifiers (2 no. 23 m diameter) have a relatively ‘aggressive’ design, being for a design settleability of SSVI = 59 mL/g (90%ile). That is, the design assumed significantly better settleability than more conservative designs (e.g. previously at (West) Byron STP, which had a design SSVI = 90 mL/g on a 50%ile basis). This is illustrated in Table 13 (see above). Table 13 shows that the existing clarifiers have a margin of safety (25% spare capacity) at sustained process peak flows of 5.8 times ADWF (255 L/s), and zero margin of safety (0% spare capacity) at a peak flow of 7.1 times ADWF (312 L/s), where ADWF is 3.8 ML/d (44 L/s) for the existing plant.
- Given that the actual settleability at BVSTP to date has typically been worse than the design settleability (SSVI range ~60 to 90 mL/g - refer to Figure 9 on page 33), it is not surprising that the operators anecdotally report problems with biomass retention under sustained peak flow conditions. Table 13 shows that theoretically the clarifiers have a deficit in capacity (i.e. a tabulated negative value for spare capacity) for the combination of peak month design MLSS (4900 mg/L) and an SSVI of 90 mL/g.
- Based on a more conservative assessment, including allowance for sustained future peak flows from the combined Mullumbimby, Brunswick Heads and Ocean Shores catchments (refer to Figure 19 on p109), it is recommended that provision be made in the plant augmentation for a minimum clarifier process capacity of sustained operation at 6 times ADWF or 396 L/s (where the augmented plant ADWF is 5.7 ML/d or 66 L/s).
- Using a more conservative sludge settleability (SSVI 90 mL/g being close to the current 90%ile or the Byron STP design 50%ile value), provision for two new clarifiers (23 m diameter each to match the two existing clarifiers) for the plant augmentation is recommended.
- With a total of 4 no. 23 m diameter clarifiers (100% augmentation) provided in future, compared with only 50% bioreactor process capacity augmentation), a change in plant flow splitting and operating philosophy will be required. These changes are described in more detail in Section 7, but in summary will entail the following:

- The new process train (one third of total bioreactor capacity after plant augmentation) will be hydraulically coupled to the two new clarifiers (representing one half of the total clarifier capacity after augmentation).
- Providing a new raw influent flow splitter upstream of inlet works to split the flow in a ratio as follows:
  - 33% to the new process train (with new clarifiers) and 67% to the existing process train (with existing clarifiers) under dry weather conditions (i.e. time-averaged influent flow rates nominally less than 2 times design ADWF)
  - 50% to the new process train (with new clarifiers) and 50% to the existing process train (with existing clarifiers) under wet weather conditions (i.e. time-averaged influent flow rates nominally greater than 2 times design ADWF)
  - Surplus wet weather flows (time-averaged influent flow rates nominally greater than 6 times design ADWF) will be diverted to a new wet weather storage facility. Provision to divert more flow to the storage facility will be made, which will be an 'emergency' operational strategy invoked by the plant operators, if required (e.g. if one or more clarifiers is out of service).
- Providing a new RAS flow splitter downstream of the inlet works and upstream of the bioreactors. The purpose of the RAS flow splitter will be to combine the RAS from all four clarifiers (new and existing) and then re-dividing the RAS in proportion to the process requirements. This approach also has the advantage of providing a common total biomass inventory for the two trains, such that their MLSS concentrations and biological behaviour remain largely consistent over the life of the plant, thereby simplifying plant control. For the same reason, it will be possible to use the clarification capacity of all four clarifiers even if one of the two bioreactors in either of the two process trains needs to be taken off line (e.g. this will be useful in future when aeration diffusers or aeration pipework require maintenance).
- The RAS flow split ratio will be consistent with raw influent flow splits (see above), namely:
  - 33% to the new process train and 67% to the existing process train under dry weather conditions
  - 50% to the new process train and 50% to the existing process train under wet weather conditions
- Existing RAS line connection to the inlet works will be closed, and RAS diverted to the new RAS flow splitter.
- RAS screening at the new RAS flow splitter will be provided.
- Providing a new mixed liquor flow splitter downstream of the bioreactors for combining mixed liquor flows (influent and RAS) from the two process trains and re-dividing the combined flow in proportion to the number of clarifiers that are on line, for example:
  - 25% to each clarifier with 4 no. clarifiers on line
  - 33% to each operating clarifier with 3 no. clarifiers on line (1 no. off line)
  - *Note: Mixed liquor flow splits will not be directly related to dry vs. wet weather flow considerations.*

Refer to the revised Process Flow Diagram for the Augmented Plant (Appendix F) for more information on the flow splitting arrangements proposed.

7. Augmentation strategy

7.1 Sewerage transfer system

Broadly, there are two options for transfer of wastewater via modifications to the sewerage system serving OSSTP and BVSTP. These are as follows:

- **Option A:** Build a new rising main pipeline from OSSTP to BVSTP. The existing rising mains from SPS 5009 and SPS 5004 that currently discharges to OSSTP inlet works will be connected to the new (common) rising main for transfers of the wastewater to BVSTP. Capacity and/or upgrade requirements of SPS 5009 and SPS 5004 will be checked at the detailed design stage to ensure adequate capacity for pumping via the new rising main extended to BVSTP.
- **Option B:** Continue to discharge wastewater from the Ocean Shores catchment via the existing inlet works, which will require provision of a second vortex grit tank to cater for future growth and hydraulic requirements, as detailed in the OSSTP Planning Study (refer to GHD, 2014b). Convert the first activated sludge bioreactor (Demand Aeration Tank or DAT) at OSSTP into a dry weather holding tank for raw wastewater. The second bioreactor (Intermittent Aeration Tank or IAT) could also be converted (as an option) to provide additional holding capacity for minor wet weather events. Neither of these tanks will continue to serve a treatment function. They would only provide a holding/balancing tank function in order to attenuate diurnal flow rate variations, mainly under dry (or minor wet) weather conditions. A new pump station will be built at OSSTP, connected to the holding tank(s), for transfer of wastewater to BVSTP for treatment. The option can be investigated if allowing surplus wet weather flows (that exceed a nominated peak treatment capacity for sustained wet weather flow at BVSTP) to be directed to the existing lagoons/wetland system at OSSTP, thereby receiving partial (natural) treatment without disinfection[37].

The relative advantages and disadvantages of these two options are summarised in Table 15. Based on this comparison, it is clear that Option B has more disadvantages and only one apparent advantage. Since the existing BVSTP operates satisfactorily and gives good performance with respect to its licence requirements without flow balancing, the single advantage for Option B (i.e. flow balancing) can be considered to relatively insignificant. Conversely, the disadvantages of Option B (e.g. potentially higher capital and operating/maintenance costs) are expected to be more significant.

Therefore, Option A was selected as the preferred strategy for the purposes of this Study.

7.2 Treatment plants

7.2.1 Consolidation at BVSTP - Option A

The strategy for Option A is to augment the BVSTP using the same process design concept as the existing plant. The augmented BVSTP plant will treat the combined wastewater loads from the Mullumbimby, Brunswick Heads and Ocean Shores catchments.

Additional biological treatment capacity will be required (refer to Section 8.2). That capacity will be provided by way of a second process train to operate in parallel with and to be integrated, as far as possible, with the existing oxidation ditch-clarifier extended aeration process. In order to facilitate plant operation, and to integrate the two treatment trains as far as possible, careful attention should be given to flow splitting. Provisions to enable the two treatment trains to

[37] Subject to future Licence requirements (refer to Section 3.3.1).

operate with a 'common biomass' (mixed liquor suspended solids) should also be made. To this end, the existing RAS line will be redirected from the existing inlet works (where it receives screening) to a new RAS flow splitter equipped with a (new) RAS screen, to serve both the existing and new RAS systems (i.e. from existing and new clarifiers).

To allow management of wet weather flows, a wet weather storage facility will be provided for the plant. This will limit (or even eliminate) the extent and/or frequency with which the clarifiers operate at peak hydraulic flow rates that exceed their design (i.e. process clarification) capacity for sustained flow. Together with the provision of additional clarifier capacity, this should largely eliminate problems that sometimes occur with the existing clarifiers suffering gross solids loss under peak wet weather conditions, threatening process stability.

To provide a 'buffer' for natural tertiary treatment of effluent, a constructed wetland is proposed as an option. The wetland will receive flow in two forms:

1. Typical conditions: UV-disinfected secondary effluent
2. Extreme wet conditions: combination of UV-disinfected secondary effluent and surplus wet weather flow spilling from a completely full wet weather storage facility

The wetland will provide a 'buffer' between the treatment plant and the receiving water (Brunswick River) to help reduce the potential for carryover of organic matter (primarily suspended solids) from the secondary clarifiers (and wet weather storage if spilling). The wetland will also have a limited capacity to 'polish' the effluent by way of some additional removal of nitrogen compounds (ammonia and/or oxidised N) if present. The wetland may offer aesthetic and community benefits (e.g. as a haven for birdlife). Apart from additional maintenance requirements (e.g. annual harvesting of reeds; prevention of clogging, channelling etc.), the main disadvantage of wetlands is that re-contamination of the effluent with pathogens from wildlife (e.g. birds) can occur. Therefore, the licence compliance point for disinfection (bacterial indicator organisms) should to be upstream of the wetland (refer to Section 3.3, particularly Section 3.3.1, and Appendix C).

7.2.2 Alternative strategy to retain both STPs – Option B

In the alternative strategy, the current operational strategies for OSSTP and BVSTP, and the associated sewerage networks, will be continued. OSSTP will be retained (upgrade required) and will continue to be used to treat the wastewater loads from the Ocean Shores catchment. BVSTP will be retained as existing, to treat the wastewater loads from the Mullumbimby and Brunswick Heads Shores catchment.

Without the transfer of loads from the Ocean Shores catchment, the existing design capacity at BVSTP (ADWF 3.8 ML/d) is projected to be sufficient beyond 2045 (the planning horizon of this Study) (refer to Section 2.2.1 and Figure 3).

If the strategy is to be retained, the capacity augmentation requirements for OSSTP have been considered in reports from a previous planning study (GHD, 2014 a,b). Based on the latest population projections, as discussed in Section 2.1.3, the capacity upgrade (to 10,700 EP) proposed in the planning study report (GHD, 2014a) would be appropriate. It would cater for requirements to beyond 2045, which would be similar to that for BVSTP without the transfer from Ocean Shores. The process option recommended for OSSTP in the planning study (GHD, 2014b) would be "Option 2" (Oxidation Ditch), which would provide close similarity to the process format at BVSTP for conformity between the two plants and ease of operation.

Table 15 Comparison of options for sewerage transfer system from Ocean Shores to Brunswick Valley STP

Option	Advantages	Disadvantages
Option A: Pump directly from Ocean Shores catchments to BVSTP	Minimises septicity of wastewater (avoids increased retention time in transfer system due to holding tanks at OSSTP)	SPS 5004 required to be upgraded to pump to BVSTP (adds capital cost)
	No need to partially upgrade OSSTP (e.g. inlet works second grit tank)	No flow balancing in system
	No ongoing operation or maintenance at OSSTP (saves operating and maintenance costs)	Does not make use of existing treatment infrastructure at OSSTP
Option B: Collect and balance flows from Ocean Shores catchments in holding tank(s) at OSSTP. Build new pump station to transfer to BVSTP.	Dry weather (or minor wet weather) flow balancing at OSSTP; facilitates BVSTP operation (attenuates loads with less variation e.g. in aeration control and effluent nutrients)	At some point in the future, OSSTP inlet works will require partial upgrade including second grit tank provision (adds capital cost).
		OSSTP requires some modification for converting existing bioreactors to holding tanks (adds capital cost), and remains partially operational (adds operating and maintenance costs).
		Holding/ balancing wastewater at OSSTP increases septicity thereby increasing odour and corrosion potential; and decreasing treatability for nutrient removal (potentially adds operating and maintenance costs (e.g. greater use of chemicals for odour control and P removal)

8. Augmentation requirements

8.1 Sewerage transfer system requirements

8.1.1 Hydraulic Analysis

The Ocean Shores STP currently receives flows from pump stations SPS 5004 and SPS 5009. Key operating parameters are summarised in Table 16. The hydraulic analysis considered a range of operating conditions (low or high pipeline friction; wet well at low level or overflow level).

Table 16 Pump station details

Parameter	SPS 5009 Kiah Close	SPS 5004 Rajah Road
Wet well diameter (m)	3.2	1.8
Wet well depth (m)	8	5
Flow at pump best efficiency point (L/s)	136 (installed pumps) 252 (older pumps)	48
Possible pump operation range (L/s)	95 – 355	15 – 70
Typical pump operating range, one pump (L/s)	110 - 140	Approx. 25
Typical pump operating range, two pumps (L/s)	135 - 175	Approx. 40

SPS 5009

Figure 11 shows the system curves for the SPS 5009 system. The estimated operating range for a single pump at 50 Hz is between 110 L/s and 140 L/s. The estimated operating range for parallel pumps at 50 Hz is between 135 L/s and 175 L/s.

The calculated operating points correlated reasonably well with the drawdown test undertaken in August 2007. It is noted that the pump operates away from its best efficiency point (BEP), with an efficiency of between 60 and 70 % (compared with 80 % at BEP). Further investigation is recommended to assess the merits of and ways to improve energy efficiency of this pump station (outside the scope of work for this Study).

The concept design has been developed based on maintaining the existing pump station capacity. A DN375 DICL common rising main was selected to service pump stations SPS 5009 and SPS 5004 for the transfer pipeline extending from OSSTP to BVSTP.

The SPS5009 system hydraulics are governed by a high point in the rising main at an elevation of approximately 47 m. Due to this high point, extending the SPS 5009 rising main to the BV STP would have limited impact on the operating point for the pumps.

SPS 5004

Figure 12 shows the system curves for the SPS 5004 system. The estimated operating range for a single pump is between 62 – 72 L/s. This is higher than the measured flow rate of approximately 25 L/s for single pump operation and 40 L/s for parallel pump operation. The reason for the deviation has not been identified and requires further investigation.

For the purposes of this Study, the concept design has been progressed on the basis of maintaining a similar flow rate. The existing pumps would need to be upgraded to extend the rising main from OSSTP to BVSTP and cater for pumping in parallel with SPS 5009 in the new section of common rising main. The preliminary pump selection is a Flygt NP 3202 HT 30 kW (60 L/s @ 26 m head). Prior to detailed design, consideration should to be given to providing variable speed drives for the new pumps, along with on-line pressure detection and control logic to optimise pump operation and energy efficiency.

The existing wet well has a diameter of 1800 mm and would be too small to cater for the larger pumps. The capital cost estimate in this Study allows for construction of a new concrete wet well in addition to new pumps and switchboard.

Note on timing of SPS 5004 upgrade

It is noted that BSC is currently planning for an upgrade SPS 5004 as part of its asset renewable program, and to meet operational requirements for increased wet well capacity to deal with weather flows. Considering timing, the pump station upgrade currently being planned is likely to take place before the transfer of flows from OSSTP to BVSTP, assuming the latter goes ahead. The design and estimated capital costs for the planned upgrade of SPS 5004 were not available at the time of writing this report. Therefore, in in terms of interface with the possible STP transfer, the following points are noted:

- For the purposes of this Study, capital costs for the upgrade of SPS 5004 were estimated to meet the concept requirements for the STP transfer (see Table 17) but a detailed design was not developed. On the basis that the actual SPS 5004 is likely to precede the STP transfer, the SPS upgrade capital cost estimates were separately listed and excluded from the total capital cost of the STP transfer and associated BVSTP upgrade proposed here (refer to Section 11).
- The detailed design for the upgrade of SPS5004 (to be commissioned by BSC) will need to make provision for the proposed STP transfer considered in this Study, assuming that it goes ahead.

8.1.2 Summary of upgrade requirements

The proposed works to divert flows from OSSTP to BVSTP are summarised in Table 17.

Table 17 Proposed upgrade works

Item	Existing equipment	Upgrade requirements	Notes
SPS 5009	2 no. 170 kW pumps, both variable speed	None	Pumps currently operate below Best Efficiency Point; further investigation required
SPS 5004	2 no. 13.5 kW pumps, both fixed speed	Upgrade pumps to 30 kW (2 no. new) New 1800 mm diameter wet well required to accommodate new pumps	Opportunity to optimise pump operation and energy efficiency with pump upgrade, by including optional variable speed drives and on-line pressure detection.
Rising main extension (OSSTP to BVSTP)	None	New common rising main, 3.25 km, DN375 DICL pipe	Air valves and scour valves to be provided to suit final pipe grading.

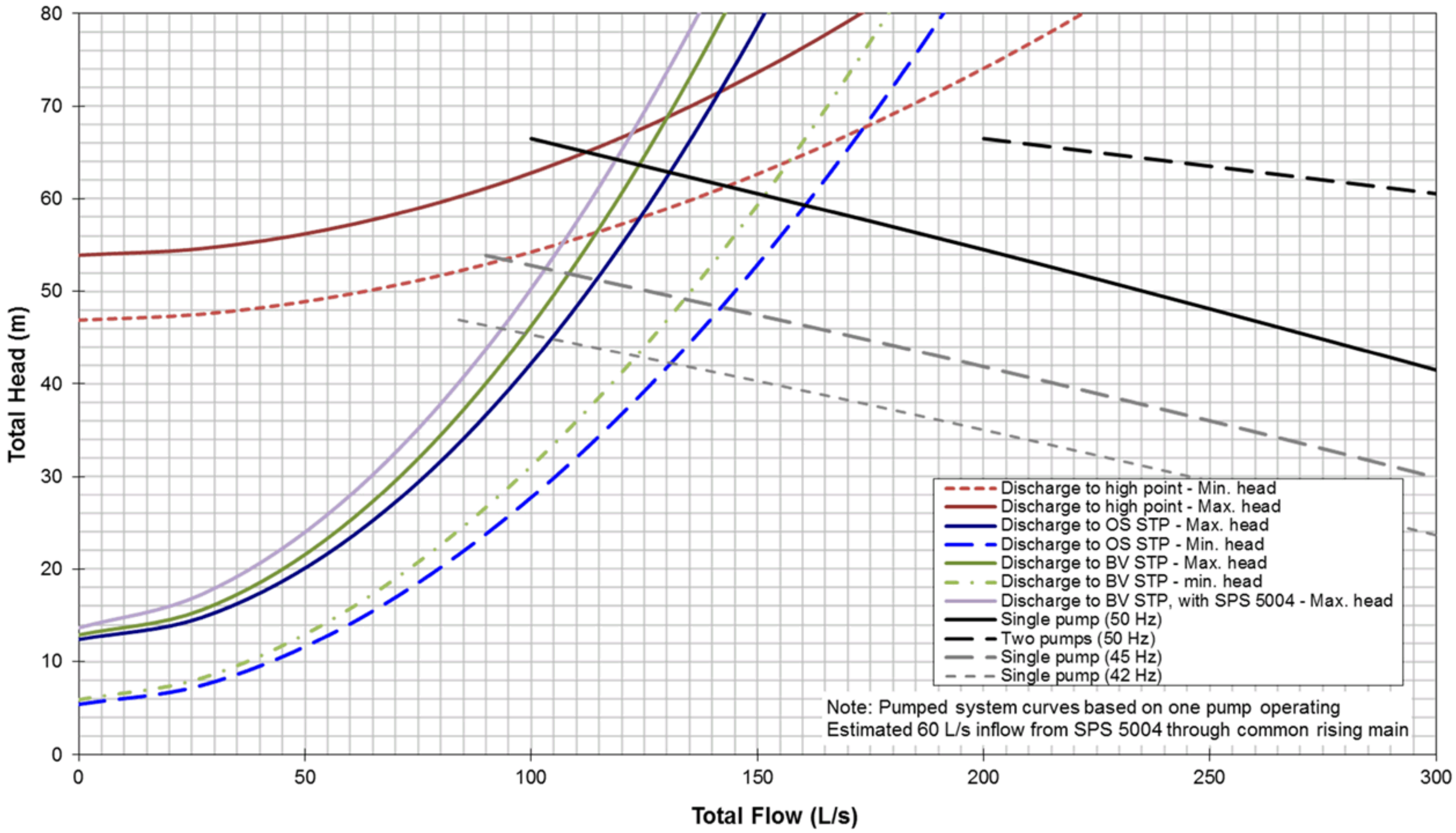

Figure 11 SPS 5009 System Curves

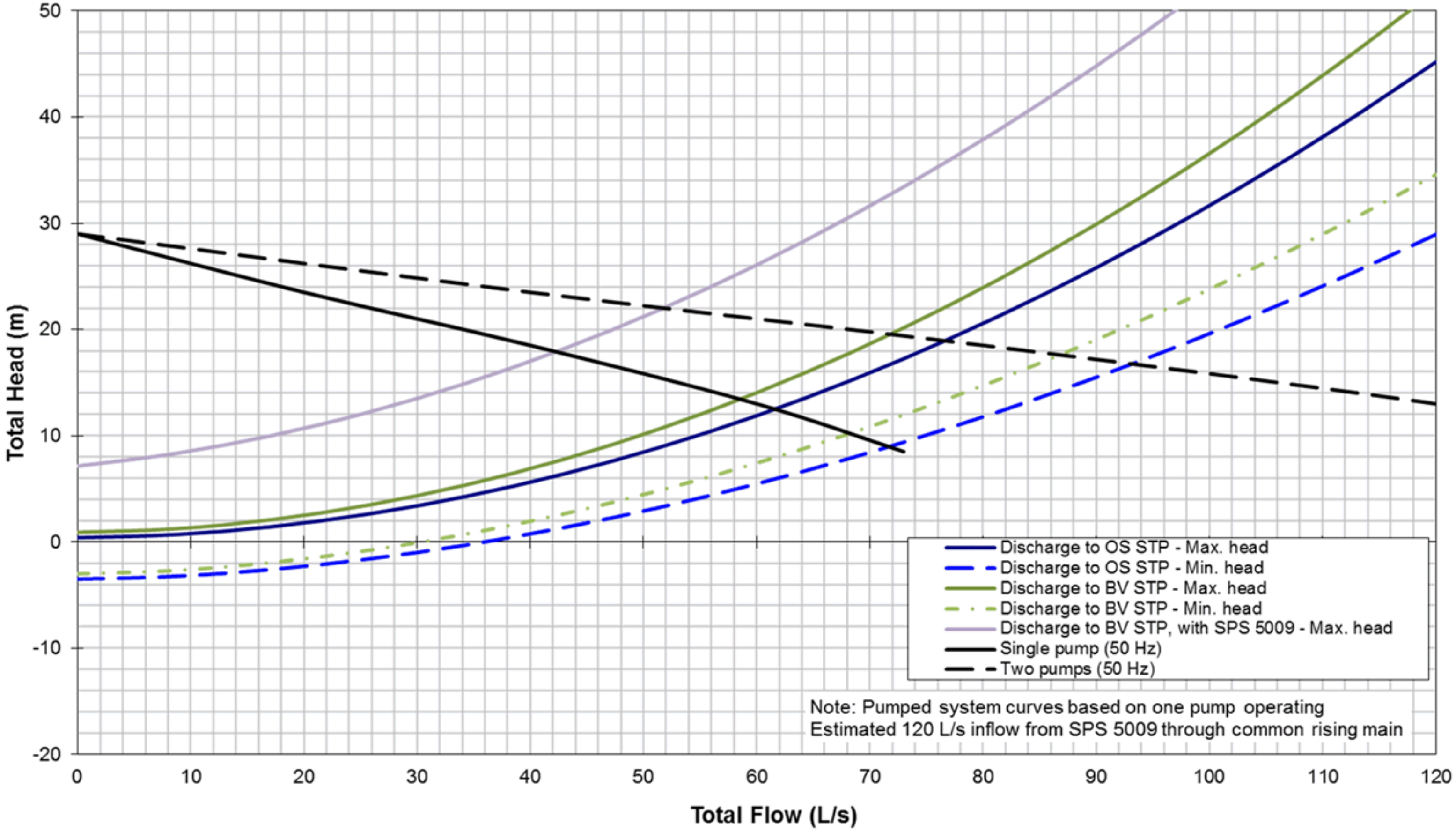

Figure 12 SPS 5004 System Curves (existing pumps)

8.2 Treatment capacity requirements for BVSTP

This section, describes the requirements for capacity augmentation at BVSTP (strategy Option A – refer to Section 7.2.1) for a full upgrade (i.e. base case), namely:

- A 50% increase in bioreactor and digester capacity from design ADWF 3.8 ML/d (currently) to 5.7 ML/d;
- A 100% increase in clarifier capacity to address current issues with solids removal performance under sustained peak flow conditions;
- A duplication of sludge dewatering and biosolids storage facilities to provide redundancy and additional capacity to meet future plant loads;
- Provision of a wet weather storage to take peak flows in excess of plant capacity to treat sustained peak flows
- Provision of a tertiary constructed wetland to act as a 'buffer' or effluent 'polishing' step before river discharge, with ancillary environmental/aesthetic/community benefits.

Figure 13 shows the projected peak day ADWF (from population projections, including tourist/day tripper loads, as discussed in Section 2.2.1) and nominal plant capacity before and after augmentation.

The rationale behind the upgrade or augmentation of each of the plant process components is discussed in the sub-sections below.

Options to defer the upgrade or augmentation of plant process components are discussed in Section 8.3.

A summary of options, including the base case from this section, is presented in Section 8.4.

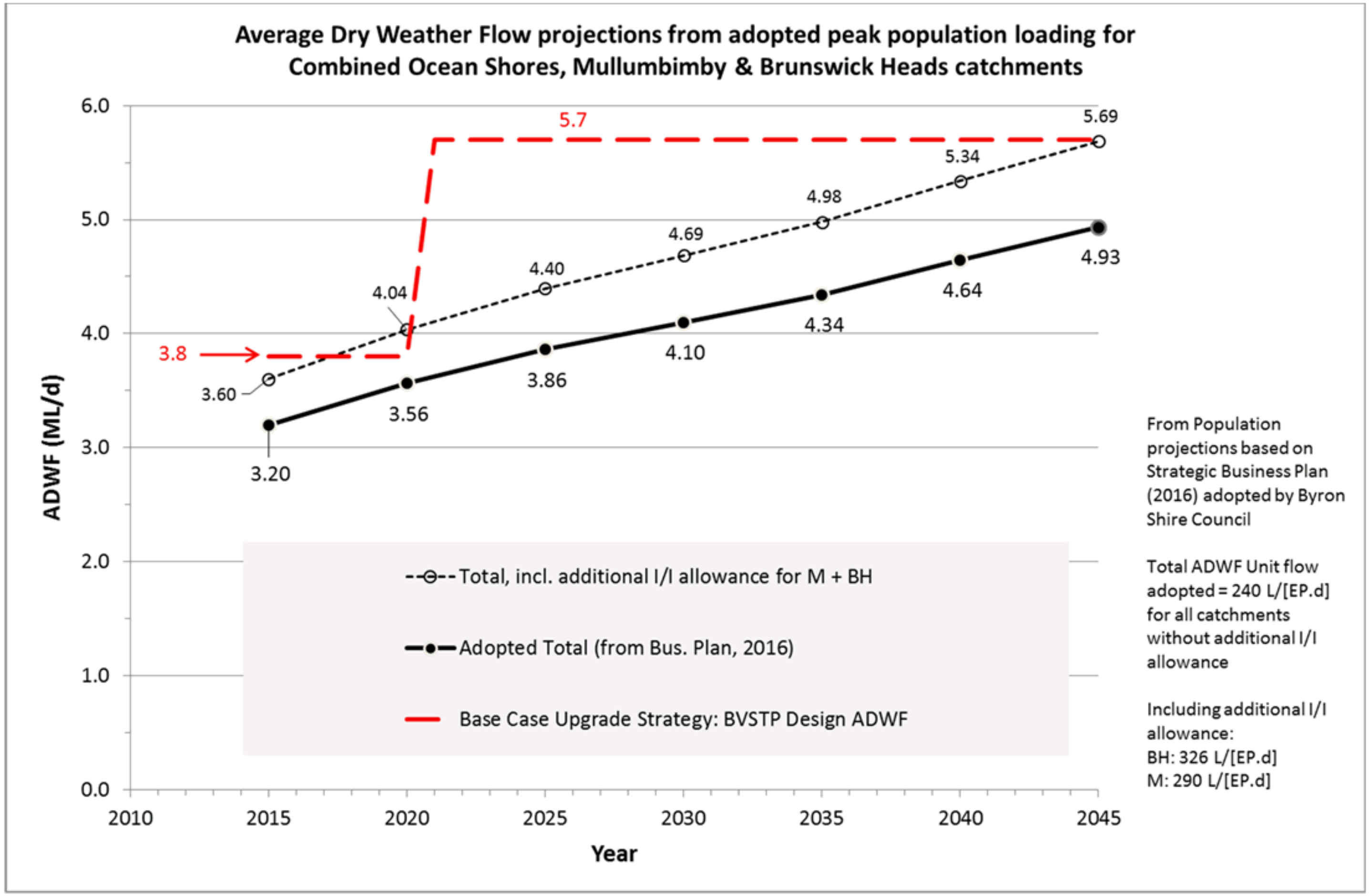

Figure 13 Projected peak day ADWF based on population projections, showing timing of BVSTP upgrade (base case, in 2020-21)

8.2.1 Primary flow splitter

A new primary flow splitter is proposed upstream of the existing inlet works. The existing raw sewage rising mains, along with the new rising main proposed from Ocean Shores, will be relocated from the existing inlet structure to the collection chamber for this new flow splitter. The new flow splitter will serve the following purposes:

- Split the flows to the downstream treatment trains (existing and new) to meet process requirements, as outlined in Section 6.5.2.
- Divert surplus wet weather flow to the proposed wet weather storage facility, as discussed in Section 6.5.2.
- Have the capability to adjust the proportion of flows split to wet weather storage, in accordance with process requirements, as outlined in Section 6.5.2.

It is envisaged that the flow splitter will be fitted with four equally-sized fixed weirs discharging via four discharge lines, each fitted with one actuated knife-gate valve. The following arrangement is proposed:

- Two of these lines will feed the existing activated sludge and clarifier (2 no.) process train. This will typically allow 50% of incoming flows to be fed to that process train, or a minimum of 33% under conditions where one of the existing clarifiers is off line; and zero flow (with both feed valves shut to the existing train) under emergency conditions where equipment failure or maintenance needs dictate it. Each of the discharge lines will be hydraulically sized for up to one quarter (25%) of the peak (instantaneous maximum) flow into the plant (i.e. nominally 154 L/s each for a total 614 L/s)[38]
- Two of these lines will feed the new process train (with new clarifiers) but one of these lines will typically remain shut under dry weather conditions, and will only be opened under wet weather conditions. This will typically allow 33% of incoming flows to be fed to that process train, but up to 50% of incoming flow under wet weather conditions; and zero flow (with both feed valves shut to the new train) under emergency conditions where equipment failure or maintenance needs dictate it.

It is envisaged that the new flow splitter will also be fitted with an actuated downward-opening penstock (weir) for diversion of a variable proportion of flow to the wet weather storage facility. The proportion of flow diverted to storage will be adjustable (operator configurable via SCADA/PLC control of the actuator setting the weir position) from zero to 100% of the incoming flow. That is, the discharge line for wet weather flow diversion from the flow splitter to the storage facility will be sized for the peak (instantaneous maximum) flow of nominally 614 L/s from the combined catchments[38]. This will allow the full flow (up to design PWWF) to be diverted to the storage facility under emergency conditions such as plant failure or a complete shutdown for maintenance purposes.

The flow spitter structure will incorporate provision for screening of flows diverted to wet weather storage. A 'self-cleaning' ('hydrosieve' or similar curved) screen with a nominal aperture max. 5 mm is envisaged for this purpose.

8.2.2 Existing inlet works

The existing equipment will be retained. The only modification is that the existing RAS line recycle via the inlet works will be discontinued. The existing RAS pipeline to inlet works can be

[38] Based on nominal instantaneous PWWF requirements of 314 L/s (Mullumbimby SPS 4000 + Brunswick Heads SPS 2000) and up to 300 L/s provision for Ocean Shores (SPS 5009 = SPS 5004), subject to confirmation prior to detailed design.

retained, but a T-intersection into the RAS line, with suitable valve arrangements, will be required to divert all RAS from the existing clarifiers and RAS pump discharge to the new RAS flow splitter (see 8.2.8 below). The existing arrangement can be retained (by changing valve settings) as a fall-back option if preferred, or for ease of construction.

8.2.3 New inlet works

A new inlet works with a nominal capacity of 314 L/s (to duplicate the peak wet weather raw wastewater hydraulic capacity of the existing inlet works) will be required. Duplication of capacity is required to match the peak flow split philosophy of the primary flow splitter, stemming from the need identified to increase the process clarification capacity of the plant with two new clarifiers, with associated peak hydraulic capacity (refer to Section 6.5.2). There are also constraints posed by the existing plant hydraulic grade line for splitting flows downstream of the existing inlet works. That is, greater use of the hydraulic capacity of the existing inlet works (as a result of diversion of the RAS flow – see Section 8.2.2) will be difficult to 'access' in terms of civil design.

Duplication of inlet works capacity will provide a nominal total peak (instantaneous) hydraulic capacity of 628 L/s for combined inlet works. This will be sufficient for at least 7 x ADWF, well beyond the projected ultimate flows within the planning horizon of this Study (i.e. beyond 2050). It also makes sufficient provision for the combined peak capacity of the rising mains and pump stations proposed to be served by the augmented plant in the immediate future (614 L/s being a conservative estimate – refer to footnote 38 on page **Error! Bookmark not defined.**).

8.2.4 New bioreactor

A new oxidation ditch bioreactor (including an anaerobic 'selector' zone with three compartments) will be required. The design capacity of the new bioreactor is proposed to be 50% of that of the existing bioreactor. In most respects, the design of the new bioreactor will mirror that of the existing bioreactor.

The required process volume of the new bioreactor will be 1.85 ML (half the existing bioreactor volume of 3.7 ML). The new anaerobic selector zone will total 185 kL in volume (62 kL per compartment, 3 no.). The new oxidation ditch will have a volume of 1.65 ML.

For reasons related to internal recycle rate (due to circulation of mixed liquor around the oxidation ditch channel) and associated aeration, the geometry of the new oxidation ditch will be somewhat different from that the existing ditch. The new oxidation ditch is proposed to have a channel width and water depth both of 3.6 m (slightly shallower and significantly narrower than the existing ditch[39]). The new bioreactor will have a similar length (approximately 59 m straight length or 66 m overall), compared with the existing bioreactor[40].

The new bioreactor will be equipped with mechanical equipment and a diffused aeration system analogous to that of the existing bioreactor, but appropriately sized for the smaller reactor volume (refer to Table 18).

[39] The existing oxidation ditch has a channel width of 6.0 m and a water depth of 4.0 m.

[40] The straight length of the existing oxidation ditch is approximately 60 m and overall length approximately 72.5 m.

Table 18 Summary of mechanical equipment requirements of existing and proposed new oxidation ditch (OD) bioreactor

Item	Existing OD bioreactor	New OD bioreactor	Notes
Anaerobic zone mixers	3 no. (1 kW) for 123 kL compartments (one mixer per compartment)	3 no. (0.5 kW assumed) for 62 kL compartments (one mixer per compartment)	Conservative estimate with relatively poor mixing efficiency due to small reactor compartment volume
Oxidation ditch mixers	2 no. 5 kW (for channel 6 wide x 4 m water depth), OD volume 3.33 ML	2 no. 3 kW (for channel 6 wide x 4 m water depth), OD volume 1.67 ML	Conservative estimate allowing 20% decrease in mixing efficiency due to narrower channel width
Oxidation ditch scum harvester	1 no. 0.6 kW, suitable for 6 m wide channel	1 no. 0.6 kW, suitable for 3.6 m wide channel	Chain and flight scraper system with helical rotor scum pump
OD aeration	Diffused aeration system SOTR 175 kg/h Submerged depth assumed 3.7 m	Diffused aeration system SOTR 87 kg/h Submerged depth assumed 3.3 m	Cascade DO control via DO, ammonia and nitrate probes located downstream of the Aeration zone; PID auto-control to DO setpoint via VSD blower speed.
OD blowers	3 no. 30 kW SAE 2.9 kgO_2/ kWh (at max. airflow)	3 no. 15 kW SAE 2.9 kgO_2/ kWh (at max. airflow)	2 no. Duty/1 no. standby positive displacement blowers. SAE for new process conservatively assumed to be unchanged (decreased oxygen transfer efficiency due to shallower depth traded off against reduced header air pressure requirement)

8.2.5 New clarifiers

Two new circular clarifiers (23 m diameter) are proposed, with the same surface area and of similar design to the existing clarifiers. Refer to Section 6.5.2 for the rationale behind doubling the clarifier capacity for increased process robustness under wet weather flow conditions (i.e. sustained flows up to 6 times ADWF).

8.2.6 New mixed liquor flow splitter

A new flow splitter for mixed liquor is proposed. This flow splitter will serve to combine the mixed liquor (i.e. inflow + RAS) from the two bioreactors (i.e. parallel process trains) and re-divide it equally among the operational clarifiers. The new mixed liquor flow splitter will be designed with the following process aims:

- Minimise the potential for unequal distribution of flow and RAS between the operational clarifiers (i.e. to equalise upflow rates and solids loading rates between the clarifiers as far as possible) for optimum clarification performance.
- Increase overall plant clarifier capacity (i.e. doubling the existing capacity) by redistributing clarifier capacity over the whole process (existing and new process trains). This also enables the plant to operate with a smaller augmentation of the bioreactor (only 50% capacity increase required) in order to reduce capital costs.
- Enable ease of control and operation for taking one or more clarifiers offline without having to take either of the bioreactors offline.

In order to facilitate the design and operation of the proposed new mixed liquor flow splitter, it is recommended that the existing mixed liquor flow splitter be retained but closed. The existing flow splitter is in the form of two adjustable weirs at the outlet of the existing oxidation ditch. To close this system, these weirs can be wound to their uppermost positions and left there, but retained for operation in emergency conditions (e.g. a potential shutdown of the new system).

Given the anticipated hydraulic grade line constraints of the existing system, it is proposed that a new pipe penetration be constructed within the existing oxidation ditch to interconnect the existing and new systems. The new pipeline will be fitted with a bell mouth in the existing oxidation ditch to direct mixed liquor to the new flow splitter. The modification to install this new pipework will need to be carried out with the existing bioreactor offline. It is anticipated that this will be possible after the new bioreactor has been built and commissioned to treat the existing load. Since the current plant dry weather flows and loads are typically less than half the design values (refer to Sections 2.2.2 and 5.1.1), this should be feasible given that the new bioreactor is proposed to have half the capacity of the existing bioreactor (see above).

The new mixed liquor flow splitter will combine flows from the two bioreactors (existing and new) via a common chamber and the split the flow via four fixed-weir overflows feeding four discharge pipes. Each of these discharge pipes will be fitted with an actuated knife-gate valve that will be operated in either a fully opened or fully-closed position. When fully closed, the relevant overflow weir at the flow splitter, associated with that given discharge line, will 'drown' and therefore be taken out of service. Mixed liquor flow will be divided among the remaining open weirs and discharge lines.

One mixed liquor discharge line will be directed to each of the four clarifiers (2 no. proposed new and 2 no. existing). Hence the flow split to each of the operational clarifiers will always be in equal proportion.

Under conditions when one or more of the clarifiers is taken out of service, the valves on relevant mixed liquor feed lines to those clarifiers will be closed. That is, the mixed liquor will be equally split between the remaining clarifiers that are in operation. Under extreme conditions (during times of minimum flow), the plant could potentially be operated with just one clarifier in operation; however this would be highly unusual and only for maintenance reasons.

Control of the actuated valves on the mixed liquor feed lines downstream of the mixed liquor flow splitter will be via SCADA/ PLC. The operator will inform the system (via an appropriate check box or similar on SCADA) when one or more clarifiers is taken out of service. Alternatively, the mixed liquor feed valve position programming can be based on automation via a 'fail' or 'off' signal from one or more of the clarifier scraper drives.

8.2.7 New RAS pump station

The new clarifiers will be served by a set of RAS pumps (2 no. per clarifier) in a similar arrangement to that for the existing clarifiers. For modelling purposes (refer to Section 6.2.2), a maximum RAS rate of 77 L/s per clarifier was assumed. This is the same design assumption as for the existing clarifiers (i.e. maximum RAS rate 3.5 times design ADWF or 154 L/s in total for two clarifiers). The existing clarifiers are fitted with variable speed RAS pumps rated for a nominal maximum duty of 150 L/s with all 4 no. pumps operating (2 no. per clarifier) and a minimum of 20 L/s with 2 no. pumps running. The RAS rate minimum of 20 L/s (for 2 no. clarifiers) or 40 L/s for 4 no. clarifiers represents a RAS ratio of 0.6 times revised design ADWF (5.7 ML/d) for the augmented plant, or a ratio of 0.9 times ADWF at startup (approximately 3.8 ML/d) for the augmented plant (with Ocean Shores load). A RAS ratio in excess of 1:1 relative to minimum (night time) flows can be tolerated or energy consumption minimised at night by means of intermittent RAS pump operation at times of minimum flow, with suitable programming via SCADA/PLC.

8.2.8 New RAS flow splitter

A new RAS flow splitter will be required. The purpose of the new flow splitter will be to:

- Combined RAS flows from the existing and new clarifiers
- Re-divide the combined RAS flows, in proportion to process requirements, between the existing and new process trains. It is noted that the new process train (see above) will have a bioreactor with 50% of the capacity of the existing bioreactor but up to 100% (i.e. doubling) of the existing clarifier capacity.
- Enable the two process trains to operate with a common mixed liquor biomass, for ease of process control and operation.
- Facilitate ease of operation to take either of the bioreactors off line, or one or more of the clarifiers off line, for maintenance purposes.

The new RAS splitter will include a new RAS screen. The existing RAS line will be redirected from the inlet works to discharging via this new screen into the RAS splitter. Similarly, the new RAS line (from new clarifiers) will be directed to discharge via this new screen.

The new RAS splitter will combine flows from the RAS pump discharge lines (existing and new) via a common chamber and then split the flow via four fixed-weir overflows feeding four discharge pipes. Each of these discharge pipes will be fitted with an actuated knife-gate valve that will be operated in either a fully opened or fully-closed position. When fully closed, the relevant overflow weir at the flow splitter, associated with that given discharge line, will ‘drown’ and therefore be taken out of service. RAS flow will be divided among the remaining open weirs and discharge lines.

Two RAS discharge lines each will be directed to the bioreactor (anaerobic zone/oxidation ditch) associated with each of the two parallel treatment trains (new and existing).

Under conditions when either of the two clarifiers associated with either of the two parallel treatment trains (new and existing) is taken out of service, one of the two RAS lines associated with that treatment train will be closed. That is, the RAS flow split will always be in proportion to the number of clarifiers on line in each process train.

The actuated valves on the RAS lines downstream of the RAS flow splitter will be under automated control via the plant SCADA/PLC system. The operator will inform the system (via an appropriate check box or similar on SCADA) when one or more clarifiers is taken out of service. Alternatively, RAS valve position programming can be based on automation via a ‘fail’ or ‘off’ signal from one or more of the clarifier scraper drives.

8.2.9 New aerobic digester

Additional aerobic digester capacity is recommended for the proposed plant augmentation. Although aerobic digestion adds to the plant total energy consumption, for a small plant of this type it represents a viable and appropriate method of sludge stabilisation, given the type of process and the need for advanced nutrient removal.

The existing aerobic digester has a process volume of 500 kL (0.5 ML) served by 2 no. 15 kW positive displacement blowers (duty/standby) with a SOTR capacity of 27 kg/h at 2.7 m minimum water depth and 45 kg/h at 4.5 m maximum water depth.

The new aerobic digester is proposed to add 50% additional aerobic digester capacity. It is envisaged that the new aerobic tank (250 kL) will be positioned immediately adjacent to the existing tanks. Additional blowers (2 no. 7.5 kW) are envisaged.

Prior to detailed design, it is recommended that process concept alternatives to providing an additional aerobic digester be investigated. For example, providing the existing aerobic digester can be taken off line for a period of time (e.g. by dewatering and separately disposing of sludge by wasting mixed liquor directly to the belt filter press), it might be feasible to raise the walls of the existing digester and operate it at a water depth of up to 6.75 m to provide additional capacity. This will increase oxygen transfer efficiency but will significantly increase air pressure requirements for aeration. Blower compatibility and/or the need for replacing the existing blowers to meet the increased pressure requirement should be investigated. The overall potential for lower capital costs can then be assessed and compared with augmentation by extension of the existing design.

8.2.10 Disinfection

Treated flows via the secondary clarifiers will be such that the combined secondary effluent from both the existing and the new process treatment trains will be disinfected via the UV disinfection facility. The existing UV facility will be expanded to provide both additional peak hydraulic capacity and increased process capacity for full disinfection catering for the requirements of the augmented plant.

It was assumed that the UV system will remain in its existing location and that it will be possible for flow to gravitate from this system to the proposed tertiary wetland. It was further assumed that, in terms of the environmental licence requirements, the point of compliance with bacteriological limits will be upstream of the proposed wetland. Additional (i.e. tertiary) disinfection downstream of the wetland was assumed to be not required under the future environmental licence requirements for the plant, after upgrading (refer to Section 3.3.1).

Further details in this respect for the upgrade of the UV disinfection system will be developed during extended concept and detailed design, in consultation with equipment suppliers and the EPA in respect of licence requirements.

8.2.11 Effluent Pump Station and Effluent Storage

The plant currently has an effluent lift pump station that takes disinfected effluent (from downstream of the UV system) to an effluent storage tank on site, which supplies an effluent reuse system. It was assumed that this system is adequate and serves the current and expected effluent reuse system requirements for the foreseeable future. No augmentation of this system after the transfer of flow from Ocean Shores was planned as part of this Study. This aspect may require further investigation prior to detailed design and subject to BSC requirements.

8.2.12 Sludge dewatering

The existing sludge dewatering building has one installed belt filter press. There is sufficient room (in theory) for installation of a second belt filter press. However, the building was designed with free space provided for maintenance of the existing press, taking into account the position of the roller door and the need for sufficient room in the building for access to the press from the side to remove rollers etc. Space for maintenance will be highly constrained with a second press installed; the building would need modification, or preferably expansion with a second roller door provided. Furthermore, the building floor will need to be modified to provide a sump and drainage pipework, power supply etc. for the second belt press. A further complication could be integration of the second belt press with the existing conveyor system for dewatered sludge cake to reach the biosolids storage area(s), both existing or new (see below).

Given the above-mentioned constraints, this aspect will require further investigation during detailed design.

An alternative strategy could be to avoid (or defer) installing a second belt filter press and to extend the operating times of the existing belt filter press. The existing press was designed to operate 35 hours per week for waste activated sludge (WAS) from the existing process train. Increasing operational times to around 53 hours per week (7.5 hours per day, 7 days per week) would theoretically be sufficient to cater for the augmented plant capacity (to ADWF of 5.7 ML/d). The manpower or automated operation adjustments (e.g. for automated shutdown) required would need to be confirmed to ensure that these met BSC preferences. Without a second belt press, the plant will have no dewatering redundancy, meaning that mobile dewatering equipment would need to be brought to site when the existing belt filter press is taken out of service for a major overhaul. The existing mobile dewatering plant from OSSTP could possibly be refurbished and used for this purpose.

For developing base case capital costs in this Study, it was assumed that a new dewatering building of similar proportions to the existing building would be provided adjacent to the new process train, equipped with a second belt filter press that provides full redundancy to the existing dewatering plant. Subject to the acceptability of the above-mentioned alternative strategy, the capital cost savings associated with deferring (or not providing) new dewatering facilities were identified (refer to Section 8.3).

8.2.13 Sludge storage

The existing storage area for dewatered sludge (biosolids) is in the form of a semi-circular covered area adjacent to the dewatering building. Biosolids cake is moved into the area via a system of conveyors directly off the belt filter press.

The sludge storage area will require expansion to cater for the augmented plant capacity. There is no obvious way to increase the size of the existing storage area, given its semi-circular form and the pattern of conveyor operation, relative to the adjacent building and road access for trucks etc. Expansion of the existing area in the same form will require significant re-building and provision of a longer-radius inclined conveyor. Alternatively, provision of a similar facility of the same design (e.g. to the north of the existing covered area) will require a longer transverse conveyor to reach that point, along with modifications to the peripheral road for truck access etc.

Given the above-mentioned constraints, this aspect will require further investigation during detailed design.

For developing base case capital costs in this Study, it was assumed that a new sludge storage area of similar design to the existing area would be provided. This would be adjacent to the new dewatering building (refer to Section 8.2.12 above). In other words, this approach would mirror the existing system with a new sludge dewatering and storage facility of similar design. If the new dewatering facility is not built (or deferred – refer to Section 8.3) then it was assumed that an alternative method of providing additional sludge storage in a covered area (at similar capital cost) would be developed.

8.2.14 Additional requirements

Wet weather storage facility

Previous studies

Previous studies (GHD, 2008a,b) for the concept and detailed design of the BVSTP (as originally conceived) included an effluent storage dam in the south-eastern corner of the site (i.e. south of the STP process treatment units). The detailed design for this dam was for a facility with the following dimensions and specifications:

- Footprint 150 x 150 m (2.25 ha)
- A maximum working volume of 35.9 ML
- Freeboard of 1.0 m (berm crest to maximum water level)
- Berm crest level at 7.0 m AHD (i.e. well above the nominated 100-year ARI flood level of 3.30 m)
- A cross section with 3H:1V batters in both cut and fill and a 4 m wide crest was adopted
- An impermeable liner was incorporated in the embankment cross section to reduce the risk of contamination of the groundwater and river by percolation of the effluent. The liner covers the entire base of the storage and the inner faces of the embankments up to the crest level. Compacted clay liner (with geotextile under layer) was selected for the concept design.

The effluent storage dam was not built. Alternative effluent storage in a steel tank was provided instead. For this Study, a wet weather storage facility for surplus raw sewage is proposed (see below). It was assumed that the location and design of this facility would be similar to that proposed for effluent storage (see above), except that the dimensions would be smaller in order to minimise cost, as discussed below.

This Study

An open lagoon-type storage facility is proposed to receive plant raw sewage inflows that exceed available process capacity. This facility will be located to the south of the existing STP works (refer to layout in Appendix H). Typically, this facility will receive wet weather flows greater than a sustained 6 x design ADWF[41] (e.g. >396 L/s, see discussion below). Sustained flow will be measured on a time-averaged basis (e.g. moving average calculated over a time period of 30 to 120 min., which can be operator-adjustable via the SCADA system and calculated in the plant PLC), using inputs from the flow meters connected to the rising mains.

Flow will be diverted to the wet weather storage facility via a downward-opening penstock at the new raw influent flow splitter. The operators will have the ability (via SCADA and PLC automatic control system) to set an override on the time-averaged flow setpoint at which the penstock opens, and by what margin it opens, so as to divert more or less flow to the storage facility. This will enable the storage facility to be invoked earlier and to receive more diverted flow in the event that the plant process capacity is constrained at less than 6 times design ADWF (e.g. if one or more clarifiers is off line).

Flows diverted to the wet weather storage facility will be screened (to <3 mm aperture), preferably using a 'self-cleaning' screen design such as a curved wedge-wire 'hydrosieve' screen, or equivalent.

[41] Augmented design ADWF = 5.7 ML/d (66 L/s)

For this Study, a high-level assessment of the required volume for wet weather storage was made, based on the following assumptions:

- Existing BVSTP influent flow meter data[42] for the period 1/6/2012 to 16/5/2015, taken as average (totalised) daily flows
- Current ADWF = 2.15 ML/d (median for the 2012-15 period) based on population projections and related assumptions, as described Section 2
- Incoming flows >6 times ADWF diverted to the wet weather storage facility
- Flows pumped back from the wet weather storage facility at an average rate of 0.5 times (design) ADWF (i.e. 33 L/s return rate) on days when plant inflow is <2 times ADWF
- Simple water balance in the wet weather storage lagoon ignores evaporation and rainfall capture[43]

This approach has inherently assumed that the flow records of 2012-15 for the existing BVSTP are reasonably representative of the current and future flow patterns, including wet weather and I/I effects. That is, it is assumed that the existing I/I issues will not become manifestly worse in future and will apply equally across the combined catchments of Mullumbimby, Brunswick Heads and Ocean Shores for the foreseeable future.

Different ADWF scenarios were modelled using a simple water balance approach, based on the above assumptions. The results are summarised in Table 19, Figure 14 and Figure 18.

Using a conservative approach[44] and based on the results presented in Table 19 (and Figure 14), for the base case costing in this Study, a provisional wet weather storage volume of 20 ML capacity is recommended. Provision should be made in the plant layout for potentially doubling this capacity in the distant future (beyond 2045).

Alternatively, using a less conservative approach (see Table 19), for the alternative case costing in this Study, a provisional wet weather storage volume of 10 ML capacity is recommended, also with the provision in the plant layout for potentially doubling this capacity in the distant future (beyond 2045).

Up to at least the years 2035-37 (indicatively), providing the STP can process up to 6 times ADWF (or 397 L/s sustained flow), a storage volume of 20 ML will provide sufficient capacity such that the probability of discharge occurring from the wet weather lagoon (to the wetland or river) will be minimised to approximately <2% of the time (typically <7 peak wet weather days in total per annum), whilst reserving up to approximately 6 ML for rainfall capture in the lagoon[45].

Alternatively (and less conservatively), up to at least the year 2035-36, if the STP can only process up to approximately 5 times ADWF (or 265 L/s sustained flow for the existing plant), a storage volume of 10 ML will provide sufficient capacity such that the probability of discharge occurring from the wet weather lagoon (to the wetland or river) will be minimised to approximately <4% of the time (typically <15 peak wet weather days in total per annum), whilst reserving up to approximately 2.5 ML for rainfall capture in the lagoon. This caters for the

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[42] Sum of PS1 and PS2 flow meters from operations records, data supplied to GHD by BSC (email R Collins to D de Haas dated 17/6/2015).

[43] The return rate (0.5 times ADWF) is relatively conservative and could be either increased (indicatively to 1 times ADWF) or return pump run time extended on dry weather days to take into account volumes of rainwater captured in the lagoon that will need to be recycled via the treatment process. Subject to more detailed analysis, as an approximate guide, at 75 mm/d rainfall (99th percentile from BOM rainfall records) over 3 consecutive days, the wet weather storage facility will accumulate approximately 5.7 ML of rainfall, reducing its useful volume for wastewater storage by this margin.

[44] Conservative assumptions: divert >6 times ADWF to wet weather storage; return flow 0.5 times ADWF when inflow <2 ADWF.

[45] Refer to Footnote 43 on page 47.

scenario where upgrading the plant process infrastructure (bioreactors and clarifiers) is deferred until ca. 2035-36.

A 20 ML capacity storage lagoon will require a facility with the following approximate dimensions: 1.5 m water depth (assumed) with 1 m vertical freeboard to top of bank; earth banks batter max. 1:2 slope; length 180 m at base (190 m at top of inner bank); width 72 m at base (82 m at top of inner bank). Subject to detailed design, and allowing for a 'turkey's nest' lagoon arrangement with earth berm perimeter walls (including 5 m berm crest to allow access by road vehicle), the total footprint is estimated to be 1.9 ha (204 m long x 96 m wide). The lagoon will be clay-lined (or similar design) for water retention. Refer to the proposed plant layout in Appendix H for the conceptual location of the proposed lagoon.

It is recommended that a more detailed water balance model be applied to this analysis prior to detailed design for the purposes of confirming the capacity requirements for the wet weather storage facility.

Table 19 Wet weather storage volume requirements for different scenarios based on simple water balance model

ADWF (ML/d)	Nominal year from population projections Indicative only (see Section 2)	Diverted PWWF (> y times ADWF)	Returned Flows (> z times ADWF)	Storage Volume (ML) at n^{th} percentile Note 2	Storage Volume (ML) at 99.7^{th} percentile Note 3
4.5	2035-37	6 (>314 L/s) Conservative	0.5	99.1%: 20 ML 99%: 18 ML 98%: 14 ML 97%: 10 ML	99.7%: 31 ML
		5.1 (>265 L/s) Less conservative	1	97.5%: 20 ML 97.1%: 18 ML 96.5%: 10 ML 95.8%: 7.5 ML	99.7%: 40 ML
5.7	Beyond 2045	6 (>397 L/s) Conservative	0.5	98.5%: 20 ML 98%: 18 ML 97.5%: 14 ML 96.4%: 10 ML	99.7%: 39 ML
		4.75 (>314 L/s) Less conservative	1	96.7%: 20 ML 95.3%: 10 ML 94.8%: 8 ML	99.7%: 57 ML

Note 1: Flows returned from wet weather storage when plant inflow is <2 ADWF (assumption). Assumptions for returned flow rate: 0.5 times ADWF (conservative) to 1 times ADWF (less conservative)

Note 2: Nominated (n^{th}) percentile. Example 99^{th} percentile, there is a probability of 1% or less that the required storage volume will be greater than the tabulated figure. A 1% probability is a likelihood of a discharge event from the wet weather storage facility occurring on typically approximately 3.7 days per year.

Note 3: At the 99.7^{th} percentile there is a probability of 0.3% or less that the required storage volume will be greater than the tabulated figure. A 0.3% probability is a likelihood of a discharge event from the wet weather storage facility occurring on typically 1 day per year.

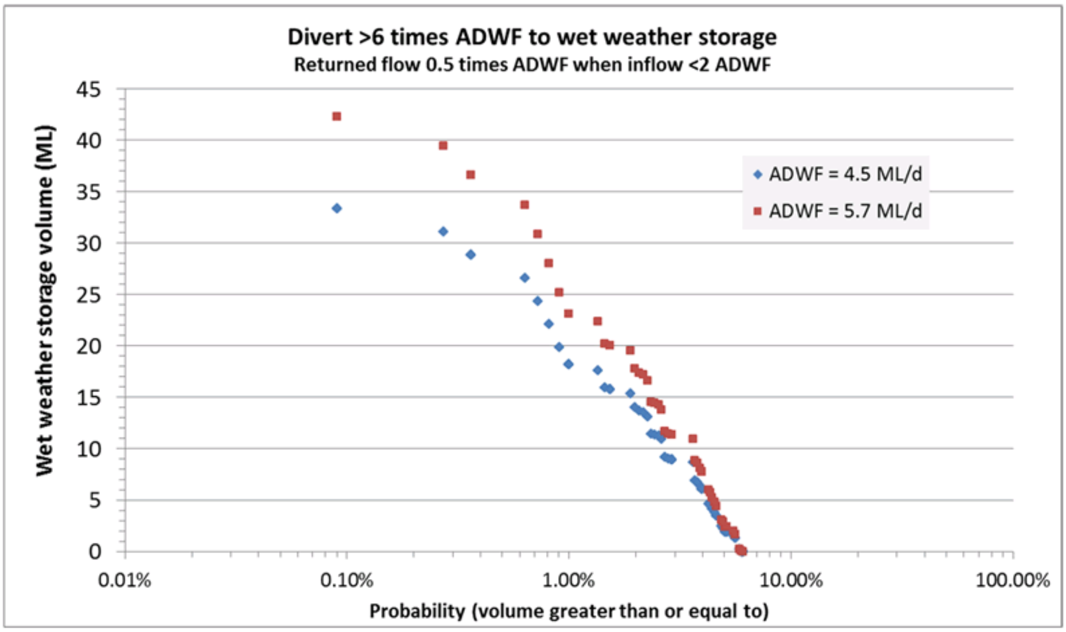

Figure 14 Probability plot of required wet weather storage volume, based on 2012-2015 BVSTP flow records and a simple water balance model using *conservative* assumptions (refer to Table 19 and text for details)

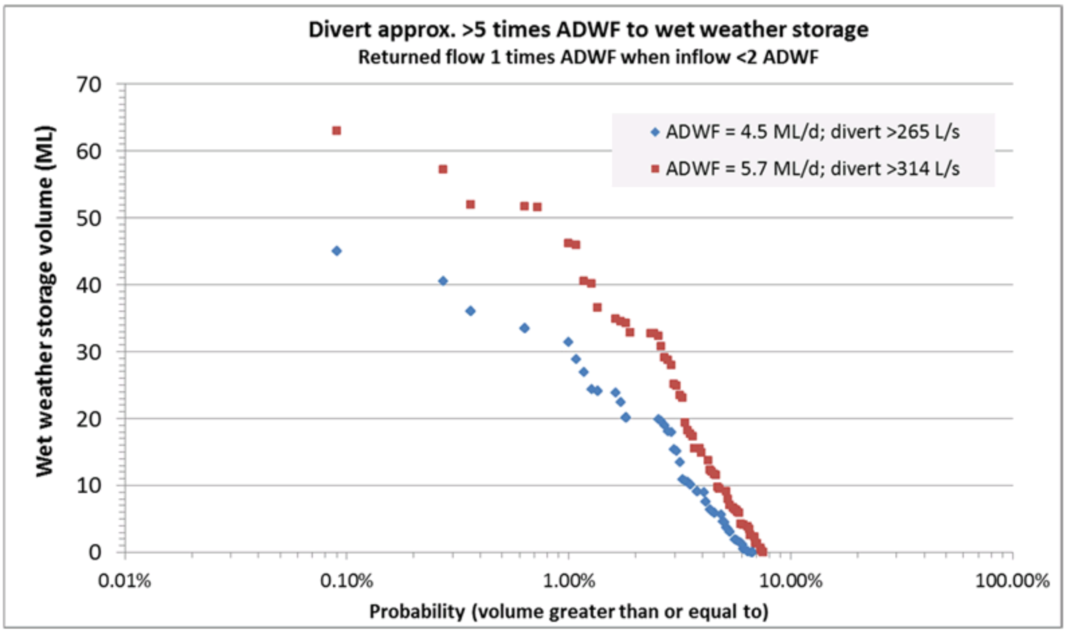

Figure 15 Probability plot of required wet weather storage volume, based on 2012-2015 BVSTP flow records and a simple water balance model using ***less* conservative** assumptions (refer to Table 19 and text for details)

Tertiary Wetlands

A previous study (GHD, 2003) highlighted the benefits of a constructed wetland for the tertiary treatment of effluent (including surplus wet weather flow) for the BVSTP site. We understand that wetlands used for this purpose carry broad community support within BSC's jurisdiction due to number of associated benefits to environmental, aesthetic and amenity values[46]. The wetland proposed as part of the original concept design (GHD, 2003) was not constructed with the new STP in 2009-10 due to financial constraints.

As part of the plant capacity augmentation proposed here, it is recommended that a constructed wetland be considered for inclusion in the upgrade, subject to cost considerations.

In view of the relatively large wet weather storage facility proposed (see above), and reserving space for possible future plant expansion, the available space on the site on the southern side (closest to the river) is approximately 3.3 ha (~133 x ~250 m). This surface area is substantially smaller than the wetland area originally proposed (3 no. cells, totalling approx. 10 ha)[47]. Nevertheless, a wetland surface area of 3 ha is sufficient to be within the practical range of hydraulic conductivities for horizontal-flow sub-surface wetlands planted in coarse gravel sand medium at flow rates up to nominally 6 x design ADWF for the augmented plant (i.e. 6 x 5.7 ML/d or 34.2 ML/d).

Given the smaller area, the wetland proposed here will have more limited nutrient removal capacity than that originally proposed (see above). However, this is of minor significance since the STP main treatment process achieves advanced nutrient removal (refer to Sections 5.2.1 and 6.5.1). The proposed wetland will still provide a useful tertiary ('backup' or 'polishing') function, particularly for trapping and degrading suspended solids that might be carried over from the clarifiers on the activated sludge (secondary) process.

Further modelling work for the wetland will be required prior to detailed design. For the purposes of assessing feasibility in this Study, a constructed wetland area of 3 ha was adopted, with a maximum water depth of 0.8 m (typical operating range approx. 0.4 to 0.6 m).

Refer to the proposed plant layout in Appendix H for the conceptual location of the proposed wetland.

Flood implications

BSC has previously undertaken a flood assessment study (Webb, McKeown & Associates, 2008) to assess the implications of construction of the (then proposed) new BVSTP. At the time, the STP concept included three wetland cells with a total area close to 10 ha positioned in on the north-west side of the property (i.e. west of the STP) and an effluent storage lagoon (1 ha area) positioned in the south-eastern corner of the property (i.e. south of the STP).

The criteria adopted for the previous flood study (Webb et al., 2008) were as follows:

- *The final dimensions of the works are such that there should be no increase in flood level greater than +0.01 m in the 100-year ARI event. A change in flood level of +0.01 m is considered to be within the accuracy of the hydraulic modelling approach and can effectively be ignored.*

The conclusions from this previous flood study included the following:

- The 100-year ARI flood level on the site was assessed to be at 3.30 m AHD.

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[46] Peter Rees (BSC Water & Sewerage Dept., Pers. Comm. to GHD, May 2015).

[47] Refer to Figure 5-3 in GHD (2003) conceptual plant layout.

- The effluent storage lagoon (maximum dimensions 150 m x 150 m) and proposed wetland (3 no. cells, max. 10 ha area) along with the rest of the STP site would allow the above-mentioned flood criteria to be met provided the following conditions are met:
  - The crest of the wetland berm walls (or any other earthworks associated with the wetlands) remains below 2.30 m AHD.
  - The crest of the effluent storage lagoon berm walls was assumed to be at a minimum 3.30 AHD (the 100-year ARI flood level)[48].
  - An open drainage channel (4m wide) is constructed along the north-western side of the proposed wetland cells and along the western side of the site) to promote drainage in the direction toward the river.

The wet weather storage facility and wetlands area proposed in this Study are expected to be of similar dimensions to (or smaller than) those proposed in 2008 (but never built). Therefore, flood implications are expected to be similar provided the design criteria and conditions summarised above are observed.

As a precaution, a repeat of the flood study for the area is recommended prior to final detailed design in order to confirm these conclusions.

8.3 Potential to defer new infrastructure at BVSTP

The following items could potentially be deferred as part of a capital infrastructure program for this proposed project:

- **Defer one new clarifier**: build one of two clarifiers at the outset and the second in ca. 2035-36 when projected ADWF = 4.5 ML/d (approximately). This approach has the disadvantage that the existing constraints around settleability and clarifier capacity (refer to Sections 5.1.3, 5.2.2 & 6.4.2) under peak wet weather flow conditions will remain and will not be relieved. The combined PWWF instantaneous pumping rate from Ocean Shores (i.e. SPS 5004 and 5009 currently) will also need to be limited[49] to around 157 L/s in order to remain within the original design parameters[50] of the existing clarifiers. Alternatively, allowing for more conservative sludge settleability design parameters proposed in this Study[51], a greater proportion of PWWF will need to be diverted to the wet weather storage facility. With only three clarifiers (two existing plus one new until ca. 2035-36), and to be consistent with the revised clarifier design parameters proposed in this Study (refer to Section 6.5.2), PWWF indicatively >300 L/s (as opposed to >400 L/s with 4 no. clarifiers) will need to be diverted to wet weather storage. Based on the simplified water balance calculations outlined in Section 8.2.14, the probability of the wet weather storage facility filling and discharging to the environment (e.g. via the proposed constructed wetland) under these conditions (i.e. 20 ML storage capacity with flows >300 L/s diverted to it, being 5.7 times ADWF of 4.5 ML/d projected for year 2035-36) will be approximately 1.5% (i.e. a 98.5%ile storage requirement close to 20 ML). This might be acceptable to meet BSC and EPA requirements, being the same probability as that proposed in this Study for the ultimate case (i.e. 20 ML storage capacity for the ultimate design ADWF = 5.7 ML/d with PWWF >6 ADWF or >400 L/s diverted to it).

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[48] The detailed design of the proposed effluent storage dam (GHD, 2008b) set the crest at 7.0 m AHD (i.e. well above the 100-year ARI flood level).

[49] Limits would need to be set on variable speed drives for SPS 5009 (SPS 5004 currently has fixed speed pumps and might have to be converted to VSDs with limits as well).

[50] Original clarifier design parameters based on better settleability typically than currently observed at BVSTP – refer to Section 5.1.3

[51] Refer to Sections 6.2.2 & 6.5.2

- **Decrease the size of the wet weather storage facility:** provide 10 ML capacity at the outset and defer constructing the remainder of the wet weather storage until ca. 2035-36 (i.e. deferring until that date construction of additional wet weather storage capacity of at least another 10 ML for an ultimate total capacity of at least 20 ML). Up to ca. 2035-36 (projected ADWF 4.5 ML/d, diverting flows >6 ADWF to storage) this will increase the probability of the wet weather storage facility filling and discharging to the environment (e.g. via the constructed wetland proposed) indicatively from 1% to 3% (i.e. for a 97%ile storage requirement of 10 ML) (refer to Figure 14). This might be acceptable to meet BSC and EPA requirements, given that partial treatment of the surplus wet weather flows will occur in the proposed wetlands and that the wet weather flows typically make a small contribution to annual nutrient load limits. Before being adopted, this approach will require further investigation (with more accurate modelling, if required) confirm that licence maximum limits on nutrient concentrations and/or disinfection (bacteriological indicator organisms, if applicable) will not be exceeded at the relevant plant final licence compliance point(s)[52].
- **Defer additional bioreactor and clarifier capacity:** Retain the size of the wet weather storage facility built as 20 ML capacity at the outset but defer augmenting both the bioreactor capacity (new bioreactor) and additional clarifiers until ca. 2035-36. Peak wet weather flows >265 L/s (i.e. the existing plant capacity to treat sustained flow, using the existing plant design criteria) or approximately >5 times ADWF (4.5 ML/d projected indicatively for year 2037) will be diverted to the wet weather storage. Based on the less conservative assumption for sizing the wet weather storage facility (including return pumping at a higher rate - refer to Section 8.2.14), the 20 ML storage (with up to 5 ML reserved for rainfall capture) will be sufficient up to indicatively the 97th percentile (i.e. storage will typically overflow 3% of the time or indicatively on 11 days in a typical year). In this scenario, the existing process will technically be loaded to approximately 18% more than its design ADWF on peak days (with peak tourist populations). Refer to Figure 16. To compensate for the higher-than-design loading on peak days, the bioreactor will need to be operated at a shorter sludge age (indicatively 16 days instead of the original design 20 days) during peak (i.e. tourist season) periods in order to remain within the design envelope of the existing clarifiers, and without adopting more conservative design settleability criteria[53] (refer to Section 6.5.2). The disadvantage of this approach is that the existing sludge settleability limitations (i.e. potential for solids carryover during sustained wet weather events) will need to be accepted and the tertiary wetlands relied upon to 'polish' the secondary effluent by trapping solids carried over from the clarifiers. A further disadvantage of this scenario is that effluent quality might be compromised in terms of nitrogen removal by aeration system capacity limitations of the existing bioreactor under peak loading conditions (diurnal peak on peak days with tourist loads). The existing aeration system will, on average be operating at 85% of its design capacity (with 2 no. duty blowers operating). Additional (dynamic) modelling will be required to accurately quantify the effluent quality impacts under this scenario. The steady-state model predictions carried out as part of this Study suggest that the average (not peak) oxygen requirements will be met at ADWF 4.3 ML/d (projected for year 2035-36) and the average effluent quality will still be below 5 mgN/L Total N. Dynamic modelling will be required to confirm whether the licence requirements for ammonia (<2 mgN/L 90%ile; 4 mgN/L max.) and Total N (<10 mgN/L 90%ile) are achievable under this scenario. The constructed

[52] The current license (refer to Appendix C) only applies limits to bacteriological indicators for disinfection at 'Point 1' being the discharge pipeline from the mainstream treatment process, and not at 'Point 2', which is the discharge from wet weather overflow as defined in the license.

[53] Based on the original process design (Hartley, 2013a & b), sludge settleability is expected to improve with increased plant loading (relative to current performance at loadings typically averaging below 50% of design loading).

wetland (if built) is expected to have a 'polishing' (tertiary treatment) effect on effluent nutrient concentrations, which will help with achieving licence requirements. The impact of the shorter operating sludge age in the bioreactor on biosolids stabilisation in the aerobic digester will also need to be modelled for this scenario. The available information from steady-state modelling suggests that the digester solids retention time can be increased by approximately 25% by means of operating the existing supernatant withdrawal valves during the 'air off' times of digester cyclic aeration. Given the digester design concentrations (RAS feed MLSS 8000 mg/L), sludge gravity thickening by this means appears to be feasible (i.e. increasing average operating MLSS in the digester from approx. 7800 to 9750 mg/L). Biosolids stabilisation criteria (e.g. specific oxygen uptake rate target <1.5 $mgO_2/(gTSS.h)$ are expected to be achievable (subject to confirmation by more detailed modelling prior to implementation).

- **Defer/eliminate the wet weather storage facility**: In this case, as with the existing plant, all peak wet weather flows will be passed directly through the treatment process, with the risk of process constraints (sludge settleability) leading to solids carryover to the secondary effluent. Either this risk to final effluent quality is accepted or the constructed wetland (assuming it is built) would be relied to provide a 'buffer' or capture of solids carried over from the clarifiers.
- **Defer/eliminate the construction of the wetland**: In that case, surplus wet weather flows that might spill from the wet weather storage facility (under extreme wet conditions) will be combined with treated (disinfected) secondary effluent and flow directly to the river. Licence conditions in this respect will need to be checked with the EPA for the necessary environmental approvals. The risk of solids carry over to the final effluent from the clarifiers will be similar to the existing plant (or tempered by the more conservative clarifier design proposed above, assuming both new clarifiers are built).
- **Defer/eliminate building new sludge dewatering facilities**: In this case, the operating times for the existing belt filter press will be extended to cater for the sludge wasting requirements of both the existing and new process trains. Some level of risk associated with the lack of redundancy in sludge dewatering equipment will have to be accepted, but but this risk can be mitigated by the provision of mobile dewatering equipment as back-up, when required (e.g. refurbish and make available the existing mobile dewatering plant at OSSTP for this purpose). Further the most practical and cost-effective way of providing additional covered storage space for dewatered biosolids will need to be investigated, either adjacent to (or by expansion of) the existing covered area, at a similar (or lower) capital cost to the existing system used to estimate costs in the base case for this Study (Section 11.1).

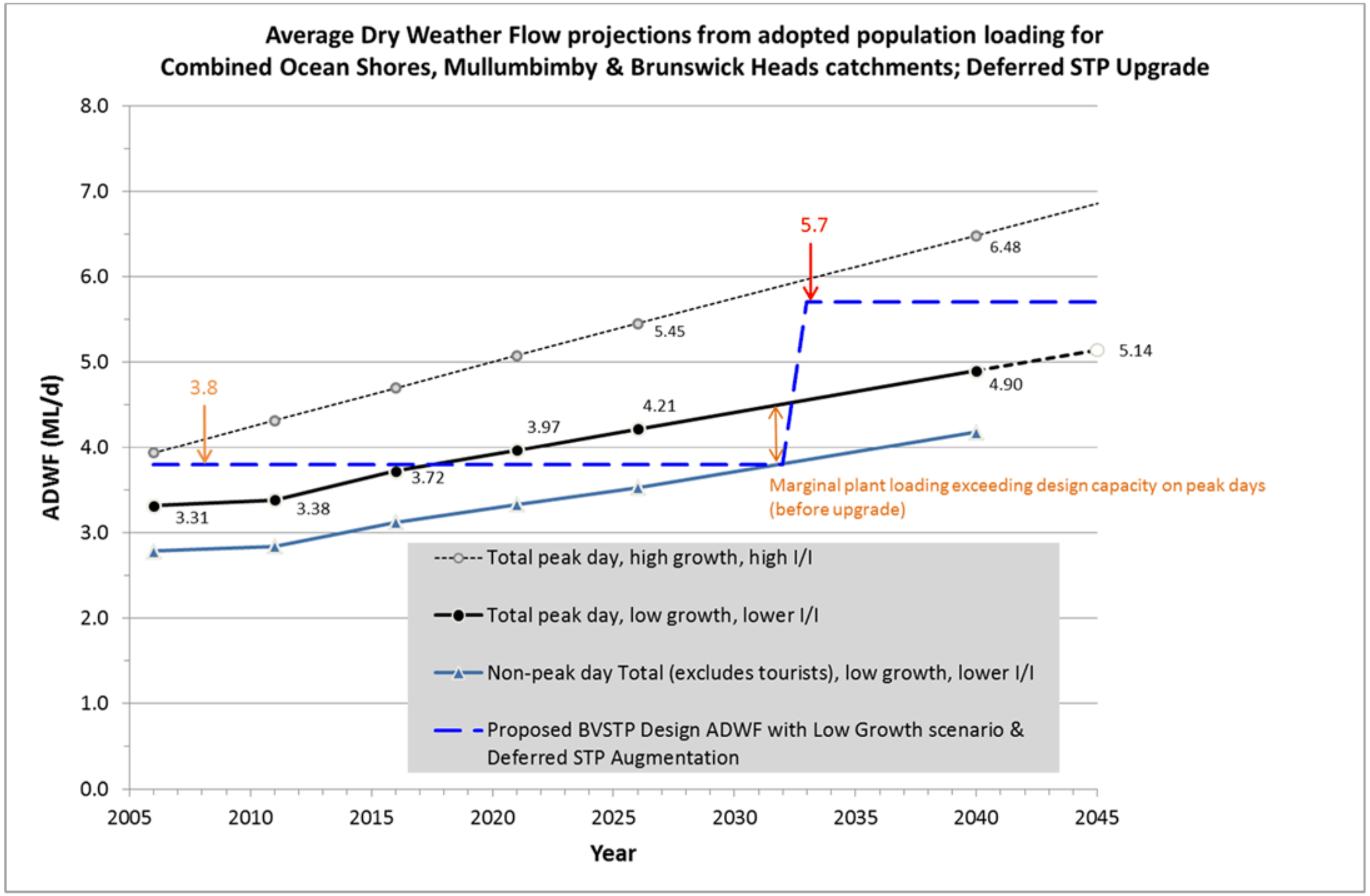

Figure 16 Projected peak and non-peak day ADWF based on population projections, showing timing of deferred plant upgrade (Option 4) in 2035-36.

8.4 Summary of augmentation strategy options for BVSTP

The plant augmentation strategy options discussed above, including potential for deferment of some items, is summarised in Table 20, with the main risks highlighted.

Table 20 Summary of strategy options for plant capacity augmentation

Item	Option 1 Full upgrade Base case	Option 2 Defer one new clarifier	Option 3 Decrease wet weather storage size	Option 4 Defer new bioreactor and both new clarifiers	Option 5 Defer/ eliminate wet weather storage	Option 6 Defer/ eliminate wetland	Option 7 Defer/ eliminate new sludge dewatering facilities
Design Flow ADWF	5.7 ML/d (66 L/s)	4.8 ML/d (55 L/s)	5.7 ML/d (66 L/s)	3.8 ML/d (44 L/s)	5.7 ML/d (66 L/s)	5.7 ML/d (66 L/s)	5.7 ML/d (66 L/s)
Full treatment (L/s)	396	300	396	256	396	396	396
Hydraulic Max[54] (L/s)	628	471	628	314	628	628	628
Wet weather storage	✓ (20 ML)	✓ (20 ML)	✓ (10 ML)	✓ (20 ML)	×	✓ (20 ML)	✓ (20 ML)
Inlet Works	✓	✓	✓	✓	✓	✓	✓
Bioreactors	✓	✓	✓	×	✓	✓	✓
Clarifiers	✓	(✓) 1 no. only	✓	×	✓	✓	✓
UV Disinfection	✓	✓	✓	×	✓	✓	✓
Chemical Storage & Dosing	✓	✓	✓	×	✓	✓	✓
Constructed Wetland	✓ (3 ha)	✓ (3 ha)	✓ (3 ha)	✓ (3 ha)	✓ (3 ha)	×	✓ (3 ha)
Aerobic Digester	✓	✓	✓	×	✓	✓	✓
Sludge Dewatering & Biosolids Storage	✓	✓	✓	(✓) (investigate further)	✓	✓	(✓) (investigate further)

[54] Hydraulic maximum (peak instantaneous) flows can be passed through treatment process but will not receive full treatment. Flows greater than nominated value to full treatment intended to be diverted to wet weather storage (if provided).

Item	Option 1 Full upgrade Base case	Option 2 Defer one new clarifier	Option 3 Decrease wet weather storage size	Option 4 Defer new bioreactor and both new clarifiers	Option 5 Defer/ eliminate wet weather storage	Option 6 Defer/ eliminate wetland	Option 7 Defer/ eliminate new sludge dewatering facilities
Switch Room & Blower Room	✓	✓	✓	×	✓	✓	✓
Other Pump Stations	✓	✓	✓	×	✓	✓	✓
Plant Pipework & Valves	✓	(✓) reduced	✓	×	✓	(✓) reduced	✓
Roads, Fencing & Landscaping	✓	(✓) marginally reduced	(✓) reduced	(✓) reduced	✓	(✓) marginally reduced	(✓) marginally reduced
General Site Works	✓	(✓) reduced	(✓) reduced	(✓) reduced	(✓) reduced	(✓) reduced	(✓) marginally reduced
Electrical, Instrumentation & Control	✓	(✓) marginally reduced	✓	(✓) reduced	✓	✓	(✓) reduced

Item	Option 1 Full upgrade Base case	Option 2 Defer one new clarifier	Option 3 Decrease wet weather storage size	Option 4 Defer new bioreactor and both new clarifiers	Option 5 Defer/ eliminate wet weather storage	Option 6 Defer/ eliminate wetland	Option 7 Defer/ eliminate new sludge dewatering facilities
Main risks	-	Greater reliance on diversion of peak wet weather flows to storage and/or more frequent discharges from storage (adding indicative 6 days per annum up to ca. 2035-37)	Increased frequency of discharges from storage to wetland/ final effluent (adding indicative 6 days per annum up to ca. 2035-37; or 9 days per annum ultimately)	Greater reliance on diversion of peak wet weather flows to storage and/or more frequent discharges from storage (adding indicative 11 days per annum up to ca. 2035-37); more constrained plant operation (e.g. higher loading; peak aeration requirements not met on peak days); impacts on effluent quality (further modelling required to simulate); longer dewatering times and sludge storage space constraints (to be further investigated)	(Similar to current plant operation) No facility to shut down treatment plant Limited operational flexibility to manage peak wet weather flows (e.g. due to capacity constraints with equipment off line or poor sludge settleability)	(Similar to current plant operation) No formal 'buffer' or (tertiary) effluent 'polishing' step before river discharge Less environmentally responsible No added community/ natural aesthetic value associated with wetland	Longer operating times on existing dewatering equipment. No standby equipment/ less flexible dewatering options Mobile dewatering plant to be brought to site to allow major overhaul of existing dewatering equipment Sludge storage space constraints (to be further investigated)

8.5 Augmentation requirements for OSSTP (Alternative strategy)

In the alternative strategy (Option B – refer to Section 7.2) the augmentation requirements for OSSTP, defined as 'Option 2 (Oxidation Ditch)' in the previous planning study (GHD, 2014b), was adopted for comparative purposes in this Study.

The projected peak day ADWF (from population projections, as discussed in Section 2.2.1) and nominal plant capacity before and after augmentation[55] at OSSTP are shown in Figure 17.

Further details can be obtained from the OSSTP planning study (GHD, 2014a,b).

(Note: The Addendum report (GHD, 2016) to this Study, which reviewed OSSTP capacity augmentation requirements to cater for lower population growth projections, is superseded by the adoption of the latest population projections from the BSC Strategic Business Plan (2016) – refer to Section 2.1.3).

[55] The previous planning study for OSSTP (GHD, 2014b) adopted a design population loading of 10,700 EP at a unit flow rate of 215 L/[EP.d], which equates to a design ADWF = 2.3 ML/d. For consistency with the planning work in this Study (based on unit flows of 590 L/[ET.d] or 240 L/[EP.d]), the equivalent design ADWF required for a projected ultimate population of 9,091 EP (2045) (based on latest projections from BSC Strategic Bus. Plan, 2016 - see Section 2.1.3) is 2.18 ML/d. This gives a close match to the planning study (GHD, 2014b) design basis and therefore the OSSTP augmentation requirements considered to be appropriate for comparative purposes in the alternative strategy under consideration here.

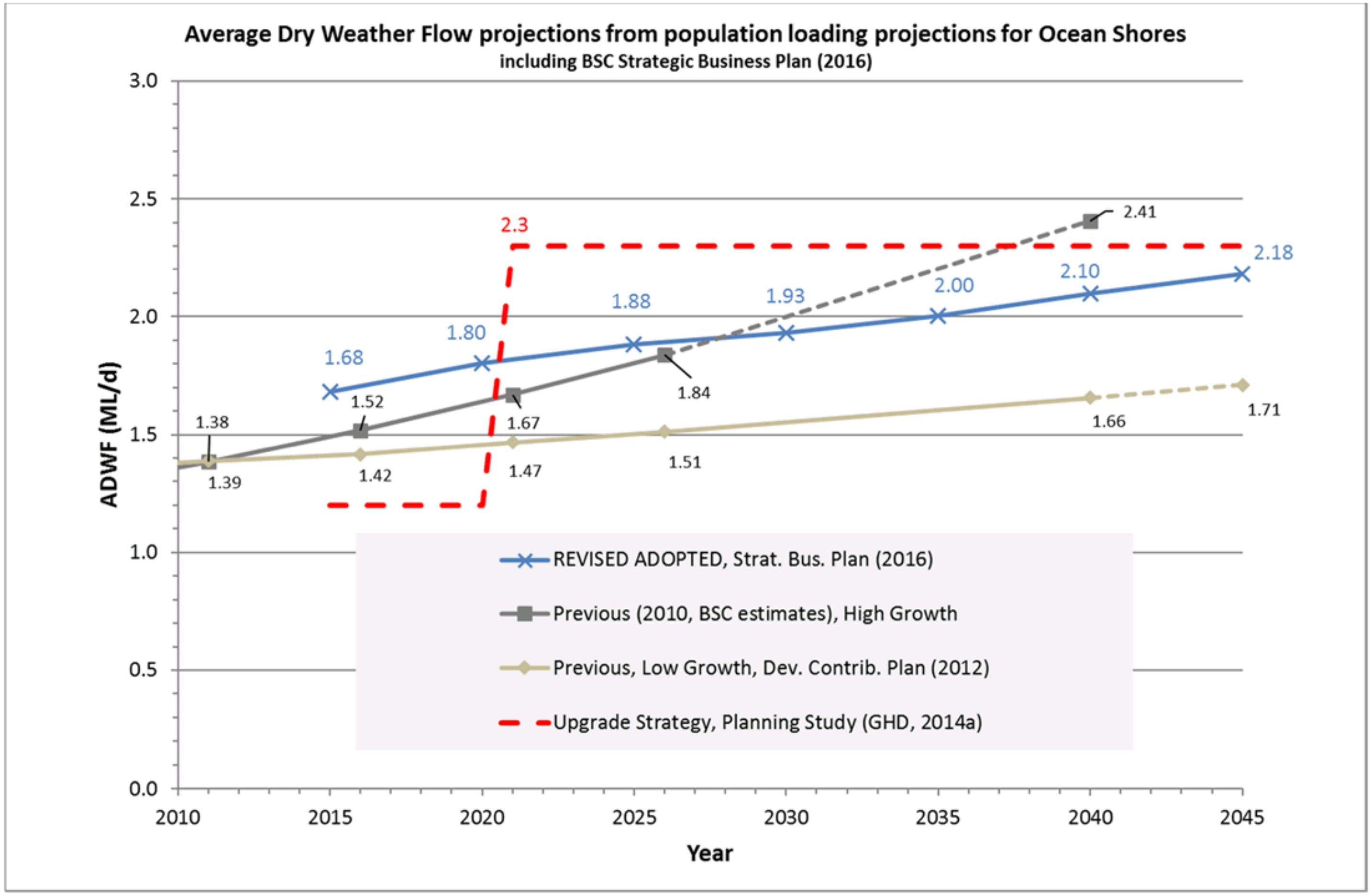

Figure 17 Projected peak day ADWF based on population projections for OSSTP (alternative strategy, with upgrade in 2020-21)

9. Safety in Design

9.1 What is 'Safety in Design'?

Safe design is a process defined as:

"The integration of hazard identification and risk assessment methods early in the design process to eliminate or minimise the risks of injury throughout the life of the product being designed."

A safety in design approach begins in the conceptual and planning phases within a design's lifecycle, with an emphasis on making choices about design, materials and methods of manufacture or construction, to enhance safety. The designer needs to consider how safety can best be achieved in each of the lifecycle phases (construction, use, maintenance, demolition).

Safety in design is part of a broader range of design objectives, including practicality, aesthetics, cost and the functionality of the plant, building or structure. A safety in design approach involves successfully achieving a balance of these sometimes competing objectives, without compromising the health and safety of those potentially affected by the plant, building or structure over its lifecycle.

9.2 What are the Principles of Safety in Design?

The key elements that impact on implementing safety in design are:

Principle 1: Persons with Control – persons who make decisions affecting the design of products, facilities or processes are able to promote health and safety at the source.

Principle 2: Product Lifecycle – safe design applies to every stage in the lifecycle from conception through to demolition. It involves eliminating hazards or minimising risks as early in the lifecycle as possible.

Principle 3: Systematic Risk Management– the application of hazard identification, risk assessment and risk control processes to achieve safe design.

Principle 4: Safe Design Knowledge and Capability – should be either demonstrated or acquired by persons with control over design and should reflect the knowledge that a competent designer would be expected to have.

Principle 5: Information Transfer – effective communication and documentation of design and risk control information between all persons involved in the phases of the lifecycle is essential for the safe design approach.

9.3 Context for this Report

The inclusion of safety in design principles within legislation means that it is no longer sufficient to assume that compliance with a code or standard is enough.

If engaged to undertake detailed design, GHD can implement safety in design processes to identify those health and safety issues in the design phase of a job that may have an effect on the construction, maintenance or end use of the final product. In some cases, the safety in design risk assessment will take the form of a HAZOP study.

Under Health and Safety legislation, a client who commissions construction work must consult with the designer of the structure about how to ensure that risks arising from the design during the construction work are eliminated or minimised. The designer of a structure must give the client a written report that specifies the hazards associated with the particular design and not with other designs of the same type of structure.

As the current scope of work is very preliminary, structures have yet to be designed and this document does not specify safety issues in detail. A more formal risk assessment associated with deferment of capacity augmentation for some STP process components has been recommended in this study, with possible areas worthy of consideration including:

- Construction
- Installation and Commissioning
- Operation
- Maintenance

10. Layout

Refer to Appendix H for the preliminary layout associated with concept put forward in this Study for the plant capacity augmentation.

11. Cost Estimates

11.1 Capital cost

11.1.1 Basis of estimates

The capital cost estimates presented in this section have been developed for planning purposes and may be used for preliminary budgeting. However, the scope and quality of the works has not been fully defined and therefore the estimates are not warranted by GHD. These estimates have been developed based on cost curves, extrapolation from recent similar project pricing and GHD experience. The accuracy of the estimates is not expected to be better than about 25% for the items described in this report. A functional design is recommended for budget setting purposes.

The capital cost estimates given below exclude GST. All costs are in 2nd Qtr 2015 AUD; this is the estimate base date, with no allowance for any escalation.

Estimate costs are based on all the site works for each Option being carried out in one contract. Should this condition change, cost increases are anticipated to cater for additional construction facilities and contract letting/administration works.

Cost elements are based upon limited geotechnical and survey information. Additional geotechnical and survey information would be required to confirm design parameters.

The cost estimates for this project were developed in 2015, and had a validity[56] period to December 2015. While the costs presented here give an approximation of likely project costs, they should be reviewed and refined at functional design

The cost estimates exclude:

- SPS5004 upgrade (separately listed - refer to Section 8.1)
- Decommissioning costs for Ocean Shores STP (where applicable, for options where the site will be closed to wastewater treatment operations).
- Costs associated with upgrading services to the site (services excluded are power supply, potable water supply and telecommunications)
- Council project team and related costs
- Costs of transferred risk
- Subsidies, finance and insurance costs
- Permits and licence fees, legal fees and compensation
- Roadworks/access improvement and traffic management control
- No allowance has been made for foreign currency risk. The project includes a number of mechanical and electrical equipment items that would probably be imported e.g. screens, mixers, pumps, motors, blowers, diffusers, instruments, electrical components etc.

The rationale for excluding (i.e. separately listing) the SPS5004 upgrade was that is likely to be required for asset renewal/ operational reasons irrespective of the STP transfer, as explained in the note regarding timing in Section 8.1.

The rationale for excluding decommissioning costs at the OSSTP site was as follows[57]:

[56] Validity set at the time the draft version (revision A) of this report was developed.

[57] As agreed with BSC Water & Sewerage representatives at meeting held 6 August 2015.

- The site is not ideal for redevelopment (low-lying and flood-prone; situated within a nature reserve)
- A number of uncertainties relating to possible future uses of the site, including timing; type of use; and the associated net cost (or revenue).

Capital costs were developed for:

- The seven BVSTP capacity augmentation options identified in this Study (refer to summary in Table 20 of Section 8.4); together with
- The sewage transfer system augmentation/upgrade requirements from Ocean Shores to BVSTP (refer to Section 8.1), which is common to all these STP options. However, the estimated capital cost of the SPS5004 upgrade was separately listed and not included in the total for the STP transfer project considered here (see below).

The capital cost estimates include on-costs as follows:

On-cost/overhead item	Percentage For BVSTP	Percentage For OSSTP	Notes
Indirect Job Costs (IJC) (Preliminaries, Engineering, Site Costs, Project Admin. etc.)	20%	20%	of Direct Job Cost (DJC)
Risk and Contingency	25%	30%	of DJC + IJC See Footnote[58]
Head Contractor Margin	5%	5%	of DJC See Footnote[59]

11.1.2 Estimates for proposed OS-BVSTP transfer strategy (OSSTP closure)

The capital cost estimates for the Ocean Shores to Brunswick Valley STP raw wastewater transfer and upgrade of BVSTP are summarised in Table 21. A detailed breakdown is given in Appendix I.

The estimates in Table 21 show that a total capital cost budget in the range $26.7 to $30.8 Million is required for this project.

The biggest opportunity for deferment of capital lies in Option 4, where the majority of the STP capacity augmentation is deferred until ca. 2035-36. By that time the existing plant will be nominally operating at 115% of its current design capacity (in average dry weather flow terms on peak days, including tourist loads, based on population projections) – refer to Section 8.3. There are some process-related risks associated with this option (Option 4), as discussed in Section 8.3. However, the required capital cost in the immediate term (nominally 2016-17) is significantly lower ($10.6 M) and the deferred capital cost is $22.7 M (nominally to 2035-36).

[58] Higher Risk and Contingency allowance for OSSTP due to greater uncertainty. BVSTP estimate (this Study) includes provision for $1.28 M in bulk earthworks (site pre-loading and flood mitigation measures included), based on actual contract prices for existing plant constructed in ca. 2009-10. Less certainty around earthworks requirements for OSSTP, due to lack of geotechnical and detailed design for OSSTP upgrade concept (refer to previous Planning Study, GHD, 2014a,b). Additional 5% for Risk & Contingency adds approx. $1.1 M to OSSTP estimate to allow for possible additional earthworks and related civils costs.

[59] OSSTP Planning Study (GHD, 2014b) allowed for 10% head contractor margin. Lower margin (5%) adopted here to be compatible with BVSTP estimate in this Study.

Other options, each carrying different risk profiles, present opportunities to defer (potentially indefinitely, or eliminate) capital costs in the range $1.2 M to $4.2 M.

11.1.3 Estimates for alternative strategy (retention and upgrade of OSSTP)

This Study has investigated the feasibility of the transfer of raw wastewater from the Ocean Shores catchment to BVSTP for treatment. In this strategy, Ocean Shores STP (OSSTP) would be closed (refer to Section 7).

The alternative strategy would be to retain and upgrade OSSTP. That strategy was previously investigated in a Planning Study (GHD, 2014a,b). If Ocean Shores raw wastewater loads are not transferred to BVSTP, then:

- The raw sewage transfer system extension/ upgrade (OS to BVSTP) will not be required.
- BVSTP will not require upgrading until after 2045 (refer to Appendix B). Hence, if Ocean Shores loads are not transferred, the augmentation of BVSTP is effectively deferred until beyond the planning horizon of this Study.
- To be consistent with current planning initiatives for recycled water (effluent reuse) (refer to GHD 2014b), and for consistency here in terms of capital cost estimates, treated effluent from OSSTP would be pumped to BVSTP to add to supply for the existing Mullumbimby recycled water scheme, which could be extended in future. The cost of the pipeline to transfer treated effluent from OSSTP to BVSTP therefore has been factored into the comparison between strategies, using the same easement.

The capital cost estimates for the upgrade of Ocean Shores STP and treated effluent transfer from OSSTP to BVSTP are summarised in Table 22. These estimates were based on the plant upgrade proposed in the Planning Study (refer to GHD, 2014b) “Option 2”, namely, a similar oxidation ditch process configuration to that at BVSTP. The estimates adopted include deferment of capital costs associated with tertiary effluent filtration, subject to licence and recycled water quality requirements[60]. Refer to the breakdown of capital costs in Appendix J.

11.1.4 Discussion

A comparison of capital costs between the strategies (OS-BVSTP transfer/ OSSTP closure vs. alternative of retaining and upgrading OSSTP) in Table 21 and Table 22 shows that:

- The transfer from OS to BVSTP and full upgrade/augmentation (base case, Option 1) proposed for BVSTP is potentially approximately $2.74 M more expensive in terms of total capital cost than the alternative (retaining and upgrading OSSTP[61]) due to a combination of the following factors:
  - Inclusion of wet weather storage facility
  - Inclusion of tertiary constructed wetland
  - Inclusion of redundancy in dewatering facilities and additional biosolids storage capacity
  - Provision of additional clarifier capacity (to compensate for apparent shortfall in clarification capacity, due to more aggressive design basis in terms of sludge settleability assumed used for the existing BVSTP clarifiers[62])

[60] Tertiary effluent filters were included in the OSSTP Planning Study (GHD, 2014b) to be conservative in the absence of specific information on future license or recycled water quality requirements. For a valid comparison with Brunswick Valley, (where unfiltered post UV-disinfected effluent is pumped to effluent reuse), the filters may be removed from the base capital cost estimates for OSSTP here.

[61] Excluding Filters at OSSTP in this comparison.

[62] Refer to Sections 4.5, 5.1.3 and 6.4.2.

  - Ample provision for future growth of the combined catchments (to beyond year 2045)[63] in the proposed BVSTP augmentation.

- The transfer from OS to BVSTP and augmentation of BVSTP excluding the wet weather storage (deferred/eliminated, Option 5) is cheaper (by $1.42 M) in terms of capital cost than the alternative (retaining and upgrading OSSTP). However, this option carries a degree of greater risk (refer to Section 8.4 and Table 20).

- The transfer from OS to BVSTP and augmentation of BVSTP excluding both the wet weather storage and the constructed wetland (both deferred/eliminated, by a combination of Options 5&6) potentially saves $2.82 M in capital cost, compared with the alternative (retaining and upgrading OSSTP). However, this option also carries greater risks (refer to Section 8.4 and Table 20).

- Additional opportunities for deferral of capital costs appear at BVSTP, but not at OSSTP, in the form of:

  - Deferral of one new clarifier (Option 2, i.e. removing provision of additional clarification capacity and accepting the risk of a more aggressive existing design basis – see above) until ca. 2035-36 potentially defers $2.38 M in capital; and
  - Deferring new sludge dewatering facilities (Option 7, i.e. accepting risks associated with lack of redundancy and longer operating times on existing mechanical equipment, with reliance on mobile dewatering as backup) at least until ca. 2035-36 or potentially indefinitely, defers $1.83 M in capital.

- There is a major opportunity for deferral of $22.66 M in capital costs at BVSTP (at least until ca. 2035-36), if risks associated with marginal (up to 15%) overloading of the existing plant is accepted on peak days, after transfer of the Ocean Shores loads (refer to Section 11.1.2 above). This opportunity does not exist at OSSTP, due to the plant already being marginally overloaded in its existing form at current Ocean Shores loads and presenting a number of operational issues (refer to GHD, 2014a & b).

Overall, on a comparable basis (excluding provision of wet weather storage and constructed wetland, both of which increase process reliability and robustness but are not critical items), the proposed strategy (i.e. transfer from OS to BVSTP and augmentation of the latter) offers the best potential to minimise and/or defer capital costs by centralising STP treatment operations for the Mullumbimby, Brunswick Heads and Ocean Shores combined catchments.

[63] In the Low Growth, low I/I scenario. Refer to Appendix B.

Table 21 Summary of Capital Cost estimates for OS-BVSTP transfer (strategy proposed in this Study)

ITEM	Scenario	CAPITAL COST (2020-21)	CAPITAL COST DEFERRED (TO 2035-36)	TOTAL CAPITAL COST*	CAPITAL COST DEFERRED INDEFINITELY (OR ELIMINATED)
OS TO BVSTP RAW SEWAGE TRANSFER SYSTEM - PUMP STATION (5004) UPGRADE	Not included in Project Totals here	$0.74 M	-	$0.74 M	
OS TO BVSTP RAW SEWAGE TRANSFER SYSTEM - PIPELINE	Common to All BVSTP Options	$2.41 M	-	$2.41 M	-
BVSTP CAPACITY AUGMENTATION					
Option 1	Full upgrade, Base case	$30.82 M	-	$30.82 M	-
Option 2	Defer* one new clarifier	$28.44 M	$2.38 M	$30.82 M	-
Option 3	Decrease wet weather storage size	$29.67 M	$1.15 M	$30.82 M	-
Option 4	Defer* new bioreactor and both new clarifiers	$8.16 M	$22.66 M	$30.82 M	-
Option 5	Defer**/eliminate wet weather storage	$26.66 M	-	$26.66 M	$4.16 M
Option 6	Defer** eliminate wetland	$29.42 M	-	$29.42 M	$1.40 M
Option 7	Defer**/eliminate new sludge dewatering facilities	$28.99 M	-	$28.99 M	$1.83 M
PROJECT TOTAL (TRANSFER + BVSTP)					
Option 1	(As above)	$33.23 M	-	$33.23 M	-
Option 2		$30.85 M	$2.38 M	$33.23 M	-
Option 3		$32.08 M	$1.15 M	$33.23 M	-
Option 4		$10.57 M	$22.66 M	$33.23 M	-
Option 5		$29.07 M	-	$29.07 M	$4.16 M
Option 6		$31.83 M	-	$31.83 M	$1.40 M
Option 7		$31.40 M	-	$31.40 M	$1.83 M

*Defer until 2035-36 (Options 2, 3 and 4)

**Defer indefinitely (Options 5, 6 and 7)

All Capital Costs include On-costs/ Overheads, Risk & Contingency allowance (refer to Section 11.1.1)

Table 22 Summary of Capital Cost estimates for OSSTP upgrade (alternative strategy)

ITEM	Scenario	CAPITAL COST* (2020-21)	CAPITAL COST* DEFERRED (TO 2035-36)	TOTAL CAPITAL COST*	CAPITAL COST* DEFERRED INDEFINITELY (OR ELIMINATED)
OS TO BVSTP TREATED EFFLUENT TRANSFER SYSTEM (PIPELINE only)	Required for comparative purposes relating to effluent reuse (Mullumbimby scheme), if OSSTP is retained & upgraded	$1.56 M	-	$1.56 M	-
OSSTP UPGRADE/ CAPACITY AUGMENTATION					
Option 2, Previous Planning Study (GHD, 2014b)	Full upgrade comparable to BVSTP Option 1 (Base case), with Filtration deferred	$28.93 M	-	$28.93 M	$1.95 M
PROJECT TOTAL (OSSTP + EFFLUENT TRANSFER)					
	(From above)	$30.49 M	-	$30.49 M	$1.95 M

All Capital Costs include On-costs/Overheads, Risk & Contingency allowance (refer to Section 11.1.1)

11.2 Operating cost

11.2.1 Basis of estimates

Operating costs were estimated using the following approach and assumptions:

- Staff costs, assuming half of one full-time equivalent (0.5 FTE) operator plus 0.5 FTE for all support staff per STP[64] whilst both STPs (OSSTP and BVSTP) are operational (i.e. before the transfer). Thereafter (with OSSTP closed and flows transferred to BVSTP), assume one full-time equivalent (1 FTE) operator plus 0.5 FTE support staff for BVSTP. Staff costs for pump stations were assumed to be external to this analysis and common to all options. One FTE was assumed to cost $120,000 per annum.
- Unit power cost: $0.19 per kWh average, based on recent 2014-16 electricity accounts data[65] for BVSTP and OSSTP.
- Power costs were scaled to flow and load based on population projections using an in-house model for with specific power use ranging 460 to 733 kW/ML, depending on plant loading. The power model used was previously calibrated to 2013 yearly data[66] for (West) Bryon STP and agreed reasonably well with 2014-16 yearly data for BVSTP (similar process configuration); the model was recalibrated for OSSTP (existing, before upgrade) to reflect the higher specific power use for that plant, based on 2014-16 yearly data[65]. Allowance for incremental power requirements for pumping was made as follows:
  - For SPS 5004 (raw sewage) upgrade to pump to BVSTP: additional 55 kWh/ML (or additional 12 kW pump power at a pump rate of ~60 L/s or 0.216 ML/h)
  - For effluent reuse transfer from OSSTP to BVSTP (for comparative purposes in alternative strategy): additional 45 kWh/ML (nominal max. 10 m head and 60% pump efficiency).
- Unit chemical costs[67] as follows:
  - Alum: $271 per tonne solution (min. 46% w/w; SG 1.31 kg/L)
  - Polymer (dry powder): $9 per kg
  - Sodium hydroxide (caustic soda): $660 per tonne (50% w/w, SG 1.50 kg/L)
  - Ferric sulphate: $623 per tonne (50% w/w, SG 1.58 kg/L)
- Chemical use was scaled to flow (ADWF) based on population projections (refer to Appendix B), as follows:
  - Supplementary chemical P removal (using alum and alkalinity correction with sodium hydroxide) assuming 2 mgP/L removal for all options, except:
    - Option 4 before BVSTP augmentation (assumed 3 mgP/L removal due to higher loading of existing plant until 2035-36)
    - OSSTP before upgrading in the alternative scenario without transfer to BVSTP (assumed 4.5 mgP/L removal, due to lack of bio-P removal process configuration at the existing plant).

[64] Revised from 1 FTE and 0.8 FTE for support staff per STP (c.f. previous OSSTP Planning Study - GHD, 2014b) following meeting held on 6 Oct. 2016 with BSC Water & Sewerage representatives.

[65] Based on Electricity Accounts data for 2014-15 and 2015-16 Financial Years supplied by BSC (B Green) to GHD (D de Haas) dated 11/7/2016: average 18.4 c/kWh for BVSTP; 19.4 c/kWh for OSSTP.

[66] Based on email communication from BSC (Ray Collins) to GHD (D de Haas) dated 19/11/2014.

[67] Based on email communication from BSC (Ray Collins) to GHD (D de Haas) dated 22/07/2015. Liquid polymer cost information provided was $13,500 per 3,000 L (assumed equivalence to dry powder based on 50% w/w solution).

  - Ferric sulphate assuming an average dissolved sulphide removal[68] of 3 mgS/L for the existing BVSTP (without OS transfer) or 5 mgS/L (with OS transfer). No ferric sulphate dosing is applied at the existing OSSTP and this was assumed to continue to be the case in the alternative scenario without transfer to BVSTP.
  - Polymer at 4.5 kg/tonne dry solids (biosolids cake)
- Biosolids production based on steady-state modelling undertaken (refer to Section 6) and assumptions above regarding supplementary chemical P removal.
- Biosolids disposal[69]: $40 per wet tonne
- Other operating costs: $85,000 pa allowance, for a range of miscellaneous costs, including: water; inspection & testing; licences; process monitoring; cleaning; air conditioning service; waste & sanitation (screenings & grit disposal).
- Maintenance costs - Approach (1) for NPV analysis:
  - For all options prior to capacity augmentation at BVSTP: 0.5% of Civil; 3% of M&E Construction Direct Job Cost
  - For BVSTP options after capacity augmentation and transfer from OSSTP, including economies of scale[70]: 0.4% of Civil; 2.4% of M&E Construction Direct Job Cost
- Maintenance costs - Approach (2) for NPV sensitivity analysis:
  - For all options (no economies of scale): 0.5% of Civil; 3% of M&E Construction Direct Job Cost.

Maintenance costs using Approach (2) and other operating cost assumptions were cross-checked against actual operating costs incurred by BSC (FY 2014-15 and 2015-16 data), excluding staff and biosolids disposal costs, for the existing STPs. A summary of the comparative costs is given in Table 23. The agreement between actual and adopted operating costs was reasonable.

[68] Original design (Fulton Hogan, 2010) assumed an average of 3 mgS/L removal for BVSTP. Increased here to 5 mgS/L to allow for likely increase septicity of combined raw wastewater with the transfer from Ocean Shores (due to proposed rising main extension).

[69] Based on email communication from BSC (Brian Green via Dean Baulch) to GHD (D de Haas) dated 1/12/2014 for Byron SC STPs. Conservative estimate for agricultural disposal. Current costs range up to approximately $38/ cubic metre.

[70] It was assumed that consolidation of treatment at BVSTP (with capacity augmentation using similar process configuration to existing plant) will offer economies of scale for maintenance (e.g. planned maintenance of similar items in both process trains; similarity of equipment, spares etc.). This assumption was tested in the NPV Analysis – refer to Approach (2).

Table 23 Comparison of recent STP actual operating costs with comparative total adopted for this Study

Plant	Year	Power	Chemicals	Other operating costs	Planned maintenance	Reactive maintenance	TOTAL	Comparative TOTAL used in this Study (adopted)
BVSTP	2015	$117,800	$87,900	$125,300	$102,700	$105,300	$539,000	**$509,300**
	2016	$102,800	$105,200	$84,400	$87,400	$110,200	$490,000	
OSSSTP	2015	$113,300	$110,300	$143,700	$81,100	$122,700	$571,100	**$565,700***
	2016	$95,400	$93,000	$114,000	$66,100	$75,900	$444,400	

Note: Excludes Staff and Biosolids Disposal costs

Costs given are $/ annum for operation of each STP separately (i.e. existing)

* OSSTP maintenance adopted costs shown here are for the plant after proposed upgrading (i.e. in alternative scenario, no transfer to BVSTP).

11.2.2 Estimates

The operating cost estimates at design flows (or year 2035-6, where relevant) are contained in Appendix K. Refer to Appendix L for the scaled operating costs used in the Net Present Value Analysis.

For comparative purposes, Ocean Shores STP operating costs were estimated on the basis of the plant upgrade proposed in the Planning Study "Option 2" (refer to GHD, 2014b), namely, a similar oxidation ditch process configuration to that at BVSTP.

The operating costs for the two STPs (upgraded Ocean Shores and Brunswick Valley) are broadly similar, given their similarity in terms of size and adopted process configurations. Minor differences arise from assumptions relating to chemical use and plant loading. The most significant opportunity for cost savings arises from operator manpower and maintenance requirements with consolidation of treatment at one STP site rather than two sites. Based on the assumptions made (refer to Section 11.2.1):

- There is no potential to save on operator staff costs, given the recent reduction in STP operator staffing levels at BSC. One FTE (currently split equally between two STPs) will be dedicated to the consolidated operations at BVSTP.
- Limited potential to save on staff overhead costs (assuming 0.5 FTE for consolidated operations at BVSTP, compared with 1 FTE assumed to be equally split between two STPs): $60,000 pa saving.
- Significant savings potential of approximately $300,000 pa in reduced maintenance costs from having treatment consolidated at one STP, particularly if economies of scale can be realised from having similar plant and equipment configurations in the existing and proposed new treatment process train at BVSTP. Even without the economies-of-scale factoring, the savings potential in reduced maintenance costs significant (approximately $250,000 pa).

11.3 Net Present Value Analysis

11.3.1 Basis of analysis

Two approaches to Net Present Value (NPV) Analysis were taken, with the following assumptions:

Approach 1 – NPV(1) Analysis

- Discount rate: 4.5%
- Base date: 2016
- Period: 30 years
- No escalation or inflation
- Variable operating costs (power, chemicals, biosolids disposal) indexed to dry weather flow predictions (from population growth)
- Maintenance costs for options prior to BVSTP capacity augmentation: 0.5% of Civil; 3% of M&E Construction Direct Job Cost

- Maintenance costs for BVSTP options after OS transfer and capacity augmentation, including economies of scale: 0.4% of Civil; 2.4% of M&E Construction Direct Job Cost

Approach 2 – NPV(2) Analysis **(sensitivity)**

As above for *Approach 1*, except:

- Maintenance costs for all options (no economies of scale): 0.5% of Civil; 3% of M&E Construction Direct Job Cost

11.3.2 Comparison of options in the proposed strategy

The strategy proposed in this Study is to consolidate treatment at BVSTP and to close OSSTP. The options within this strategy were summarised in Section 8.4 and capital costs for these options were discussed in Section 11.1.2.

Taking into account both capital and operating costs, the results of the NPV analysis for these options are summarised in Table 24. Refer to Appendix L for details.

Using *Approach 1* (see section 11.3.1), the results show an NPV of $48.49 M for Option 1 (Base Case) with potential to save between approximately $0.6 M and $3.2 M in NPV terms by reduced size or deferment of individual process units (one new clarifier, wet weather storage, wetland or new sludge dewatering facilities). Deferment of the major process capacity augmentation (Option 4) until 2035-36 offers the potential to save approximately $12.6 M in NPV terms.

Comparing the results for *Approach 1 with Approach 2* in Table 24 illustrates the sensitivity of NPV to maintenance cost assumptions. Assuming no economies of scale for maintenance costs at one plant (BVSTP) (*Approach 2*) adds: about 1% to the NPV for options that have either no deferment of capital or deferment of one process item (i.e. all options except Option 4); or about 0.6% additional NPV where major capacity augmentation at BVSTP is deferred until 2035-36 (Option 4).

Table 24 Net Present Value Summary for Proposed Strategy

ITEM	Scenario	NPV (1)	NPV (2)	NPV (1)	NPV (2)
OS TO BVSTP RAW SEWAGE TRANSFER SYSTEM (PIPELINE excluding P/STN upgrade) AND BVSTP CAPACITY AUGMENTATION				Saving relative to Alternative Strategy of retaining both OSSTP & BVSTP (refer to Section 11.3.3):	
PROJECT TOTAL (TRANSFER + STP)					
BVSTP Option 1	Full upgrade, Base case	$48.49 M	$49.03 M	-$5.53 M	-$4.99 M
BVSTP Option 2	Defer* one new clarifier	$47.05 M	$47.57 M	-$6.97 M	-$6.45 M
BVSTP Option 3	Decrease wet weather storage size	$47.90 M	$48.44 M	-$6.12 M	-$5.58 M
BVSTP Option 4	Defer* new bioreactor and both new clarifiers	$35.92 M	$36.13 M	-$18.10 M	-$17.89 M
BVSTP Option 5	Defer**/eliminate wet weather storage	$45.33 M	$45.83 M	-$8.69 M	-$8.19 M
BVSTP Option 6	Defer**/eliminate wetland	$47.19 M	$47.72 M	-$6.83 M	-$6.30 M
BVSTP Option 7	Defer**/eliminate new sludge dewatering facilities	$46.69 M	$47.19 M	-$7.33 M	-$6.83 M

*Defer until 2035-36 (Options 2, 3 and 4)

**Defer indefinitely (Options 5, 6 and 7)

Refer to text for definition of approaches in NPV(1) & NPV(2) (sensitivity to Maintenance Costs)

11.3.3 Comparison with alternative strategy

For a comparison of costs, the alternative strategy will be to retain both BVSTP and OSSTP. BVSTP will not need to be upgraded until after 2045 but OSSTP will require a major upgrade (GHD, 2014a,b) in the near future (nominally 2020-21). A transfer pipeline from OSSTP to BVSTP for effluent reuse will replace the raw sewage transfer rising main, but will follow the same easement. Refer to Sections 7.2.2 and 8.5 for a further discussion of the rationale adopted for this alternative strategy.

The capital costs for the alternative strategy were discussed in Section 11.1.3.

The NPV calculations for the alternative strategy followed *Approach 2* – refer to Section 11.3.2.

In the absence of capital costs in this strategy for BVSTP (no upgrade), the NPV component for BVSTP is made up of the aggregate discounted operating costs. For OSSTP a major upgrade is required (as identified by the GHD (2014b) planning study), and a comparable approach was used to estimate the associated capital and operating costs as for BVSTP.

The results of the NPV calculation in this strategy are summarised in Table 25.

The Total NPV for both STPs in this strategy is estimated to be $54.02 M. This provides the basis against which to compare the NPV estimates for the proposed strategy for the transfer to BVSTP (refer to Table 24).

The results in Table 24 show that for all the options considered, the proposed strategy of transfer from Ocean Shores to BVSTP offers savings in terms of NPV (project whole of life cost). The NPV savings are at least approximately $5 M (for Option 1, base case, assuming full augmentation of capacity at BVSTP including the wet weather storage, wetland and additional bioreactor and clarifier capacity). If the additional bioreactor and clarifier capacity is deferred to 2035-36, then very significant NPV savings of approximately $18 M are possible.

The NPV estimates were not very sensitive to the maintenance costs assumptions relating to economies of scale associated with consolidating operations at BVSTP using a similar process configuration and/or equipment (compare NPV(1) and NPV(2) estimates in Table 24).

Table 25 Net Present Value Summary for Alternative Strategy

ITEM	Scenario	NPV (2)
NO RAW SEWAGE TRANSFER SYSTEM / NO BVSTP CAPACITY AUGMENTATION; UPGRADE OSSTP		
PROJECT TOTAL		
Maintain Existing BVSTP Operations	No Capacity Augmentation; No Upgrade	$17.23 M
Retain OSSTP and Upgrade	Capacity Augmentation and Upgrade (No Filters); including New Effluent Reuse Transfer Pipeline to BVSTP	$36.79 M
TOTAL FOR BOTH STPs		**$54.02 M**

Refer to text for definition of approach in NPV(2) calculation.

12. Conclusions

The following main conclusions may be drawn from this Study:

1. It is technically feasible and cost-effective in the long term (on a whole-of-life cost basis) to transfer raw wastewater from Ocean Shores to Brunswick Valley STP (BVSTP) for treatment. If this proposed strategy is implemented, then treatment at the Ocean Shores STP (OSSTP) will permanently cease and the STP can be closed.

2. There is sufficient space at the BVSTP site to treat the combined flows and loads from the Mullumbimby, Brunswick Heads and Ocean Shores catchments in the long term, using a similar process format to the existing plant at this site. There is also sufficient space to incorporate optional additional process components in the form of a wet weather storage facility for raw wastewater and a constructed wetland for tertiary effluent treatment. Taking into account requirements for the combined catchments, including Ocean Shores, and site space constraints, the sizes of these additional components proposed in this Study differ from those proposed in the original concept design (ca. 2008). Final selection of sizes will need to be confirmed by additional investigation, as part of the revised concept and detailed design for the plant capacity augmentation.

3. The most recent population estimates (from the Byron Shire Council Strategic Business Plan, 2016) have lower growth projections for the future. The latest estimates are indicatively 5 to 15% lower than those previously adopted from the original planning and concept designs for both STPs (GHD, 2003; 2007; 2008a,b; 2014a,b) and the previous Byron Shire Developer Contribution Plan (2012). Based on the latest projections and adopted unit flows per population equivalent (or tenement) the following conclusions were drawn:

   - The combined average dry weather flow (ADWF) on peak days (including tourists) from the Mullumbimby and Brunswick Heads catchments currently treated at BVSTP (excluding Ocean Shores) is expected to reach somewhere between 2.75 and 3.51 ML/d by 2045, depending on the flow allowance made for Inflow/Infiltration (I/I). That is the existing BVSTP design capacity (3.8 ML/d ADWF) is not expected to be exceeded within the planning horizon (30 years) of this Study unless a higher growth scenario materialises. Hence, if Ocean Shores flow is not transferred then BVSTP will not require a capacity augmentation in the foreseeable future.
   - If Ocean Shores wastewater flow is not transferred to BVSTP then OSSTP will need to be upgraded, based on the latest population projections and a previous planning study for that plant (GHD, 2014a&b). The projected ADWF for OSSTP is projected to reach 2.2 ML/d by 2045, which is approximately double the existing treatment capacity of the existing OSSTP (last upgraded more than twenty years ago and currently experiencing a number of operational issues or capacity constraints).
   - The combined ADWF on peak days (including tourists) from the combined catchments of Mullumbimby, Brunswick Heads and Ocean Shores (i.e. after transfer from Ocean Shores to BVSTP) is projected to reach just under 5 ML/d by 2045 without additional allowance for I/I in the long-term I/I, or approximately 5.7 ML/d by 2045 including additional allowance for I/I. The ADWF on non-peak days (excluding tourists) from the combined catchments is expected to reach the existing design capacity of BVSTP (3.8 ML/d) indicatively by 2035-36. That is, if the raw wastewater transfer from Ocean Shores is implemented, then the existing BVSTP will need to have its process capacity augmented to meet peak day treatment capacity requirements, including peak wet weather flow requirements. Provided a minimum plant upgrade is put in

place to meet peak (hydraulic) flow requirements in wet weather, the plant can be operated close to its design capacity on non-peak days, and marginally over its design capacity on peak dry weather days. In this proposed strategy, the major capital works for process augmentation (i.e. including additional bioreactor and clarifiers) can be deferred until no later than 2035-36, by which time the plant is projected to be operating close to 100% design capacity on non-peak days and up to 115% of design capacity on peak days under dry weather conditions.

4. This Study identified the following major risks in terms of planning for the transfer of wastewater loads from the Ocean Shores catchment to the Brunswick Valley plant:

   – BVSTP currently has no wet weather storage facilities, which means there is no fall-back (or backup) operational strategy for managing flows at the plant (e.g. high wet weather flows or dry weather flows, particularly if the need arises to take critical process units offline for maintenance).
   – BVSTP currently has no tertiary wetland, unlike Council's other STPs at (West) Byron and Ocean Shores. Wetlands can serve useful effluent quality 'polishing' or buffering process functions and also have aesthetic benefits (e.g. bird habitat) that typically carry broad stakeholder support.
   – The existing BVSTP has hydraulic capacity constraints (posed by inlet works and downstream pipework) at less than the combined peak pumping capacity from the Mullumbimby, Brunswick Heads and Ocean Shores catchments. To varying extents, all of these catchments tend to be prone to high peak weather flows, due to on-going issues with infiltration and inflow.
   – Peak wet weather flows from the combined catchments (Mullumbimby, Brunswick Heads and Ocean Shores) are expected to exceed the hydraulic capacity of the existing treatment plant. Therefore, peak wet weather flows will need to be separately managed (via diversion to a new storage facility and return pumping when plant inflows permit), in order to operate within the hydraulic capacity constraints posed by the existing plant. The existing arrangement in which return activated sludge is pumped via inlet works will also need to be modified in order maximise the hydraulic capacity of the existing inlet works. This will help to minimise the risk of the new wet weather storage facility filling and discharging partially-treated or treated wastewater from being discharged to the environment.
   – A new environmental licence will likely be required for the plant to incorporate approval for the proposed new wet weather storage and wetland facilities, as well as the increased plant capacity and effluent quality targets.
   – A full duplication of the bioreactor capacity at BVSTP will provide surplus treatment capacity that poses risks of over-capitalisation and long-term operational issues (e.g. on-going poor sludge settleability; over-aeration; reduced energy efficiency).
   – No upgrade of BVSTP poses long-term risks of significant overloading and compromised plant operation (e.g. aeration and clarification capacity constraints; deterioration in effluent quality; decreased biosolids stabilisation and associated odour).
   – The proposed strategy, with deferment of the main process augmentation at BVSTP until no later than 2035-36, has some process risk associated with effluent quality due to the main biological treatment units (bioreactors and clarifiers) being marginally overloaded, relative to their nominal design capacity, from ca. 2024-25 until the upgrade in 2035-36. However, the level of this risk is expected to be acceptable, subject to confirmation of new licence requirements for effluent quality and further investigation using dynamic process modelling during detailed planning and design.

- There is anecdotal operational experience (and theoretical evidence from flux theory) of constraints on current clarification capacity at BVSTP posed by worse-than-design sludge settleability performance. According to the original designer (Hartley, 2013a&b), settleability is expected to improve with increased plant loading, considering that the existing plant is currently operating at around 50% of its design loading, or less at times. However, the operators have little control over sludge settleability in practice. A more conservative approach to clarifier design sizing for future capacity augmentation is proposed to significantly reduce risks of gross solids loss from the plant under peak wet weather flow conditions. This is particularly relevant considering that the existing peak (wet weather) pumping capacity from Ocean Shores is potentially up to approximately 10 times ADWF (projected), compared with the process design philosophy of 5.8 times ADWF for full treatment (including clarification) at BVSTP.

5. A number of options for capacity augmentation/upgrade of BVSTP were identified in this Study, catering for transfer of flows and loads from Ocean Shores as well as future growth in the existing catchments. The base case option (Option 1) reduces risks to the minimum and involves provision of the following:

- Lagoon-type wet weather storage (20 ML) with return pumping facilities
- Tertiary constructed wetland
- 50% bioreactor capacity augmentation (3-stage 'Phoredox' concept oxidation ditch similar to that existing)
- 100% clarifier capacity augmentation (2 no. clarifiers of same dimensions to existing)
- New sludge dewatering and additional (covered) biosolids storage facilities, essentially duplicating those existing.
- Capital cost (assuming implementation within the next 5 years or indicatively in 2016-17) of $33.2 M and NPV of $48.5 M (over 30 years at 4.5% pa discount rate).

6. Other options involving minor deferment of capital costs (either until ca. 2035-36 or potentially indefinitely) have a slightly increased risk profile, which will need to be managed. These involve the deferment of capital costs and lower NPV in the range approximately $1.15 M to $4.2 M (relative to the base case).

7. If the Ocean Shores-BVSTP transfer strategy is be implemented, the biggest opportunity to reduce capital costs (indicatively within the next 20 years) and reduce whole-of-life cost (NPV) comes from deferring the BVSTP capacity augmentation for major process components until no later than 2035-36 (i.e. Option 4 identified in this Study). This option has the potential to defer up to $22.7 M in capital (until 2035-36) and reduce NPV by approximately $12.6 M, compared with the base case (see above). However, further study is recommended to better understand and quantify the risks associated with this strategy and to ensure that the sizing and staging of the proposed BVSTP upgrades are appropriate and acceptable to BSC. A risk assessment of the proposed strategy should be carried out and should involve the BSC team responsible for operating the BVSTP plant at or beyond its nominal design capacity in the medium term after the transfer from Ocean Shores.

8. All of the options proposed for the Ocean Shores- BVSTP transfer offered lower whole-of-life (NPV) costs than the alternative strategy of retaining both STPs and upgrading OSSTP as per a previous planning study for that plant (GHD, 2014b). The NPV analysis was tested for sensitivity to assumptions around maintenance costs. Even without economies of scale (assumed for maintenance costs associated with one plant instead of two plants), the proposed strategy (Ocean Shores-BVSTP transfer) had a lower whole-of-life (NPV) cost profile for all options and is therefore recommended.

13. Recommendations

The following recommendations can be made from this Study:

1. Commence planning for the capacity augmentation at Brunswick Valley STP (BVSTP), transfer of wastewater flows and loads from the Ocean Shores catchment and closure of Ocean Shores STP

2. For the transfer of Ocean Shores flows and loads, a rising main pipeline extension from OSSTP to BVSTP will be required. A potentially suitable easement for this pipeline has already been identified by Byron Shire Council. Further negotiation with existing landholders and the necessary planning approvals will need to be put in place. To enable the proposed transfer, it is recommended that these negotiations and planning approval applications be progressed further.

3. Given constraints on capital expenditure faced by Byron Shire Council in the short to medium term, the option with lowest capital and whole-of-life costs (NPV) identified in this Study (Option 4) involves the transfer of wastewater from Ocean Shores to BVSTP but deferral of a major process capacity augmentation at BVSTP. Based on the current low-growth population projections for all three catchments (Mullumbimby, Brunswick Heads and Ocean Shores), capacity augmentation at BVSTP can be deferred until ca. 2035-36 at the latest. By then, the loading on the plant will reach indicatively up to 115% of design loads on peak days (including tourist loads) or 100% of non-peak days (nominally excluding tourists). This deferral option is expected to carry a marginally increased risk profile (see below). Subject to these risks being further studied and found to be acceptable to Council, this option is recommended. It will require an estimated capital budget of $11.3 M within an indicative timeframe of less than four years (nominally 2020-21), including the cost of the raw wastewater transfer from Ocean Shores and the provision of wet weather storage and tertiary wetland facilities at BVSTP. The capital cost (in 2015 dollars), deferred indicatively until 2035-36, will be $22.7 M. The Net Present Value (NPV) of this option is estimated to be $35.9 M, which represents a significant saving of $12.6 M in whole-of-life terms, compared with the base case (lowest risk) option.

4. The lowest risk approach identified in this Study was the base case for full augmentation of treatment capacity at BVSTP (Option 1) at the same time as the transfer of loads from Ocean Shores (nominally in 2020-21). It will require an estimated capital budget of $33.2 M, including the cost of the raw wastewater transfer from Ocean Shores, within an indicative timeframe of less than four years. The Net Present Value (NPV) of this option is estimated to be $48.5 M. This option is not recommended due to the significantly higher whole-of-life cost and the risk of providing additional process treatment capacity that is well in excess of requirements (i.e. under-loading) in the short-medium term (<10 years, indicatively). Option 1 is only recommended if the risks associated with the other options (including the recommended Option 4, see above) are found to be unacceptable after further investigation.

5. Before implementation of the lowest capital and whole-of-life costs (NPV) option recommended from this Study (Option 4, see above), it is recommended that additional studies be undertaken to better understand and quantify the associated risks. These risks may be grouped and summarised as follows:

   – **Operational risks relating to hydraulic treatment capacity**, which can be managed through staged implementation of inlet works and wet weather storage/return pumping facilities and tertiary wetland. It is recommended that more detailed water balance model simulations of peak wet weather events for the combined catchments be undertaken. This will assist in confirming wet weather storage and return pumping requirements, and will enable appropriate risk mitigation.

- **Operational risks relating to process treatment capacity** (e.g. aeration, clarification, biosolids handling) and plant peak loading. These risks can be partly managed by use of the wet weather storage/return pumping facilities on peak (dry weather) days but will need to be largely absorbed by careful plant operation (e.g. increased solids wasting for sludge age control; aeration settings for use of full duty and/or standby blower capacity to maximise air supply on peak days). It is recommended that more detailed dynamic process model simulations of peak and average dry weather events for the combined catchments be undertaken. This will enable the residual risks associated with the existing STP operating in the range of approximately 100-120% of its design loading (in terms of effluent quality compliance) to be more fully quantified. These simulations will need to take into account the ability of the proposed tertiary wetland to 'polish' effluent quality (including nutrient removal) prior to discharge to the receiving water (river).

6. For detailed process modelling and future design purposes, it is recommended that Ocean Shores raw wastewater quality be fully characterised (no recent characterisation data available). At the same time, consideration should also be given to repeating the characterisation of raw wastewater from the Mullumbimby and Brunswick Heads catchments (characterisation last carried out in 2006-7).

7. Prior to implementation, it is recommended that agreement in principle and future licence requirements for BVSTP be negotiated with the regulatory agencies (notably NSW EPA). Careful consideration of the licence compliance point is required. For example, it is recommended that the final plant licence compliance point for nutrients be set downstream of the proposed constructed wetland for combined flows (i.e. fully treated plus surplus wet weather flows). Conversely, from a cost point of view, it would be preferred that the licence compliance point for bacteriological indicators (if limits are set) be upstream of the constructed wetlands (post-secondary treatment). If limits for bacteriological indicators are set downstream of wetlands, then the risk of pathogen re-contamination due to wildlife in wetlands will need to be recognised in the new licence conditions. The design will then also require tertiary disinfection (UV or similar), which was not included in the cost estimates for this study.

   Note that the current licence for BVSTP only applies limits to bacteriological indicators at 'Point 1', being the discharge pipeline from the mainstream treatment process, and not at 'Point 2', which is the discharge from any wet weather overflow. In this respect, when negotiating with regulating agencies, it is recommended that Council seeks to achieve conformity around future licence requirements between its treatment plants at Brunswick Valley and Byron Bay. These two STPs will have similar process formats if the recommendations of this Study are implemented.

8. Future effluent reuse requirements were not examined as part of this Study. It was assumed that the existing infrastructure at BVSTP is adequate to serve effluent reuse requirements in the area for the foreseeable future. It is recommended that this assumption be tested by further investigation, prior to detailed design and subject to BSC requirements.

9. This Study relied on information from previous flood assessments (ca. 2008) for the BVSTP site. Once the scope of work for the major earthworks associated with the proposed BVSTP capacity augmentation has been detailed, it is recommended a flood assessment of the site be repeated before adoption of the final design. This will be

particularly important where the proposed wet weather storage facility and constructed wetlands have different dimensions to those previously proposed in ca. 2008.

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Appendices

Appendix A – Population projections breakdown

Table 26 Population Projections for Low Growth Scenario derived from previous studies (Section 2.1.1)

Year	Residential OS, low growth	OS Business & Industrial zones	OS*	M	BH	M + BH	Tourists (Overnight + Day Trippers)	M + BH + Tourists	TOTAL
2,006	5,581	52	5,633	3,125	1,613	4,738	4,037	8,775	14,408
2,011	5,667	113	5,780	3,172	1,639	4,811	4,120	8,931	14,712
2,016	5,717	184	5,901	3,434	2,180	5,614	4,538	10,152	16,053
2,021	5,851	265	6,116	3,701	2,413	6,114	4,833	10,947	17,063
2,026	5,951	355	6,306	3,971	2,647	6,618	5,175	11,793	18,099
2,040	6,241	657	6,898	4,838	3,431	8,268	5,252	13,521	20,419

Table 27 Population Projections for High Growth Scenario derived from previous studies (Section 2.1.1)

Year	Residential OS, low growth	OS Business & Industrial zones	OS*	M	BH	M + BH	Tourists (Overnight + Day Trippers)	M + BH + Tourists	TOTAL
2,006	5,280	52	5,332	2,722	3,425	6147	3,652	9,799	15,131
2,011	5,764	113	5,877	3,129	3,625	6755	4,006	10,761	16,639
2,016	6,323	184	6,507	3,493	3,826	7318	4,329	11,647	18,154
2,021	6,955	265	7,220	3,811	4,026	7837	4,619	12,456	19,676
2,026	7,661	355	8,016	4,085	4,226	8311	4,877	13,188	21,204
2,040	10,032	657	10,690	4,615	4,787	9402	5,428	14,830	25,519

OS: Ocean Shores; M: Mullumbimby; BH: Brunswick Heads

Table 28 Adopted population projections for this Study

Year	BH (ET)	M (ET)	OS (ET)	Total (ET)	BH (EP)	M (EP)	OS (EP)	Total (EP)	Tourists (Overnight + Day Trippers), allowance, included in Total EP (persons[71])
2015	1,028	1,541	2,848	5,417	2,527	3,788	7,001	13,317	4,400
2020	1,213	1,771	3,055	6,039	2,982	4,354	7,510	14,846	4,700
2025	1,433	1,918	3,189	6,540	3,523	4,715	7,840	16,078	5,000
2030	1,561	2,109	3,276	6,946	3,837	5,185	8,054	17,076	5,300
2035	1,696	2,269	3,395	7,360	4,169	5,578	8,346	18,093	5,350
2040	1,850	2,466	3,553	7,869	4,548	6,062	8,734	19,345	5,400
2045	2,021	2,645	3,698	8,364	4,968	6,502	9,091	20,562	5,450

Assumed EP/ET ratio = 2.46 (except allowance for Tourists, see footnote and refer to Section 2.2.1)

[71] Flow per person for Tourists (Overnight & Day Trippers) varies (refer to Section 2.2.1).

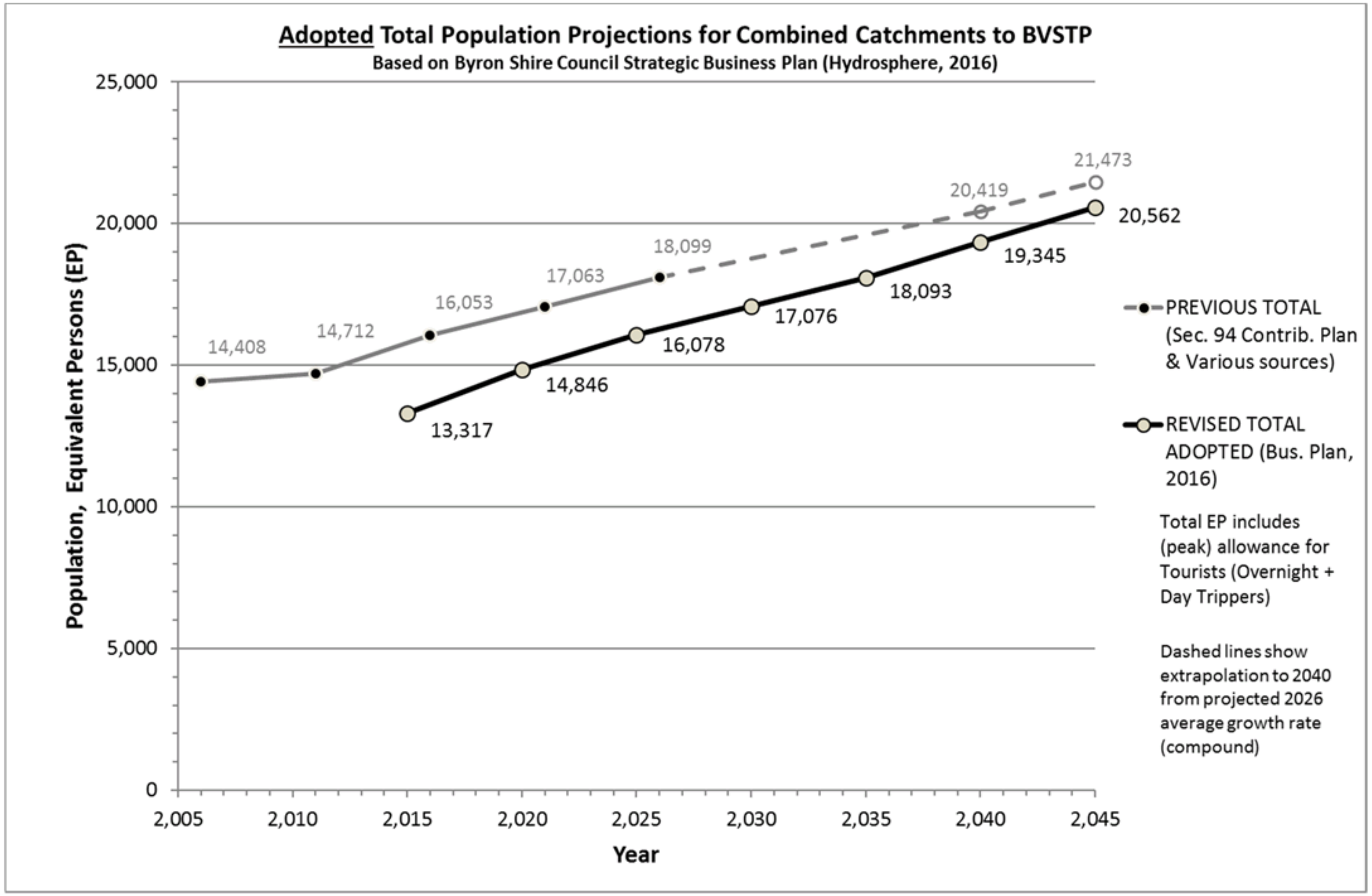

Figure 18 Adopted Total Population Projections, showing comparison to previous projections

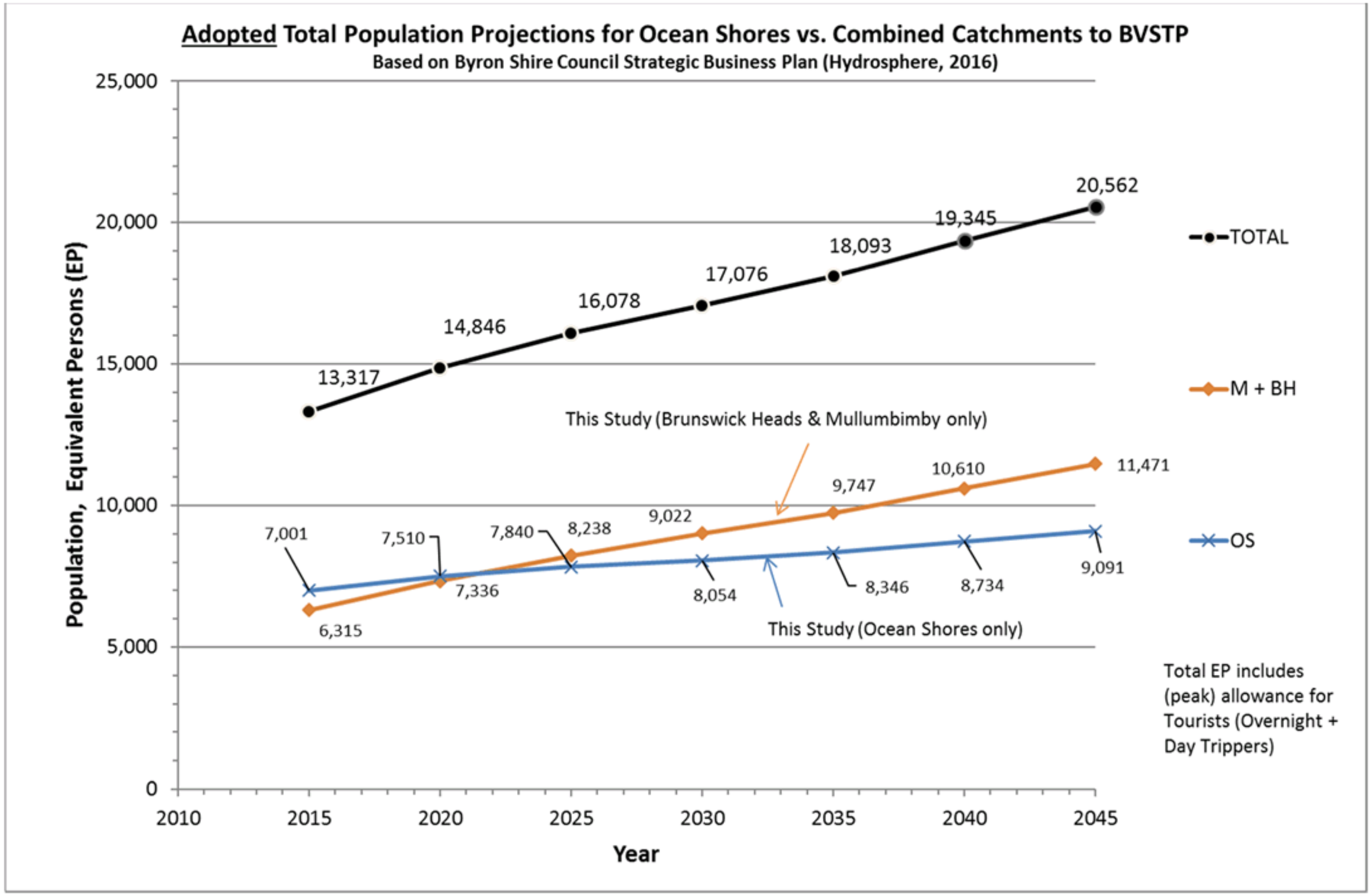

Figure 19 Adopted Population Projections, showing breakdown by catchment

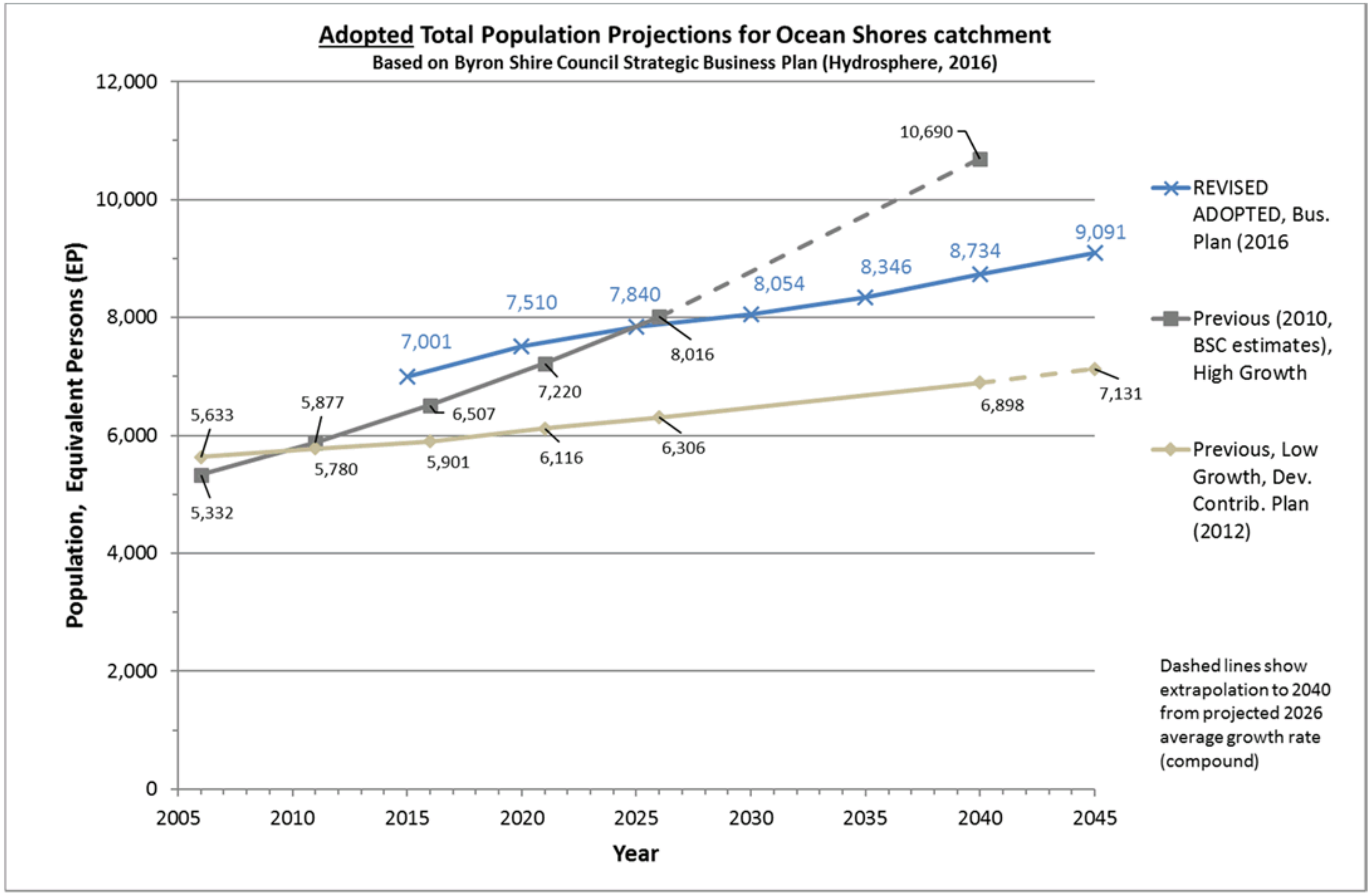

Figure 20 Adopted Population Projections for Ocean Shores catchment, showing comparison to previous projections

Appendix B Flow projection breakdown

Table 29 ADWF (ML/d) flow projections from adopted population projections and design unit flow assumptions (see Section 2.2.1)

Year	BH (ML/d)	M (ML/d)	OS (ML/d)	**TOTAL ADWF (ML/d)**	BH + M (ML/d)	Overnight Tourists (ML/d)	Day Tripper Tourists (ML/d)	BH + M' ADWF *minus* Tourists (Overnight + Day Trippers) (ML/d)	TOTAL ADWF *minus* Tourists (Overnight + Day Trippers) (ML/d)
2015	0.61	0.91	1.68	**3.20**	1.52	0.43	0.068	1.020	2.70
2020	0.72	1.04	1.80	**3.56**	1.76	0.46	0.072	1.231	3.03
2025	0.85	1.13	1.88	**3.86**	1.98	0.49	0.077	1.413	3.29
2030	0.92	1.24	1.93	**4.10**	2.17	0.52	0.082	1.568	3.50
2035	1.00	1.34	2.00	**4.34**	2.34	0.52	0.082	1.736	3.74
2040	1.09	1.45	2.10	**4.64**	2.55	0.53	0.083	1.938	4.03
2045	1.19	1.56	2.18	**4.93**	2.75	0.53	0.084	2.139	4.32

OS: Ocean Shores; M: Mullumbimby; BH: Brunswick Heads

Table 30 ADWF (ML/d) flow projections from adopted population projections and design unit flow assumptions, *including additional I/I allowance* (see Section 2.2.1)

Year	BH (ML/d), incl. additional I/I allowance	M (ML/d), incl. additional I/I allowance	OS (ML/d) (no additional I/I allowance)	**TOTAL ADWF (ML/d),** incl. additional I/I allowance	BH + M (ML/d), incl. additional I/I allowance
2015	0.82	1.10	1.68	**3.60**	1.92
2020	0.97	1.26	1.80	**4.04**	2.23
2025	1.15	1.37	1.88	**4.40**	2.52
2030	1.25	1.50	1.93	**4.69**	2.75
2035	1.36	1.62	2.00	**4.98**	2.98
2040	1.48	1.76	2.10	**5.34**	3.24
2045	1.62	1.89	2.18	**5.69**	3.51

Appendix C Existing BVSTP Environmental Licence

Section 58(5) Protection of the Environment Operations Act 1997

Licence Variation

Licence - 13266

BYRON SHIRE COUNCIL

ABN 14 472 131 473

PO BOX 219

MULLUMBIMBY NSW 2482

Attention: Phil Warner

Notice Number	1511708
File Number	LIC10/577
Date	11-Feb-2013

NOTICE OF VARIATION OF LICENCE NO. 13266

BACKGROUND

A. BYRON SHIRE COUNCIL ("the licensee") is the holder of Environment Protection Licence No. 13266 ("the licence") issued under the *Protection of the Environment Operations Act 1997* ("the Act"). The licence authorises the carrying out of activities at VALLANCES ROAD, MULLUMBIMBY, NSW, 2481 ("the premises").

B. This variation is issued in order to amend the licence to correct anomalies resulting from the transfer of the licence from ISEMS to the PALMS licence management system.

C. Other changes shown on the Licence Variation Summary are a result of correcting errors associated with an update of the EPA's licensing system and are not new additions to the licence. As a result of this update, some conditions are now located in different sections to the previous licence version. Some obsolete conditions have also been removed.

VARIATION OF LICENCE NO. 13266

1. By this notice the EPA varies licence No. 13266. The attached licence document contains all variations that are made to the licence by this notice.

2. The following variations have been made to the licence:

   - Most of the variations to this licence are detailed in the attached Licence Variation Summary.

Section 58(5) Protection of the Environment Operations Act 1997

Licence Variation

....

Graeme Budd

Head Environmental Management Unit

North - North Coast

(by Delegation)

INFORMATION ABOUT THIS NOTICE

- This notice is issued under section 58(5) of the Act.
- Details provided in this notice, along with an updated version of the licence, will be available on the EPA's Public Register (http://www.environment.nsw.gov.au/prpoeo/index.htm) in accordance with section 308 of the Act.

Appeals against this decision

- You can appeal to the Land and Environment Court against this decision. The deadline for lodging the appeal is 21 days after you were given notice of this decision.

When this notice begins to operate

- The variations to the licence specified in this notice begin to operate immediately from the date of this notice, unless another date is specified in this notice.
- If an appeal is made against this decision to vary the licence and the Land and Environment Court directs that the decision is stayed the decision does not operate until the stay ceases to have effect or the Land and Environment Court confirms the decision or the appeal is withdrawn (whichever occurs first).

.icence Variation Summary

icence - 13266

iis Summary serves merely to highlight changes made to areas of this licence. Changes made to tables thin the licence are indicated using underline (for additions) and Strikethrough (for deletions). hile changes to conditions are indicated under subheadings such as 'New condition', 'Old condition', eplaced by', and ' Removed condition.

ie attached licence document contains all the changes made to this licence by the attached variation ıtice.

ŀ Operating Conditions

:ffluent application to land

New condition:

The irrigation of treated effluent must be conducted in accordance with: Environmental Guidelines - Use of Effluent by Irrigation (DEC, 2004).

; Monitoring and Recording Conditions

'esting methods - load limits

New condition:

Division 3 of the *Protection of the Environment Operations (General) Regulation 2009* requires that monitoring of actual loads of assessable pollutants listed in L2.2 must be carried out in accordance with the relevant load calculation protocol set out for the fee-based activity classification listed in the Administrative Conditions of this licence.

ꞩequirement to record overflow or bypass incidents

Removed condition:

The licensee must record the following details in respect of each bypass of any of the appropriate treatment processes required by condition O3 which may be reasonably expected to adversely affect the quality of the final discharge:

a) the EPA point identification number through which the bypass discharged;
b) the date, estimated start time and estimated duration of the bypass;
c) the estimated volume of the bypass;
d) the level of treatment of the sewage at the STP prior to discharge;
e) the probable cause of the bypass;
f) any actions taken to stop the bypass happening; and
g) any actions taken to prevent the bypass happening again.

Removed condition:

In addition to the details listed in the previous condition, the licensee must also record classification as a wet or dry weather bypass in respect of each bypass referred to in the previous condition. A dry weather bypass is a bypass that occurs when the flow rate of sewage at the inflow volume monitoring point of the STP does not exceed 6 x ADWF and a wet weather bypass occurs when this flow is

.icence Variation Summary

equalled or exceeded at any time during the bypass event.

New condition:

The licensee must record the following details in respect of each bypass of any of the treatment processes at the premises, which may be reasonably expected to adversely affect the quality of the final discharge:

a) the EPA point identification number through which the bypass discharged;
b) the date, start time and duration of the bypass;
c) the estimated volume of the bypass;
d) the level of treatment of the sewage at the premises prior to discharge;
e) classification as a dry or wet weather bypass;
f) the probable cause of the bypass;
g) the name(s) of the treatment process or processes bypassed;
h) any actions taken to stop the bypass happening;
i) any actions taken to prevent the bypass happening again.

New condition:

The licensee must record the following details in relation to each observed or reported overflow from the reticulation system and from the sewage treatment plant:

a) the location of the overflow;
b) the date, estimated start time and estimated duration of the overflow;
c) the estimated volume of the overflow;
d) a description of the receiving environment of the overflow;
e) classification as a dry or wet weather overflow;
f) the probable cause of the overflow;
g) any actions taken to stop the overflow happening;
h) any actions taken to clean up the overflow; and
i) any actions taken to prevent the overflow happening again.

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Licence Details	
Number:	13266
Anniversary Date:	27-September

Licensee
BYRON SHIRE COUNCIL
PO BOX 219
MULLUMBIMBY NSW 2482

Premises
BRUNSWICK VALLEY SEWAGE TREATMENT PLANT
VALLANCES ROAD
MULLUMBIMBY NSW 2482

Scheduled Activity
Sewage Treatment

Fee Based Activity	Scale
Sewage treatment processing by small plants	> 1000-5000 ML discharged

Region
North - North Coast
NSW Govt Offices, 49 Victoria Street GRAFTON NSW 2460
Phone: (02) 6640 2500
Fax: (02) 6642 7743
PO Box 498 GRAFTON
NSW 2460

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Information about this licence

Dictionary

A definition of terms used in the licence can be found in the dictionary at the end of this licence.

Responsibilities of licensee

Separate to the requirements of this licence, general obligations of licensees are set out in the Protection of the Environment Operations Act 1997 ("the Act") and the Regulations made under the Act. These include obligations to:

- ensure persons associated with you comply with this licence, as set out in section 64 of the Act;
- control the pollution of waters and the pollution of air (see for example sections 120 - 132 of the Act); and
- report incidents causing or threatening material environmental harm to the environment, as set out in Part 5.7 of the Act.

Variation of licence conditions

The licence holder can apply to vary the conditions of this licence. An application form for this purpose is available from the EPA.

The EPA may also vary the conditions of the licence at any time by written notice without an application being made.

Where a licence has been granted in relation to development which was assessed under the Environmental Planning and Assessment Act 1979 in accordance with the procedures applying to integrated development, the EPA may not impose conditions which are inconsistent with the development consent conditions until the licence is first reviewed under Part 3.6 of the Act.

Duration of licence

This licence will remain in force until the licence is surrendered by the licence holder or until it is suspended or revoked by the EPA or the Minister. A licence may only be surrendered with the written approval of the EPA.

Licence review

The Act requires that the EPA review your licence at least every 5 years after the issue of the licence, as set out in Part 3.6 and Schedule 5 of the Act. You will receive advance notice of the licence review.

Fees and annual return to be sent to the EPA

For each licence fee period you must pay:

- an administrative fee; and
- a load-based fee (if applicable).

The EPA publication "A Guide to Licensing" contains information about how to calculate your licence fees. The licence requires that an Annual Return, comprising a Statement of Compliance and a summary of any monitoring required by the licence (including the recording of complaints), be submitted to the EPA. The Annual Return must be submitted within 60 days after the end of each reporting period. See condition R1 regarding the Annual Return reporting requirements.

Usually the licence fee period is the same as the reporting period.

Transfer of licence

The licence holder can apply to transfer the licence to another person. An application form for this purpose is available from the EPA.

Public register and access to monitoring data

Part 9.5 of the Act requires the EPA to keep a public register of details and decisions of the EPA in relation to, for example:

- licence applications;
- licence conditions and variations;
- statements of compliance;
- load based licensing information; and
- load reduction agreements.

Under s320 of the Act application can be made to the EPA for access to monitoring data which has been submitted to the EPA by licensees.

This licence is issued to:

BYRON SHIRE COUNCIL
PO BOX 219
MULLUMBIMBY NSW 2482

subject to the conditions which follow.

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I Administrative Conditions

\1 What the licence authorises and regulates

\1.1 This licence authorises the carrying out of the scheduled activities listed below at the premises specified in A2. The activities are listed according to their scheduled activity classification, fee-based activity classification and the scale of the operation.

Unless otherwise further restricted by a condition of this licence, the scale at which the activity is carried out must not exceed the maximum scale specified in this condition.

Scheduled Activity	Fee Based Activity	Scale
Sewage Treatment	Sewage treatment processing by small plants	> 1000 - 5000 ML discharged

\2 Premises or plant to which this licence applies

\2.1 The licence applies to the following premises:

Premises Details
BRUNSWICK VALLEY SEWAGE TREATMENT PLANT
VALLANCES ROAD
MULLUMBIMBY
NSW 2482
LOT 1 DP 129374

\3 Information supplied to the EPA

\3.1 Works and activities must be carried out in accordance with the proposal contained in the licence application, except as expressly provided by a condition of this licence.

In this condition the reference to "the licence application" includes a reference to:
a) the applications for any licences (including former pollution control approvals) which this licence replaces under the Protection of the Environment Operations (Savings and Transitional) Regulation 1998; and
b) the licence information form provided by the licensee to the EPA to assist the EPA in connection with the issuing of this licence.

? Discharges to Air and Water and Applications to Land

?1 Location of monitoring/discharge points and areas

?1.1 The following points referred to in the table are identified in this licence for the purposes of the monitoring and/or the setting of limits for discharges of pollutants to water from the point.

P1.2 The following utilisation areas referred to in the table below are identified in this licence for the purposes of the monitoring and/or the setting of limits for any application of solids or liquids to the utilisation area.

Water and land

EPA Identi-fication no.	Type of Monitoring Point	Type of Discharge Point	Location Description
1	Discharge to Waters	Discharge to Waters	Discharge pipe on eastern arm of western billabong of Brunswick River at 550568E and 6842193N
2	Discharge to Waters - Wet Weather Overflow	Discharge to Waters - Wet Weather Overflow	Treated Effluent Storage Overflow pipe at 548989E and 6842386N at old Mullumbimby STP.
3		Discharge to Land - Effluent Reuse	Discharge to Irrigation Storage Pond at Lot 2 DP 1010894. 544853E and 6842756N.
4		Discharge to Land - Effluent Reuse	Discharge to Irrigation Storage Pond at Lot 2 DP 839178. 544462E and 6843175N.
5	Total Volume Monitoring		Two magflow meters on Inlet Works @ 551002E and 6841820N
6	Volume Monitoring (Effluent Reuse)		Magflow meter on Mainarm reuse pump well at 548984E and 6842320N
7	Total Volume Monitoring		Discharge volume monitoring via Magflow meter @ 550856E and 6842333N
8	Effluent Quality Monitoring (Reuse)		Tap on Effluent Reuse Line at corner of Main Arm Rd and Johnstones Ln Main Arm. 545057E and 6843676N

3 Limit Conditions

.1 Pollution of waters

.1.1 Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.

.2 Load limits

.2.1 The actual load of an assessable pollutant discharged from the premises during the reporting period must not exceed the load limit specified for the assessable pollutant in the table below.

.2.2 The actual load of an assessable pollutant must be calculated in accordance with the relevant load calculation protocol.

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Assessable Pollutant	Load limit (kg)
BOD (Estuarine Water)	15818.00
Nitrogen (total) (Estuarine Water)	15818.00
Oil and Grease (Estuarine Water)	3163.00
Phosphorus (total) (Estuarine Water)	475.00
Total suspended solids (Estuarine Water)	23726.00

Note: An assessable pollutant is a pollutant which affects the licence fee payable for the licence.

.3 Concentration limits

.3.1 For each monitoring/discharge point or utilisation area specified in the table\s below (by a point number), the concentration of a pollutant discharged at that point, or applied to that area, must not exceed the concentration limits specified for that pollutant in the table.

.3.2 Where a pH quality limit is specified in the table, the specified percentage of samples must be within the specified ranges.

.3.3 To avoid any doubt, this condition does not authorise the pollution of waters by any pollutant other than those specified in the table\s.

.3.4 Water and/or Land Concentration Limits

'OINT 1

Pollutant	Units of Measure	N/A	90 percentile concentration limit	N/A	100 percentile concentration limit
Ammonia	milligrams per litre		2		4
BOD	milligrams per litre		10		20
Faecal Coliforms	colony forming units per 100 millilitres		200		600
Nitrogen (total)	milligrams per litre		10		15
Oil and Grease	milligrams per litre		5		10
pH	pH		6.5 - 8.5		6.5 - 8.5

Phosphorus (total)	milligrams per litre	0.3	1
Total suspended solids	milligrams per litre	15	30

.4 Volume and mass limits

.4.1 For each discharge point or utilisation area specified below (by a point number), the volume/mass of:
a) liquids discharged to water; or;
b) solids or liquids applied to the area;
must not exceed the volume/mass limit specified for that discharge point or area.

Point	Unit of Measure	Volume/Mass Limit
1	kilolitres per day	22040

.5 Waste

.5.1 The licensee must not cause, permit or allow any waste generated outside the premises to be received at the premises for storage, treatment, processing, reprocessing or disposal or any waste generated at the premises to be disposed of at the premises, except as expressly permitted by the licence.

.5.2 This condition only applies to the storage, treatment, processing, reprocessing or disposal of waste at the premises if those activities require an environment protection licence.

.5.3 The licensee may receive, store, treat, process or reprocess and/or transfer at the premises sewage products generated or stored outside the premises by the licensee's other sewage treatment systems. Sewage products must be received, treated, processed or reprocessed in accordance with this licence.

.6 Potentially offensive odour

.6.1 No condition in this licence identifies a potentially offensive odour for the purposes of section 129 of the Protection of the Environment Operations Act 1997.

Note: Section 129 of the Protection of the Environment Operations Act 1997 provides that the licensee must not cause or permit the emission of any offensive odour from the premises but provides a defence if the emission is identified in the relevant environment protection licence as a potentially offensive odour and the odour was emitted in accordance with the conditions of a licence directed at minimising odour.

4 Operating Conditions

⊃1 Activities must be carried out in a competent manner

⊃1.1 Licensed activities must be carried out in a competent manner.
This includes:
a) the processing, handling, movement and storage of materials and substances used to carry out the activity; and
b) the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activity.

Note: The requirements of O1.1 apply to the whole of the premises, including the reticulation system.

⊃1.2 Biosolids at the premises must be stored, treated, processed, classified, transported and disposed in accordance with the Biosolids Guidelines, or as otherwise approved in writing by the EPA.

Note: This condition does not apply to the reuse or disposal of biosolids by the licensee at locations other than the premises.

⊃2 Maintenance of plant and equipment

⊃2.1 All plant and equipment installed at the premises or used in connection with the licensed activity:
a) must be maintained in a proper and efficient condition; and
b) must be operated in a proper and efficient manner.

Note: The requirements of O2.1 apply to the whole of the premises, including the reticulation system.

⊃2.2 For the purposes of this condition, “plant and equipment” includes drainage systems, infrastructure, pollution control equipment and fuel burning equipment, but does not refer to equipment which has been decommissioned but is still on site.

⊃3 Effluent application to land

⊃3.1 The irrigation of treated effluent must be conducted in accordance with: Environmental Guidelines - Use of Effluent by Irrigation (DEC, 2004).

⊃3.2 The quantity of effluent applied to the utilisation area(s) must not exceed the capacity of the utilisation area(s) to effectively utilise the effluent.

For the purpose of this condition, “effectively utilise” includes the ability of the soil to absorb the nutrient, salt and hydraulic loads and the applied organic material without causing harm to the environment.

⊃3.3 Effluent application to the utilisation area(s) must not occur in a manner that causes surface run-off from the utilisation area(s).

⊃3.4 Spray from effluent application to the utilisation area(s) must not drift beyond the boundary of the utilisation area(s) to which it has been applied.

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; Monitoring and Recording Conditions

/I1 Monitoring records

/I1.1 The results of any monitoring required to be conducted by this licence or a load calculation protocol must be recorded and retained as set out in this condition.

/I1.2 All records required to be kept by this licence must be:
a) in a legible form, or in a form that can readily be reduced to a legible form;
b) kept for at least 4 years after the monitoring or event to which they relate took place; and
c) produced in a legible form to any authorised officer of the EPA who asks to see them.

/I1.3 The following records must be kept in respect of any samples required to be collected for the purposes of this licence:
a) the date(s) on which the sample was taken;
b) the time(s) at which the sample was collected;
c) the point at which the sample was taken; and
d) the name of the person who collected the sample.

/I2 Requirement to monitor concentration of pollutants discharged

/I2.1 For each monitoring/discharge point or utilisation area specified below (by a point number), the licensee must monitor (by sampling and obtaining results by analysis) the concentration of each pollutant specified in Column 1. The licensee must use the sampling method, units of measure, and sample at the frequency, specified opposite in the other columns:

/I2.2 Water and/ or Land Monitoring Requirements

'OINT 1

Pollutant	Units of measure	Frequency	Sampling Method
Ammonia	milligrams per litre	Special Frequency 1	Representative sample
BOD	milligrams per litre	Special Frequency 1	Representative sample
Faecal Coliforms	colony forming units per 100 millilitres	Special Frequency 1	Representative sample
Nitrogen (total)	milligrams per litre	Special Frequency 1	Representative sample
Oil and Grease	milligrams per litre	Special Frequency 1	Representative sample
pH	pH	Special Frequency 1	Representative sample
Phosphorus (total)	milligrams per litre	Special Frequency 1	Representative sample
Total suspended solids	milligrams per litre	Special Frequency 1	Representative sample

'OINT 8

Pollutant	Units of measure	Frequency	Sampling Method
Ammonia	milligrams per litre	Special Frequency 1	Representative sample

BOD	milligrams per litre	Special Frequency 1	Representative sample
Faecal Coliforms	colony forming units per 100 millilitres	Special Frequency 1	Representative sample
Nitrogen (total)	milligrams per litre	Special Frequency 1	Representative sample
Oil and Grease	milligrams per litre	Special Frequency 1	Representative sample
pH	pH	Special Frequency 1	Representative sample
Phosphorus (total)	milligrams per litre	Special Frequency 1	Representative sample
Total suspended solids	milligrams per litre	Special Frequency 1	Representative sample

/I2.3 For the purposes of the table(s) above Special Frequency 1 means the collection of samples at least once every fortnight and at a minimum of ten day intervals.

/I3 Testing methods - concentration limits

/I3.1 Subject to any express provision to the contrary in this licence, monitoring for the concentration of a pollutant discharged to waters or applied to a utilisation area must be done in accordance with the Approved Methods Publication unless another method has been approved by the EPA in writing before any tests are conducted.

/I4 Testing methods - load limits

\ote: Division 3 of the *Protection of the Environment Operations (General) Regulation 2009* requires that monitoring of actual loads of assessable pollutants listed in L2.2 must be carried out in accordance with the relevant load calculation protocol set out for the fee-based activity classification listed in the Administrative Conditions of this licence.

/I5 Recording of pollution complaints

/I5.1 The licensee must keep a legible record of all complaints made to the licensee or any employee or agent of the licensee in relation to pollution arising from any activity to which this licence applies.

/I5.2 The record must include details of the following:
a) the date and time of the complaint;
b) the method by which the complaint was made;
c) any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect;
d) the nature of the complaint;
e) the action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant; and
f) if no action was taken by the licensee, the reasons why no action was taken.

/I5.3 The record of a complaint must be kept for at least 4 years after the complaint was made.

/I5.4 The record must be produced to any authorised officer of the EPA who asks to see them.

/I6 Telephone complaints line

/I6.1 The licensee must operate during its operating hours a telephone complaints line for the purpose of receiving any complaints from members of the public in relation to activities conducted at the premises or by the vehicle or mobile plant, unless otherwise specified in the licence.

/I6.2 The licensee must notify the public of the complaints line telephone number and the fact that it is a complaints line so that the impacted community knows how to make a complaint.

/I6.3 The preceding two conditions do not apply until 3 months after:
a) the date of the issue of this licence or
b) if this licence is a replacement licence within the meaning of the Protection of the Environment Operations (Savings and Transitional) Regulation 1998, the date on which a copy of the licence was served on the licensee under clause 10 of that regulation.

/I7 Requirement to monitor volume or mass

/I7.1 For each discharge point or utilisation area specified below, the licensee must monitor:
a) the volume of liquids discharged to water or applied to the area;
b) the mass of solids applied to the area;
c) the mass of pollutants emitted to the air;
at the frequency and using the method and units of measure, specified below.

POINT 5

Frequency	Unit of Measure	Sampling Method
Daily	kilolitres per day	Magnetic flow meter

POINT 6

Frequency	Unit of Measure	Sampling Method
Daily	kilolitres per day	Magnetic flow meter

POINT 7

Frequency	Unit of Measure	Sampling Method
Daily	kilolitres per day	Magnetic flow meter

/I7.2 In the event that the licensee cannot comply with a volume monitoring method as required by this licence solely due to the failure or malfunction of essential monitoring equipment, volume may be estimated using another agreed method approved in writing by the EPA. This provision only applies for the duration of the failure or malfunction. The licensee is to rectify the failure or malfunction as soon as practicable.

/I7.3 The licensee must:

a) submit in writing to the EPA a proposal for a method of volume estimation; or

b) use a method of volume estimation already approved in writing by the EPA,

to be used in the event that essential monitoring equipment referred to in the previous condition has failed or malfunctioned.

/l8 Requirement to record overflow or bypass incidents

/l8.1 The licensee must record the following details in respect of each bypass of any of the treatment processes at the premises, which may be reasonably expected to adversely affect the quality of the final discharge:

a) the EPA point identification number through which the bypass discharged;
b) the date, start time and duration of the bypass;
c) the estimated volume of the bypass;
d) the level of treatment of the sewage at the premises prior to discharge;
e) classification as a dry or wet weather bypass;
f) the probable cause of the bypass;
g) the name(s) of the treatment process or processes bypassed;
h) any actions taken to stop the bypass happening;
i) any actions taken to prevent the bypass happening again.

/l8.2 The licensee must record the following details in relation to each observed or reported overflow from the reticulation system and from the sewage treatment plant:

a) the location of the overflow;
b) the date, estimated start time and estimated duration of the overflow;
c) the estimated volume of the overflow;
d) a description of the receiving environment of the overflow;
e) classification as a dry or wet weather overflow;
f) the probable cause of the overflow;
g) any actions taken to stop the overflow happening;
h) any actions taken to clean up the overflow; and
i) any actions taken to prevent the overflow happening again.

/l9 Other monitoring and recording conditions

/l9.1 Biosolids at the premises must be recorded, monitored and classified in accordance with the Biosolids Guidelines, to the extent that those Guidelines are applicable, or as otherwise approved in writing by the EPA.

\ote: This condition does not apply to the reuse or disposal of biosolids by the licensee at locations other than the premises.

; Reporting Conditions

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₹1 Annual return documents

₹1.1 The licensee must complete and supply to the EPA an Annual Return in the approved form comprising:
a) a Statement of Compliance; and
b) a Monitoring and Complaints Summary.
At the end of each reporting period, the EPA will provide to the licensee a copy of the form that must be completed and returned to the EPA.

₹1.2 An Annual Return must be prepared in respect of each reporting period, except as provided below.

₹1.3 Where this licence is transferred from the licensee to a new licensee:
a) the transferring licensee must prepare an Annual Return for the period commencing on the first day of the reporting period and ending on the date the application for the transfer of the licence to the new licensee is granted; and
b) the new licensee must prepare an Annual Return for the period commencing on the date the application for the transfer of the licence is granted and ending on the last day of the reporting period.

₹1.4 Where this licence is surrendered by the licensee or revoked by the EPA or Minister, the licensee must prepare an Annual Return in respect of the period commencing on the first day of the reporting period and ending on:
a) in relation to the surrender of a licence - the date when notice in writing of approval of the surrender is given; or
b) in relation to the revocation of the licence - the date from which notice revoking the licence operates.

₹1.5 The Annual Return for the reporting period must be supplied to the EPA by registered post not later than 60 days after the end of each reporting period or in the case of a transferring licence not later than 60 days after the date the transfer was granted (the 'due date').

₹1.6 Where the licensee is unable to complete a part of the Annual Return by the due date because the licensee was unable to calculate the actual load of a pollutant due to circumstances beyond the licensee's control, the licensee must notify the EPA in writing as soon as practicable, and in any event not later than the due date. The notification must specify:
a) the assessable pollutants for which the actual load could not be calculated; and
b) the relevant circumstances that were beyond the control of the licensee.

₹1.7 The licensee must retain a copy of the Annual Return supplied to the EPA for a period of at least 4 years after the Annual Return was due to be supplied to the EPA.

₹1.8 Within the Annual Return, the Statement of Compliance must be certified and the Monitoring and Complaints Summary must be signed by:
a) the licence holder; or
b) by a person approved in writing by the EPA to sign on behalf of the licence holder.

₹1.9 A person who has been given written approval to certify a certificate of compliance under a licence issued under the Pollution Control Act 1970 is taken to be approved for the purpose of this condition until the date of first review of this licence.

Note: The term "reporting period" is defined in the dictionary at the end of this licence. Do not complete the Annual Return until after the end of the reporting period.

Note: An application to transfer a licence must be made in the approved form for this purpose.

₹2 Notification of environmental harm

₹2.1 Notifications must be made by telephoning the Environment Line service on 131 555.

₹2.2 The licensee must provide written details of the notification to the EPA within 7 days of the date on which the incident occurred.

Jote: The licensee or its employees must notify all relevant authorities of incidents causing or threatening material harm to the environment immediately after the person becomes aware of the incident in accordance with the requirements of Part 5.7 of the Act.

₹3 Written report

₹3.1 Where an authorised officer of the EPA suspects on reasonable grounds that:
a) where this licence applies to premises, an event has occurred at the premises; or
b) where this licence applies to vehicles or mobile plant, an event has occurred in connection with the carrying out of the activities authorised by this licence,
and the event has caused, is causing or is likely to cause material harm to the environment (whether the harm occurs on or off premises to which the licence applies), the authorised officer may request a written report of the event.

₹3.2 The licensee must make all reasonable inquiries in relation to the event and supply the report to the EPA within such time as may be specified in the request.

₹3.3 The request may require a report which includes any or all of the following information:
a) the cause, time and duration of the event;
b) the type, volume and concentration of every pollutant discharged as a result of the event;
c) the name, address and business hours telephone number of employees or agents of the licensee, or a specified class of them, who witnessed the event;
d) the name, address and business hours telephone number of every other person (of whom the licensee is aware) who witnessed the event, unless the licensee has been unable to obtain that information after making reasonable effort;
e) action taken by the licensee in relation to the event, including any follow-up contact with any complainants;
f) details of any measure taken or proposed to be taken to prevent or mitigate against a recurrence of such an event; and
g) any other relevant matters.

₹3.4 The EPA may make a written request for further details in relation to any of the above matters if it is not satisfied with the report provided by the licensee. The licensee must provide such further details to the EPA within the time specified in the request.

ʻ General Conditions

;1 Copy of licence kept at the premises or plant

;1.1 A copy of this licence must be kept at the premises to which the licence applies.

;1.2 The licence must be produced to any authorised officer of the EPA who asks to see it.

;1.3 The licence must be available for inspection by any employee or agent of the licensee working at the premises.

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)ictionary

;eneral Dictionary

3DGM [in relation to a concentration limit]	Means the three day geometric mean, which is calculated by multiplying the results of the analysis of three samples collected on consecutive days and then taking the cubed root of that amount. Where one or more of the samples is zero or below the detection limit for the analysis, then 1 or the detection limit respectively should be used in place of those samples
Act	Means the Protection of the Environment Operations Act 1997
activity	Means a scheduled or non-scheduled activity within the meaning of the Protection of the Environment Operations Act 1997
actual load	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
AM	Together with a number, means an ambient air monitoring method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales.*
AMG	Australian Map Grid
anniversary date	The anniversary date is the anniversary each year of the date of issue of the licence. In the case of a licence continued in force by the Protection of the Environment Operations Act 1997, the date of issue of the licence is the first anniversary of the date of issue or last renewal of the licence following the commencement of the Act.
annual return	Is defined in R1.1
Approved Methods Publication	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
assessable pollutants	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
BOD	Means biochemical oxygen demand
CEM	Together with a number, means a continuous emission monitoring method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales.*
COD	Means chemical oxygen demand
composite sample	Unless otherwise specifically approved in writing by the EPA, a sample consisting of 24 individual samples collected at hourly intervals and each having an equivalent volume.
cond.	Means conductivity
environment	Has the same meaning as in the Protection of the Environment Operations Act 1997
environment protection legislation	Has the same meaning as in the Protection of the Environment Administration Act 1991
EPA	Means Environment Protection Authority of New South Wales.
fee-based activity classification	Means the numbered short descriptions in Schedule 1 of the Protection of the Environment Operations (General) Regulation 2009.
general solid waste (non-putrescible)	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997

flow weighted composite sample	Means a sample whose composites are sized in proportion to the flow at each composites time of collection.
general solid waste (putrescible)	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environmen t Operations Act 1997
grab sample	Means a single sample taken at a point at a single time
hazardous waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
licensee	Means the licence holder described at the front of this licence
load calculation protocol	Has the same meaning as in the Protection of the Environment Operations (General) Regulation 2009
local authority	Has the same meaning as in the Protection of the Environment Operations Act 1997
material harm	Has the same meaning as in section 147 Protection of the Environment Operations Act 1997
MBAS	Means methylene blue active substances
Minister	Means the Minister administering the Protection of the Environment Operations Act 1997
mobile plant	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
motor vehicle	Has the same meaning as in the Protection of the Environment Operations Act 1997
O&G	Means oil and grease
percentile [in relation to a concentration limit of a sample]	Means that percentage [eg.50%] of the number of samples taken that must meet the concentration limit specified in the licence for that pollutant over a specified period of time. In this licence, the specified period of time is the Reporting Period unless otherwise stated in this licence.
plant	Includes all plant within the meaning of the Protection of the Environment Operations Act 1997 as well as motor vehicles.
pollution of waters [or water pollution]	Has the same meaning as in the Protection of the Environment Operations Act 1997
premises	Means the premises described in condition A2.1
public authority	Has the same meaning as in the Protection of the Environment Operations Act 1997
regional office	Means the relevant EPA office referred to in the Contacting the EPA document accompanying this licence
reporting period	For the purposes of this licence, the reporting period means the period of 12 months after the issue of the licence, and each subsequent period of 12 mo nths. In the case of a licence continued in force by the Protection of the Environment Operations Act 1997, the date of issue of the licence is the first anniversary of the date of issue or last renewal of the licence following the commencement of the Act.
restricted solid waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
scheduled activity	Means an activity listed in Schedule 1 of the Protection of the Environment Operations Act 1997
special waste	Has the same meaning as in Part 3 of Schedule 1 of the Protection of the Environment Operations Act 1997
TM	Together with a number, means a test method of that number prescribed by the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*.

:nvironment Protection Licence

icence - 13266

TSP	Means total suspended particles
TSS	Means total suspended solids
Type 1 substance	Means the elements antimony, arsenic, cadmium, lead or mercury or any compound containing one or more of those elements
Type 2 substance	Means the elements beryllium, chromium, cobalt, manganese, nickel, selenium, tin or vanadium or any compound containing one or more of those elements
utilisation area	Means any area shown as a utilisation area on a map submitted with the application for this licence
waste	Has the same meaning as in the Protection of the Environment Operations Act 1997
waste type	Means liquid, restricted solid waste, general solid waste (putrescible), general solid waste (non - putrescible), special waste or hazardous waste

r Graeme Budd

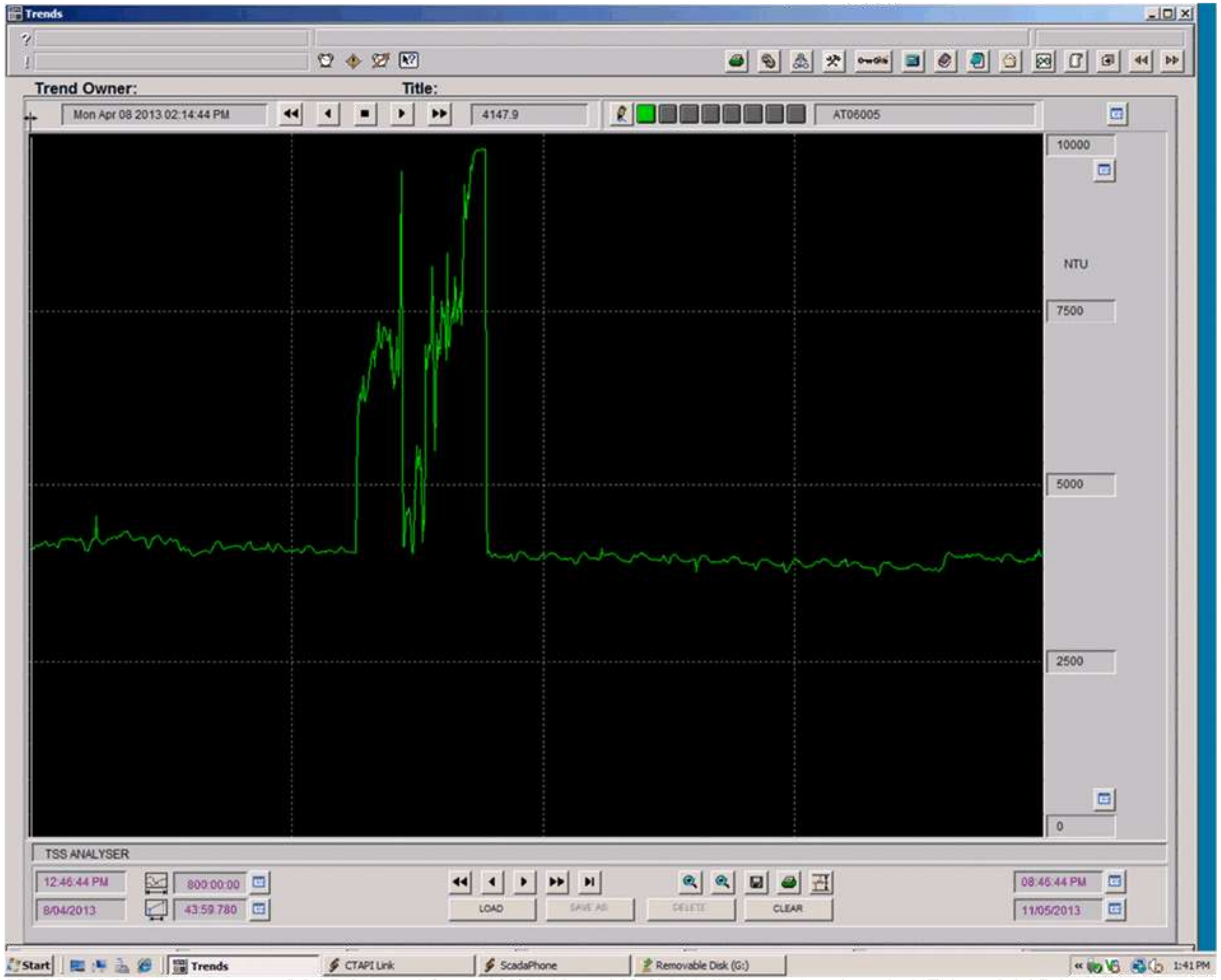
ıvironment Protection Authority

y Delegation)

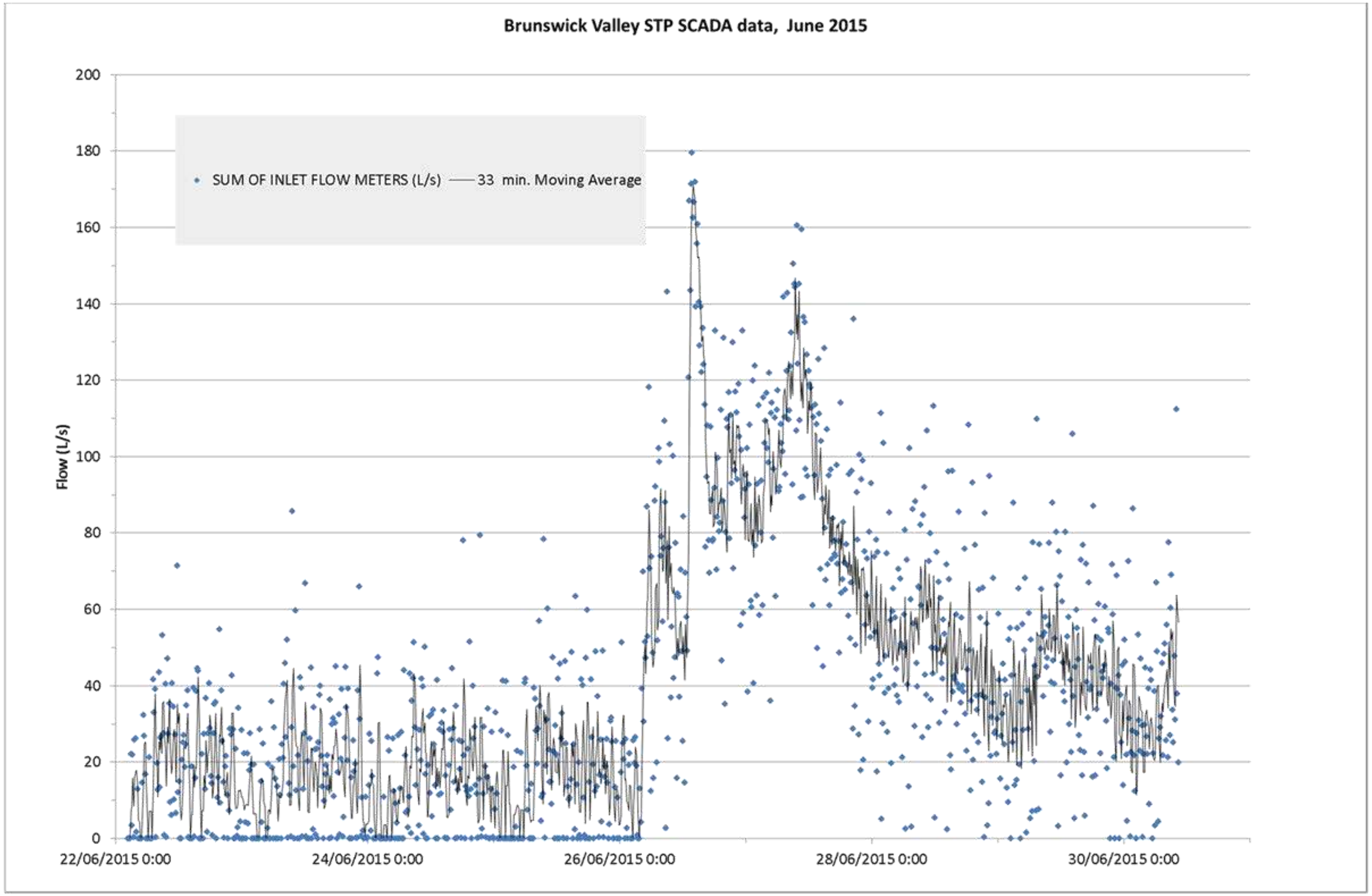
ıte of this edition: 27-September-2010

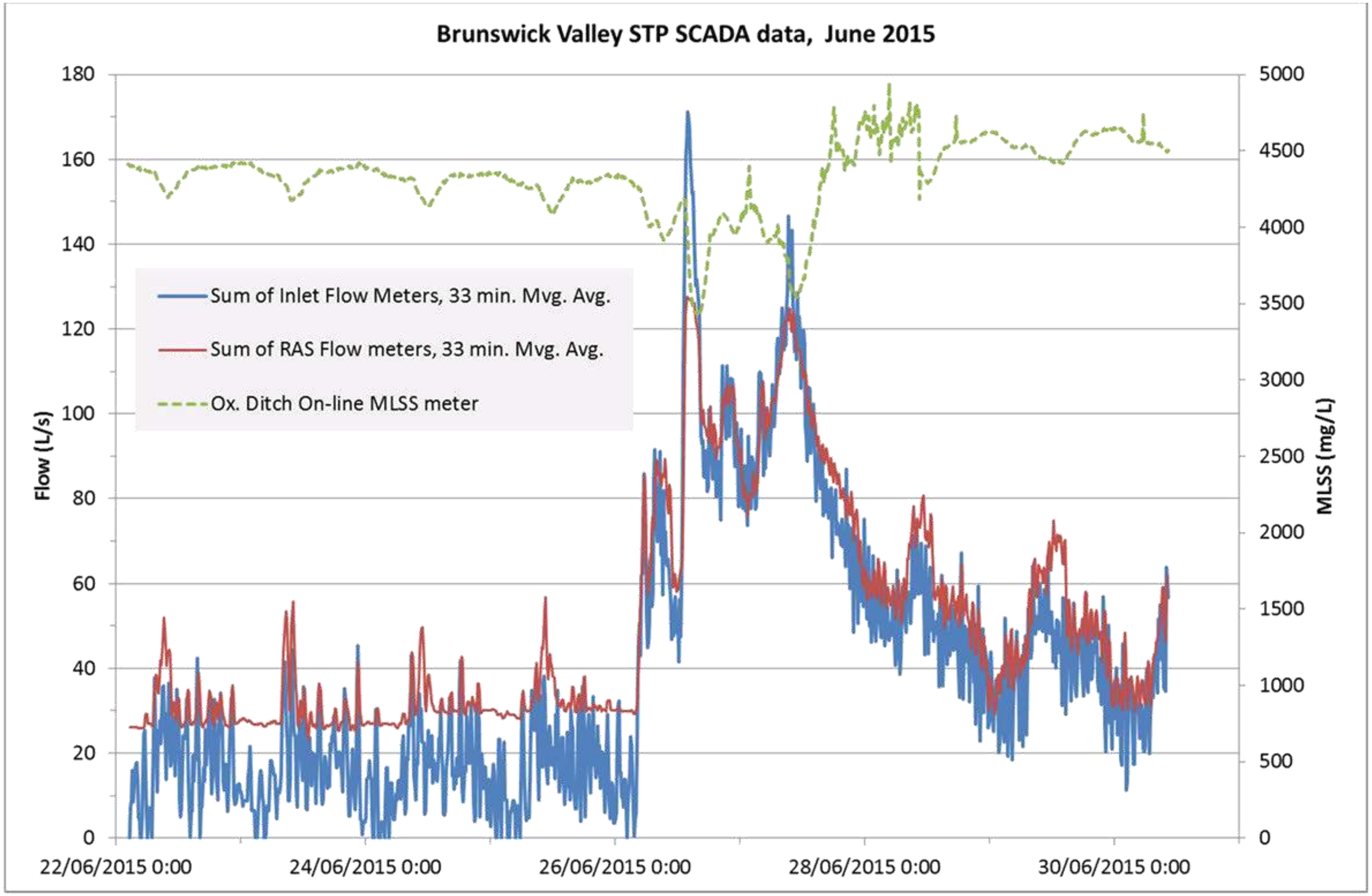
nd Notes

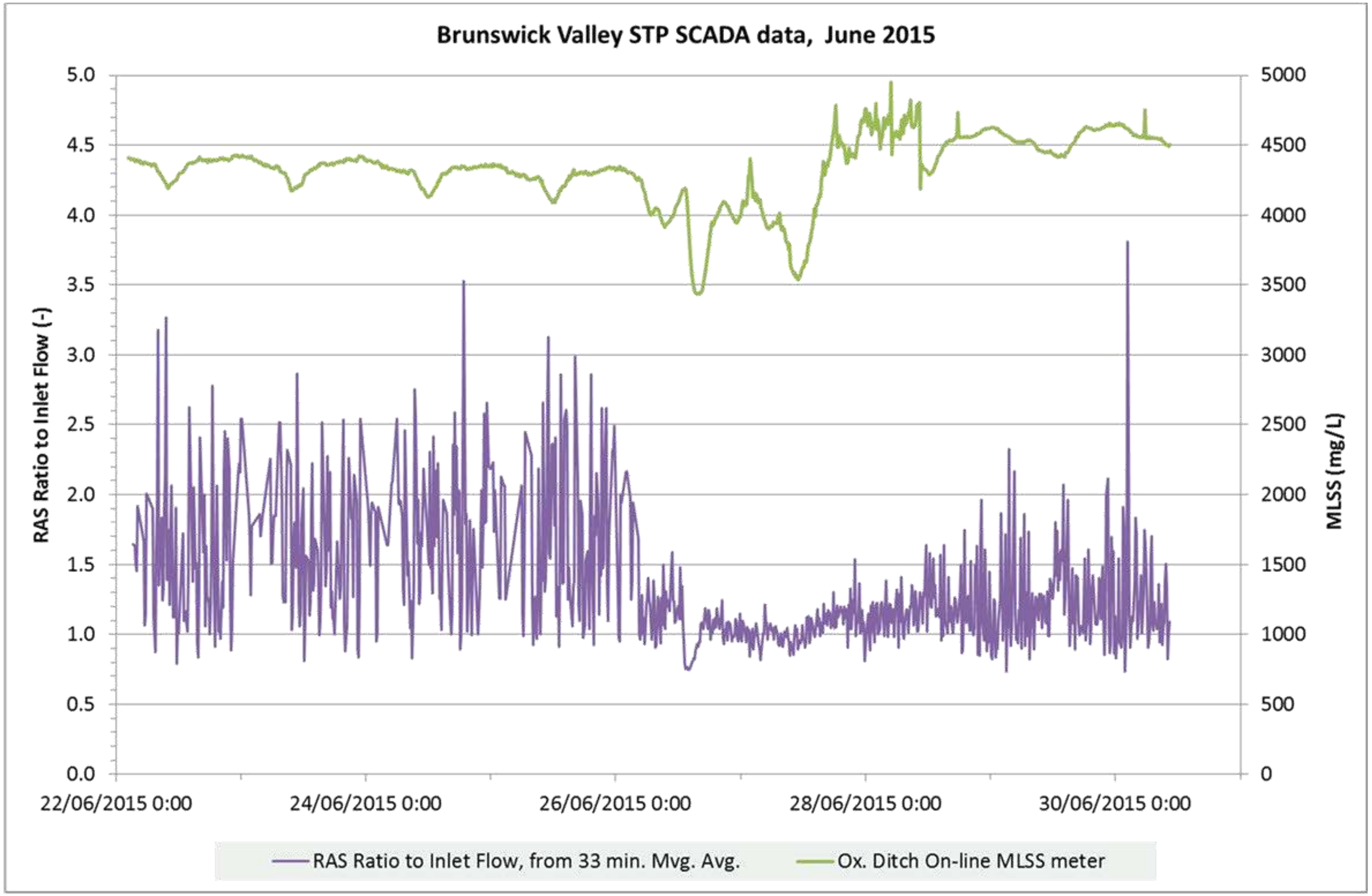
Appendix D Example of flow and online MLSS meter output from plant SCADA for minor wet weather event at BVSTP, ca. 10 April 2013.



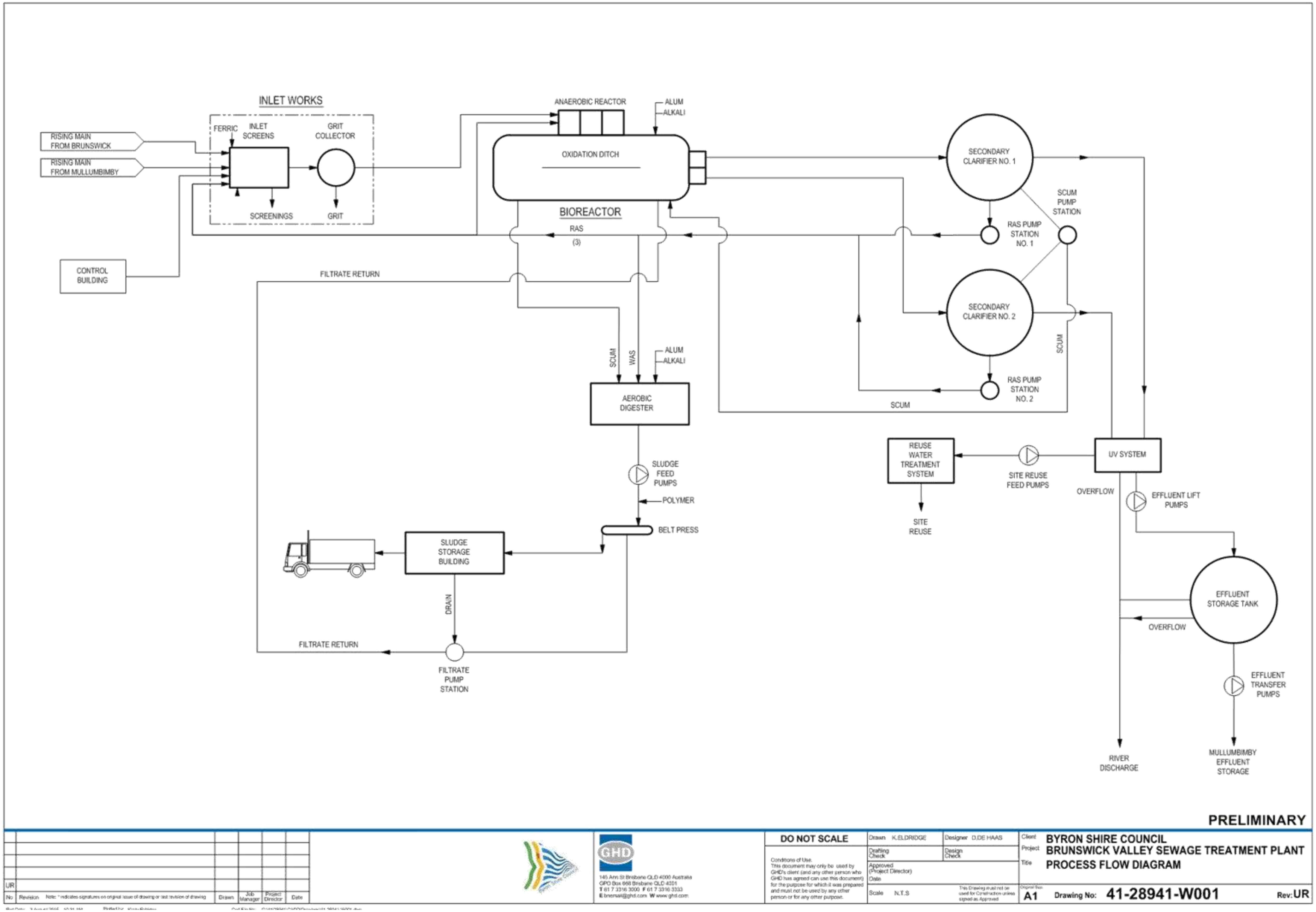
BVSTP MLSS (TSS) on-line meter SCADA trend from 8/4/2013 to 11/5/2013 (Note: units given in NTU on SCADA but requires checking)


Brunswick Valley STP SCADA data, June 2015
SUM OF INLET FLOW METERS (L/s)
33 min. Moving Average
Flow (L/s)
200
180
160
140
120
100
80
60
40
20
0
22/06/2015 0:00
24/06/2015 0:00
26/06/2015 0:00
28/06/2015 0:00
30/06/2015 0:00

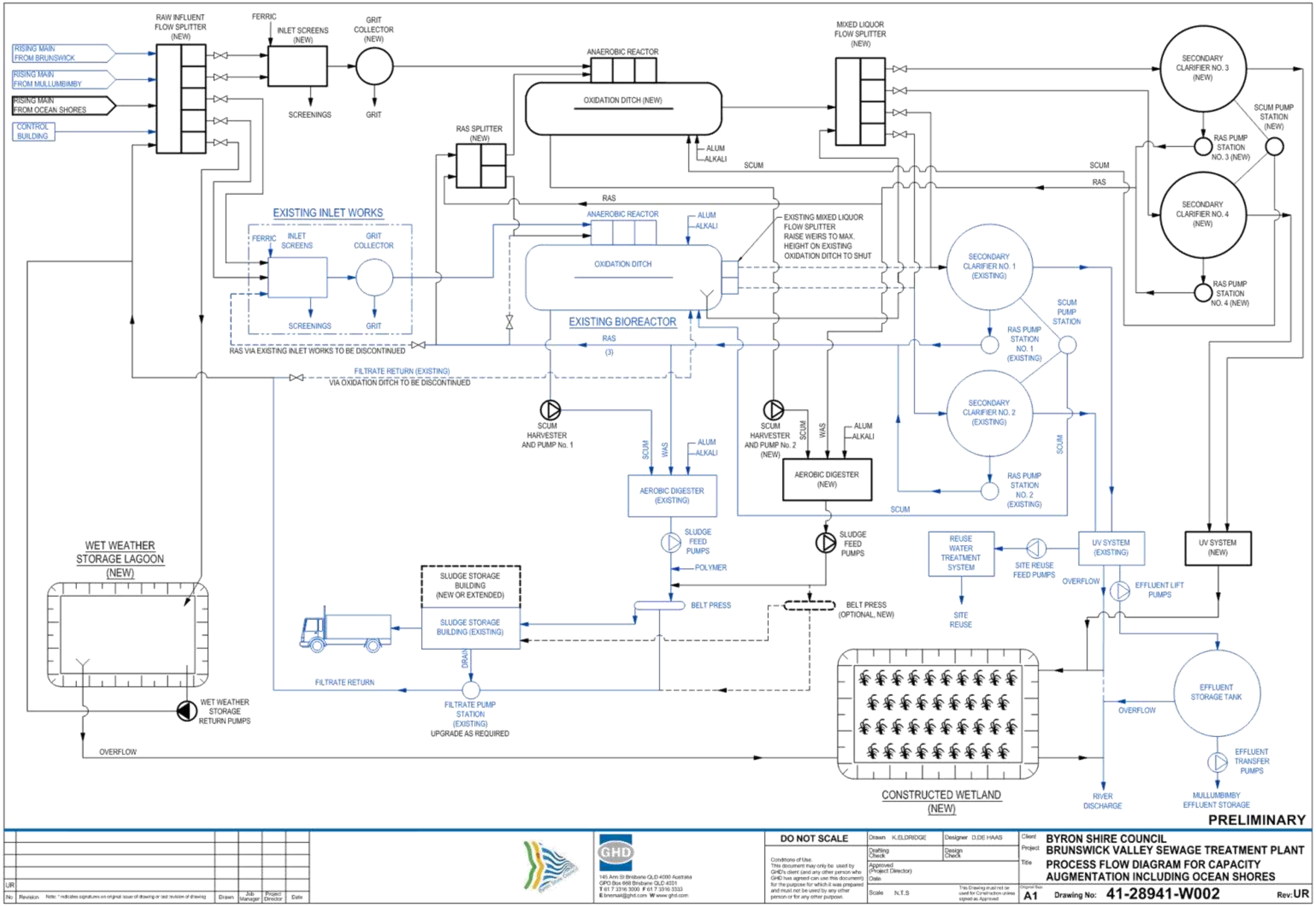

Brunswick Valley STP SCADA data, June 2015
Sum of Inlet Flow Meters, 33 min. Mvg. Avg.
Sum of RAS Flow meters, 33 min. Mvg. Avg.
Ox. Ditch On-line MLSS meter
Flow (L/s)
MLSS (mg/L)
0
20
40
60
80
100
120
140
160
180
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
22/06/2015 0:00
24/06/2015 0:00
26/06/2015 0:00
28/06/2015 0:00
30/06/2015 0:00


Brunswick Valley STP SCADA data, June 2015
RAS Ratio to Inlet Flow (-)
MLSS (mg/L)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
22/06/2015 0:00
24/06/2015 0:00
26/06/2015 0:00
28/06/2015 0:00
30/06/2015 0:00
RAS Ratio to Inlet Flow, from 33 min. Mvg. Avg.
Ox. Ditch On-line MLSS meter

Appendix E Process Flow Diagram – Existing Plant


INLET WORKS
RISING MAIN FROM BRUNSWICK
RISING MAIN FROM MULLUMBIMBY
FERRIC
INLET SCREENS
GRIT COLLECTOR
SCREENINGS
GRIT
CONTROL BUILDING
ANAEROBIC REACTOR
ALUM
ALKALI
OXIDATION DITCH
BIOREACTOR
RAS
(3)
FILTRATE RETURN
SECONDARY CLARIFIER NO. 1
SCUM PUMP STATION
RAS PUMP STATION NO. 1
SECONDARY CLARIFIER NO. 2
RAS PUMP STATION NO. 2
SCUM
WAS
AEROBIC DIGESTER
SLUDGE FEED PUMPS
POLYMER
BELT PRESS
SLUDGE STORAGE BUILDING
DRAIN
FILTRATE PUMP STATION
REUSE WATER TREATMENT SYSTEM
SITE REUSE
SITE REUSE FEED PUMPS
UV SYSTEM
OVERFLOW
EFFLUENT LIFT PUMPS
EFFLUENT STORAGE TANK
EFFLUENT TRANSFER PUMPS
RIVER DISCHARGE
MULLUMBIMBY EFFLUENT STORAGE
PRELIMINARY
UR
No Revision Drawn Job Manager Project Director Date
GHD
DO NOT SCALE
Drawn K.ELDRIDGE
Designer D.DE HAAS
Drafting Check
Design Check
Approved (Project Director)
Date
Scale N.T.S
Client BYRON SHIRE COUNCIL
Project BRUNSWICK VALLEY SEWAGE TREATMENT PLANT
Title PROCESS FLOW DIAGRAM
A1
Drawing No: 41-28941-W001
Rev: UR

Appendix F Process Flow Diagram – Proposed Plant Augmentation


RAW INFLUENT FLOW SPLITTER (NEW)
FERRIC
INLET SCREENS (NEW)
GRIT COLLECTOR (NEW)
RISING MAIN FROM BRUNSWICK
RISING MAIN FROM MULLUMBIMBY
RISING MAIN FROM OCEAN SHORES
CONTROL BUILDING
SCREENINGS
GRIT
ANAEROBIC REACTOR
OXIDATION DITCH (NEW)
ALUM
ALKALI
SCUM
RAS SPLITTER (NEW)
MIXED LIQUOR FLOW SPLITTER (NEW)
SECONDARY CLARIFIER NO. 3 (NEW)
SCUM PUMP STATION (NEW)
RAS PUMP STATION NO. 3 (NEW)
RAS
SECONDARY CLARIFIER NO. 4 (NEW)
RAS PUMP STATION NO. 4 (NEW)
EXISTING INLET WORKS
INLET SCREENS
GRIT COLLECTOR
OXIDATION DITCH
EXISTING MIXED LIQUOR FLOW SPLITTER RAISE WEIRS TO MAX. HEIGHT ON EXISTING OXIDATION DITCH TO SHUT
SECONDARY CLARIFIER NO. 1 (EXISTING)
SCUM PUMP STATION
RAS PUMP STATION NO. 1 (EXISTING)
EXISTING BIOREACTOR
RAS (3)
RAS VIA EXISTING INLET WORKS TO BE DISCONTINUED
FILTRATE RETURN (EXISTING) VIA OXIDATION DITCH TO BE DISCONTINUED
SECONDARY CLARIFIER NO. 2 (EXISTING)
RAS PUMP STATION NO. 2 (EXISTING)
SCUM HARVESTER AND PUMP No. 1
SCUM HARVESTER AND PUMP No. 2 (NEW)
WAS
AEROBIC DIGESTER (EXISTING)
AEROBIC DIGESTER (NEW)
SLUDGE FEED PUMPS
POLYMER
BELT PRESS
BELT PRESS (OPTIONAL, NEW)
REUSE WATER TREATMENT SYSTEM
SITE REUSE FEED PUMPS
UV SYSTEM (EXISTING)
UV SYSTEM (NEW)
SITE REUSE
OVERFLOW
EFFLUENT LIFT PUMPS
WET WEATHER STORAGE LAGOON (NEW)
SLUDGE STORAGE BUILDING (NEW OR EXTENDED)
SLUDGE STORAGE BUILDING (EXISTING)
DRAIN
FILTRATE RETURN
FILTRATE PUMP STATION (EXISTING) UPGRADE AS REQUIRED
WET WEATHER STORAGE RETURN PUMPS
EFFLUENT STORAGE TANK
EFFLUENT TRANSFER PUMPS
CONSTRUCTED WETLAND (NEW)
RIVER DISCHARGE
MULLUMBIMBY EFFLUENT STORAGE
PRELIMINARY
DO NOT SCALE
Drawn K.ELDRIDGE
Designer D.DE HAAS
Client BYRON SHIRE COUNCIL
Project BRUNSWICK VALLEY SEWAGE TREATMENT PLANT
Title PROCESS FLOW DIAGRAM FOR CAPACITY AUGMENTATION INCLUDING OCEAN SHORES
Scale N.T.S
A1
Drawing No: 41-28941-W002
Rev: UR
GHD

Appendix G Results of Process Modelling

Insert here from PDF of Excel Workbook

EXISTING BRUNSWICK VALLEY STP

ANALYSIS OF OXIDATION DITCH PROCESS FOR NDBEPR

This worksheet calculates process N & P performance for a given set of wastewater, process and kinetic parameters.

The process modelled is the mechanically aerated oxidation ditch with RAS returned to an upstream anaerobic reactor. Mass fraction of the anaerobic reactor can be set to zero.

REFERENCES

1. WRC "Theory, Design and Operation of Nutrient Removal Activated Sludge Processes" 1984.
2. Wentzel, Ekama & Marais "Biological Excess Phosphorus Removal-Steady State Process Design" Water SA, 16, 1, 29 (Jan 1990).
3. Clayton, Ekama, Wentzel & Marais "Denitrification Kinetics in Biological Nitrogen and Phosphorus Removal Activated Systems Treating Municipal Waste Waters" Proc IAWPRC Kyoto Conf, July 1990.
4. Hartley "Hydraulics of Horizontal Shaft Oxidation Ditches" Jnl WPCF, 59, 7, 686 (Jul 1987).
5. Hartley "Tuning Biological Nutrient Removal Plants, IWA Publishing, 2013.

NOTES

Nomenclature is as per the references.

Modified denitrification kinetics are used as per Ref 3, in which the K2 denitrification rate specific to the process format is applied to the heterotrophic sludge mass only. Denitrification of the s-recycle to a maximum equivalent to the available RBCOD occurs in the anaerobic zone.

Temperature is taken into account for N removal but not P removal.

The model allows dosing of COD to the anaerobic and/or primary anoxic zones.

Point source oxygen addition is assumed to occur at each aerator.

In using this model, give consideration to the effects of changes in the various parameters, and operation under variable operating conditions and at lower than design load.

Note that in using the worksheet three iterative calculations are involved in Sections 2,3 & 4 as explained in those Sections.

CONTENTS

SELECT VALUES IN HEAVY BOXES
OTHER VALUES ARE CALCULATED AUTOMATICALLY

SECTION 1. FLOW & PROCESS PARAMETERS

FLOW RATE,Q, ML/d	3.8	15833 EP		
		240 L/EP.d		

WASTEWATER CHARACTERISTICS

COD total, Sti, mg/L	540			
TKN, Nti, mg/L	54			
TP, Pti, mg/L	10			
RBCOD/COD biodegradable, fbs(ts)	0.150			
RBCOD/COD biodegradable, fsbs	0.200			
Unbiodegradable particulate fraction of COD total,fup	0.200			
Unbiodegradable soluble fraction of COD total,fus	0.05	Sus	27	
Unbiodegradable soluble fraction of TKN, fnu	0.027	Nus	1.46	*with zero alum. Note: Nus is recalculated below from Eqn in Row 89, from Alum dose*
Ammonia fraction of TKN, fna	0.75	Nai	40.50	
N content of VSS, Np/VSS, Cxr	0.06	Noi	7.66	Note: Effluent Total N includes residual org. biodegradable soluble TKN in effluent (from ammonification calculation), see Row 275
COD biodegradable, Sbi, mg/L	405			
RBCOD, Sbsi, mg/L	81	fsc	0.19	
		VFA	15.1	
Total Alkalinity, mg/L CaCO3	230			

PROCESS PARAMETERS

Process:					
Bioreactor Volume, Vr, ML	3.70	*See Ditches compare dimensions.xls*			
Sludge age, Rs, d	20				
Anaerobic mass fraction, fxa	0.1				
No. of anaerobic reactors in series, N	3				
Primary Anoxic mass fraction, fx1m	0.32				
Secondary Anoxic mass fraction, fx3m	0.05	Assumed to be in the clarifier sludge blanket			
Sum of Primary & Sec. Anoxic mass fractions	0.37				
Total unaerated mass fraction, fxt	0.47				
RAS recycle ratio, s	0.8				
DO in a-recycle, Oa, mg/L	0	Always assume zero for oxidation ditch			
DO in s-recycle, Os, mg/L	0				
Effluent SS, SSe, mg/L	4				
Effluent soluble organic N conc, Nus, mg/L	1.07	C in Eqn:	0.005	D in Eqn:	0.0220 Calc. Depends on Alum Dose below (Byron regression from KJH book Fig 3.38; must match Nus assumed above at Da=0)
COD dose to anaerobic zone, Dcod1, mg/L of influent	0				
COD dose to anoxic zone, Dcod2, mg/L of influent	0				
RBCOD/Total COD for dosed material, fcod	1				
Alum Dose, mg/L as Al2(SO4)3.14H2O, Da	10				
Ditch:					
Channel water depth, y, m	4.00				
Channel width, b, m	6.00	*See Ditches compare dimensions.xls*			
Average circulating velocity, v, m/s	0.25				
No. of rotors operating, Nr	1.87	Adjust to get the average DO for diffused air			
Mixed liquor recycle ratio,a	136				
Environmental:					
Tmin, deg C	19				
Tmax, deg C	29				
Mixed liquor pH, pH	6.9	If pH>7.2, enter 7.2			

BIOMASS PARAMETERS

Yield coefficients, mgVSS/mgCOD:	
Heterotrophs, Yh	0.45
Poly-P organisms,Yg	0.45
N fraction of VSS, fn	0.1
P fraction of VSS:	
Heterotrophic active mass, fxbhp	0.03
Heterotrophic endogenous mass, fxehp	0.03
Poly-P active mass, fxbgp	0.38
Poly-P endogenous mass, fxegp	0.03
Inert mass, fxip	0.03
Unbiodegradable cell fraction:	
Heterotrophs, feph	0.2
Poly-P organisms, fepg	0.25
VSS/TSS ratio:	
Heterotrophs, fvth	0.83
Poly-P organisms, fvtg	0.46
COD/VSS ratio, fcv	1.48
RBCOD conversion rate, K, d-1	0.06

Temperature-sensitive parameters	**20 deg C**	**Tmin**	**Tmax**	
Nitrifier maximum specific growth rate, umT20, d-1	1			
Nitrification half-saturation coefficient, KnT, mgN/L	1	0.89047195	2.84066052	Adj. for pH
Org. N conversion (ammonification) rate, KrT, l/mgVASS.d-1	0.023	0.0223518	0.02974858	
Primary denitrification rate, K2T, mg NO3-N/mg VASS. d	0.21	0.19444444	0.41979097	from Ekama, 1997, BNR3
Secondary denitrification rate, K3T, mg NO3-N/mg VASS. d	0.072	0.06997085	0.09312598	from WRC (1984)
Endogenous decay rates, d-1:				
Heterotrophs, bhT	0.24	0.23323615	0.31041994	
Nitrifiers, bnT	0.04	0.03887269	0.05173666	
Poly-P organisms, bg	0.04			

SECTION 2. SOLIDS INVENTORY & P REMOVAL

Calculate the process solids inventory and biological P removal.
Based on Ref. 2 equations (1) to (27).

20 deg C

Two iterative calculations are involved in Sections 2 and 4:
*Adjust NO3s, then adjust Sbsn, until NneT20 calculated in Section 5 is compatible with NO3s allowing for denitrification in the secondary clarifier.
*Adjust Sbsn assumed until Sbsn calculated agrees.
*If fxa is zero the assumed values of NO3s and Sbsn are irrelevant.

An iterative calculation is also required in Section 3 but this is not as sensitive.

NO3-N recycled to the anaerobic zone, NO3s, mg/L	0.000	Assumed	Effluent nitrate, T=20:	0.26995535		
RBCOD exiting the anaerobic zone, Sbsn, mg/L	11.100	Assumed				
Influent RBCOD available, S.bsi	81					
Heterotroph active mass, MXbh, kg	2028	2077	1632			
RBCOD exiting the anaerobic zone, Sbsn, mg/L	11.130	Calculated				
		Insert Sbsn calculated into Sbsn assumed and recalculate until the two agree.				
Substrate sequestered by poly-P organisms, MSseq, kg/d	231.876					
Substrate available to heterotrophs, MSbh, kg/d	1307.124					
Poly-P organisms active mass, MXbg, kg	1159					
Poly-P organisms endogenous mass, MXeg, kg	232					
Heterotroph active mass, MXbh, kg	2028					
Heterotroph endogenous mass, MXeh, kg	1947					
Inert mass, MXi, kg	5546	Vp, ML:	3.70	See Ditches compare dimensions.xls		
Total VSS, MXv, kg	10913	**Average VSS**	**2949** mg/L			
Chemical ppt inert mass, MXc, kg	269					
Total SS, MXt, kg	14765	**Average MLSS**	**3991** mg/L	**3791** mg/L	If Sec. Anoxic mass fraction is assumed to be in the clarifier	
Peak month COD load factor	1.30	**Peak Month MLSS**	**5188** mg/L	**4928** mg/L	Ditto	
P removal by poly-P organisms, dPg, mg/L	5.89					
P removal by heterotrophs, dPh, mg/L	1.57					
P removal by inert mass, dPi, mg/L	2.19					
P removal by alum, dPc, mg/L	0.28	From KJH book p64				
Total P removal, dP, mg/L	9.93					
Total P content of MLSS, mgP/mgMLSS	0.05					
Effluent soluble P, Pse, mg/L (before chemical dosing)	0.07	Target Pe:	0.1 mgP/L	**qm:** **0.864** mgP/mgAl	**Kp:** **0.175** mgP/L	**q (calc):** **0.31** mgP/mgAl for Alum stoichiometry from KJH book p63-64
Effluent Total P, Pe, mg/L	0.27	includes Bse				
Alkalinity depletion due to alum dosed, mg/L CaCO3	4.11	Alkalinity depletion (mgCaCO3/ mg dry alum dosed)	**Ta:**	0.411 From KJH book Eqn 3.18, p64		

SECTION 3. OXYGEN DEMAND AND DO LEVELS

alpha (F): 0.8		Cs (20°C, 1 atm):	9.08		
beta: 0.95		Cs @ Tmin:		9.26	
		Cs @ Tmax:			7.73
Diffuser mounting height (from floor), m			0.25		
		Cs_inf (20°C, 1 atm):	10.40		
		Cs_inf @ Tmin:		10.60	
		Cs_inf @ Tmax:			8.85

Peak factors for Aeration (synthesis only):

Startup load demand factor	0.55	Assumed	
Peak month demand factor	1.3		
Diurnal max. demand factor	1.33	Assumes 0.333 times amplitude of peak TOD	
Diurnal min. demand factor	0.70	Assumed	
Effluent NH3-N, Nasa, mg/L	0.69	Assumed. Adj. to match NaeT20 calc. below:	0.69
Effluent NO3-N, Nnea mg/L	0.27	Assumed. Adj. to match NneT20 calc. below:	0.27

Oxygen Transfer Rate (Reactor OTR)	**20 deg C**	**Tmin**	**Tmax**	
At FULL DESIGN LOAD				
Average carbonaceous oxygen demand, MOc, kg/c	1142			
Average nitrogenous oxygen demand, MOn, kg/c	658			
Average denitrification oxygen recovery, MOd, kg/c	409			
Average total oxygen demand, MOt, kg/c	1391			
Average DO at each rotor, Cr, mg/L	**1.43**			
Average OTR/SOTR, surface aeration	0.475	0.475	0.483	
Average OTR/SOTR, diffused aeration	0.487	0.487	0.498	
Peak total oxygen demand, peak MOt, kg/c	1854			does NOT include 1/PFpm because full design population loading is already for the peak month
Peak DO at each rotor, Cr, mg/L	**1.91**			
Peak OTR/SOTR, surface aeration	0.444	0.444	0.444	
Peak OTR/SOTR, diffused aeration	0.460	0.460	0.464	
Minimum total oxygen demand, peak MOt, kg/d	749			includes 1/PFpm for off-peak season population loadings
Peak DO at each rotor, Cr, mg/L	**0.77**			
Min OTR/SOTR, surface aeration	0.519	0.518	0.538	
Min OTR/SOTR, diffused aeration	0.525	0.524	0.546	
At STARTUP LOAD				
Average total oxygen demand, MOt, kg/c	765			
Average DO at each rotor, Cr, mg/L	**0.79**			
Average OTR/SOTR, surface aeration	0.518	0.517	0.536	
Average OTR/SOTR, diffused aeration	0.524	0.523	0.544	
Peak total oxygen demand, peak MOt, kg/c	1020			
Peak DO at each rotor, Cr, mg/L	**1.05**			
Peak OTR/SOTR, surface aeration	0.500	0.500	0.515	
Peak OTR/SOTR, diffused aeration	0.509	0.508	0.526	
Minimum total oxygen demand, peak MOt, kg/d	412			includes 1/PFpm for off-peak season population loadings
Peak DO at each rotor, Cr, mg/L	**0.42**			
Min OTR/SOTR, surface aeration	0.542	0.540	0.566	
Min OTR/SOTR, diffused aeration	0.545	0.544	0.570	

Standard Oxygen Transfer Rate (SOTR), kg/h — FOR SURFACE AERATION - *Note: THIS CALCULATION DOES NOT TAKE INTO ACCOUNT DIFFUSER SUBMERGENCE (DO concentration at a fraction of submerged depth)*

At FULL DESIGN LOAD			
Average	122	122	120
Maximum	174	174	174
Minimum	60	60	58
At STARTUP LOAD			
Average	62	62	59
Maximum	85	85	83
Minimum	32	32	30
Aeration Turndown required	5.7		

Standard Oxygen Transfer Rate (SOTR), kg/h — *FOR DIFFUSED AERATION*

At FULL DESIGN LOAD			
Average	119	119	116
Maximum	168	168	166
Minimum	59	60	57
At STARTUP LOAD			
Average	61	61	59
Maximum	83	84	81
Minimum	31	32	30
Aeration Turndown required	5.6		

SECTION 4. NITRIFICATION

	20 deg C	Tmin	Tmax	
Adjust nitrification parameters for temperature, pH and ditch DO profile:				
Nitrifier growth rate, unT, d-1	0.490	0.436	1.392	
Nitrifier ammonia half-saturation coefficient, KnT, mgN/L	1.292	1.151	3.671	
Calculate effluent NH3-N and soluble TKN:				
Effluent NH3-N, NaeT, mg/L	0.69	0.72	0.59	Calculated
Effluent residual sol. biodegradable org. N, NoeT, mg/L	0.58	0.59	0.45	
Effluent soluble TKN, NteT, mg/L	2.33	2.38	2.11	

SECTION 5. DENITRIFICATION

	20 deg C	Tmin	Tmax	
N incorporated in biomass, Ns, mg/L	14.36			
N content of biomass MLSS, mgN/mgMLSS	0.074			
Nitrification capacity, NcT, mg/L	37.31	37.27	37.53	
Primary denitrification potential, Dpp, mg/L	43.81	41.65	69.04	Assumes SbsN fully used for DN; adopts fxdm (refer to WRC, Eqn 6.24 for Bardenpho system; here we have assumed Sso. Anoxic fraction is in the clarifier sludge blanket)
Effluent NO3-N, NneT, mg/L	0.27	0.27	0.27	Calculated
Effluent Total N, mg/L	2.89	2.94	2.67	includes Sso

Deduct an allowance for denitrification in the secondary clarifier sludge blanket and insert in NO3e assumed in Section 2. Adjust Sbsn and repeat until calculated NneT is compatible with assumed NO3e.

SECTION 6. OUTPUT SUMMARY

	20 deg C	Tmin 19	Tmax 29
Average MLSS concentration, mg/L	3791		
Peak month MLSS concentration, mg/L	4926		
Average Actual Total Oxygen demand, kg/d	1391		
Average SOTR, kg/h (diffused air)	119	119	116
Maximum SOTR, kg/h (diffused air)	168	168	165
SOTR turndown required	5.6		
Alum dose, mg/L as dry alum	10		
Alkalinity depletion due to alum dosed, mg/L CaCO3	4		
Effluent Ammonia, mgN/L	0.7	0.7	0.6
Effluent Nitrate, mgN/L	0.3	0.3	0.3
Effluent Total N, mgN/L	2.9	2.9	2.7
Effluent soluble P, mgP/L	0.07		
Effluent Total P, mgP/L	0.27		
Effluent TSS, mg/L (assumed)	4		

EXISTING BVSTP PROCESS AUGMENTED (INCORPORATING OCEAN SHORES)

ANALYSIS OF OXIDATION DITCH PROCESS FOR NDBEPR

This worksheet calculates process N & P performance for a given set of wastewater, process and kinetic parameters.

The process modelled is the mechanically aerated oxidation ditch with RAS returned to an upstream anaerobic reactor. Mass fraction of the anaerobic reactor can be set to zero.

REFERENCES

1. WRC "Theory, Design and Operation of Nutrient Removal Activated Sludge Processes" 1984.
2. Wentzel, Ekama & Marais "Biological Excess Phosphorus Removal-Steady State Process Design" Water SA, 16, 1, 29 (Jan 1990).
3. Clayton, Ekama, Wentzel & Marais "Denitrification Kinetics in Biological Nitrogen and Phosphorus Removal Activated Systems Treating Municipal Waste Waters" Proc IAWPRC Kyoto Conf, July 1990.
4. Hartley "Hydraulics of Horizontal Shaft Oxidation Ditches" Jnl WPCF, 59, 7, 686 (Jul 1987).
5. Harley "Tuning Biological Nutrient Removal Plants, IWA Publishing, 2013.

NOTES

Nomenclature is as per the references.

Modified denitrification kinetics are used as per Ref 3, in which the K2 denitrification rate specific to the process format is applied to the heterotrophic sludge mass only. Denitrification of the s-recycle to a maximum equivalent to the available RBCOD occurs in the anaerobic zone.

Temperature is taken into account for N removal but not P removal.

The model allows dosing of COD to the anaerobic and/or primary anoxic zones.

Point source oxygen addition is assumed to occur at each aerator.

In using this model, give consideration to the effects of changes in the various parameters, and operation under variable operating conditions and at lower than design load.

Note that in using the worksheet three iterative calculations are involved in Sections 2,3 & 4 as explained in those Sections.

CONTENTS

SELECT VALUES IN HEAVY BOXES
OTHER VALUES ARE CALCULATED AUTOMATICALLY

SECTION 1. FLOW & PROCESS PARAMETERS

FLOW RATE,Q, ML/d	3.8	15833 EP		
		240 L/EP.d		

WASTEWATER CHARACTERISTICS

COD total, Sti, mg/L	560			
TKN, Nti, mg/L	57.5			
TP, Pti, mg/L	9.9			
RBCOD/COD biodegradable, fbs(ts)	0.150			
RBCOD/COD biodegradable, fbs	0.200			
Unbiodegradable particulate fraction of COD total,fup	0.200			
Unbiodegradable soluble fraction of COD total,fus	0.05	Sus	28	
Unbiodegradable soluble fraction of TKN, fnu	0.027	Nus	1.55	*with zero alum. Note: Nus is recalculated below from Eqn in Row 89, from Alum dose*
Ammonia fraction of TKN, fna	0.75	Na	43.13	
N content of VSS, Np/VSS, Cxr	0.06	Noi	8.28	Note: Effluent Total N includes residual org. biodegradable soluble TKN in effluent (from ammonification calculation), see Row 275
COD biodegradable, Sbi, mg/L	420			
RBCOD, Sbsi, mg/L	84	fac	0.18	
		VFA	15.1	
Total Alkalinity, mg/L CaCO3	230			

PROCESS PARAMETERS

Process:		
Bioreactor Volume, Vr, ML	3.70	*See Ditches compare dimensions.xls*
Sludge age, Rs, d	19.5	To match peak MLSS to existing design for clarifiers
Anaerobic mass fraction, fxa	0.1	
No. of anaerobic reactors in series, N	3	
Primary Anoxic mass fraction, fx1m	0.32	
Secondary Anoxic mass fraction, fx3m	0.05	Assumed to be in the clarifier sludge blanket
Sum of Primary & Sec. Anoxic mass fractions	0.37	
Total unaerated mass fraction, fxt	0.47	
RAS recycle ratio, s	0.8	
DO in a-recycle, Oa, mg/L	0	Always assume zero for oxidation ditch
DO in s-recycle, Os, mg/L	0	
Effluent SS, SSe, mg/L	4	
Effluent soluble organic N conc, Nus, mg/L	1.55	C in Eqn: 0.005 D in Eqn: 0.0220 Calc. Depends on Alum Dose below (Byron regression from KJH book Fig 3.38; must match Nus assumed above at Da=0)
COD dose to anaerobic zone, Dcod1, mg/L of influent	0	
COD dose to anoxic zone, Dcod2, mg/L of influent	0	
RBCOD/Total COD for dosed material, fcod	1	
Alum Dose, mg/L as Al2(SO4)3.14H2O, Da	0	Alum not required with higher influent COD
Ditch:		
Channel water depth, y, m	4.00	
Channel width, b, m	6.00	*See Ditches compare dimensions.xls*
Average circulating velocity, v, m/s	0.25	
No. of rotors operating, Nr	1.87	Adjust to get the average DO for diffused air
Mixed liquor recycle ratio,a	136	
Environmental:		
Tmin, deg C	19	
Tmax, deg C	29	
Mixed liquor pH, pH	6.9	If pH>7.2, enter 7.2

BIOMASS PARAMETERS

Yield coefficients, mgVSS/mgCOD:	
Heterotrophs, Yh	0.45
Poly-P organisms,Yg	0.45
N fraction of VSS, fn	0.1
P fraction of VSS:	
Heterotrophic active mass, fxbhp	0.03
Heterotrophic endogenous mass, fxehp	0.03
Poly-P active mass, fxbgp	0.38
Poly-P endogenous mass, fxegp	0.03
Inert mass, fxip	0.03
Unbiodegradable cell fraction:	
Heterotrophs, feph	0.2
Poly-P organisms, fepg	0.25
VSS/TSS ratio:	
Heterotrophs, fvh	0.83
Poly-P organisms, fvg	0.46
COD/VSS ratio, fcv	1.48
RBCOD conversion rate, K, d-1	0.06

Temperature-sensitive parameters	**20 deg C**	**Tmin**	**Tmax**	
Nitrifier maximum specific growth rate, umnT20, d-1	1			
Nitrification half-saturation coefficient, KnT, mgN/L	1	0.89047195	2.84065052	Adj. for pH
Org. N conversion (ammonification) rate, KrT, l/mgVASS.d-1	0.023	0.0223518	0.02974858	
Primary denitrification rate, K2T, mg NO3-N/mg VASS.d	0.21	0.19444444	0.41979097	from Ekama, 1997, BNR3
Secondary denitrification rate, K3T, mg NO3-N/mg VASS.d	0.072	0.05997085	0.09312598	from WRC (1984)
Endogenous decay rates, d-1:				
Heterotrophs, bhT	0.24	0.23323615	0.31041994	
Nitrifiers, bnT	0.04	0.03887269	0.05173656	
Poly-P organisms, bg	0.04			

SECTION 2. SOLIDS INVENTORY & P REMOVAL

Calculate the process solids inventory and biological P removal.
Based on Ref. 2 equations (1) to (27).

20 deg C

Two iterative calculations are involved in Sections 2 and 4:
*Adjust NO3s, then adjust Sbsn, until NneT20 calculated in Section 5 is compatible with NO3s allowing for denitrification in the secondary clarifier.
*Adjust Sbsn assumed until Sbsn calculated agrees.
*If fxa is zero the assumed values of NO3s and Sbsn are irrelevant.

An iterative calculation is also required in Section 3 but this is not as sensitive.

NO3-N recycled to the anaerobic zone, NO3s, mg/L	0.003	Assumed	Effluent nitrate, T=20:	0.28716955			
RBCOD exiting the anaerobic zone, Sbsn, mg/L	11.100	Assumed					
Influent RBCOD available, S.bsi	84						
Heterotroph active mass, MXbh, kg	2090	2139	1683				
RBCOD exiting the anaerobic zone, Sbsn, mg/L	11.160	Calculated					
		Insert Sbsn calculated into Sbsn assumed and recalculate until the two agree.					
Substrate sequestered by poly-P organisms, MSseq, kg/d	243.276						
Substrate available to heterotrophs, MSbh, kg/d	1352.724						
Poly-P organisms active mass, MXbg, kg	1199						
Poly-P organisms endogenous mass, MXeg, kg	234						
Heterotroph active mass, MXbh, kg	2090						
Heterotroph endogenous mass, MXeh, kg	1866						
Inert mass, MXi, kg	5608	Vp, ML:	3.70	See Ditches compare dimensions.xls			
Total VSS, MXv, kg	11087	**Average VSS**	**2996** mg/L				
Chemical ppt inert mass, MXc, kg	0						
Total SS, MXt, kg	14746	**Average MLSS**	**3985** mg/L	**3786** mg/L	If Sec. Anoxic mass fraction is assumed to be in the clarifier		
Peak month COD load factor	1.30	**Peak Month MLSS**	**5181** mg/L	**4922** mg/L	Ditto		
P removal by poly-P organisms, dPg, mg/L	6.24						
P removal by heterotrophs, dPh, mg/L	1.64						
P removal by inert mass, dPi, mg/L	2.27						
P removal by alum, dPc, mg/L	0.00	From KJH book p64					
Total P removal, dP, mg/L	10.15						
Total P content of MLSS, mgP/mgMLSS	0.05						
Effluent soluble P, Pse, mg/L (before chemical dosing)	0.01	Target Pe:	0.1 mgP/L	**qm:**	**0.864** mgP/mgAl	**Kp:**	**0.175** mgP/L; **q (calc):** **0.31** mgP/mgAl for Alum stoichiometry from KJH book p63-64
Effluent Total P, Pe, mg/L	0.21	includes Bse					
Alkalinity depletion due to alum dosed, mg/L CaCO3	0.00	Alkalinity depletion (mgCaCO3/ mg dry alum dosed)		**Ta:**	0.411 From KJH book Eqn 3.16, p64		

SECTION 3. OXYGEN DEMAND AND DO LEVELS

	Cs (20°C, 1 atm):	9.08		
alpha (F): 0.8	Cs @ Tmin:		9.26	
beta: 0.95	Cs @ Tmax:			7.73
Diffuser mounting height (from floor), m		0.25		
	Cs_inf (20°C, 1 atm):	10.40		
	Cs_inf @ Tmin:		10.60	
	Cs_inf @ Tmax:			8.85

Peak factors for Aeration (synthesis only):

Startup load demand factor	0.55	Assumed	
Peak month demand factor	1.3		
Diurnal max. demand factor	1.33	Assumes 0.333 times amplitude of peak TOD	
Diurnal min. demand factor	0.70	Assumed	
Effluent NH3-N, Nasa, mg/L	0.67	Assumed. Adj. to match NaeT20 calc. below:	0.69
Effluent NO3-N, Nnea mg/L	0.29	Assumed. Adj. to match NneT20 calc. below:	0.29

Oxygen Transfer Rate (Reactor OTR)	**20 deg C**	**Tmin**	**Tmax**	
At FULL DESIGN LOAD				
Average carbonaceous oxygen demand, MOc, kg/d	1180			
Average nitrogenous oxygen demand, MOn, kg/d	700			
Average denitrification oxygen recovery, MOd, kg/d	435			
Average total oxygen demand, MOt, kg/d	1445			
Average DO at each rotor, Cr, mg/L	**1.49**			
Average OTR/SOTR, surface aeration	0.471	0.471	0.479	
Average OTR/SOTR, diffused aeration	0.484	0.484	0.494	
Peak total oxygen demand, peak MOt, kg/d	1927			does NOT include 1/PFpm because full design population loading is already for the peak month
Peak DO at each rotor, Cr, mg/L	**1.99**			
Peak OTR/SOTR, surface aeration	0.439	0.439	0.438	
Peak OTR/SOTR, diffused aeration	0.455	0.456	0.459	
Minimum total oxygen demand, peak MOt, kg/d	778			includes 1/PFpm for off-peak season population loadings
Min. DO at each rotor, Cr, mg/L	**0.80**			
Min OTR/SOTR, surface aeration	0.517	0.516	0.535	
Min OTR/SOTR, diffused aeration	0.524	0.522	0.543	
At STARTUP LOAD				
Average total oxygen demand, MOt, kg/d	795			
Average DO at each rotor, Cr, mg/L	**0.82**			
Average OTR/SOTR, surface aeration	0.516	0.515	0.534	
Average OTR/SOTR, diffused aeration	0.523	0.521	0.542	
Peak total oxygen demand, peak MOt, kg/d	1060			
Peak DO at each rotor, Cr, mg/L	**1.09**			
Peak OTR/SOTR, surface aeration	0.488	0.497	0.511	
Peak OTR/SOTR, diffused aeration	0.507	0.506	0.523	
Minimum total oxygen demand, peak MOt, kg/d	428			includes 1/PFpm for off-peak season population loadings
Min. DO at each rotor, Cr, mg/L	**0.44**			
Min OTR/SOTR, surface aeration	0.541	0.539	0.565	
Min OTR/SOTR, diffused aeration	0.545	0.543	0.569	
	1			

Standard Oxygen Transfer Rate (SOTR), kg/h — FOR SURFACE AERATION - *Note: THIS CALCULATION DOES NOT TAKE INTO ACCOUNT DIFFUSER SUBMERGENCE (DO concentration at a fraction of submerged depth)*

At FULL DESIGN LOAD			
Average	128	128	126
Maximum	183	183	183
Minimum	63	63	61
At STARTUP LOAD			
Average	64	64	62
Maximum	89	89	86
Minimum	33	33	32
Aeration Turndown required	5.8		

Standard Oxygen Transfer Rate (SOTR), kg/h — *FOR DIFFUSED AERATION*

At FULL DESIGN LOAD			
Average	124	125	122
Maximum	176	176	175
Minimum	62	62	60
At STARTUP LOAD			
Average	63	64	61
Maximum	87	87	84
Minimum	33	33	31
Aeration Turndown required	5.6		

SECTION 4. NITRIFICATION

	20 deg C	Tmin	Tmax	
Adjust nitrification parameters for temperature, pH and ditch DO profile:				
Nitrifier growth rate, unT, d-1	0.495	0.441	1.408	
Nitrifier ammonia half-saturation coefficient, KnT, mgN/L	1.292	1.151	3.671	
Calculate effluent NH3-N and soluble TKN:				
Effluent NH3-N, NaeT, mg/L	0.69	0.72	0.59	Calculated
Effluent residual sol. biodegradable org. N, NoeT, mg/L	0.61	0.62	0.48	
Effluent soluble TKN, NteT, mg/L	2.85	2.90	2.62	

SECTION 5. DENITRIFICATION

	20 deg C	Tmin	Tmax	
N incorporated in biomass, Ns, mg/L	14.95			
N content of biomass MLSS, mgN/mgMLSS	0.075			
Nitrification capacity, NcT, mg/L	39.69	39.64	39.92	
Primary denitrification potential, Dpp, mg/L	45.06	42.84	71.12	Assumes SbsN fully used for DN; adopts fxdm (refer to WRC, Eqn 6.24 for Bardenpho system; here we have assumed Sec. Anoxic fraction is in the clarifier sludge blanket)
Effluent NO3-N, NneT, mg/L	0.29	0.29	0.29	Calculated
Effluent Total N, mg/L	3.43	3.48	3.21	includes Sse

Deduct an allowance for denitrification in the secondary clarifier sludge blanket and insert in NO3s assumed in Section 2. Adjust Sbsn and repeat until calculated NneT is compatible with assumed NO3s.

SECTION 6. OUTPUT SUMMARY

	20 deg C	Tmin 19	Tmax 29
Average MLSS concentration, mg/L	3786		
Peak month MLSS concentration, mg/L	4922		
Average Actual Total Oxygen demand, kg/d	1445		
Average SOTR, kg/h (diffused air)	124	125	122
Maximum SOTR, kg/h (diffused air)	176	176	175
SOTR turndown required	5.6		
Alum dose, mg/L as dry alum	0		
Alkalinity depletion due to alum dosed, mg/L CaCO3	0		
Effluent Ammonia, mgN/L	0.7	0.7	0.6
Effluent Nitrate, mgN/L	0.3	0.3	0.3
Effluent Total N, mgN/L	3.4	3.5	3.2
Effluent soluble P, mgP/L	0.01		
Effluent Total P, mgP/L	0.21		
Effluent TSS, mg/L (assumed)	4		

NEW BVSTP PROCESS AUGMENTED (INCORPORATING OCEAN SHORES)

ANALYSIS OF OXIDATION DITCH PROCESS FOR NDBEPR

This worksheet calculates process N & P performance for a given set of wastewater, process and kinetic parameters.

The process modelled is the mechanically aerated oxidation ditch with RAS returned to an upstream anaerobic reactor. Mass fraction of the anaerobic reactor can be set to zero.

REFERENCES

1. WRC "Theory, Design and Operation of Nutrient Removal Activated Sludge Processes" 1984.
2. Wentzel, Ekama & Marais "Biological Excess Phosphorus Removal-Steady State Process Design" Water SA, 16, 1, 29 (Jan 1990).
3. Clayton, Ekama, Wentzel & Marais "Denitrification Kinetics in Biological Nitrogen and Phosphorus Removal Activated Systems Treating Municipal Waste Waters" Proc IAWPRC Kyoto Conf, July 1990.
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NOTES

Nomenclature is as per the references.

Modified denitrification kinetics are used as per Ref 3, in which the K2 denitrification rate specific to the process format is applied to the heterotrophic sludge mass only. Denitrification of the s-recycle to a maximum equivalent to the available RBCOD occurs in the anaerobic zone.

Temperature is taken into account for N removal but not P removal.

The model allows dosing of COD to the anaerobic and/or primary anoxic zones.

Point source oxygen addition is assumed to occur at each aerator.

In using this model, give consideration to the effects of changes in the various parameters, and operation under variable operating conditions and at lower than design load.

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SELECT VALUES IN HEAVY BOXES
OTHER VALUES ARE CALCULATED AUTOMATICALLY

SECTION 1. FLOW & PROCESS PARAMETERS

FLOW RATE,Q, ML/d	1.9	7917 EP 240 L/EP.d	

WASTEWATER CHARACTERISTICS

COD total, Sti, mg/L	560			
TKN, Nti, mg/L	67.5			
TP, Pti, mg/L	9.5			
RBCOD/COD biodegradable, fbs(ts)	0.155			
RBCOD/COD biodegradable, fsbs	0.200			
Unbiodegradable particulate fraction of COD total,fup	0.200			
Unbiodegradable soluble fraction of COD total,fus	0.05	Sus	28	
Unbiodegradable soluble fraction of TKN, fna	0.027	Nus	1.55	with zero alum. Note: Nus is recalculated below from Eqn in Row 89, from Alum dose
Ammonia fraction of TKN, fna	0.75	Nai	43.13	
N content of VSS, Nb/VSS, Cxr	0.06	Noi	8.28	Note: Effluent Total N includes residual org. biodegradable soluble TKN in effluent (from ammonification calculation), see Row 275
COD biodegradable, Sbi, mg/L	420			
RBCOD, Sbsi, mg/L	84	fac	0.16	
		VFA	15.1	
Total Alkalinity, mg/L CaCO3	230			

PROCESS PARAMETERS

Process:		
Bioreactor Volume, Vr, ML	1.85	See Ditches compare dimensions.xls
Sludge age, Rs, d	19.5	To match peak MLSS to existing design for clarifiers
Anaerobic mass fraction, fxa	0.1	
No. of anaerobic reactors in series, N	3	
Primary Anoxic mass fraction, fx1m	0.32	
Secondary Anoxic mass fraction, fx3m	0.05	Assumed to be in the clarifier sludge blanket
Sum of Primary & Sec. Anoxic mass fractions	0.37	
Total unaerated mass fraction, fxt	0.47	
RAS recycle ratio, s	0.8	
DO in a-recycle, Oa, mg/L	0	Always assume zero for oxidation ditch
DO in s-recycle, Os, mg/L	0	
Effluent SS, SSe, mg/L	4	
Effluent soluble organic N conc, Nue, mg/L	1.55	C in Eqn: 0.005 D in Eqn: 0.0220 Calc. Depends on Alum Dose below (Byron regression from KJH book Fig 3.38; must match Nus assumed above at Da=0)
COD dose to anaerobic zone, Dcod1, mg/L of influent	0	
COD dose to anoxic zone, Dcod2, mg/L of influent	0	
RBCOD/Total COD for dosed material, fcod	1	
Alum Dose, mg/L as Al2(SO4)3.14H2O, Da	0	Alum not required with higher influent COD
Ditch:		
Channel water depth, y, m	3.60	
Channel width, b, m	3.60	See Ditches compare dimensions.xls
Average circulating velocity, v, m/s	0.25	
No. of rotors operating, Nr	1.87	Adjust to get the average DO for diffused air
Mixed liquor recycle ratio,a	147	
Environmental:		
Tmin, deg C	19	
Tmax, deg C	29	
Mixed liquor pH, pH	6.9	If pH>7.2, enter 7.2

BIOMASS PARAMETERS

Yield coefficients, mgVSS/mgCOD:	
Heterotrophs, Yh	0.45
Poly-P organisms,Yg	0.45
N fraction of VSS, fn	0.1
P fraction of VSS:	
Heterotrophic active mass, fxbhp	0.03
Heterotrophic endogenous mass, fxehp	0.03
Poly-P active mass, fxbgp	0.38
Poly-P endogenous mass, fxegp	0.03
Inert mass, fxip	0.03
Unbiodegradable cell fraction:	
Heterotrophs, feph	0.2
Poly-P organisms, fepg	0.25
VSS/TSS ratio:	
Heterotrophs, fvth	0.83
Poly-P organisms, fvtg	0.46
COD/VSS ratio, fcv	1.48
RBCOD conversion rate, K, d-1	0.06

Temperature-sensitive parameters	**20 deg C**	**Tmin**	**Tmax**	
Nitrifier maximum specific growth rate, unmT20, d-1	1			
Nitrification half-saturation coefficient, KnT, mgN/L	1	0.89047195	2.84066052	Adj. for pH
Org. N conversion (ammonification) rate, KrT, l/mgVASS.d-1	0.023	0.0223616	0.02974858	
Primary denitrification rate, K2T, mg NO3-N/mg VASS. d	0.21	0.19444444	0.41979097	from Ekama, 1997, BNR3
Secondary denitrification rate, K3T, mg NO3-N/mg VASS. d	0.072	0.06697085	0.09312598	from WRC (1984)
Endogenous decay rates, d-1:				
Heterotrophs, bhT	0.24	0.23323615	0.31041994	
Nitrifiers, bnT	0.04	0.03887269	0.05173666	
Poly-P organisms, bg	0.04			

SECTION 2. SOLIDS INVENTORY & P REMOVAL

Calculate the process solids inventory and biological P removal.
Based on Ref. 2 equations (1) to (27).

20 deg C

Two iterative calculations are involved in Sections 2 and 4:
*Adjust NO3s, then adjust Sbsn, until NneT20 calculated in Section 5 is compatible with NO3s allowing for denitrification in the secondary clarifier.
*Adjust Sbsn assumed until Sbsn calculated agrees.
*If fxa is zero the assumed values of NO3s and Sbsn are irrelevant.

An iterative calculation is also required in Section 3 but this is not as sensitive.

NO3-N recycled to the anaerobic zone, NO3s, mg/L	0.000	Assumed	Effluent nitrate, T=20:	0.26598288		
RBCOD exiting the anaerobic zone, Sbsn, mg/L	11.100	Assumed				
Influent RBCOD available, S.bsi	84					
Heterotroph active mass, MXbh, kg	1045	1070	841			
RBCOD exiting the anaerobic zone, Sbsn, mg/L	11.160	Calculated				
		Insert Sbsn calculated into Sbsn assumed and recalculate until the two agree.				
Substrate sequestered by poly-P organisms, MSseq, kg/d	121.638					
Substrate available to heterotrophs, MSbh, kg/d	676.362					
Poly-P organisms active mass, MXbg, kg	600					
Poly-P organisms endogenous mass, MXeg, kg	117					
Heterotroph active mass, MXbh, kg	1045					
Heterotroph endogenous mass, MXeh, kg	978					
Inert mass, MXi, kg	2804	Vp, ML:	1.85	See Ditches compare dimensions.xls		
Total VSS, MXv, kg	5543	**Average VSS**	**2996** mg/L			
Chemical ppt inert mass, MXc, kg	0					
Total SS, MXt, kg	7373	**Average MLSS**	**3984** mg/L	**3785** mg/L	If Sec. Anoxic mass fraction is assumed to be in the clarifier	
Peak month COD load factor	1.30	**Peak Month MLSS**	**5180** mg/L	**4921** mg/L	Ditto	
P removal by poly-P organisms, dPg, mg/L	6.24					
P removal by heterotrophs, dPh, mg/L	1.64					
P removal by inert mass, dPi, mg/L	2.27					
P removal by alum, dPc, mg/L	0.00	From KJH book p64				
Total P removal, dP, mg/L	10.15					
Total P content of MLSS, mgP/mgMLSS	0.05					
Effluent soluble P, Pse, mg/L (before chemical dosing)	0.01	Target Pe:	0.1 mgP/L	**qm:** **0.864** mgP/mgAl	**Kp:** **0.175** mgP/L	**q (calc):** **0.31** mgP/mgAl for Alum stoichiometry from KJH book p63-64
Effluent Total P, Pe, mg/L	0.21	includes Bso				
Alkalinity depletion due to alum dosed, mg/L CaCO3	0.00	Alkalinity depletion (mgCaCO3/ mg dry alum dosed)	**Ta:** 0.411 From KJH book Eqn 3.16, p64			Ditto

SECTION 3. OXYGEN DEMAND AND DO LEVELS

		Cs (20°C, 1 atm):	9.08		
alpha (F):	0.8	Cs @ Tmin:		9.26	
beta:	0.95	Cs @ Tmax:			7.73
Diffuser mounting height (from floor), m			0.25		
		Cs_inf (20°C, 1 atm):	10.25		
		Cs_inf @ Tmin:		10.46	
		Cs_inf @ Tmax:			8.73

Peak factors for Aeration (synthesis only):

Startup load demand factor	0.55	Assumed	
Peak month demand factor	1.3		
Diurnal max. demand factor	1.33	Assumes 0.333 times amplitude of peak TOD	
Diurnal min. demand factor	0.70	Assumed	
Effluent NH3-N, Nasa, mg/L	0.70	Assumed. Adj. to match NaeT20 calc. below:	0.71
Effluent NO3-N, Nnea mg/L	0.27	Assumed. Adj. to match NneT20 calc. below:	0.27

Oxygen Transfer Rate (Reactor OTR)	**20 deg C**	**Tmin**	**Tmax**	
At FULL DESIGN LOAD				
Average carbonaceous oxygen demand, MOc, kg/d	590			
Average nitrogenous oxygen demand, MOn, kg/d	360			
Average denitrification oxygen recovery, MOd, kg/d	217			
Average total oxygen demand, MOt, kg/d	722			
Average DO at each rotor, Cr, mg/L	**1.38**			
Average OTR/SOTR, surface aeration	0.479	0.479	0.488	
Average OTR/SOTR, diffused aeration	0.489	0.489	0.501	
Peak total oxygen demand, peak MOt, kg/d	983			does NOT include 1/PFpm because full design population loading is already for the peak month
Peak DO at each rotor, Cr, mg/L	**1.84**			
Peak OTR/SOTR, surface aeration	0.448	0.449	0.450	
Peak OTR/SOTR, diffused aeration	0.462	0.463	0.468	
Minimum total oxygen demand, peak MOt, kg/d	389			includes 1/PFpm for off-peak season population loadings
Peak DO at each rotor, Cr, mg/L	**0.74**			
Min OTR/SOTR, surface aeration	0.521	0.520	0.540	
Min OTR/SOTR, diffused aeration	0.527	0.525	0.547	
At STARTUP LOAD				
Average total oxygen demand, MOt, kg/d	397			
Average DO at each rotor, Cr, mg/L	**0.76**			
Average OTR/SOTR, surface aeration	0.520	0.519	0.539	
Average OTR/SOTR, diffused aeration	0.526	0.524	0.546	
Peak total oxygen demand, peak MOt, kg/d	530			
Peak DO at each rotor, Cr, mg/L	**1.01**			
Peak OTR/SOTR, surface aeration	0.503	0.502	0.518	
Peak OTR/SOTR, diffused aeration	0.511	0.510	0.528	
Minimum total oxygen demand, peak MOt, kg/d	214			includes 1/PFpm for off-peak season population loadings
Peak DO at each rotor, Cr, mg/L	**0.41**			
Min OTR/SOTR, surface aeration	0.543	0.541	0.567	
Min OTR/SOTR, diffused aeration	0.546	0.544	0.571	

Standard Oxygen Transfer Rate (SOTR), kg/h — FOR SURFACE AERATION - *Note: THIS CALCULATION DOES NOT TAKE INTO ACCOUNT DIFFUSER SUBMERGENCE (DO concentration at a fraction of submerged depth)*

At FULL DESIGN LOAD			
Average	63	63	62
Maximum	89	89	89
Minimum	31	31	30
At STARTUP LOAD			
Average	32	32	31
Maximum	44	44	43
Minimum	16	16	16
Aeration Turndown required	5.7		

Standard Oxygen Transfer Rate (SOTR), kg/h — *FOR DIFFUSED AERATION*

At FULL DESIGN LOAD			
Average	62	62	60
Maximum	87	87	86
Minimum	31	31	30
At STARTUP LOAD			
Average	31	32	30
Maximum	43	43	42
Minimum	16	16	16
Aeration Turndown required	5.6		

SECTION 4. NITRIFICATION

	20 deg C	Tmin	Tmax	
Adjust nitrification parameters for temperature, pH and ditch DO profile:				
Nitrifier growth rate, unT, d-1	0.484	0.431	1.375	
Nitrifier ammonia half-saturation coefficient, KnT, mgN/L	1.292	1.151	3.671	
Calculate effluent NH3-N and soluble TKN:				
Effluent NH3-N, NaeT, mg/L	0.71	0.75	0.60	Calculated
Effluent residual sol. biodegradable org. N, NoeT, mg/L	0.61	0.62	0.48	
Effluent soluble TKN, NteT, mg/L	2.87	2.92	2.63	

SECTION 5. DENITRIFICATION

N incorporated in biomass, Ns, mg/L	14.96			
N content of biomass MLSS, mgN/mgMLSS	0.075			

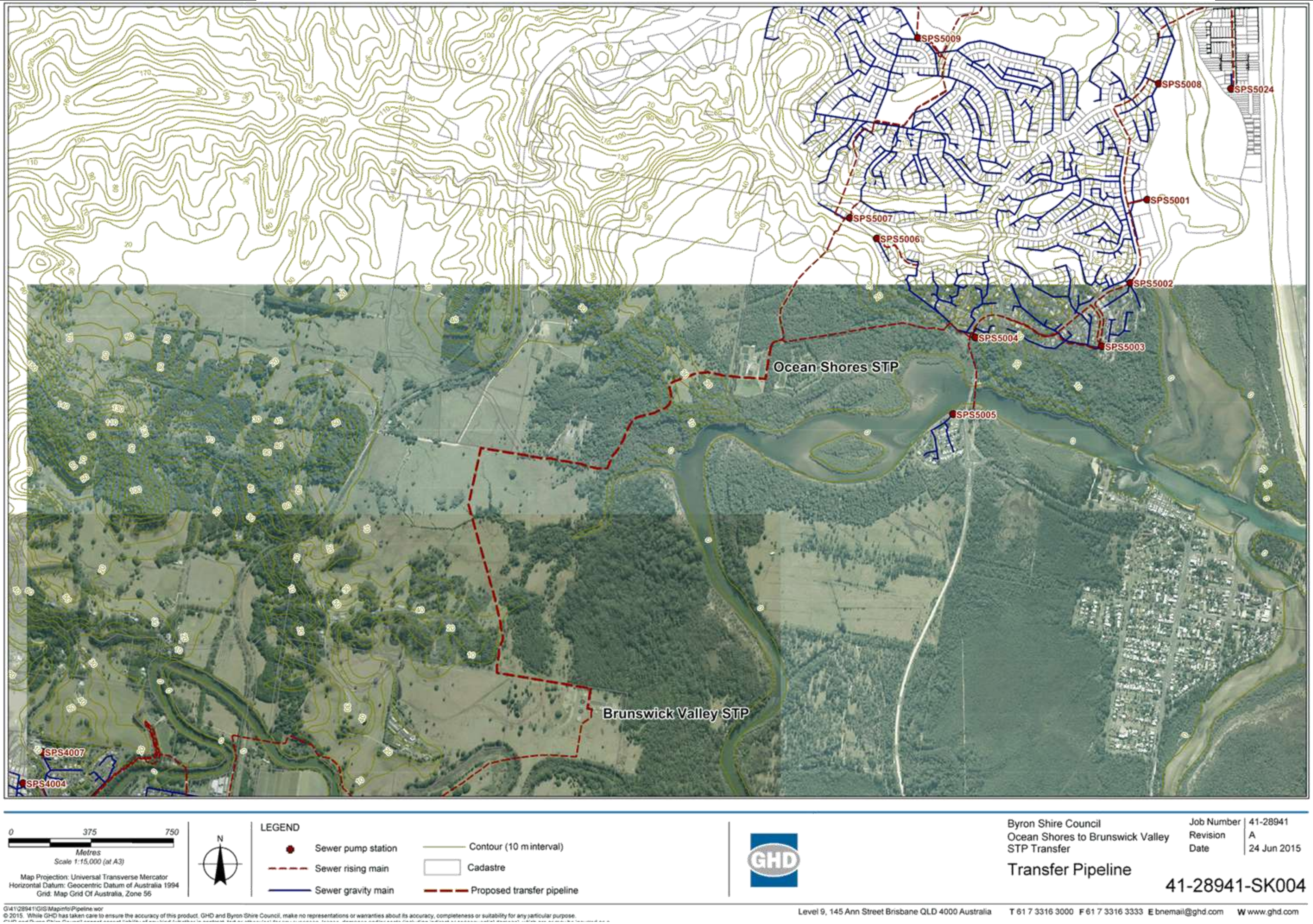
	20 deg C	Tmin	Tmax	
Nitrification capacity, NcT, mg/L	38.67	38.61	39.91	
Primary denitrification potential, Dpp, mg/L	45.06	42.84	71.12	Assumes SbsN fully used for DN; adopts fxdm (refer to WRC, Eqn 6.24 for Bardenpho system; here we have assumed Sec. Anoxic fraction is in the clarifier sludge blanket)
Effluent NO3-N, NneT, mg/L	0.27	0.27	0.27	Calculated
Effluent Total N, mg/L	3.44	3.49	3.20	includes Sse

Deduct an allowance for denitrification in the secondary clarifier sludge blanket and insert in NO3e assumed in Section 2. Adjust Sben and repeat until calculated NneT is compatible with assumed NO3e.

SECTION 6. OUTPUT SUMMARY

	20 deg C	Tmin 19	Tmax 29
Average MLSS concentration, mg/L	3785		
Peak month MLSS concentration, mg/L	4921		
Average Actual Total Oxygen demand, kg/d	722		
Average SOTR, kg/h (diffused air)	62	62	60
Maximum SOTR, kg/h (diffused air)	87	87	85
SOTR turndown required	5.6		
Alum dose, mg/L as dry alum	0		
Alkalinity depletion due to alum dosed, mg/L CaCO3	0		
Effluent Ammonia, mgN/L	0.7	0.8	0.6
Effluent Nitrate, mgN/L	0.3	0.3	0.3
Effluent Total N, mgN/L	3.4	3.5	3.2
Effluent soluble P, mgP/L	0.01		
Effluent Total P, mgP/L	0.21		
Effluent TSS, mg/L (assumed)	4		

Appendix H Proposed augmented plant layout


SPS5009
SPS5008
SPS5024
SPS5001
SPS5007
SPS5006
SPS5002
SPS5004
SPS5003
Ocean Shores STP
SPS5005
Brunswick Valley STP
SPS4007
SPS4004
0 375 750
Metres
Scale 1:15,000 (at A3)
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid Of Australia, Zone 56
N
LEGEND
Sewer pump station
Sewer rising main
Sewer gravity main
Contour (10 m interval)
Cadastre
Proposed transfer pipeline
GHD
Byron Shire Council
Ocean Shores to Brunswick Valley
STP Transfer
Transfer Pipeline
Job Number 41-28941
Revision A
Date 24 Jun 2015
41-28941-SK004
G:\41\28941\GIS\Mapinfo\Pipeline.wor
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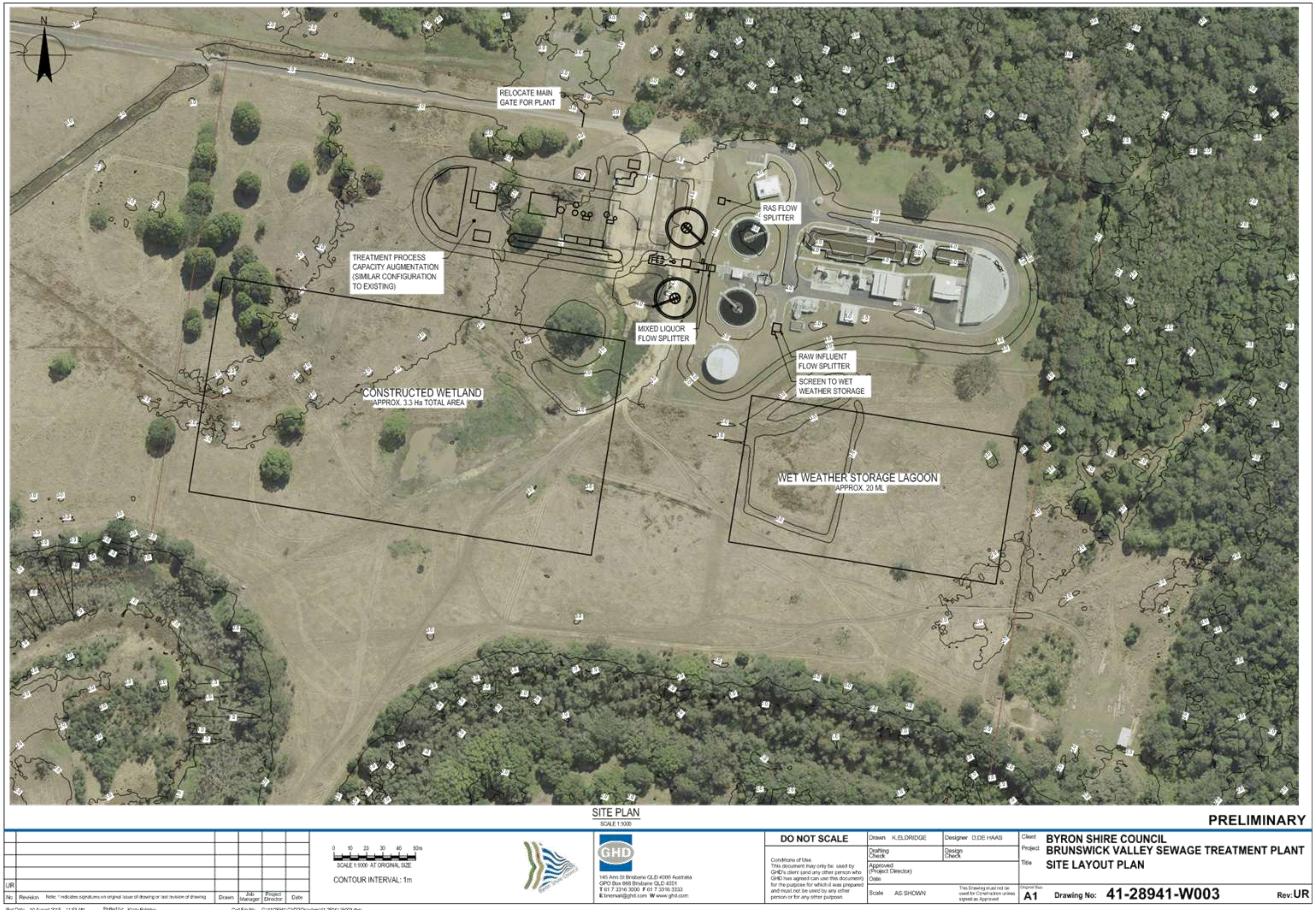
N
RELOCATE MAIN GATE FOR PLANT
TREATMENT PROCESS CAPACITY AUGMENTATION (SIMILAR CONFIGURATION TO EXISTING)
RAS FLOW SPLITTER
MIXED LIQUOR FLOW SPLITTER
RAW INFLUENT FLOW SPLITTER
SCREEN TO WET WEATHER STORAGE
CONSTRUCTED WETLAND
APPROX. 3.3 Ha TOTAL AREA
WET WEATHER STORAGE LAGOON
APPROX. 20 ML
SITE PLAN
SCALE 1:1000
PRELIMINARY
SCALE 1:1000 AT ORIGINAL SIZE
CONTOUR INTERVAL: 1m
GHD
DO NOT SCALE
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Drawn K.ELDRIDGE
Designer D.DE HAAS
Drafting Check
Design Check
Approved (Project Director)
Date
Scale AS SHOWN
This Drawing must not be used for Construction unless signed as Approved
Client BYRON SHIRE COUNCIL
Project BRUNSWICK VALLEY SEWAGE TREATMENT PLANT
Title SITE LAYOUT PLAN
A1
Drawing No: 41-28941-W003
Rev: UR

Appendix I Capital cost estimates breakdown for BVSTP augmentation

Ocean Shores STP - Transfer to Brunswick Valley STP

Capital Cost Estimate

Concept Design Option **Construction Year**

Common to all options **2016-17**

Extend raw sewage rising main for SPS 5009 and SPS 5004 to BV STP

ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
1.0	**Pipeline**									**$ 1,555,000**
1.1		Pipe supply DN375 DICL PN20	3250	m	DN375	$ 200	$ 650,000	$ -	$ 650,000	
1.2		Pipe install incl excavate, lay, backfill and test DN375 DICL (trench 1 - 2 m deep, rural, high water table, acid sulfate soils)	3250	m	DN375	$ 220	$ 715,000	$ -	$ 715,000	
1.3		Allowance for air valves	1	Item	Allowance	$ 100,000	$ 100,000	$ -	$ 100,000	
1.4		Allowance for scour valves	1	Item	Allowance	$ 50,000	$ 50,000	$ -	$ 50,000	
1.5		Connection to existing rising mains	2	no.	Allowance	$ 15,000	$ 30,000	$ -	$ 30,000	
1.6		Isolation valves	2	no.	DN250 gate valves	$ 5,000	$ 10,000	$ -	$ 10,000	
1.7										
		Direct Job Costs (Sub-Total 1)					**$ 1,555,000**	**$ -**		**$ 1,555,000**
		Indirect Job Costs (Engineering, Site Costs, Project Administration etc.)	20%	of DJC			$ 311,000	$ -		$ 311,000
		Risk and Contingency	25%	of DJC + IJC			$ 467,000	$ -		$ 467,000
		Head Contractor Margin	5%	of DJC			$ 78,000	$ -		$ 78,000
		PROJECT SUB-TOTAL (Sub-Total 2)					**$ 2,411,000**	**$ -**		**$ 2,411,000**
		TOTAL PROJECT BUDGET					**$ 2,411,000**	**$ -**		**$2,411,000**

Client: Byron SC
Job No. 41/27528
Author:DDH

BVSTP Upgrade Cost Estimate_ddh2, Capex - OS-BVSTP Pipeline
18/11/2016

Ocean Shores STP - Transfer to Brunswick Valley STP

Capital Cost Estimate

Concept Design Option **Construction Year**

Common to all options **2016-17**

Upgrade SPS 5004

	ITEM	Qty	Unit	Size	Rate	Civil	M&E	Total	
2.0	**SPS 5004 upgrade**								**$ 475,000**
2.1	Construct reinforced concrete pump well (Caisson type)	1	Item	3 m dia, 5 m deep	$ 200,000	$ 200,000	$ -	$ 200,000	
2.2	Construct RC valve pit	1	Item	2.5 m x 3 m	$ 75,000	$ 75,000	$ -	$ 75,000	
2.3	Supply & Install 2 No 30kw pumps, discharge pipework & ancilliaries; including guide rails, lifting chains, wet well washer and backflow prevention, discharge pipework (incl Valve Pit), instrumentation etc.	1	Item	30kW pumps duty/standby	$ 100,000	$ -	$ 100,000	$ 100,000	
2.4	Supply & Install 2 No 30kw pump switchboard, cabling & associated works; inclusive of all field wiring, consumer mains, control software installation & wiring, installation & commissioning of telemetry	1	Item	30kW pumps duty/standby	$ 100,000	$ -	$ 100,000	$ 100,000	
2.5						$ -	$ -	$ -	
	Direct Job Costs (Sub-Total 1)					**$ 275,000**	**$ 200,000**		**$ 475,000**
	Indirect Job Costs (Engineering, Site Costs, Project Administration etc.)	20%	of DJC			$ 55,000	$ 40,000		$ 95,000
	Risk and Contingency	25%	of DJC + IJC			$ 83,000	$ 50,000		$ 143,000
	Head Contractor Margin	5%	of DJC			$ 14,000	$ 10,000		$ 24,000
	PROJECT SUB-TOTAL (Sub-Total 2)					**$ 427,000**	**$ 300,000**		**$ 737,000**
	TOTAL PROJECT BUDGET					**$ 427,000**	**$ 300,000**		**$737,000**

Client: Byron SC
Job No. 41/27528
Author:DDH

BVSTP Upgrade Cost Estimate_ddh2, Capex - OS-BVSTP SPS5004
18/11/2016

Ocean Shores - Brunswick Valley STP Feasibility Study
Capital Cost Estimate

	Concept Design Option	Construction Year	
Option 1: OD	25,000 EP (Nominal) Capacity Augmentation	2016-17	NO DEFERMENT OF CAPITAL ITEMS
	Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)		
	Includes new Aerobic Digester		
	5.70 ML/d Design ADWF		
	628 L/s PWWF (nominal) augmentation		

ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
1.0	Wet Weather Storage									$ 2,526,000
1.1		1 no. 20 ML clay-lined earthern storage lagoon	1	no.	Estimate	$ 2,110,000	$ 2,110,000	$ -	$ 2,110,000	
1.2		Concrete paved drainage area	375	m2	Estimate	$ 375	$ 141,000	$ -	$ 141,000	
1.2		Inlet/ Outlet Pipework & Valves	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
1.3		Other minor civils, including overflow structure, culverts, headwalls etc.	1	No.	Allowance	$ 80,000	$ 80,000	$ -	$ 80,000	
1.4		Embankment gravel road. 150 mm thick, 4 m wide	2040	m2	Estimate	$ 22	$ 44,880	$ -	$ 44,880	
2.0	Inlet Works									$ 1,185,000
2.1		Raw influent flow splitter, upstream of inlet works	1	no.	Allowance	$ 270,000	$ 220,000	$ 50,000	$ 270,000	
2.2		Screen on by-pass flow to Wet Weather Storage	1	no.	Estimate for Max. 628 L/s	$ 142,000	$ -	$ 142,000	$ 142,000	
2.2		New inlet channel, grit tank & related - CIVILS	1	no.	Max. 314 L/s	$ 349,000	$ 349,000	$ -	$ 349,000	
2.3		New inlet channel, grit tank & related - METALWORK	1	no.	Ditto	$ 72,000	$ 72,000	$ -	$ 72,000	
2.4		New inlet channel, grit tank & related - MECHANICAL	1	no.	Ditto	$ 298,000	$ -	$ 298,000	$ 298,000	
2.5		Odour Control (odour bed or equivalent filter)	1	no.	Estimate	$ 54,000	$ 36,000	$ 18,000	$ 54,000	
3.0	Bioreactors									$ 2,463,000
3.1		RAS Flow influent splitter, downstream of inlet works	1	no.	Allowance	$ 215,000	$ 175,000	$ 40,000	$ 215,000	
3.2		New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - CIVILS	1	no.	185 kL Anaerobic; 1665 kL Ox. Ditch (estimate)	$ 1,298,000	$ 1,298,000	$ -	$ 1,298,000	
3.3		New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - METALWORK	1	no.	Estimate	$ 47,000	$ -	$ -		
3.4		New RAS screen and conveyor/ press	1	no.	Allowance, Max. 300 L/s	$ 161,000	$ -	$ 161,000	$ 161,000	
3.5		Aeration equipment, Mixers, RAS & WAS pumps - MECHANICAL	1	no.	Estimate	$ 515,000	$ -	$ 515,000	$ 515,000	
3.6		Aeration testing	1	no.	Allowance	$ 42,000	$ -	$ 42,000	$ 42,000	
3.7		Scum harvester & Scum Pump for Ox. Ditch - MECHANICAL	1	no.	Allowance, 3.6 m long to span channel width	$ 132,000	$ 132,000	$ -	$ 132,000	
3.8		Pipework modifications to outlet of Existing Ox. Ditch	1	no.	Allowance	$ 100,000	$ 100,000	$ -	$ 100,000	

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BVSTP Upgrade Cost Estimate_ddh2, Capex - BVSTP_Opt1
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ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
4.0	**Clarifiers**									**$ 2,246,000**
4.1		Mixed liquor flow splitter	1	no.	Allowance	$ 215,000	$ 215,000	$ -	$ 215,000	
4.2		Secondary Clarifiers - CIVILS (incl. METALWORK)	2	no.	23 m dia, 1.45 ML each (Estimate)	$ 770,000	$ 1,540,000	$ -	$ 1,540,000	
4.3		Secondary Clarifier & RAS P/Stn- MECHANICAL	1	no.	Estimate	$ 427,000	$ -	$ 427,000	$ 427,000	
4.4		RAS Pump Station - CIVILS (incl. METALWORK)	1	no.	Max. 150 L/s (Estimate)	$ 64,000	$ 64,000	$ -	$ 64,000	
5.0	**UV Disinfection**									**$ 745,000**
5.1		UV channels - CIVILS (incl. METALWORK)	1	no.	314 L/s (Estimate)	$ 198,000	$ 198,000	$ -	$ 198,000	
5.2		UV disinfection equipment	1	no.	314 L/s (Estimate); dose 30 mJ/cm^2	$ 490,000	$ -	$ 490,000	$ 490,000	
5.3		UV control/ switchroom building	1	no.	Estimate (Colourbond building, airconditioned)	$ 57,000	$ 57,000	$ -	$ 57,000	
6.0	**Chemical Storage & Dosing**									**$ 575,000**
6.1		Earthworks & Drainage for bunded areas	1	no.	Allowance	$ 12,000	$ 12,000	$ -	$ 12,000	
6.2		Concrete for bunded areas	1	no.	Allowance	$ 134,000	$ 134,000	$ -	$ 134,000	
6.3		Building structure	1	no.	Allowance	$ 108,000	$ 108,000	$ -	$ 108,000	
6.4		Ferric sulphate storage tanks	1	no.	Allowance	$ 57,000	$ 57,000	$ -	$ 57,000	
6.5		Alum storage tanks	1	no.	Allowance	$ 80,000	$ 80,000	$ -	$ 80,000	
6.6		Sodium hydroxide storage tanks	1	no.	Allowance	$ 79,000	$ 79,000	$ -	$ 79,000	
6.7		Chemical dosing skids (pumps and pipework)	3	no.	Allowance	$ 35,000	$ 15,000	$ 90,000	$ 105,000	
6.0	**Tertiary Constructed Wetland (total area ~3 ha)**									**$ 761,000**
6.1		Earthmoving	10,500	m3	Allowance	$ 20	$ 210,000	$ -	$ 210,000	
6.2		Main distributor pipe	300	m	DN 750	$ 800	$ 240,000	$ -	$ 240,000	
6.3		Valves	3	no.	DN 750	$ 10,000	$ 30,000	$ -	$ 30,000	
6.4		Minor distributor pipes	150	m	DN 450	$ 420	$ 63,000	$ -	$ 63,000	
6.5		HDPE (2mm) liner under berms, lineal length x 3 m wide	2400	m2	Allowance	$ 20	$ 48,000	$ -	$ 48,000	
6.6		Planting and initial maintenance	1	no.	Allowance	$ 60,000	$ 60,000	$ -	$ 60,000	
6.7		Other Civils (incl. gravel roads)	1	no.	Allowance	$ 110,000	$ 110,000	$ -	$ 110,000	

Client: Byron SC
Job No. 41/28941
Author:DDH

BVSTP Upgrade Cost Estimate_ddh2, Capex - BVSTP_Opt1
18/11/2016

ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
7.0	**Aerobic Digester**									**$ 433,000**
7.1		Aeration Tank (incl. internal peipwork & valves) - CIVILS	1	no.	0.25 ML (Estimate)	$ 264,000	$ 264,000	$ -	$ 264,000	
7.2		Aeration System (incl. Blowers) - MECHANICAL	1	no.	Estimate	$ 169,000	$ -	$ 169,000	$ 169,000	
8.0	**Sludge Dewatering & Biosolids Storage**									**$ 1,687,000**
8.1		New Gravity Drainage Deck, Belt Filter Press & Feed Pumps, Conveyors to Sludge Storage - MECHANICAL	1	no.	200 kg/h feed (Estimate)	$ 550,000	$ -	$ 550,000	$ 550,000	
8.2		Sludge dewatering equipment - METALWORK	1	no.	Estimate	$ 24,000	$ 24,000	$ -	$ 24,000	
8.3		Sludge dewatering building - CIVILS	1	no.	Estimate	$ 288,000	$ 288,000	$ -	$ 288,000	
8.4		Polymer Make-up and Dosing System	1	no.	Estimate	$ 50,000	$ -	$ 50,000	$ 50,000	
8.5		Biosolids Storage Facility (Building) - CIVILS	1	no.	Estimate	$ 775,000	$ 775,000	$ -	$ 775,000	
9.0	**Switch Room & Blower Room**									**$ 411,000**
9.1		Switchroom building	1	no.	Estimate	$ 96,000	$ 96,000	$ -	$ 96,000	
9.2		Blower room building	1	no.	Estimate	$ 315,000	$ 315,000	$ -	$ 315,000	
10.0	**Pump Stations (where not included above)**									**$ 210,000**
10.1		Scum Pump Station	1	No.	incl.	$ -	$ -	$ -	$ -	
10.2		Service Water System	1	No.	~5 L/s	$ 92,000	$ 30,000	$ 62,000	$ 92,000	
10.3		General Purpose (Filtrate/ Site Utility) pump station	1	No.	~42 L/s	$ 46,000	$ 16,000	$ 30,000	$ 46,000	
10.4		Wet Weather Storage Return pump station	1	no.	~33 L/s max.	$ 46,000	$ 16,000	$ 30,000	$ 46,000	
10.5		P/Stns Miscellaneous - METALWORK	1	No.	Allowance	$ 26,000	$ 26,000	$ -	$ 26,000	
11.0	**Plant Pipework & Valves**									**$ 1,860,000**
11.1		Pipework to Inlet works	1	No.	Allowance	$ 248,000	$ 248,000	$ -	$ 248,000	
11.2		Inlet works to Bioreactor	1	No.	Allowance	$ 65,000	$ 65,000	$ -	$ 65,000	
11.3		Bioreactor to Clarifiers	1	No.	Allowance	$ 140,000	$ 140,000	$ -	$ 140,000	
11.4		Clarifiers to UV Treatment	1	No.	Allowance	$ 46,000	$ 46,000	$ -	$ 46,000	
11.5		Treated Effluent Pipework	1	No.	Allowance	$ 540,000	$ 540,000	$ -	$ 540,000	
11.6		RAS Pipework	1	No.	Allowance	$ 214,000	$ 214,000	$ -	$ 214,000	
11.7		WAS Pipework	1	No.	Allowance	$ 46,000	$ 46,000	$ -	$ 46,000	
11.8		Chemical Dosing Pipework	1	No.	Allowance	$ 34,000	$ 34,000	$ -	$ 34,000	
11.9		Service Water Pipework	1	No.	Allowance	$ 78,000	$ 78,000	$ -	$ 78,000	
11.10		Odour Pipework	1	No.	Allowance	$ 36,000	$ 36,000	$ -	$ 36,000	
11.11		Scum Pipework	1	No.	Allowance	$ 75,000	$ 75,000	$ -	$ 75,000	
11.12		Effluent Transfer Pipework	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
11.13		Sludge Dewatering Pipework	1	No.	Allowance	$ 130,000	$ 130,000	$ -	$ 130,000	
11.14		Drainage Pipework	1	No.	Allowance	$ 27,000	$ 27,000	$ -	$ 27,000	
11.15		Roadworks Drainage Pipework	1	No.	Allowance	$ 31,000	$ 31,000	$ -	$ 31,000	

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Job No. 41/28941
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18/11/2016

ITEM		Qty	Unit	Size	Rate	Civil	M&E	Total	
12.0	**Roads, Fencing & Landscaping**								**$ 442,000**
12.1	Earthworks	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
12.2	Paving	1	No.	Allowance	$ 66,000	$ 66,000	$ -	$ 66,000	
12.3	Other roadworks, incl. temporary gravel roads	1	No.	Allowance	$ 35,000	$ 35,000	$ -	$ 35,000	
12.4	Stormwater drains	1	No.	Allowance	$ 92,000	$ 92,000	$ -	$ 92,000	
12.5	Fencing	1	No.	Allowance	$ 17,000	$ 17,000	$ -	$ 17,000	
12.6	Landscaping	1	No.	Allowance	$ 82,000	$ 82,000	$ -	$ 82,000	
13.0	**General Site Works**								**$ 1,640,000**
13.1	Bulk earthworks of site (incl. preloading/ flood mitigation)	1	No.	Allowance	$ 1,280,000	$ 1,280,000	$ -	$ 1,280,000	
13.2	Plant commissioning & performance testing	1	No.	Allowance	$ 330,000	$ 165,000	$ 165,000	$ 330,000	
13.3	Spare parts for mechanical equipment	1	No.	Allowance	$ 30,000	$ -	$ 30,000	$ 30,000	
14.0	**Electrical, Instrumentation & Control**								**$ 2,699,000**
14.1	Main Switchboard, supply & install	1	No.	Allowance	$ 207,000		$ 207,000	$ 207,000	
14.2	Motor Control Centres, supply & install	1	No.	Allowance	$ 409,000		$ 409,000	$ 409,000	
14.3	Distribution Boards and Local Control Stations & VSD's	1	No.	Allowance	$ 198,000		$ 198,000	$ 198,000	
14.4	Miscellaneous Control Panels - install	1	No.	Allowance	$ 16,000		$ 16,000	$ 16,000	
14.5	Conduits and Pits, supply and install	1	No.	Allowance	$ 181,000		$ 181,000	$ 181,000	
14.6	Supply, install and terminate Cabling	1	No.	Allowance	$ 232,000		$ 232,000	$ 232,000	
14.7	Other Cabling (Lighting & Earthing)	1	No.	Allowance	$ 112,000		$ 112,000	$ 112,000	
14.8	Instrumentation and Control Cabling	1	No.	Allowance	$ 87,000		$ 87,000	$ 87,000	
14.9	Instrumentation	1	No.	Allowance	$ 307,000		$ 307,000	$ 307,000	
14.10	PLC and interface with existing SCADA system	1	No.	Allowance	$ 171,000		$ 171,000	$ 171,000	
14.11	Software and programming	1	No.	Allowance	$ 129,000		$ 129,000	$ 129,000	
14.12	UPS for all essential equipment and controls	1	No.	Allowance	$ 36,000		$ 36,000	$ 36,000	
14.13	SCADA system	1	No.	Allowance	$ 254,000		$ 254,000	$ 254,000	
14.14	Standby Generator	1	No.	Allowance	$ 360,000		$ 360,000	$ 360,000	
	Direct Job Costs (Sub-Total 1)					**$ 13,825,000**	**$ 6,058,000**		**$ 19,883,000**
	Indirect Job Costs (Preliminaries, Engineering, Site Costs, Project Admin. etc.)	20%	of DJC			$ 2,765,000	$ 1,211,600		$ 3,977,000
	Risk and Contingency	25%	of DJC + IJC			$ 4,147,500	$ 1,817,400		$ 5,965,000
	Head Contractor Margin	5%	of DJC			$ 691,250	$ 302,900		$ 995,000
	PROJECT SUB-TOTAL (Sub-Total 2)					**$ 21,429,000**	**$ 9,390,000**		**$ 30,820,000**
	TOTAL PROJECT BUDGET					**$ 21,429,000**	**$ 9,390,000**		**$30,820,000**

Client: Byron SC
Job No. 41/28941
Author:DDH

BVSTP Upgrade Cost Estimate_ddh2, Capex - BVSTP_Opt1
18/11/2016

Ocean Shores - Brunswick Valley STP Feasibility Study
Capital Cost Estimate

	Concept Design Option	Construction Year	
Option 2: OD	**19,000 EP (Nominal) Capacity Augmentation**	**2016-17**	**DEFERMENT OF ONE NEW CLARIFIER**
	Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)		
	Includes new Aerobic Digester; One New Clarifier only		
	4.30 ML/d Design ADWF		
	471 L/s PWWF (nominal) augmentation		

ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
1.0	**Wet Weather Storage**									**$ 2,526,000**
1.1		1 no. 20 ML clay-lined earthern storage lagoon	1	no.	Estimate	$ 2,110,000	$ 2,110,000	$ -	$ 2,110,000	
1.2		Concrete paved drainage area	375	m2	Estimate	$ 375	$ 141,000	$ -	$ 141,000	
1.2		Inlet/ Outlet Pipework & Valves	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
1.3		Other minor civils, including overflow structure, culverts, headwalls etc.	1	No.	Allowance	$ 80,000	$ 80,000	$ -	$ 80,000	
1.4		Embankment gravel road. 150 mm thick, 4 m wide	2040	m2	Estimate	$ 22	$ 44,880	$ -	$ 44,880	
2.0	**Inlet Works**									**$ 1,185,000**
2.1		Raw influent flow splitter, upstream of inlet works	1	no.	Allowance	$ 270,000	$ 220,000	$ 50,000	$ 270,000	
2.2		Screen on by-pass flow to Wet Weather Storage	1	no.	Estimate for Max. 628 L/s	$ 142,000	$ -	$ 142,000	$ 142,000	
2.2		New inlet channel, grit tank & related - CIVILS	1	no.	Max. 314 L/s	$ 349,000	$ 349,000	$ -	$ 349,000	
2.3		New inlet channel, grit tank & related - METALWORK	1	no.	Ditto	$ 72,000	$ 72,000	$ -	$ 72,000	
2.4		New inlet channel, grit tank & related - MECHANICAL	1	no.	Ditto	$ 298,000	$ -	$ 298,000	$ 298,000	
2.5		Odour Control (odour bed or equivalent filter)	1	no.	Estimate	$ 54,000	$ 36,000	$ 18,000	$ 54,000	
3.0	**Bioreactors**									**$ 2,463,000**
3.1		RAS Flow influent splitter, downstream of inlet works	1	no.	Allowance	$ 215,000	$ 175,000	$ 40,000	$ 215,000	
3.2		New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - CIVILS	1	no.	185 kL Anaerobic; 1665 kL Ox. Ditch (estimate)	$ 1,298,000	$ 1,298,000	$ -	$ 1,298,000	
3.3		New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - METALWORK	1	no.	Estimate	$ 47,000	$ -	$ -		
3.4		New RAS screen and conveyor/ press	1	no.	Allowance, Max. 300 L/s	$ 161,000	$ -	$ 161,000	$ 161,000	
3.5		Aeration equipment, Mixers, RAS & WAS pumps - MECHANICAL	1	no.	Estimate	$ 515,000	$ -	$ 515,000	$ 515,000	
3.6		Aeration testing	1	no.	Allowance	$ 42,000	$ -	$ 42,000	$ 42,000	
3.7		Scum harvester & Scum Pump for Ox. Ditch - MECHANICAL	1	no.	Allowance, 3.6 m long to span channel width	$ 132,000	$ 132,000	$ -	$ 132,000	
3.8		Pipework modifications to outlet of Existing Ox. Ditch	1	no.	Allowance	$ 100,000	$ 100,000	$ -	$ 100,000	

Client: Byron SC
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BVSTP Upgrade Cost Estimate_ddh2, Capex - BVSTP_Opt2
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ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
4.0	**Clarifiers**									**$ 1,231,000**
4.1		Mixed liquor flow splitter	1	no.	Allowance	$ 215,000	$ 215,000	$ -	$ 215,000	
4.2		Secondary Clarifiers - CIVILS (incl. METALWORK)	1	no.	23 m dia, 1.45 ML each (Estimate)	$ 770,000	$ 770,000	$ -	$ 770,000	
4.3		Secondary Clarifier & RAS P/Stn- MECHANICAL	1	no.	Estimate	$ 427,000	$ -	$ 214,000	$ 214,000	
4.4		RAS Pump Station - CIVILS (incl. METALWORK)	0.5	no.	Max. 150 L/s (Estimate)	$ 64,000	$ 32,000	$ -	$ 32,000	
5.0	**UV Disinfection**									**$ 745,000**
5.1		UV channels - CIVILS (incl. METALWORK)	1	no.	314 L/s (Estimate)	$ 198,000	$ 198,000	$ -	$ 198,000	
5.2		UV disinfection equipment	1	no.	314 L/s (Estimate); dose 30 mJ/cm^2	$ 490,000	$ -	$ 490,000	$ 490,000	
5.3		UV control/ switchroom building	1	no.	Estimate (Colourbond building, airconditioned)	$ 57,000	$ 57,000	$ -	$ 57,000	
6.0	**Chemical Storage & Dosing**									**$ 575,000**
6.1		Earthworks & Drainage for bunded areas	1	no.	Allowance	$ 12,000	$ 12,000	$ -	$ 12,000	
6.2		Concrete for bunded areas	1	no.	Allowance	$ 134,000	$ 134,000	$ -	$ 134,000	
6.3		Building structure	1	no.	Allowance	$ 108,000	$ 108,000	$ -	$ 108,000	
6.4		Ferric sulphate storage tanks	1	no.	Allowance	$ 57,000	$ 57,000	$ -	$ 57,000	
6.5		Alum storage tanks	1	no.	Allowance	$ 80,000	$ 80,000	$ -	$ 80,000	
6.6		Sodium hydroxide storage tanks	1	no.	Allowance	$ 79,000	$ 79,000	$ -	$ 79,000	
6.7		Chemical dosing skids (pumps and pipework)	3	no.	Allowance	$ 35,000	$ 15,000	$ 90,000	$ 105,000	
6.0	**Tertiary Constructed Wetland (total area ~3 ha)**									**$ 761,000**
6.1		Earthmoving	10,500	m3	Allowance	$ 20	$ 210,000	$ -	$ 210,000	
6.2		Main distributor pipe	300	m	DN 750	$ 800	$ 240,000	$ -	$ 240,000	
6.3		Valves	3	no.	DN 750	$ 10,000	$ 30,000	$ -	$ 30,000	
6.4		Minor distributor pipes	150	m	DN 450	$ 420	$ 63,000	$ -	$ 63,000	
6.5		HDPE (2mm) liner under berms, lineal length x 3 m wide	2400	m2	Allowance	$ 20	$ 48,000	$ -	$ 48,000	
6.6		Planting and initial maintenance	1	no.	Allowance	$ 60,000	$ 60,000	$ -	$ 60,000	
6.7		Other Civils (incl. gravel roads)	1	no.	Allowance	$ 110,000	$ 110,000	$ -	$ 110,000	

Client: Byron SC
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BVSTP Upgrade Cost Estimate_ddh2, Capex - BVSTP_Opt2
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ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
7.0	**Aerobic Digester**									**$ 433,000**
7.1		Aeration Tank (incl. internal peipwork & valves) - CIVILS	1	no.	0.25 ML (Estimate)	$ 264,000	$ 264,000	$ -	$ 264,000	
7.2		Aeration System (incl. Blowers) - MECHANICAL	1	no.	Estimate	$ 169,000	$ -	$ 169,000	$ 169,000	
8.0	**Sludge Dewatering & Biosolids Storage**									**$ 1,687,000**
8.1		New Gravity Drainage Deck, Belt Filter Press & Feed Pumps, Conveyors to Sludge Storage - MECHANICAL	1	no.	200 kg/h feed (Estimate)	$ 550,000	$ -	$ 550,000	$ 550,000	
8.2		Sludge dewatering equipment - METALWORK	1	no.	Estimate	$ 24,000	$ 24,000	$ -	$ 24,000	
8.3		Sludge dewatering building - CIVILS	1	no.	Estimate	$ 288,000	$ 288,000	$ -	$ 288,000	
8.4		Polymer Make-up and Dosing System	1	no.	Estimate	$ 50,000	$ -	$ 50,000	$ 50,000	
8.5		Biosolids Storage Facility (Building) - CIVILS	1	no.	Estimate	$ 775,000	$ 775,000	$ -	$ 775,000	
9.0	**Switch Room & Blower Room**									**$ 411,000**
9.1		Switchroom building	1	no.	Estimate	$ 96,000	$ 96,000	$ -	$ 96,000	
9.2		Blower room building	1	no.	Estimate	$ 315,000	$ 315,000	$ -	$ 315,000	
10.0	**Pump Stations (where not included above)**									**$ 210,000**
10.1		Scum Pump Station	1	No.	incl.	$ -	$ -	$ -	$ -	
10.2		Service Water System	1	No.	~5 L/s	$ 92,000	$ 30,000	$ 62,000	$ 92,000	
10.3		General Purpose (Filtrate/ Site Utility) pump station	1	No.	~42 L/s	$ 46,000	$ 16,000	$ 30,000	$ 46,000	
10.4		Wet Weather Storage Return pump station	1	no.	~33 L/s max.	$ 46,000	$ 16,000	$ 30,000	$ 46,000	
10.5		P/Stns Miscellaneous - METALWORK	1	No.	Allowance	$ 26,000	$ 26,000	$ -	$ 26,000	
11.0	**Plant Pipework & Valves**									**$ 1,671,000**
11.1		Pipework to Inlet works	1	No.	Allowance	$ 248,000	$ 248,000	$ -	$ 248,000	
11.2		Inlet works to Bioreactor	1	No.	Allowance	$ 65,000	$ 65,000	$ -	$ 65,000	
11.3		Bioreactor to Clarifiers	0.75	No.	Allowance	$ 140,000	$ 105,000	$ -	$ 105,000	
11.4		Clarifiers to UV Treatment	0.5	No.	Allowance	$ 46,000	$ 23,000	$ -	$ 23,000	
11.5		Treated Effluent Pipework	1	No.	Allowance	$ 540,000	$ 540,000	$ -	$ 540,000	
11.6		RAS Pipework	0.5	No.	Allowance	$ 214,000	$ 107,000	$ -	$ 107,000	
11.7		WAS Pipework	1	No.	Allowance	$ 46,000	$ 46,000	$ -	$ 46,000	
11.8		Chemical Dosing Pipework	1	No.	Allowance	$ 34,000	$ 34,000	$ -	$ 34,000	
11.9		Service Water Pipework	1	No.	Allowance	$ 78,000	$ 78,000	$ -	$ 78,000	
11.10		Odour Pipework	1	No.	Allowance	$ 36,000	$ 36,000	$ -	$ 36,000	
11.11		Scum Pipework	0.752	No.	Allowance	$ 75,000	$ 56,400	$ -	$ 56,400	
11.12		Effluent Transfer Pipework	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
11.13		Sludge Dewatering Pipework	1	No.	Allowance	$ 130,000	$ 130,000	$ -	$ 130,000	
11.14		Drainage Pipework	0.8	No.	Allowance	$ 27,000	$ 21,600	$ -	$ 21,600	
11.15		Roadworks Drainage Pipework	1	No.	Allowance	$ 31,000	$ 31,000	$ -	$ 31,000	

Client: Byron SC
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BVSTP Upgrade Cost Estimate_ddh2, Capex - BVSTP_Opt2
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	ITEM		Qty	Unit	Size	Rate	Civil	M&E	Total	
12.0	**Roads, Fencing & Landscaping**									**$ 420,000**
12.1		Earthworks	0.95	No.	Allowance	$ 150,000	$ 142,500	$ -	$ 142,500	
12.2		Paving	0.95	No.	Allowance	$ 66,000	$ 62,700	$ -	$ 62,700	
12.3		Other roadworks, incl. temporary gravel roads	0.95	No.	Allowance	$ 35,000	$ 33,250	$ -	$ 33,250	
12.4		Stormwater drains	0.95	No.	Allowance	$ 92,000	$ 87,400	$ -	$ 87,400	
12.5		Fencing	0.95	No.	Allowance	$ 17,000	$ 16,150	$ -	$ 16,150	
12.6		Landscaping	0.95	No.	Allowance	$ 82,000	$ 77,900	$ -	$ 77,900	
13.0	**General Site Works**									**$ 1,384,000**
13.1		Bulk earthworks of site (incl. preloading/ flood mitigation)	0.8	No.	Allowance	$ 1,280,000	$ 1,024,000	$ -	$ 1,024,000	
13.2		Plant commissioning & performance testing	1	No.	Allowance	$ 330,000	$ 165,000	$ 165,000	$ 330,000	
13.3		Spare parts for mechanical equipment	1	No.	Allowance	$ 30,000	$ -	$ 30,000	$ 30,000	
14.0	**Electrical, Instrumentation & Control**									**$ 2,644,000**
14.1		Main Switchboard, supply & install	1	No.	Allowance	$ 207,000		$ 207,000	$ 207,000	
14.2		Motor Control Centres, supply & install	0.95	No.	Allowance	$ 409,000		$ 389,000	$ 389,000	
14.3		Distribution Boards and Local Control Stations & VSD's	0.95	No.	Allowance	$ 198,000		$ 188,000	$ 188,000	
14.4		Miscellaneous Control Panels - install	1	No.	Allowance	$ 16,000		$ 16,000	$ 16,000	
14.5		Conduits and Pits, supply and install	0.95	No.	Allowance	$ 181,000		$ 172,000	$ 172,000	
14.6		Supply, install and terminate Cabling	0.95	No.	Allowance	$ 232,000		$ 220,000	$ 220,000	
14.7		Other Cabling (Lighting & Earthing)	1	No.	Allowance	$ 112,000		$ 112,000	$ 112,000	
14.8		Instrumentation and Control Cabling	0.95	No.	Allowance	$ 87,000		$ 83,000	$ 83,000	
14.9		Instrumentation	1	No.	Allowance	$ 307,000		$ 307,000	$ 307,000	
14.10		PLC and interface with existing SCADA system	1	No.	Allowance	$ 171,000		$ 171,000	$ 171,000	
14.11		Software and programming	1	No.	Allowance	$ 129,000		$ 129,000	$ 129,000	
14.12		UPS for all essential equipment and controls	1	No.	Allowance	$ 36,000		$ 36,000	$ 36,000	
14.13		SCADA system	1	No.	Allowance	$ 254,000		$ 254,000	$ 254,000	
14.14		Standby Generator	1	No.	Allowance	$ 360,000		$ 360,000	$ 360,000	
		Direct Job Costs (Sub-Total 1)					**$ 12,556,000**	**$ 5,790,000**		**$ 18,346,000**
		Indirect Job Costs (Preliminaries, Engineering, Site Costs, Project Admin. etc.)	20%	of DJC			$ 2,511,200	$ 1,158,000		$ 3,670,000
		Risk and Contingency	25%	of DJC + IJC			$ 3,766,800	$ 1,737,000		$ 5,504,000
		Head Contractor Margin	5%	of DJC			$ 627,800	$ 289,500		$ 918,000
		PROJECT SUB-TOTAL (Sub-Total 2)					**$ 19,462,000**	**$ 8,975,000**		**$ 28,438,000**
		TOTAL PROJECT BUDGET					**$ 19,462,000**	**$ 8,975,000**		**$28,438,000**

Client: Byron SC
Job No. 41/28941
Author:DDH

BVSTP Upgrade Cost Estimate_ddh2, Capex - BVSTP_Opt2
18/11/2016

Ocean Shores - Brunswick Valley STP Feasibility Study

Capital Cost Estimate

Concept Design Option **Construction Year**

Option 3 OD 25,000 EP (Nominal) Capacity Augmentation 2016-17 DECREASE WET WEATHER STORAGE VOLUME

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)

Includes new Aerobic Digester; Smaller Wet Weather Storage

5.70 ML/d Design ADWF

628 L/s PWWF (nominal) augmentation

	ITEM		Qty	Unit	Size	Rate	Civil	M&E	Total	
1.0	**Wet Weather Storage**									**$ 1,783,000**
1.1		1 no. 10 ML clay-lined earthern storage lagoon	1	no.	Estimate	$ 1,380,000	$ 1,380,000	$ -	$ 1,380,000	
1.2		Concrete paved drainage area	375	m2	Estimate	$ 375	$ 141,000	$ -	$ 141,000	
1.2		Inlet/ Outlet Pipework & Valves	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
1.3		Other minor civils, including overflow structure, culverts, headwalls etc.	1	No.	Allowance	$ 80,000	$ 80,000	$ -	$ 80,000	
1.4		Embankment gravel road. 150 mm thick, 4 m wide	1440	m2	Estimate	$ 22	$ 31,680	$ -	$ 31,680	
2.0	**Inlet Works**									**$ 1,185,000**
2.1		Raw influent flow splitter, upstream of inlet works	1	no.	Allowance	$ 270,000	$ 220,000	$ 50,000	$ 270,000	
2.2		Screen on by-pass flow to Wet Weather Storage	1	no.	Estimate for Max. 628 L/s	$ 142,000	$ -	$ 142,000	$ 142,000	
2.2		New inlet channel, grit tank & related - CIVILS	1	no.	Max. 314 L/s	$ 349,000	$ 349,000	$ -	$ 349,000	
2.3		New inlet channel, grit tank & related - METALWORK	1	no.	Ditto	$ 72,000	$ 72,000	$ -	$ 72,000	
2.4		New inlet channel, grit tank & related - MECHANICAL	1	no.	Ditto	$ 298,000	$ -	$ 298,000	$ 298,000	
2.5		Odour Control (odour bed or equivalent filter)	1	no.	Estimate	$ 54,000	$ 36,000	$ 18,000	$ 54,000	
3.0	**Bioreactors**									**$ 2,463,000**
3.1		RAS Flow influent splitter, downstream of inlet works	1	no.	Allowance	$ 215,000	$ 175,000	$ 40,000	$ 215,000	
3.2		New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - CIVILS	1	no.	185 kL Anaerobic; 1665 kL Ox. Ditch (estimate)	$ 1,298,000	$ 1,298,000	$ -	$ 1,298,000	
3.3		New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - METALWORK	1	no.	Estimate	$ 47,000	$ -	$ -		
3.4		New RAS screen and conveyor/ press	1	no.	Allowance, Max. 300 L/s	$ 161,000	$ -	$ 161,000	$ 161,000	
3.5		Aeration equipment, Mixers, RAS & WAS pumps - MECHANICAL	1	no.	Estimate	$ 515,000	$ -	$ 515,000	$ 515,000	
3.6		Aeration testing	1	no.	Allowance	$ 42,000	$ -	$ 42,000	$ 42,000	
3.7		Scum harvester & Scum Pump for Ox. Ditch - MECHANICAL	1	no.	Allowance, 3.6 m long to span channel width	$ 132,000	$ 132,000	$ -	$ 132,000	
3.8		Pipework modifications to outlet of Existing Ox. Ditch	1	no.	Allowance	$ 100,000	$ 100,000	$ -	$ 100,000	

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BVSTP Upgrade Cost Estimate_ddh2, Capex - BVSTP_Opt3
18/11/2016

ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
4.0	**Clarifiers**									**$ 2,246,000**
4.1		Mixed liquor flow splitter	1	no.	Allowance	$ 215,000	$ 215,000	$ -	$ 215,000	
4.2		Secondary Clarifiers - CIVILS (incl. METALWORK)	2	no.	23 m dia, 1.45 ML each (Estimate)	$ 770,000	$ 1,540,000	$ -	$ 1,540,000	
4.3		Secondary Clarifier & RAS P/Stn- MECHANICAL	1	no.	Estimate	$ 427,000	$ -	$ 427,000	$ 427,000	
4.4		RAS Pump Station - CIVILS (incl. METALWORK)	1	no.	Max. 150 L/s (Estimate)	$ 64,000	$ 64,000	$ -	$ 64,000	
5.0	**UV Disinfection**									**$ 745,000**
5.1		UV channels - CIVILS (incl. METALWORK)	1	no.	314 L/s (Estimate)	$ 198,000	$ 198,000	$ -	$ 198,000	
5.2		UV disinfection equipment	1	no.	314 L/s (Estimate); dose 30 mJ/cm^2	$ 490,000	$ -	$ 490,000	$ 490,000	
5.3		UV control/ switchroom building	1	no.	Estimate (Colourbond building, airconditioned)	$ 57,000	$ 57,000	$ -	$ 57,000	
6.0	**Chemical Storage & Dosing**									**$ 575,000**
6.1		Earthworks & Drainage for bunded areas	1	no.	Allowance	$ 12,000	$ 12,000	$ -	$ 12,000	
6.2		Concrete for bunded areas	1	no.	Allowance	$ 134,000	$ 134,000	$ -	$ 134,000	
6.3		Building structure	1	no.	Allowance	$ 108,000	$ 108,000	$ -	$ 108,000	
6.4		Ferric sulphate storage tanks	1	no.	Allowance	$ 57,000	$ 57,000	$ -	$ 57,000	
6.5		Alum storage tanks	1	no.	Allowance	$ 80,000	$ 80,000	$ -	$ 80,000	
6.6		Sodium hydroxide storage tanks	1	no.	Allowance	$ 79,000	$ 79,000	$ -	$ 79,000	
6.7		Chemical dosing skids (pumps and pipework)	3	no.	Allowance	$ 35,000	$ 15,000	$ 90,000	$ 105,000	
6.0	**Tertiary Constructed Wetland (total area ~3 ha)**									**$ 761,000**
6.1		Earthmoving	10,500	m3	Allowance	$ 20	$ 210,000	$ -	$ 210,000	
6.2		Main distributor pipe	300	m	DN 750	$ 800	$ 240,000	$ -	$ 240,000	
6.3		Valves	3	no.	DN 750	$ 10,000	$ 30,000	$ -	$ 30,000	
6.4		Minor distributor pipes	150	m	DN 450	$ 420	$ 63,000	$ -	$ 63,000	
6.5		HDPE (2mm) liner under berms, lineal length x 3 m wide	2400	m2	Allowance	$ 20	$ 48,000	$ -	$ 48,000	
6.6		Planting and initial maintenance	1	no.	Allowance	$ 60,000	$ 60,000	$ -	$ 60,000	
6.7		Other Civils (incl. gravel roads)	1	no.	Allowance	$ 110,000	$ 110,000	$ -	$ 110,000	

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	ITEM	Qty	Unit	Size	Rate	Civil	M&E	Total	
7.0	**Aerobic Digester**								**$ 433,000**
7.1	Aeration Tank (incl. internal peipwork & valves) - CIVILS	1	no.	0.25 ML (Estimate)	$ 264,000	$ 264,000	$ -	$ 264,000	
7.2	Aeration System (incl. Blowers) - MECHANICAL	1	no.	Estimate	$ 169,000	$ -	$ 169,000	$ 169,000	
8.0	**Sludge Dewatering & Biosolids Storage**								**$ 1,687,000**
8.1	New Gravity Drainage Deck, Belt Filter Press & Feed Pumps, Conveyors to Sludge Storage - MECHANICAL	1	no.	200 kg/h feed (Estimate)	$ 550,000	$ -	$ 550,000	$ 550,000	
8.2	Sludge dewatering equipment - METALWORK	1	no.	Estimate	$ 24,000	$ 24,000	$ -	$ 24,000	
8.3	Sludge dewatering building - CIVILS	1	no.	Estimate	$ 288,000	$ 288,000	$ -	$ 288,000	
8.4	Polymer Make-up and Dosing System	1	no.	Estimate	$ 50,000	$ -	$ 50,000	$ 50,000	
8.5	Biosolids Storage Facility (Building) - CIVILS	1	no.	Estimate	$ 775,000	$ 775,000	$ -	$ 775,000	
9.0	**Switch Room & Blower Room**								**$ 411,000**
9.1	Switchroom building	1	no.	Estimate	$ 96,000	$ 96,000	$ -	$ 96,000	
9.2	Blower room building	1	no.	Estimate	$ 315,000	$ 315,000	$ -	$ 315,000	
10.0	**Pump Stations (where not included above)**								**$ 210,000**
10.1	Scum Pump Station	1	No.	incl.	$ -	$ -	$ -	$ -	
10.2	Service Water System	1	No.	~5 L/s	$ 92,000	$ 30,000	$ 62,000	$ 92,000	
10.3	General Purpose (Filtrate/ Site Utility) pump station	1	No.	~42 L/s	$ 46,000	$ 16,000	$ 30,000	$ 46,000	
10.4	Wet Weather Storage Return pump station	1	no.	~33 L/s max.	$ 46,000	$ 16,000	$ 30,000	$ 46,000	
10.5	P/Stns Miscellaneous - METALWORK	1	No.	Allowance	$ 26,000	$ 26,000	$ -	$ 26,000	
11.0	**Plant Pipework & Valves**								**$ 1,860,000**
11.1	Pipework to Inlet works	1	No.	Allowance	$ 248,000	$ 248,000	$ -	$ 248,000	
11.2	Inlet works to Bioreactor	1	No.	Allowance	$ 65,000	$ 65,000	$ -	$ 65,000	
11.3	Bioreactor to Clarifiers	1	No.	Allowance	$ 140,000	$ 140,000	$ -	$ 140,000	
11.4	Clarifiers to UV Treatment	1	No.	Allowance	$ 46,000	$ 46,000	$ -	$ 46,000	
11.5	Treated Effluent Pipework	1	No.	Allowance	$ 540,000	$ 540,000	$ -	$ 540,000	
11.6	RAS Pipework	1	No.	Allowance	$ 214,000	$ 214,000	$ -	$ 214,000	
11.7	WAS Pipework	1	No.	Allowance	$ 46,000	$ 46,000	$ -	$ 46,000	
11.8	Chemical Dosing Pipework	1	No.	Allowance	$ 34,000	$ 34,000	$ -	$ 34,000	
11.9	Service Water Pipework	1	No.	Allowance	$ 78,000	$ 78,000	$ -	$ 78,000	
11.10	Odour Pipework	1	No.	Allowance	$ 36,000	$ 36,000	$ -	$ 36,000	
11.11	Scum Pipework	1	No.	Allowance	$ 75,000	$ 75,000	$ -	$ 75,000	
11.12	Effluent Transfer Pipework	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
11.13	Sludge Dewatering Pipework	1	No.	Allowance	$ 130,000	$ 130,000	$ -	$ 130,000	
11.14	Drainage Pipework	1	No.	Allowance	$ 27,000	$ 27,000	$ -	$ 27,000	
11.15	Roadworks Drainage Pipework	1	No.	Allowance	$ 31,000	$ 31,000	$ -	$ 31,000	

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	ITEM	Qty	Unit	Size	Rate	Civil	M&E	Total	
12.0	**Roads, Fencing & Landscaping**								**$ 442,000**
12.1	Earthworks	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
12.2	Paving	1	No.	Allowance	$ 66,000	$ 66,000	$ -	$ 66,000	
12.3	Other roadworks, incl. temporary gravel roads	1	No.	Allowance	$ 35,000	$ 35,000	$ -	$ 35,000	
12.4	Stormwater drains	1	No.	Allowance	$ 92,000	$ 92,000	$ -	$ 92,000	
12.5	Fencing	1	No.	Allowance	$ 17,000	$ 17,000	$ -	$ 17,000	
12.6	Landscaping	1	No.	Allowance	$ 82,000	$ 82,000	$ -	$ 82,000	
13.0	**General Site Works**								**$ 1,640,000**
13.1	Bulk earthworks of site (incl. preloading/ flood mitigation)	1	No.	Allowance	$ 1,280,000	$ 1,280,000	$ -	$ 1,280,000	
13.2	Plant commissioning & performance testing	1	No.	Allowance	$ 330,000	$ 165,000	$ 165,000	$ 330,000	
13.3	Spare parts for mechanical equipment	1	No.	Allowance	$ 30,000	$ -	$ 30,000	$ 30,000	
14.0	**Electrical, Instrumentation & Control**								**$ 2,699,000**
14.1	Main Switchboard, supply & install	1	No.	Allowance	$ 207,000		$ 207,000	$ 207,000	
14.2	Motor Control Centres, supply & install	1	No.	Allowance	$ 409,000		$ 409,000	$ 409,000	
14.3	Distribution Boards and Local Control Stations & VSD's	1	No.	Allowance	$ 198,000		$ 198,000	$ 198,000	
14.4	Miscellaneous Control Panels - install	1	No.	Allowance	$ 16,000		$ 16,000	$ 16,000	
14.5	Conduits and Pits, supply and install	1	No.	Allowance	$ 181,000		$ 181,000	$ 181,000	
14.6	Supply, install and terminate Cabling	1	No.	Allowance	$ 232,000		$ 232,000	$ 232,000	
14.7	Other Cabling (Lighting & Earthing)	1	No.	Allowance	$ 112,000		$ 112,000	$ 112,000	
14.8	Instrumentation and Control Cabling	1	No.	Allowance	$ 87,000		$ 87,000	$ 87,000	
14.9	Instrumentation	1	No.	Allowance	$ 307,000		$ 307,000	$ 307,000	
14.10	PLC and interface with existing SCADA system	1	No.	Allowance	$ 171,000		$ 171,000	$ 171,000	
14.11	Software and programming	1	No.	Allowance	$ 129,000		$ 129,000	$ 129,000	
14.12	UPS for all essential equipment and controls	1	No.	Allowance	$ 36,000		$ 36,000	$ 36,000	
14.13	SCADA system	1	No.	Allowance	$ 254,000		$ 254,000	$ 254,000	
14.14	Standby Generator	1	No.	Allowance	$ 360,000		$ 360,000	$ 360,000	
	Direct Job Costs (Sub-Total 1)					**$ 13,082,000**	**$ 6,058,000**		**$ 19,140,000**
	Indirect Job Costs (Preliminaries, Engineering, Site Costs, Project Admin. etc.)	20%	of DJC			$ 2,616,400	$ 1,211,600		$ 3,828,000
	Risk and Contingency	25%	of DJC + IJC			$ 3,924,600	$ 1,817,400		$ 5,742,000
	Head Contractor Margin	5%	of DJC			$ 654,100	$ 302,900		$ 957,000
	PROJECT SUB-TOTAL (Sub-Total 2)					**$ 20,278,000**	**$ 9,390,000**		**$ 29,667,000**
	TOTAL PROJECT BUDGET					**$ 20,278,000**	**$ 9,390,000**		**$29,667,000**

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Ocean Shores - Brunswick Valley STP Feasibility Study

Capital Cost Estimate

Concept Design Option **Construction Year**

Option 4: OD **16,700 EP (Nominal) Capacity Augmentation** **2016-17** **DEFERMENT OF TREATMENT CAPACITY AUGMENTATION**

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)

Existing treatment plant process capacity, with wet weather storage, tertiary wetland & increased biosolids storage capacity

3.80 ML/d Design ADWF

314 L/s PWWF (nominal) with remainder (up to 628 L/s) diverted to wet weather storage

	ITEM	Qty	Unit	Size	Rate	Civil	M&E	Total	
1.0	**Wet Weather Storage**								**$ 2,526,000**
1.1	1 no. 20 ML clay-lined earthern storage lagoon	1	no.	Estimate	$ 2,110,000	$ 2,110,000	$ -	$ 2,110,000	
1.2	Concrete paved drainage area	375	m2	Estimate	$ 375	$ 141,000	$ -	$ 141,000	
1.2	Inlet/ Outlet Pipework & Valves	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
1.3	Other minor civils, including overflow structure, culverts, headwalls etc.	1	No.	Allowance	$ 80,000	$ 80,000	$ -	$ 80,000	
1.4	Embankment gravel road. 150 mm thick, 4 m wide	2040	m2	Estimate	$ 22	$ 44,880	$ -	$ 44,880	
2.0	**Inlet Works**								**$ 412,000**
2.1	Raw influent flow splitter, upstream of inlet works	1	no.	Allowance	$ 270,000	$ 220,000	$ 50,000	$ 270,000	
2.2	Screen on by-pass flow to Wet Weather Storage	1	no.	Estimate for Max. 628 L/s	$ 142,000	$ -	$ 142,000	$ 142,000	
2.2	New inlet channel, grit tank & related - CIVILS	0	no.	Max. 314 L/s	$ 349,000	$ -	$ -	$ -	
2.3	New inlet channel, grit tank & related - METALWORK	0	no.	Ditto	$ 72,000	$ -	$ -	$ -	
2.4	New inlet channel, grit tank & related - MECHANICAL	0	no.	Ditto	$ 298,000	$ -	$ -	$ -	
2.5	Odour Control (odour bed or equivalent filter)	0	no.	Estimate	$ 54,000	$ -	$ -	$ -	
3.0	**Bioreactors**								**$ -**
3.1	RAS Flow influent splitter, downstream of inlet works	0	no.	Allowance	$ 215,000	-$ 40,000	$ 40,000	$ -	
3.2	New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - CIVILS	0	no.	185 kL Anaerobic; 1665 kL Ox. Ditch (estimate)	$ 1,298,000	$ -	$ -	$ -	
3.3	New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - METALWORK	0	no.	Estimate	$ 47,000	$ -	$ -		
3.4	New RAS screen and conveyor/ press	0	no.	Allowance, Max. 300 L/s	$ 161,000	$ -	$ -	$ -	
3.5	Aeration equipment, Mixers, RAS & WAS pumps - MECHANICAL	0	no.	Estimate	$ 515,000	$ -	$ -	$ -	
3.6	Aeration testing	0	no.	Allowance	$ 42,000	$ -	$ -	$ -	
3.7	Scum harvester & Scum Pump for Ox. Ditch - MECHANICAL	0	no.	Allowance, 3.6 m long to span channel width	$ 132,000	$ -	$ -	$ -	
3.8	Pipework modifications to outlet of Existing Ox. Ditch	0	no.	Allowance	$ 100,000	$ 100,000	-$ 100,000	$ -	

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ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
4.0	**Clarifiers**									$ -
4.1		Mixed liquor flow splitter	0	no.	Allowance	$ 215,000	$ -	$ -	$ -	
4.2		Secondary Clarifiers - CIVILS (incl. METALWORK)	0	no.	23 m dia, 1.45 ML each (Estimate)	$ 770,000	$ -	$ -	$ -	
4.3		Secondary Clarifier & RAS P/Stn- MECHANICAL	0	no.	Estimate	$ 427,000	$ -	$ -	$ -	
4.4		RAS Pump Station - CIVILS (incl. METALWORK)	0	no.	Max. 150 L/s (Estimate)	$ 64,000	$ -	$ -	$ -	
5.0	**UV Disinfection**									$ -
5.1		UV channels - CIVILS (incl. METALWORK)	0	no.	314 L/s (Estimate)	$ 198,000	$ -	$ -	$ -	
5.2		UV disinfection equipment	0	no.	314 L/s (Estimate); dose 30 mJ/cm^2	$ 490,000	$ -	$ -	$ -	
5.3		UV control/ switchroom building	0	no.	Estimate (Colourbond building, airconditioned)	$ 57,000	$ -	$ -	$ -	
6.0	**Chemical Storage & Dosing**									$ -
6.1		Earthworks & Drainage for bunded areas	0	no.	Allowance	$ 12,000	$ -	$ -	$ -	
6.2		Concrete for bunded areas	0	no.	Allowance	$ 134,000	$ -	$ -	$ -	
6.3		Building structure	0	no.	Allowance	$ 108,000	$ -	$ -	$ -	
6.4		Ferric sulphate storage tanks	0	no.	Allowance	$ 57,000	$ -	$ -	$ -	
6.5		Alum storage tanks	0	no.	Allowance	$ 80,000	$ -	$ -	$ -	
6.6		Sodium hydroxide storage tanks	0	no.	Allowance	$ 79,000	$ -	$ -	$ -	
6.7		Chemical dosing skids (pumps and pipework)	0	no.	Allowance	$ 35,000	$ 15,000	-$ 15,000	$ -	
6.0	**Tertiary Constructed Wetland (total area ~3 ha)**									$ 761,000
6.1		Earthmoving	10,500	m3	Allowance	$ 20	$ 210,000	$ -	$ 210,000	
6.2		Main distributor pipe	300	m	DN 750	$ 800	$ 240,000	$ -	$ 240,000	
6.3		Valves	3	no.	DN 750	$ 10,000	$ 30,000	$ -	$ 30,000	
6.4		Minor distributor pipes	150	m	DN 450	$ 420	$ 63,000	$ -	$ 63,000	
6.5		HDPE (2mm) liner under berms, lineal length x 3 m wide	2400	m2	Allowance	$ 20	$ 48,000	$ -	$ 48,000	
6.6		Planting and initial maintenance	1	no.	Allowance	$ 60,000	$ 60,000	$ -	$ 60,000	
6.7		Other Civils (incl. gravel roads)	1	no.	Allowance	$ 110,000	$ 110,000	$ -	$ 110,000	

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ITEM		Qty	Unit	Size	Rate	Civil	M&E	Total	
7.0	**Aerobic Digester**								$ -
7.1	Aeration Tank (incl. internal peipwork & valves) - CIVILS	0	no.	0.25 ML (Estimate)	$ 264,000	$ -	$ -	$ -	
7.2	Aeration System (incl. Blowers) - MECHANICAL	0	no.	Estimate	$ 169,000	$ -	$ -	$ -	
8.0	**Sludge Dewatering & Biosolids Storage**								$ 885,000
8.1	New Gravity Drainage Deck, Belt Filter Press & Feed Pumps, Conveyors to Sludge Storage - MECHANICAL	0.2	no.	200 kg/h feed (Estimate)	$ 550,000	$ -	$ 110,000	$ 110,000	
8.2	Sludge dewatering equipment - METALWORK	0	no.	Estimate	$ 24,000	$ -	$ -	$ -	
8.3	Sludge dewatering building - CIVILS	0	no.	Estimate	$ 288,000	$ -	$ -	$ -	
8.4	Polymer Make-up and Dosing System	0	no.	Estimate	$ 50,000	$ -	$ -	$ -	
8.5	Biosolids Storage Facility (Building) - CIVILS	1	no.	Estimate	$ 775,000	$ 775,000	$ -	$ 775,000	
9.0	**Switch Room & Blower Room**								$ -
9.1	Switchroom building	0	no.	Estimate	$ 96,000	$ -	$ -	$ -	
9.2	Blower room building	0	no.	Estimate	$ 315,000	$ -	$ -	$ -	
10.0	**Pump Stations (where not included above)**								$ 46,000
10.1	Scum Pump Station	0	No.	incl.	$ -	$ -	$ -	$ -	
10.2	Service Water System	0	No.	~5 L/s	$ 92,000	$ -	$ -	$ -	
10.3	General Purpose (Filtrate/ Site Utility) pump station	0	No.	~42 L/s	$ 46,000	$ -	$ -	$ -	
10.4	Wet Weather Storage Return pump station	1	no.	~33 L/s max.	$ 46,000	$ 16,000	$ 30,000	$ 46,000	
10.5	P/Stns Miscellaneous - METALWORK	0	No.	Allowance	$ 26,000	$ -	$ -	$ -	
11.0	**Plant Pipework & Valves**								$ 354,000
11.1	Pipework to Inlet works	1	No.	Allowance	$ 248,000	$ 248,000	$ -	$ 248,000	
11.2	Inlet works to Bioreactor	0	No.	Allowance	$ 65,000	$ -	$ -	$ -	
11.3	Bioreactor to Clarifiers	0	No.	Allowance	$ 140,000	$ -	$ -	$ -	
11.4	Clarifiers to UV Treatment	0	No.	Allowance	$ 46,000	$ -	$ -	$ -	
11.5	Treated Effluent Pipework	0	No.	Allowance	$ 540,000	$ -	$ -	$ -	
11.6	RAS Pipework	0	No.	Allowance	$ 214,000	$ -	$ -	$ -	
11.7	WAS Pipework	0	No.	Allowance	$ 46,000	$ -	$ -	$ -	
11.8	Chemical Dosing Pipework	0	No.	Allowance	$ 34,000	$ -	$ -	$ -	
11.9	Service Water Pipework	0	No.	Allowance	$ 78,000	$ -	$ -	$ -	
11.10	Odour Pipework	0	No.	Allowance	$ 36,000	$ -	$ -	$ -	
11.11	Scum Pipework	0	No.	Allowance	$ 75,000	$ -	$ -	$ -	
11.12	Effluent Transfer Pipework	0.67	No.	Allowance	$ 150,000	$ 100,000	$ -	$ 100,000	
11.13	Sludge Dewatering Pipework	0	No.	Allowance	$ 130,000	$ -	$ -	$ -	
11.14	Drainage Pipework	0.1	No.	Allowance	$ 27,000	$ 2,700	$ -	$ 2,700	
11.15	Roadworks Drainage Pipework	0.1	No.	Allowance	$ 31,000	$ 3,100	$ -	$ 3,100	

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ITEM		Qty	Unit	Size	Rate	Civil	M&E	Total	
12.0	**Roads, Fencing & Landscaping**								**$ 45,000**
12.1	Earthworks	0.1	No.	Allowance	$ 150,000	$ 15,000	$ -	$ 15,000	
12.2	Paving	0.1	No.	Allowance	$ 66,000	$ 6,600	$ -	$ 6,600	
12.3	Other roadworks, incl. temporary gravel roads	0.1	No.	Allowance	$ 35,000	$ 3,500	$ -	$ 3,500	
12.4	Stormwater drains	0.1	No.	Allowance	$ 92,000	$ 9,200	$ -	$ 9,200	
12.5	Fencing	0.1	No.	Allowance	$ 17,000	$ 1,700	$ -	$ 1,700	
12.6	Landscaping	0.1	No.	Allowance	$ 82,000	$ 8,200	$ -	$ 8,200	
13.0	**General Site Works**								**$ 128,000**
13.1	Bulk earthworks of site (incl. preloading/ flood mitigation)	0.1	No.	Allowance	$ 1,280,000	$ 128,000	$ -	$ 128,000	
13.2	Plant commissioning & performance testing	0	No.	Allowance	$ 330,000	$ -	$ -	$ -	
13.3	Spare parts for mechanical equipment	0	No.	Allowance	$ 30,000	$ -	$ -	$ -	
14.0	**Electrical, Instrumentation & Control**								**$ 104,000**
14.1	Main Switchboard, supply & install	0	No.	Allowance	$ 207,000		$ -	$ -	
14.2	Motor Control Centres, supply & install	0.06	No.	Allowance	$ 409,000		$ 25,000	$ 25,000	
14.3	Distribution Boards and Local Control Stations & VSD's	0.06	No.	Allowance	$ 198,000		$ 12,000	$ 12,000	
14.4	Miscellaneous Control Panels - install	0.06	No.	Allowance	$ 16,000		$ 1,000	$ 1,000	
14.5	Conduits and Pits, supply and install	0.06	No.	Allowance	$ 181,000		$ 11,000	$ 11,000	
14.6	Supply, install and terminate Cabling	0.06	No.	Allowance	$ 232,000		$ 14,000	$ 14,000	
14.7	Other Cabling (Lighting & Earthing)	0	No.	Allowance	$ 112,000		$ -	$ -	
14.8	Instrumentation and Control Cabling	0.06	No.	Allowance	$ 87,000		$ 5,000	$ 5,000	
14.9	Instrumentation	0.06	No.	Allowance	$ 307,000		$ 18,000	$ 18,000	
14.10	PLC and interface with existing SCADA system	0.06	No.	Allowance	$ 171,000		$ 10,000	$ 10,000	
14.11	Software and programming	0.06	No.	Allowance	$ 129,000		$ 8,000	$ 8,000	
14.12	UPS for all essential equipment and controls	0	No.	Allowance	$ 36,000		$ -	$ -	
14.13	SCADA system	0	No.	Allowance	$ 254,000		$ -	$ -	
14.14	Standby Generator	0	No.	Allowance	$ 360,000		$ -	$ -	
	Direct Job Costs (Sub-Total 1)					**$ 4,899,000**	**$ 361,000**		**$ 5,261,000**
	Indirect Job Costs (Preliminaries, Engineering, Site Costs, Project Admin. etc.)	20%	of DJC			$ 979,800	$ 72,200		$ 1,053,000
	Risk and Contingency	25%	of DJC + IJC			$ 1,469,700	$ 108,300		$ 1,579,000
	Head Contractor Margin	5%	of DJC			$ 244,950	$ 18,050		$ 264,000
	PROJECT SUB-TOTAL (Sub-Total 2)					**$ 7,594,000**	**$ 560,000**		**$ 8,157,000**
	TOTAL PROJECT BUDGET					**$ 7,594,000**	**$ 560,000**		**$8,157,000**

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BVSTP Upgrade Cost Estimate_ddh2, Capex - BVSTP_Opt4
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Ocean Shores - Brunswick Valley STP Feasibility Study

Capital Cost Estimate

		Concept Design Option	Construction Year	
Option 5:	**OD**	**25,000 EP (Nominal) Capacity Augmentation**	**2016-17**	**DEFERMENT OF WET WEATHER STORAGE**
		Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)		
		Includes new Aerobic Digester; Excludes Wet Weather Storage		
	5.70	**ML/d Design ADWF**		
	628	**L/s PWWF (nominal) augmentation**		

ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
1.0	**Wet Weather Storage**									**$ -**
1.1		1 no. 20 ML clay-lined earthern storage lagoon	0	no.	Estimate	$ 2,110,000	$ -	$ -	$ -	
1.2		Concrete paved drainage area	0	m2	Estimate	$ 375	$ -	$ -	$ -	
1.2		Inlet/ Outlet Pipework & Valves	0	No.	Allowance	$ 150,000	$ -	$ -	$ -	
1.3		Other minor civils, including overflow structure, culverts, headwalls etc.	0	No.	Allowance	$ 80,000	$ -	$ -	$ -	
1.4		Embankment gravel road. 150 mm thick, 4 m wide	0	m2	Estimate	$ 22	$ -	$ -	$ -	
2.0	**Inlet Works**									**$ 1,043,000**
2.1		Raw influent flow splitter, upstream of inlet works	1	no.	Allowance	$ 270,000	$ 220,000	$ 50,000	$ 270,000	
2.2		Screen on by-pass flow to Wet Weather Storage	0	no.	Estimate for Max. 628 L/s	$ 142,000	$ -	$ -	$ -	
2.2		New inlet channel, grit tank & related - CIVILS	1	no.	Max. 314 L/s	$ 349,000	$ 349,000	$ -	$ 349,000	
2.3		New inlet channel, grit tank & related - METALWORK	1	no.	Ditto	$ 72,000	$ 72,000	$ -	$ 72,000	
2.4		New inlet channel, grit tank & related - MECHANICAL	1	no.	Ditto	$ 298,000	$ -	$ 298,000	$ 298,000	
2.5		Odour Control (odour bed or equivalent filter)	1	no.	Estimate	$ 54,000	$ 36,000	$ 18,000	$ 54,000	
3.0	**Bioreactors**									**$ 2,463,000**
3.1		RAS Flow influent splitter, downstream of inlet works	1	no.	Allowance	$ 215,000	$ 175,000	$ 40,000	$ 215,000	
3.2		New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - CIVILS	1	no.	185 kL Anaerobic; 1665 kL Ox. Ditch (estimate)	$ 1,298,000	$ 1,298,000	$ -	$ 1,298,000	
3.3		New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - METALWORK	1	no.	Estimate	$ 47,000	$ -	$ -		
3.4		New RAS screen and conveyor/ press	1	no.	Allowance, Max. 300 L/s	$ 161,000	$ -	$ 161,000	$ 161,000	
3.5		Aeration equipment, Mixers, RAS & WAS pumps - MECHANICAL	1	no.	Estimate	$ 515,000	$ -	$ 515,000	$ 515,000	
3.6		Aeration testing	1	no.	Allowance	$ 42,000	$ -	$ 42,000	$ 42,000	
3.7		Scum harvester & Scum Pump for Ox. Ditch - MECHANICAL	1	no.	Allowance, 3.6 m long to span channel width	$ 132,000	$ 132,000	$ -	$ 132,000	
3.8		Pipework modifications to outlet of Existing Ox. Ditch	1	no.	Allowance	$ 100,000	$ 100,000	$ -	$ 100,000	

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ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
4.0	**Clarifiers**									**$ 2,246,000**
4.1		Mixed liquor flow splitter	1	no.	Allowance	$ 215,000	$ 215,000	$ -	$ 215,000	
4.2		Secondary Clarifiers - CIVILS (incl. METALWORK)	2	no.	23 m dia, 1.45 ML each (Estimate)	$ 770,000	$ 1,540,000	$ -	$ 1,540,000	
4.3		Secondary Clarifier & RAS P/Stn- MECHANICAL	1	no.	Estimate	$ 427,000	$ -	$ 427,000	$ 427,000	
4.4		RAS Pump Station - CIVILS (incl. METALWORK)	1	no.	Max. 150 L/s (Estimate)	$ 64,000	$ 64,000	$ -	$ 64,000	
5.0	**UV Disinfection**									**$ 745,000**
5.1		UV channels - CIVILS (incl. METALWORK)	1	no.	314 L/s (Estimate)	$ 198,000	$ 198,000	$ -	$ 198,000	
5.2		UV disinfection equipment	1	no.	314 L/s (Estimate); dose 30 mJ/cm^2	$ 490,000	$ -	$ 490,000	$ 490,000	
5.3		UV control/ switchroom building	1	no.	Estimate (Colourbond building, airconditioned)	$ 57,000	$ 57,000	$ -	$ 57,000	
6.0	**Chemical Storage & Dosing**									**$ 575,000**
6.1		Earthworks & Drainage for bunded areas	1	no.	Allowance	$ 12,000	$ 12,000	$ -	$ 12,000	
6.2		Concrete for bunded areas	1	no.	Allowance	$ 134,000	$ 134,000	$ -	$ 134,000	
6.3		Building structure	1	no.	Allowance	$ 108,000	$ 108,000	$ -	$ 108,000	
6.4		Ferric sulphate storage tanks	1	no.	Allowance	$ 57,000	$ 57,000	$ -	$ 57,000	
6.5		Alum storage tanks	1	no.	Allowance	$ 80,000	$ 80,000	$ -	$ 80,000	
6.6		Sodium hydroxide storage tanks	1	no.	Allowance	$ 79,000	$ 79,000	$ -	$ 79,000	
6.7		Chemical dosing skids (pumps and pipework)	3	no.	Allowance	$ 35,000	$ 15,000	$ 90,000	$ 105,000	
6.0	**Tertiary Constructed Wetland (total area ~3 ha)**									**$ 761,000**
6.1		Earthmoving	10,500	m3	Allowance	$ 20	$ 210,000	$ -	$ 210,000	
6.2		Main distributor pipe	300	m	DN 750	$ 800	$ 240,000	$ -	$ 240,000	
6.3		Valves	3	no.	DN 750	$ 10,000	$ 30,000	$ -	$ 30,000	
6.4		Minor distributor pipes	150	m	DN 450	$ 420	$ 63,000	$ -	$ 63,000	
6.5		HDPE (2mm) liner under berms, lineal length x 3 m wide	2400	m2	Allowance	$ 20	$ 48,000	$ -	$ 48,000	
6.6		Planting and initial maintenance	1	no.	Allowance	$ 60,000	$ 60,000	$ -	$ 60,000	
6.7		Other Civils (incl. gravel roads)	1	no.	Allowance	$ 110,000	$ 110,000	$ -	$ 110,000	

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ITEM		Qty	Unit	Size	Rate	Civil	M&E	Total	
7.0	**Aerobic Digester**								**$ 433,000**
7.1	Aeration Tank (incl. internal peipwork & valves) - CIVILS	1	no.	0.25 ML (Estimate)	$ 264,000	$ 264,000	$ -	$ 264,000	
7.2	Aeration System (incl. Blowers) - MECHANICAL	1	no.	Estimate	$ 169,000	$ -	$ 169,000	$ 169,000	
8.0	**Sludge Dewatering & Biosolids Storage**								**$ 1,687,000**
8.1	New Gravity Drainage Deck, Belt Filter Press & Feed Pumps, Conveyors to Sludge Storage - MECHANICAL	1	no.	200 kg/h feed (Estimate)	$ 550,000	$ -	$ 550,000	$ 550,000	
8.2	Sludge dewatering equipment - METALWORK	1	no.	Estimate	$ 24,000	$ 24,000	$ -	$ 24,000	
8.3	Sludge dewatering building - CIVILS	1	no.	Estimate	$ 288,000	$ 288,000	$ -	$ 288,000	
8.4	Polymer Make-up and Dosing System	1	no.	Estimate	$ 50,000	$ -	$ 50,000	$ 50,000	
8.5	Biosolids Storage Facility (Building) - CIVILS	1	no.	Estimate	$ 775,000	$ 775,000	$ -	$ 775,000	
9.0	**Switch Room & Blower Room**								**$ 411,000**
9.1	Switchroom building	1	no.	Estimate	$ 96,000	$ 96,000	$ -	$ 96,000	
9.2	Blower room building	1	no.	Estimate	$ 315,000	$ 315,000	$ -	$ 315,000	
10.0	**Pump Stations (where not included above)**								**$ 210,000**
10.1	Scum Pump Station	1	No.	incl.	$ -	$ -	$ -	$ -	
10.2	Service Water System	1	No.	~5 L/s	$ 92,000	$ 30,000	$ 62,000	$ 92,000	
10.3	General Purpose (Filtrate/ Site Utility) pump station	1	No.	~42 L/s	$ 46,000	$ 16,000	$ 30,000	$ 46,000	
10.4	Wet Weather Storage Return pump station	1	no.	~33 L/s max.	$ 46,000	$ 16,000	$ 30,000	$ 46,000	
10.5	P/Stns Miscellaneous - METALWORK	1	No.	Allowance	$ 26,000	$ 26,000	$ -	$ 26,000	
11.0	**Plant Pipework & Valves**								**$ 1,845,000**
11.1	Pipework to Inlet works	1	No.	Allowance	$ 248,000	$ 248,000	$ -	$ 248,000	
11.2	Inlet works to Bioreactor	1	No.	Allowance	$ 65,000	$ 65,000	$ -	$ 65,000	
11.3	Bioreactor to Clarifiers	1	No.	Allowance	$ 140,000	$ 140,000	$ -	$ 140,000	
11.4	Clarifiers to UV Treatment	1	No.	Allowance	$ 46,000	$ 46,000	$ -	$ 46,000	
11.5	Treated Effluent Pipework	1	No.	Allowance	$ 540,000	$ 540,000	$ -	$ 540,000	
11.6	RAS Pipework	1	No.	Allowance	$ 214,000	$ 214,000	$ -	$ 214,000	
11.7	WAS Pipework	1	No.	Allowance	$ 46,000	$ 46,000	$ -	$ 46,000	
11.8	Chemical Dosing Pipework	1	No.	Allowance	$ 34,000	$ 34,000	$ -	$ 34,000	
11.9	Service Water Pipework	1	No.	Allowance	$ 78,000	$ 78,000	$ -	$ 78,000	
11.10	Odour Pipework	1	No.	Allowance	$ 36,000	$ 36,000	$ -	$ 36,000	
11.11	Scum Pipework	1	No.	Allowance	$ 75,000	$ 75,000	$ -	$ 75,000	
11.12	Effluent Transfer Pipework	0.9	No.	Allowance	$ 150,000	$ 135,000	$ -	$ 135,000	
11.13	Sludge Dewatering Pipework	1	No.	Allowance	$ 130,000	$ 130,000	$ -	$ 130,000	
11.14	Drainage Pipework	1	No.	Allowance	$ 27,000	$ 27,000	$ -	$ 27,000	
11.15	Roadworks Drainage Pipework	1	No.	Allowance	$ 31,000	$ 31,000	$ -	$ 31,000	

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ITEM		Qty	Unit	Size	Rate	Civil	M&E	Total	
12.0	**Roads, Fencing & Landscaping**								**$ 442,000**
12.1	Earthworks	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
12.2	Paving	1	No.	Allowance	$ 66,000	$ 66,000	$ -	$ 66,000	
12.3	Other roadworks, incl. temporary gravel roads	1	No.	Allowance	$ 35,000	$ 35,000	$ -	$ 35,000	
12.4	Stormwater drains	1	No.	Allowance	$ 92,000	$ 92,000	$ -	$ 92,000	
12.5	Fencing	1	No.	Allowance	$ 17,000	$ 17,000	$ -	$ 17,000	
12.6	Landscaping	1	No.	Allowance	$ 82,000	$ 82,000	$ -	$ 82,000	
13.0	**General Site Works**								**$ 1,640,000**
13.1	Bulk earthworks of site (incl. preloading/ flood mitigation)	1	No.	Allowance	$ 1,280,000	$ 1,280,000	$ -	$ 1,280,000	
13.2	Plant commissioning & performance testing	1	No.	Allowance	$ 330,000	$ 165,000	$ 165,000	$ 330,000	
13.3	Spare parts for mechanical equipment	1	No.	Allowance	$ 30,000	$ -	$ 30,000	$ 30,000	
14.0	**Electrical, Instrumentation & Control**								**$ 2,699,000**
14.1	Main Switchboard, supply & install	1	No.	Allowance	$ 207,000		$ 207,000	$ 207,000	
14.2	Motor Control Centres, supply & install	1	No.	Allowance	$ 409,000		$ 409,000	$ 409,000	
14.3	Distribution Boards and Local Control Stations & VSD's	1	No.	Allowance	$ 198,000		$ 198,000	$ 198,000	
14.4	Miscellaneous Control Panels - install	1	No.	Allowance	$ 16,000		$ 16,000	$ 16,000	
14.5	Conduits and Pits, supply and install	1	No.	Allowance	$ 181,000		$ 181,000	$ 181,000	
14.6	Supply, install and terminate Cabling	1	No.	Allowance	$ 232,000		$ 232,000	$ 232,000	
14.7	Other Cabling (Lighting & Earthing)	1	No.	Allowance	$ 112,000		$ 112,000	$ 112,000	
14.8	Instrumentation and Control Cabling	1	No.	Allowance	$ 87,000		$ 87,000	$ 87,000	
14.9	Instrumentation	1	No.	Allowance	$ 307,000		$ 307,000	$ 307,000	
14.10	PLC and interface with existing SCADA system	1	No.	Allowance	$ 171,000		$ 171,000	$ 171,000	
14.11	Software and programming	1	No.	Allowance	$ 129,000		$ 129,000	$ 129,000	
14.12	UPS for all essential equipment and controls	1	No.	Allowance	$ 36,000		$ 36,000	$ 36,000	
14.13	SCADA system	1	No.	Allowance	$ 254,000		$ 254,000	$ 254,000	
14.14	Standby Generator	1	No.	Allowance	$ 360,000		$ 360,000	$ 360,000	
	Direct Job Costs (Sub-Total 1)					**$ 11,284,000**	**$ 5,916,000**		**$ 17,200,000**
	Indirect Job Costs (Preliminaries, Engineering, Site Costs, Project Admin. etc.)	20%	of DJC			$ 2,256,800	$ 1,183,200		$ 3,440,000
	Risk and Contingency	25%	of DJC + IJC			$ 3,385,200	$ 1,774,800		$ 5,160,000
	Head Contractor Margin	5%	of DJC			$ 564,200	$ 295,800		$ 860,000
	PROJECT SUB-TOTAL (Sub-Total 2)					**$ 17,491,000**	**$ 9,170,000**		**$ 26,660,000**
	TOTAL PROJECT BUDGET					**$ 17,491,000**	**$ 9,170,000**		**$26,660,000**

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BVSTP Upgrade Cost Estimate_ddh2, Capex - BVSTP_Opt5
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Ocean Shores - Brunswick Valley STP Feasibility Study

Capital Cost Estimate

Concept Design Option **Construction Year**

Option 6: OD **25,000 EP (Nominal) Capacity Augmentation** **2016-17** **DEFERMENT OF TERTIARY CONSTRUCTED WETLAND**

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)

Includes new Aerobic Digester; Excludes Constructed Wetland

5.70 ML/d Design ADWF

628 L/s PWWF (nominal) augmentation

ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
1.0	**Wet Weather Storage**									**$ 2,526,000**
1.1		1 no. 20 ML clay-lined earthern storage lagoon	1	no.	Estimate	$ 2,110,000	$ 2,110,000	$ -	$ 2,110,000	
1.2		Concrete paved drainage area	375	m2	Estimate	$ 375	$ 141,000	$ -	$ 141,000	
1.2		Inlet/ Outlet Pipework & Valves	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
1.3		Other minor civils, including overflow structure, culverts, headwalls etc.	1	No.	Allowance	$ 80,000	$ 80,000	$ -	$ 80,000	
1.4		Embankment gravel road. 150 mm thick, 4 m wide	2040	m2	Estimate	$ 22	$ 44,880	$ -	$ 44,880	
2.0	**Inlet Works**									**$ 1,185,000**
2.1		Raw influent flow splitter, upstream of inlet works	1	no.	Allowance	$ 270,000	$ 220,000	$ 50,000	$ 270,000	
2.2		Screen on by-pass flow to Wet Weather Storage	1	no.	Estimate for Max. 628 L/s	$ 142,000	$ -	$ 142,000	$ 142,000	
2.2		New inlet channel, grit tank & related - CIVILS	1	no.	Max. 314 L/s	$ 349,000	$ 349,000	$ -	$ 349,000	
2.3		New inlet channel, grit tank & related - METALWORK	1	no.	Ditto	$ 72,000	$ 72,000	$ -	$ 72,000	
2.4		New inlet channel, grit tank & related - MECHANICAL	1	no.	Ditto	$ 298,000	$ -	$ 298,000	$ 298,000	
2.5		Odour Control (odour bed or equivalent filter)	1	no.	Estimate	$ 54,000	$ 36,000	$ 18,000	$ 54,000	
3.0	**Bioreactors**									**$ 2,463,000**
3.1		RAS Flow influent splitter, downstream of inlet works	1	no.	Allowance	$ 215,000	$ 175,000	$ 40,000	$ 215,000	
3.2		New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - CIVILS	1	no.	185 kL Anaerobic; 1665 kL Ox. Ditch (estimate)	$ 1,298,000	$ 1,298,000	$ -	$ 1,298,000	
3.3		New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - METALWORK	1	no.	Estimate	$ 47,000	$ -	$ -		
3.4		New RAS screen and conveyor/ press	1	no.	Allowance, Max. 300 L/s	$ 161,000	$ -	$ 161,000	$ 161,000	
3.5		Aeration equipment, Mixers, RAS & WAS pumps - MECHANICAL	1	no.	Estimate	$ 515,000	$ -	$ 515,000	$ 515,000	
3.6		Aeration testing	1	no.	Allowance	$ 42,000	$ -	$ 42,000	$ 42,000	
3.7		Scum harvester & Scum Pump for Ox. Ditch - MECHANICAL	1	no.	Allowance, 3.6 m long to span channel width	$ 132,000	$ 132,000	$ -	$ 132,000	
3.8		Pipework modifications to outlet of Existing Ox. Ditch	1	no.	Allowance	$ 100,000	$ 100,000	$ -	$ 100,000	

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ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
4.0	**Clarifiers**									**$ 2,246,000**
4.1		Mixed liquor flow splitter	1	no.	Allowance	$ 215,000	$ 215,000	$ -	$ 215,000	
4.2		Secondary Clarifiers - CIVILS (incl. METALWORK)	2	no.	23 m dia, 1.45 ML each (Estimate)	$ 770,000	$ 1,540,000	$ -	$ 1,540,000	
4.3		Secondary Clarifier & RAS P/Stn- MECHANICAL	1	no.	Estimate	$ 427,000	$ -	$ 427,000	$ 427,000	
4.4		RAS Pump Station - CIVILS (incl. METALWORK)	1	no.	Max. 150 L/s (Estimate)	$ 64,000	$ 64,000	$ -	$ 64,000	
5.0	**UV Disinfection**									**$ 745,000**
5.1		UV channels - CIVILS (incl. METALWORK)	1	no.	314 L/s (Estimate)	$ 198,000	$ 198,000	$ -	$ 198,000	
5.2		UV disinfection equipment	1	no.	314 L/s (Estimate); dose 30 mJ/cm^2	$ 490,000	$ -	$ 490,000	$ 490,000	
5.3		UV control/ switchroom building	1	no.	Estimate (Colourbond building, airconditioned)	$ 57,000	$ 57,000	$ -	$ 57,000	
6.0	**Chemical Storage & Dosing**									**$ 575,000**
6.1		Earthworks & Drainage for bunded areas	1	no.	Allowance	$ 12,000	$ 12,000	$ -	$ 12,000	
6.2		Concrete for bunded areas	1	no.	Allowance	$ 134,000	$ 134,000	$ -	$ 134,000	
6.3		Building structure	1	no.	Allowance	$ 108,000	$ 108,000	$ -	$ 108,000	
6.4		Ferric sulphate storage tanks	1	no.	Allowance	$ 57,000	$ 57,000	$ -	$ 57,000	
6.5		Alum storage tanks	1	no.	Allowance	$ 80,000	$ 80,000	$ -	$ 80,000	
6.6		Sodium hydroxide storage tanks	1	no.	Allowance	$ 79,000	$ 79,000	$ -	$ 79,000	
6.7		Chemical dosing skids (pumps and pipework)	3	no.	Allowance	$ 35,000	$ 15,000	$ 90,000	$ 105,000	
6.0	**Tertiary Constructed Wetland (total area ~3 ha)**									**$ -**
6.1		Earthmoving	-	m3	Allowance	$ 20	$ -	$ -	$ -	
6.2		Main distributor pipe	0	m	DN 750	$ 800	$ -	$ -	$ -	
6.3		Valves	0	no.	DN 750	$ 10,000	$ -	$ -	$ -	
6.4		Minor distributor pipes	0	m	DN 450	$ 420	$ -	$ -	$ -	
6.5		HDPE (2mm) liner under berms, lineal length x 3 m wide	0	m2	Allowance	$ 20	$ -	$ -	$ -	
6.6		Planting and initial maintenance	0	no.	Allowance	$ 60,000	$ -	$ -	$ -	
6.7		Other Civils (incl. gravel roads)	0	no.	Allowance	$ 110,000	$ -	$ -	$ -	

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BVSTP Upgrade Cost Estimate_ddh2, Capex - BVSTP_Opt6
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ITEM		Qty	Unit	Size	Rate	Civil	M&E	Total	
7.0	**Aerobic Digester**								**$ 433,000**
7.1	Aeration Tank (incl. internal peipwork & valves) - CIVILS	1	no.	0.25 ML (Estimate)	$ 264,000	$ 264,000	$ -	$ 264,000	
7.2	Aeration System (incl. Blowers) - MECHANICAL	1	no.	Estimate	$ 169,000	$ -	$ 169,000	$ 169,000	
8.0	**Sludge Dewatering & Biosolids Storage**								**$ 1,687,000**
8.1	New Gravity Drainage Deck, Belt Filter Press & Feed Pumps, Conveyors to Sludge Storage - MECHANICAL	1	no.	200 kg/h feed (Estimate)	$ 550,000	$ -	$ 550,000	$ 550,000	
8.2	Sludge dewatering equipment - METALWORK	1	no.	Estimate	$ 24,000	$ 24,000	$ -	$ 24,000	
8.3	Sludge dewatering building - CIVILS	1	no.	Estimate	$ 288,000	$ 288,000	$ -	$ 288,000	
8.4	Polymer Make-up and Dosing System	1	no.	Estimate	$ 50,000	$ -	$ 50,000	$ 50,000	
8.5	Biosolids Storage Facility (Building) - CIVILS	1	no.	Estimate	$ 775,000	$ 775,000	$ -	$ 775,000	
9.0	**Switch Room & Blower Room**								**$ 411,000**
9.1	Switchroom building	1	no.	Estimate	$ 96,000	$ 96,000	$ -	$ 96,000	
9.2	Blower room building	1	no.	Estimate	$ 315,000	$ 315,000	$ -	$ 315,000	
10.0	**Pump Stations (where not included above)**								**$ 210,000**
10.1	Scum Pump Station	1	No.	incl.	$ -	$ -	$ -	$ -	
10.2	Service Water System	1	No.	~5 L/s	$ 92,000	$ 30,000	$ 62,000	$ 92,000	
10.3	General Purpose (Filtrate/ Site Utility) pump station	1	No.	~42 L/s	$ 46,000	$ 16,000	$ 30,000	$ 46,000	
10.4	Wet Weather Storage Return pump station	1	no.	~33 L/s max.	$ 46,000	$ 16,000	$ 30,000	$ 46,000	
10.5	P/Stns Miscellaneous - METALWORK	1	No.	Allowance	$ 26,000	$ 26,000	$ -	$ 26,000	
11.0	**Plant Pipework & Valves**								**$ 1,845,000**
11.1	Pipework to Inlet works	1	No.	Allowance	$ 248,000	$ 248,000	$ -	$ 248,000	
11.2	Inlet works to Bioreactor	1	No.	Allowance	$ 65,000	$ 65,000	$ -	$ 65,000	
11.3	Bioreactor to Clarifiers	1	No.	Allowance	$ 140,000	$ 140,000	$ -	$ 140,000	
11.4	Clarifiers to UV Treatment	1	No.	Allowance	$ 46,000	$ 46,000	$ -	$ 46,000	
11.5	Treated Effluent Pipework	1	No.	Allowance	$ 540,000	$ 540,000	$ -	$ 540,000	
11.6	RAS Pipework	1	No.	Allowance	$ 214,000	$ 214,000	$ -	$ 214,000	
11.7	WAS Pipework	1	No.	Allowance	$ 46,000	$ 46,000	$ -	$ 46,000	
11.8	Chemical Dosing Pipework	1	No.	Allowance	$ 34,000	$ 34,000	$ -	$ 34,000	
11.9	Service Water Pipework	1	No.	Allowance	$ 78,000	$ 78,000	$ -	$ 78,000	
11.10	Odour Pipework	1	No.	Allowance	$ 36,000	$ 36,000	$ -	$ 36,000	
11.11	Scum Pipework	1	No.	Allowance	$ 75,000	$ 75,000	$ -	$ 75,000	
11.12	Effluent Transfer Pipework	0.9	No.	Allowance	$ 150,000	$ 135,000	$ -	$ 135,000	
11.13	Sludge Dewatering Pipework	1	No.	Allowance	$ 130,000	$ 130,000	$ -	$ 130,000	
11.14	Drainage Pipework	1	No.	Allowance	$ 27,000	$ 27,000	$ -	$ 27,000	
11.15	Roadworks Drainage Pipework	1	No.	Allowance	$ 31,000	$ 31,000	$ -	$ 31,000	

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ITEM		Qty	Unit	Size	Rate	Civil	M&E	Total	
12.0	**Roads, Fencing & Landscaping**								$ 442,000
12.1	Earthworks	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
12.2	Paving	1	No.	Allowance	$ 66,000	$ 66,000	$ -	$ 66,000	
12.3	Other roadworks, incl. temporary gravel roads	1	No.	Allowance	$ 35,000	$ 35,000	$ -	$ 35,000	
12.4	Stormwater drains	1	No.	Allowance	$ 92,000	$ 92,000	$ -	$ 92,000	
12.5	Fencing	1	No.	Allowance	$ 17,000	$ 17,000	$ -	$ 17,000	
12.6	Landscaping	1	No.	Allowance	$ 82,000	$ 82,000	$ -	$ 82,000	
13.0	**General Site Works**								$ 1,512,000
13.1	Bulk earthworks of site (incl. preloading/ flood mitigation)	0.9	No.	Allowance	$ 1,280,000	$ 1,152,000	$ -	$ 1,152,000	
13.2	Plant commissioning & performance testing	1	No.	Allowance	$ 330,000	$ 165,000	$ 165,000	$ 330,000	
13.3	Spare parts for mechanical equipment	1	No.	Allowance	$ 30,000	$ -	$ 30,000	$ 30,000	
14.0	**Electrical, Instrumentation & Control**								$ 2,699,000
14.1	Main Switchboard, supply & install	1	No.	Allowance	$ 207,000		$ 207,000	$ 207,000	
14.2	Motor Control Centres, supply & install	1	No.	Allowance	$ 409,000		$ 409,000	$ 409,000	
14.3	Distribution Boards and Local Control Stations & VSD's	1	No.	Allowance	$ 198,000		$ 198,000	$ 198,000	
14.4	Miscellaneous Control Panels - install	1	No.	Allowance	$ 16,000		$ 16,000	$ 16,000	
14.5	Conduits and Pits, supply and install	1	No.	Allowance	$ 181,000		$ 181,000	$ 181,000	
14.6	Supply, install and terminate Cabling	1	No.	Allowance	$ 232,000		$ 232,000	$ 232,000	
14.7	Other Cabling (Lighting & Earthing)	1	No.	Allowance	$ 112,000		$ 112,000	$ 112,000	
14.8	Instrumentation and Control Cabling	1	No.	Allowance	$ 87,000		$ 87,000	$ 87,000	
14.9	Instrumentation	1	No.	Allowance	$ 307,000		$ 307,000	$ 307,000	
14.10	PLC and interface with existing SCADA system	1	No.	Allowance	$ 171,000		$ 171,000	$ 171,000	
14.11	Software and programming	1	No.	Allowance	$ 129,000		$ 129,000	$ 129,000	
14.12	UPS for all essential equipment and controls	1	No.	Allowance	$ 36,000		$ 36,000	$ 36,000	
14.13	SCADA system	1	No.	Allowance	$ 254,000		$ 254,000	$ 254,000	
14.14	Standby Generator	1	No.	Allowance	$ 360,000		$ 360,000	$ 360,000	
	Direct Job Costs (Sub-Total 1)					**$ 12,921,000**	**$ 6,058,000**		**$ 18,979,000**
	Indirect Job Costs (Preliminaries, Engineering, Site Costs, Project Admin. etc.)	20%	of DJC			$ 2,584,200	$ 1,211,600		$ 3,796,000
	Risk and Contingency	25%	of DJC + IJC			$ 3,876,300	$ 1,817,400		$ 5,694,000
	Head Contractor Margin	5%	of DJC			$ 646,050	$ 302,900		$ 949,000
	PROJECT SUB-TOTAL (Sub-Total 2)					**$ 20,028,000**	**$ 9,390,000**		**$ 29,418,000**
	TOTAL PROJECT BUDGET					**$ 20,028,000**	**$ 9,390,000**		**$29,418,000**

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Ocean Shores - Brunswick Valley STP Feasibility Study

Capital Cost Estimate

Concept Design Option **Construction Year**

Option 7: OD **25,000 EP (Nominal) Capacity Augmentation** **2016-17** **DEFERMENT OF NEW SLUDGE DEWATERING FACILITIES**

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)

Includes new Aerobic Digester; Excludes new Sludge Dewatering Facilities (but Includes New Sludge Storage Area)

5.70 ML/d Design ADWF

628 L/s PWWF (nominal) augmentation

	ITEM		Qty	Unit	Size	Rate	Civil	M&E	Total	
1.0	**Wet Weather Storage**									**$ 2,526,000**
1.1		1 no. 20 ML clay-lined earthern storage lagoon	1	no.	Estimate	$ 2,110,000	$ 2,110,000	$ -	$ 2,110,000	
1.2		Concrete paved drainage area	375	m2	Estimate	$ 375	$ 141,000	$ -	$ 141,000	
1.2		Inlet/ Outlet Pipework & Valves	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
1.3		Other minor civils, including overflow structure, culverts, headwalls etc.	1	No.	Allowance	$ 80,000	$ 80,000	$ -	$ 80,000	
1.4		Embankment gravel road. 150 mm thick, 4 m wide	2040	m2	Estimate	$ 22	$ 44,880	$ -	$ 44,880	
2.0	**Inlet Works**									**$ 1,185,000**
2.1		Raw influent flow splitter, upstream of inlet works	1	no.	Allowance	$ 270,000	$ 220,000	$ 50,000	$ 270,000	
2.2		Screen on by-pass flow to Wet Weather Storage	1	no.	Estimate for Max. 628 L/s	$ 142,000	$ -	$ 142,000	$ 142,000	
2.2		New inlet channel, grit tank & related - CIVILS	1	no.	Max. 314 L/s	$ 349,000	$ 349,000	$ -	$ 349,000	
2.3		New inlet channel, grit tank & related - METALWORK	1	no.	Ditto	$ 72,000	$ 72,000	$ -	$ 72,000	
2.4		New inlet channel, grit tank & related - MECHANICAL	1	no.	Ditto	$ 298,000	$ -	$ 298,000	$ 298,000	
2.5		Odour Control (odour bed or equivalent filter)	1	no.	Estimate	$ 54,000	$ 36,000	$ 18,000	$ 54,000	
3.0	**Bioreactors**									**$ 2,463,000**
3.1		RAS Flow influent splitter, downstream of inlet works	1	no.	Allowance	$ 215,000	$ 175,000	$ 40,000	$ 215,000	
3.2		New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - CIVILS	1	no.	185 kL Anaerobic; 1665 kL Ox. Ditch (estimate)	$ 1,298,000	$ 1,298,000	$ -	$ 1,298,000	
3.3		New Oxidation Ditch bioreactors (includes Anaerobic & Ox. Ditch reactors) - METALWORK	1	no.	Estimate	$ 47,000	$ -	$ -		
3.4		New RAS screen and conveyor/ press	1	no.	Allowance, Max. 300 L/s	$ 161,000	$ -	$ 161,000	$ 161,000	
3.5		Aeration equipment, Mixers, RAS & WAS pumps - MECHANICAL	1	no.	Estimate	$ 515,000	$ -	$ 515,000	$ 515,000	
3.6		Aeration testing	1	no.	Allowance	$ 42,000	$ -	$ 42,000	$ 42,000	
3.7		Scum harvester & Scum Pump for Ox. Ditch - MECHANICAL	1	no.	Allowance, 3.6 m long to span channel width	$ 132,000	$ 132,000	$ -	$ 132,000	
3.8		Pipework modifications to outlet of Existing Ox. Ditch	1	no.	Allowance	$ 100,000	$ 100,000	$ -	$ 100,000	

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ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
4.0	**Clarifiers**									**$ 2,246,000**
4.1		Mixed liquor flow splitter	1	no.	Allowance	$ 215,000	$ 215,000	$ -	$ 215,000	
4.2		Secondary Clarifiers - CIVILS (incl. METALWORK)	2	no.	23 m dia, 1.45 ML each (Estimate)	$ 770,000	$ 1,540,000	$ -	$ 1,540,000	
4.3		Secondary Clarifier & RAS P/Stn- MECHANICAL	1	no.	Estimate	$ 427,000	$ -	$ 427,000	$ 427,000	
4.4		RAS Pump Station - CIVILS (incl. METALWORK)	1	no.	Max. 150 L/s (Estimate)	$ 64,000	$ 64,000	$ -	$ 64,000	
5.0	**UV Disinfection**									**$ 745,000**
5.1		UV channels - CIVILS (incl. METALWORK)	1	no.	314 L/s (Estimate)	$ 198,000	$ 198,000	$ -	$ 198,000	
5.2		UV disinfection equipment	1	no.	314 L/s (Estimate); dose 30 mJ/cm^2	$ 490,000	$ -	$ 490,000	$ 490,000	
5.3		UV control/ switchroom building	1	no.	Estimate (Colourbond building, airconditioned)	$ 57,000	$ 57,000	$ -	$ 57,000	
6.0	**Chemical Storage & Dosing**									**$ 575,000**
6.1		Earthworks & Drainage for bunded areas	1	no.	Allowance	$ 12,000	$ 12,000	$ -	$ 12,000	
6.2		Concrete for bunded areas	1	no.	Allowance	$ 134,000	$ 134,000	$ -	$ 134,000	
6.3		Building structure	1	no.	Allowance	$ 108,000	$ 108,000	$ -	$ 108,000	
6.4		Ferric sulphate storage tanks	1	no.	Allowance	$ 57,000	$ 57,000	$ -	$ 57,000	
6.5		Alum storage tanks	1	no.	Allowance	$ 80,000	$ 80,000	$ -	$ 80,000	
6.6		Sodium hydroxide storage tanks	1	no.	Allowance	$ 79,000	$ 79,000	$ -	$ 79,000	
6.7		Chemical dosing skids (pumps and pipework)	3	no.	Allowance	$ 35,000	$ 15,000	$ 90,000	$ 105,000	
6.0	**Tertiary Constructed Wetland (total area ~3 ha)**									**$ 761,000**
6.1		Earthmoving	10,500	m3	Allowance	$ 20	$ 210,000	$ -	$ 210,000	
6.2		Main distributor pipe	300	m	DN 750	$ 800	$ 240,000	$ -	$ 240,000	
6.3		Valves	3	no.	DN 750	$ 10,000	$ 30,000	$ -	$ 30,000	
6.4		Minor distributor pipes	150	m	DN 450	$ 420	$ 63,000	$ -	$ 63,000	
6.5		HDPE (2mm) liner under berms, lineal length x 3 m wide	2400	m2	Allowance	$ 20	$ 48,000	$ -	$ 48,000	
6.6		Planting and initial maintenance	1	no.	Allowance	$ 60,000	$ 60,000	$ -	$ 60,000	
6.7		Other Civils (incl. gravel roads)	1	no.	Allowance	$ 110,000	$ 110,000	$ -	$ 110,000	

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ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
7.0	**Aerobic Digester**									**$ 433,000**
7.1		Aeration Tank (incl. internal peipwork & valves) - CIVILS	1	no.	0.25 ML (Estimate)	$ 264,000	$ 264,000	$ -	$ 264,000	
7.2		Aeration System (incl. Blowers) - MECHANICAL	1	no.	Estimate	$ 169,000	$ -	$ 169,000	$ 169,000	
8.0	**Sludge Dewatering & Biosolids Storage**									**$ 885,000**
8.1		New Gravity Drainage Deck, Belt Filter Press & Feed Pumps, Conveyors to Sludge Storage - MECHANICAL	0.2	no.	200 kg/h feed (Estimate)	$ 550,000	$ -	$ 110,000	$ 110,000	
8.2		Sludge dewatering equipment - METALWORK	0	no.	Estimate	$ 24,000	$ -	$ -	$ -	
8.3		Sludge dewatering building - CIVILS	0	no.	Estimate	$ 288,000	$ -	$ -	$ -	
8.4		Polymer Make-up and Dosing System	0	no.	Estimate	$ 50,000	$ -	$ -	$ -	
8.5		Biosolids Storage Facility (Building) - CIVILS	1	no.	Estimate	$ 775,000	$ 775,000	$ -	$ 775,000	
9.0	**Switch Room & Blower Room**									**$ 411,000**
9.1		Switchroom building	1	no.	Estimate	$ 96,000	$ 96,000	$ -	$ 96,000	
9.2		Blower room building	1	no.	Estimate	$ 315,000	$ 315,000	$ -	$ 315,000	
10.0	**Pump Stations (where not included above)**									**$ 210,000**
10.1		Scum Pump Station	1	No.	incl.	$ -	$ -	$ -	$ -	
10.2		Service Water System	1	No.	~5 L/s	$ 92,000	$ 30,000	$ 62,000	$ 92,000	
10.3		General Purpose (Filtrate/ Site Utility) pump station	1	No.	~42 L/s	$ 46,000	$ 16,000	$ 30,000	$ 46,000	
10.4		Wet Weather Storage Return pump station	1	no.	~33 L/s max.	$ 46,000	$ 16,000	$ 30,000	$ 46,000	
10.5		P/Stns Miscellaneous - METALWORK	1	No.	Allowance	$ 26,000	$ 26,000	$ -	$ 26,000	
11.0	**Plant Pipework & Valves**									**$ 1,729,000**
11.1		Pipework to Inlet works	1	No.	Allowance	$ 248,000	$ 248,000	$ -	$ 248,000	
11.2		Inlet works to Bioreactor	1	No.	Allowance	$ 65,000	$ 65,000	$ -	$ 65,000	
11.3		Bioreactor to Clarifiers	1	No.	Allowance	$ 140,000	$ 140,000	$ -	$ 140,000	
11.4		Clarifiers to UV Treatment	1	No.	Allowance	$ 46,000	$ 46,000	$ -	$ 46,000	
11.5		Treated Effluent Pipework	1	No.	Allowance	$ 540,000	$ 540,000	$ -	$ 540,000	
11.6		RAS Pipework	1	No.	Allowance	$ 214,000	$ 214,000	$ -	$ 214,000	
11.7		WAS Pipework	1	No.	Allowance	$ 46,000	$ 46,000	$ -	$ 46,000	
11.8		Chemical Dosing Pipework	1	No.	Allowance	$ 34,000	$ 34,000	$ -	$ 34,000	
11.9		Service Water Pipework	1	No.	Allowance	$ 78,000	$ 78,000	$ -	$ 78,000	
11.10		Odour Pipework	1	No.	Allowance	$ 36,000	$ 36,000	$ -	$ 36,000	
11.11		Scum Pipework	1	No.	Allowance	$ 75,000	$ 75,000	$ -	$ 75,000	
11.12		Effluent Transfer Pipework	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
11.13		Sludge Dewatering Pipework	0	No.	Allowance	$ 130,000	$ -	$ -	$ -	
11.14		Drainage Pipework	0.95	No.	Allowance	$ 27,000	$ 26,000	$ -	$ 26,000	
11.15		Roadworks Drainage Pipework	1	No.	Allowance	$ 31,000	$ 31,000	$ -	$ 31,000	

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ITEM		Qty	Unit	Size	Rate	Civil	M&E	Total	
12.0	**Roads, Fencing & Landscaping**								**$ 442,000**
12.1	Earthworks	1	No.	Allowance	$ 150,000	$ 150,000	$ -	$ 150,000	
12.2	Paving	1	No.	Allowance	$ 66,000	$ 66,000	$ -	$ 66,000	
12.3	Other roadworks, incl. temporary gravel roads	1	No.	Allowance	$ 35,000	$ 35,000	$ -	$ 35,000	
12.4	Stormwater drains	1	No.	Allowance	$ 92,000	$ 92,000	$ -	$ 92,000	
12.5	Fencing	1	No.	Allowance	$ 17,000	$ 17,000	$ -	$ 17,000	
12.6	Landscaping	1	No.	Allowance	$ 82,000	$ 82,000	$ -	$ 82,000	
13.0	**General Site Works**								**$ 1,576,000**
13.1	Bulk earthworks of site (incl. preloading/ flood mitigation)	0.95	No.	Allowance	$ 1,280,000	$ 1,216,000	$ -	$ 1,216,000	
13.2	Plant commissioning & performance testing	1	No.	Allowance	$ 330,000	$ 165,000	$ 165,000	$ 330,000	
13.3	Spare parts for mechanical equipment	1	No.	Allowance	$ 30,000	$ -	$ 30,000	$ 30,000	
14.0	**Electrical, Instrumentation & Control**								**$ 2,514,800**
14.1	Main Switchboard, supply & install	1	No.	Allowance	$ 207,000		$ 207,000	$ 207,000	
14.2	Motor Control Centres, supply & install	0.9	No.	Allowance	$ 409,000		$ 368,100	$ 368,100	
14.3	Distribution Boards and Local Control Stations & VSD's	0.9	No.	Allowance	$ 198,000		$ 178,200	$ 178,200	
14.4	Miscellaneous Control Panels - install	0.9	No.	Allowance	$ 16,000		$ 14,400	$ 14,400	
14.5	Conduits and Pits, supply and install	0.9	No.	Allowance	$ 181,000		$ 162,900	$ 162,900	
14.6	Supply, install and terminate Cabling	0.9	No.	Allowance	$ 232,000		$ 208,800	$ 208,800	
14.7	Other Cabling (Lighting & Earthing)	0.9	No.	Allowance	$ 112,000		$ 100,800	$ 100,800	
14.8	Instrumentation and Control Cabling	0.9	No.	Allowance	$ 87,000		$ 78,300	$ 78,300	
14.9	Instrumentation	0.9	No.	Allowance	$ 307,000		$ 276,300	$ 276,300	
14.10	PLC and interface with existing SCADA system	0.9	No.	Allowance	$ 171,000		$ 153,900	$ 153,900	
14.11	Software and programming	0.9	No.	Allowance	$ 129,000		$ 116,100	$ 116,100	
14.12	UPS for all essential equipment and controls	1	No.	Allowance	$ 36,000		$ 36,000	$ 36,000	
14.13	SCADA system	1	No.	Allowance	$ 254,000		$ 254,000	$ 254,000	
14.14	Standby Generator	1	No.	Allowance	$ 360,000		$ 360,000	$ 360,000	
	Direct Job Costs (Sub-Total 1)					**$ 13,318,000**	**$ 5,384,000**		**$ 18,702,000**
	Indirect Job Costs (Preliminaries, Engineering, Site Costs, Project Admin. etc.)	20%	of DJC			$ 2,663,600	$ 1,076,800		$ 3,741,000
	Risk and Contingency	25%	of DJC + IJC			$ 3,995,400	$ 1,615,200		$ 5,611,000
	Head Contractor Margin	5%	of DJC			$ 665,900	$ 269,200		$ 936,000
	PROJECT SUB-TOTAL (Sub-Total 2)					**$ 20,643,000**	**$ 8,346,000**		**$ 28,990,000**
	TOTAL PROJECT BUDGET					**$ 20,643,000**	**$ 8,346,000**		**$28,990,000**

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Appendix J Capital cost estimates breakdown for OSSTP upgrade

Ocean Shores STP (Values here from GHD 2014 Planning Study; GHD Job no. 41/27528 Doc. 462193)

Cost Estimate **Concept Design Option**

Construction Year

Option 2: OD **New 5-stage 'Phoredox' Oxidation Ditch Process** **2016-17**

With Anaerobic, Secondary Anoxic & Secondary Aerobic Reactors

Includes Effluent Filtration, Effluent Storage (in modified existing IAT), and Aerobic Digester (modified existing DAT)

2.30 ML/d Design ADWF

232 L/s PWWF

ITEM			Qty	Unit	Size	Rate	Civil	M&E	Total	
1.0	**Inlet Works**									**$ 509,000**
1.1		New Step Screen & Conveyor/ Press	1	no.	Max. 270 L/s	$ 155,000	$ -	$ 155,000	$ 155,000	
1.2		New Grit Tank (concrete)	1	no.	3.05 m diameter	$ 178,000	$ 178,000	$ -	$ 178,000	
1.3		New Grit Tank mechanical equipment and pipework (Airlift Pumps & related)	1	no.	To suit grit tank, Max. 270 L/s	$ 150,000	$ -	$ 150,000	$ 150,000	
1.4		New bins and bagging systems for screenings and grit	2	no.	2 kL bins	$ 13,000	$ 22,000	$ 4,000	$ 26,000	
2.0	**Flow Splitter**									**$ 204,000**
2.1		Refurbishment (weirs, penstocks etc.)	1	no.	Allowance	$ 99,000	$ 99,000	$ -	$ 99,000	
2.2		Pipework modifications	1	no.	Allowance	$ 50,000	$ 50,000	$ -	$ 50,000	
2.3		Valves	4	no.	DN 375 gate valves	$ 10,000	$ -	$ 40,000	$ 40,000	
2.4		Grating and handrails (modifications)	1	no.	Allowance	$ 12,000	$ 12,000	$ -	$ 12,000	
2.5		Level transmitter	1	no.	Allowance	$ 3,000	$ -	$ 3,000	$ 3,000	
3.0	**Stormflow (wet weather storage)**									**$ 231,000**
3.1		Cleanout of existing Catch Pond	1	no.	Allowance	$ 28,000	$ 28,000	$ -	$ 28,000	
3.2		Floor slab modifications for return pump station	1	no.	Allowance	$ 34,000	$ 34,000	$ -	$ 34,000	
3.3		Return pump station	1	no.	13 L/s, ~10 m head, ~3 kW	$ 93,000	$ 74,000	$ 19,000	$ 93,000	
3.4		Elevated walkway to return p/stn, incl. handrails etc.	1	no.	Allowance	$ 65,000	$ 65,000	$ -	$ 65,000	
3.5		Davits for return pumps on walkway	2	no.	Estimate	$ 4,000	$ -	$ 8,000	$ 8,000	
3.6		Level transmitter	1	no.	Allowance	$ 3,000	$ -	$ 3,000	$ 3,000	

4.0	**Bioreactors**									**$ 4,378,000**
4.1		New Oxidation Ditch bioreactors (includes Anaerobic, Ox. Ditch and Sec. Anoxic & Sec. Aerobic reactors)	1	no.	190 kL Anaerobic; 2320 kL Ox. Ditch; 190 kL each Sec. Anoxic & Sec. Aerobic Tanks (Estimate)	$ 2,980,000	$ 2,980,000	$ -	$ 2,980,000	
4.2		New RAS screen and conveyor/ press	1	no.	Max. 100 L/s	$ 108,000	$ 108,000	$ -	$ 108,000	
4.3		RAS valves & pipework for alternative process configurations (UCT/ Phoredox)	2	no.	DN 300 gate valves, tee piece, pipe penetrations etc.	$ 116,000	$ 232,000	$ -	$ 232,000	
4.4		Mixers for Anaerobic reactor	3	no.	0.375kW	$ 5,000	$ -	$ 15,000	$ 15,000	
4.5		Aeration system for Ox. Ditch	1	no.	Max. 2050 Nm3/h (Estimate)	$ 400,000	$ -	$ 400,000	$ 400,000	
4.6		Aeration testing	1	no.	Allowance	$ 42,000	$ -	$ 42,000	$ 42,000	
4.7		Blowers for Ox. Ditch	3	no.	22 kW (estimate)	$ 45,000	$ -	$ 135,000	$ 135,000	
4.8		Submersible aerators for Sec. Aerobic reactor	2	no.	11 kW (estimate)	$ 31,000	$ -	$ 62,000	$ 62,000	
4.9		Mixers for Ox. Ditch	4	no.	5.5 kW	$ 34,000	$ -	$ 136,000	$ 136,000	
4.10		Mixers for Sec. Anoxic reactor	1	no.	1.1 kW	$ 11,000	$ 8,800	$ 2,200	$ 11,000	
4.11		Scum harvester for Ox. Ditch	1	no.	4.5m long to span channel width	$ 114,000	$ 97,000	$ 17,000	$ 114,000	
4.12		WAS pump station	1	no.	4 L/s (estimate)	$ 125,000	$ 107,000	$ 18,000	$ 125,000	
4.13		Instrumentation (DO, pH, Temp, Susp. Solids meters)	6	no.	Estimate	$ 3,000	$ -	$ 18,000	$ 18,000	
5.0	**Clarifiers**									**$ 2,272,000**
5.1		Mixed liquor flow splitter (incl. penstocks)	1	no.	Allowance	$ 82,000	$ 82,000	$ -	$ 82,000	
5.2		Secondary Clarifiers	2	no.	21 m dia, 1.4 ML each (Estimate)	$ 744,000	$ 1,042,000	$ 446,000	$ 1,488,000	
5.3		Piles for Secondary Clarifiers (2 no.)	44	no.	Estimate	$ 4,400	$ 194,000	$ -	$ 194,000	
5.4		RAS Pump Stations	2	no.	Max. 80 L/s each (Estimate)	$ 245,000	$ 392,000	$ 98,000	$ 490,000	
5.5		RAS flow meters	2	no.	Estimate	$ 6,000	$ -	$ 12,000	$ 12,000	
5.6		RAS suspended solids meters	2	no.	Estimate	$ 3,000	$ -	$ 6,000	$ 6,000	
6.0	**Effluent Filtration**									**$ 1,174,000**
6.1		Preliminary earthworks	1	no.	Allowance	$ 30,000	*$ 30,000*	-	*$ 30,000*	
6.2		Secondary Effluent Pump Station	1	no.	Allowance	$ 141,000	$ 112,800	$ 28,200	$ 141,000	
6.3		Secondary Effluent Wet Well/ Flow Splitter	1	no.	incl.	$ -	$ -	$ -	$ -	
6.4		Cloth Media Disc Filters (incl. Backwash Pumps)	1	no.	Max. 108 L/s (Estimate)	$ 824,000	$ -	$ 824,000	$ 824,000	
6.5		Elevated support structure for filters, incl. fabricated steelwork for handrails, stairs etc.	1	no.	Allowance	$ 175,000	$ 50,000	$ 125,000	$ 175,000	
6.6		Backwash line flow meter	1	no.	Estimate	$ 4,000	$ -	$ 4,000	$ 4,000	

7.0	**Effluent Storage Tank**									**$ 513,000**
7.1		Modifications to existing tank (IAT) internals (pipework & ex-aerator supports)	1	no.	Allowance	$ 23,000	$ 23,000	$ -	$ 23,000	
7.2		New colorbond roof covers on existing IAT, incl. steel roof truss supports	570	m2	Estimate	$ 790	$ 450,000	$ -	$ 450,000	
7.3		Modifications to IAT tank outlet/ Pit no. 3 and removal of	1	no.	Allowance	$ 20,000	$ 20,000	$ -	$ 20,000	
7.4		New Pipework connections	1	no.	Allowance	$ 20,000	$ 20,000	$ -	$ 20,000	
8.0	**UV Disinfection**									**$ 1,063,000**
8.1		UV channels	1	no.	240 L/s (Estimate)	$ 258,000	$ 258,000	$ -	$ 258,000	
8.2		UV disinfection equipment	1	no.	240 L/s (Estimate); dose 30 mJ/cm^2	$ 720,000	$ -	$ 720,000	$ 720,000	
8.3		UV control/ switchroom building	1	no.	Estimate (Colourbond building, airconditioned)	$ 85,000	$ 85,000	$ -	$ 85,000	
9.0	**Chemical Storage & Dosing**									**$ 402,000**
9.1		Alum Storage Facility (incl. Bunding)	1	no.	Estimate	$ 189,000	$ 189,000	$ -	$ 189,000	
9.2		Alum Dosing Pumps, skid & pipework	1	no.	Estimate	$ 29,000	$ -	$ 29,000	$ 29,000	
9.3		Alum Bund Sump Pump	1	no.	Estimate	$ 5,000	$ -	$ 5,000	$ 5,000	
9.4		Sodium Hydroxide Storage Facility (incl. Bunding)	1	no.	Estimate	$ 147,000	$ 147,000	$ -	$ 147,000	
9.5		Sodium Hydroxide Dosing Pumps, skid & pipework	1	no.	Estimate	$ 27,000	$ -	$ 27,000	$ 27,000	
9.6		Sodium Hydroxide Sump Pump	1	no.	Estimate	$ 5,000	$ -	$ 5,000	$ 5,000	
10.0	**Aerobic Digester**									**$ 469,000**
10.1		Modifications to existing tank (DAT) internals (pipework & ex-aerator supports)	1	no.	Allowance	$ 23,000	$ 23,000	$ -	$ 23,000	
10.2		Aeration System	1	no.	Max. 418 Nm3/h (Estimate)	$ 228,000	$ -	$ 228,000	$ 228,000	
10.3		Blowers for digester	2	no.	7.5 kW (Estimate)	$ 23,000	$ -	$ 46,000	$ 46,000	
10.4		Decanter mechanism (for supernatant withdrawal)	1	no.	~11 L/s, Allowance	$ 82,000	$ -	$ 82,000	$ 82,000	
10.5		Internal pipework & valves	1	no.	Allowance	$ 90,000	$ 90,000	$ -	$ 90,000	

10.0	**Sludge Dewatering & Biosolids Storage**									**$ 1,327,000**
10.1		New Gravity Drainage Deck & Belt Filter Press	1	no.	175 kg/h feed (Estimate)	$ 330,000	$ -	$ 330,000	$ 330,000	
10.2		Sludge Feed Pump Station	1	no.	6 L/s (Estimate)	$ 125,000	$ 100,000	$ 25,000	$ 125,000	
10.3		Washwater Pump Station	1	no.	3 L/s (Estimate)	$ 70,000	$ 56,000	$ 14,000	$ 70,000	
10.4		Polymer Make-up and Dosing System	1	no.	4 kg/d, 4 L/min (Estimate)	$ 50,000	$ -	$ 50,000	$ 50,000	
10.5		Dewatering Building	1	no.	200 m2 (Allowance)	$ 400,000	$ 400,000	$ -	$ 400,000	
10.6		Biosolids Cake Conveyors (to Storage Facility)	2	no.	10 m L (Allowance)	$ 20,000	$ -	$ 40,000	$ 40,000	
10.7		Biosolids Storage Facility	1	no.	200 m2 (Allowance)	$ 312,000	$ 312,000	$ -	$ 312,000	
11.0	**Switchroom & Blower Room**									**$ 800,000**
11.1		Switchroom building	1	no.	150 m2	$ 360,000	$ 360,000	$ -	$ 360,000	
11.2		Blower room building	1	no.	250 m2	$ 440,000	$ 440,000	$ -	$ 440,000	
12.0	**Pump Stations (where not included above)**									**$ 259,000**
12.1		Scum Pump Station	1	No.	~1 L/s	$ 44,000	$ 35,000	$ 9,000	$ 44,000	
12.2		Service Water System	1	No.	~5 L/s	$ 97,000	$ 78,000	$ 19,000	$ 97,000	
12.3		General Purpose (Site Utility) pump station	1	No.	~20 L/s	$ 118,000	$ 94,000	$ 24,000	$ 118,000	
13.0	**Plant Pipework & Valves**									**$ 1,441,000**
13.1		Flow splitter to Anaerobic Reactor	60	m	DICL DN 450	$ 720	$ 43,200	$ -	$ 43,200	
13.2		Flow splitter to Stormflow Lagoon (wet weather by-pass)	100	m	DICL DN 450	$ 720	$ 72,000	$ -	$ 72,000	
13.3		Anaerobic Reactor to Ox Ditch	1	no.	Allowance	$ 50,000	$ 50,000	$ -	$ 50,000	
13.4		Oxidation Ditch to Anoxic Reactor	1	no.	Allowance	$ 50,000	$ 50,000	$ -	$ 50,000	
13.5		Secondary Reactor to Flow Splitter	35	m	DICL DN 500	$ 900	$ 31,500	$ -	$ 31,500	
13.6		Flow Splitter to Sec. Clarifiers (2 no.)	40	m	DICL DN 450	$ 720	$ 28,800	$ -	$ 28,800	
13.7		Sec. Clarifiers (2 no.) to UV	40	m	DICL DN 300	$ 400	$ 16,000	$ -	$ 16,000	
13.8		Sec. Clarifiers (Combined) to UV	20	m	DICL DN 450	$ 720	$ 14,400	$ -	$ 14,400	
13.9		UV to Effluent Outfall	150	m	DICL DN 500	$ 900	$ 135,000	$ -	$ 135,000	
14.00		Allowance for all other pipework & valves on plant	1	No.	Allowance	$ 1,000,000	$ 1,000,000	$ -	$ 1,000,000	
14.0	**Roads, Car Park, Fencing & Landscaping**									**$ 480,000**
14.1		Earthworks	1	No.	Allowance	$ 79,000	$ 79,000	$ -	$ 79,000	
14.2		Paving	1	No.	Allowance	$ 233,000	$ 233,000	$ -	$ 233,000	
14.3		Road Kerbing	1	No.	Allowance	$ 51,000	$ 51,000	$ -	$ 51,000	
14.4		Signs	1	No.	Allowance	$ 3,000	$ 3,000	$ -	$ 3,000	
14.5		Fencing	1	No.	Allowance	$ 50,000	$ 50,000	$ -	$ 50,000	
14.6		Landscaping	1	No.	Allowance	$ 64,000	$ 64,000	$ -	$ 64,000	

15.0	**General Site Works**								**$ 300,000**
15.1	Plant commissioning	1	No.	Allowance	$ 300,000	$ 150,000	$ 150,000	$ 300,000	
16.0	**Electrical and Instrumentation**								**$ 2,781,000**
16.1	Conduits (100mm PVC)	2%					$ 47,000	$ 47,000	
16.2	Pits	3%					$ 85,000	$ 85,000	
16.3	Supply, Install and Terminate Cables	21%					$ 579,000	$ 579,000	
16.4	Switchboards	3%					$ 84,000	$ 84,000	
16.5	Motor Control Centres (MCC's)	13%					$ 359,000	$ 359,000	
16.6	Motor Starters	5%					$ 129,000	$ 129,000	
16.7	Local Controls	2%					$ 54,000	$ 54,000	
16.8	Instrumentation	9%					$ 248,000	$ 248,000	
16.9	PLCs	3%					$ 73,000	$ 73,000	
16.10	SCADA system incl. programming	4%					$ 107,000	$ 107,000	
16.11	PCs in Control Room	1%					$ 17,000	$ 17,000	
16.12	Substation	1%					$ 19,000	$ 19,000	
16.13	Standby Generator	20%					$ 548,000	$ 548,000	
16.14	Lighting	4%					$ 101,000	$ 101,000	
16.15	Other Items	12%					$ 331,000	$ 331,000	
	Direct Job Costs (Sub-Total 1)					**$ 11,249,000**	**$ 7,355,000**		**$ 18,603,000**
	Indirect Job Costs (Engineering, Site Costs, Project Administration etc.)	20%	of DJC			$ 2,249,800	$ 1,471,000		$ 3,721,000
	Risk and Contingency	30%	of DJC + IJC			$ 4,049,640	$ 2,647,800		$ 6,698,000
	Head Contractor Margin	10%	of DJC			$ 1,124,900	$ 735,500		$ 1,861,000
	PROJECT SUB-TOTAL (Sub-Total 2)					**$ 18,674,000**	**$ 12,210,000**		**$ 30,883,000**
	TOTAL PROJECT BUDGET					**$ 18,674,000**	**$ 12,210,000**		**$30,883,000**

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Appendix K Operating cost estimates

Ocean Shores- Brunswick Valley STP Feasibility Study
BVSTP Operating Cost Estimate at Design Flow & Load

Option 1: OD **25,000 EP (Nominal) Capacity Augmentation**
Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)
Includes new Aerobic Digester
5.70 ML/d Design ADWF
628 L/s PWWF (nominal) augmentation

	ITEM				Qty/Yr	Unit	Rate	Total		Comments
1.0	**Staff Expenses**								**$ 180,000**	
1.1	Operator salary (Includes O'heads)				1	no.	$ 120,000	$ 120,000		One FTE full-time operators
1.2	Other staff costs				0.5	no.	$ 120,000	$ 60,000		Part-time of one FTE for support staff (collectively)
2.0	**Chemical Expenses**	Ave L/d	SG kg/L	Ave kg/d					**$ 224,000**	
2.1	Alum	671	1.31	879	321	tonne	$ 271	$ 86,984		
2.2	Polymer			5.6	2.1	tonne	$ 9,000	$ 18,478		
2.3	Sodium Hydroxide	177	1.50	265	97	tonne	$ 660	$ 63,926		
2.4	Ferric Sulphate	150	1.58	237	87	tonne	$ 623	$ 53,979		
3.0	**Electricity Expenses**	Design EP	Ave kW	Hrs/yr	kWh/(EP.y)	$/kWh	kWh/Yr		**$ 214,000**	
	Total plant power	25,000	128	8,760	45.0	$ 0.190	1,124,266	$ 213,611		
4.0	**Sludge Disposal Expenses**	Ave. g/(EP/d)	Cake ds	Ave. kg/d ds					**$ 153,000**	
4.1	Contractor sludge disposal	50	12%	1250	3802	wet tonne	$ 40	$ 152,083		Conservative estimate, range ~$20 to $35/ wet tonne based on information supplied by Byron Shire Council for current disposal costs
5.0	**Other Operating Costs**								**$ 85,000**	
5.1	Allowance (for various)							$ 85,000		
6.0	**Maintenance Expenses**								**$ 226,000**	
6.1	Civil maintenance (new)	Total Civils	$ 13,825,000			-	0.4%	$ 55,300		Civil maintenance costs assumed to be 0.4% of capital costs (new structures)
6.2	M&E maintenance (new)	Total M&E	$ 6,058,000			-	2.4%	$ 145,392		M&E/I maintenance costs assumed to be 2.4% of capital costs (new M&E/I)
6.3	Lagoon/ wetland maintenance	Allowance			1	no.	$ 25,000	$ 25,000		Approx. wetland maintenance costs (2013-14) at Byron STP
							TOTAL		**$ 1,082,000**	**per year**
							Total $/ML		**$ 520**	**per kL**

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Ocean Shores- Brunswick Valley STP Feasibility Study
BVSTP Operating Cost Estimate at Flow & Load in year 2035-36 (projected)

Option 1: OD **18,000 EP (Nominal) Loading in year 2035-36**
Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration); one clarifier deferred
Includes new Aerobic Digester
4.32 ML/d Design ADWF
628 L/s PWWF (nominal) augmentation

ITEM					Qty/Yr	Unit	Rate	Total		Comments
1.0	**Staff Expenses**								**$ 180,000**	
1.1	Operator salary (Includes O'heads)				1	no.	$ 120,000	$ 120,000		One FTE full-time operators
1.2	Other staff costs				0.5	no.	$ 120,000	$ 60,000		Part-time of one FTE for support staff (collectively)
2.0	**Chemical Expenses**	Ave L/d	SG kg/L	Ave kg/d					**$ 171,000**	
2.1	Alum	509	1.31	666	243	tonne	$ 271	$ 65,925		
2.2	Polymer			4.5	1.6	tonne	$ 9,000	$ 14,783		
2.3	Sodium Hydroxide	134	1.50	201	73	tonne	$ 660	$ 48,449		
2.4	Ferric Sulphate	114	1.58	180	66	tonne	$ 623	$ 40,911		
3.0	**Electricity Expenses**	Operating EP	Ave kW	Hrs/yr	kWh/(EP.y)	$/kWh	kWh/Yr		**$ 222,000**	
	Total plant power	20,000	133	8,760	58.2	$ 0.190	1,163,488	$ 221,063		
4.0	**Sludge Disposal Expenses**	Ave. g/(EP/d)	Cake ds	Ave. kg/d ds					**$ 122,000**	
4.1	Contractor sludge disposal	50	12%	1000	3042	wet tonne	$ 40	$ 121,667		Conservative estimate, range ~$20 to $35/ wet tonne based on information supplied by Byron Shire Council for current disposal costs
5.0	**Other Operating Costs**								**$ 85,000**	
5.1	Allowance (for various)							$ 85,000		
6.0	**Maintenance Expenses**								**$ 226,000**	
6.1	Civil maintenance (new)	Total Civils	$ 13,825,000			-	0.4%	$ 55,300		Civil maintenance costs assumed to be 0.4% of capital costs (new structures)
6.2	M&E maintenance (new)	Total M&E	$ 6,058,000			-	2.4%	$ 145,392		M&E/I maintenance costs assumed to be 2.4% of capital costs (new M&E/I)
6.3	Lagoon/ wetland maintenance	Allowance			1	no.	$ 25,000	$ 25,000		Approx. wetland maintenance costs (2013-14) at Byron STP
							TOTAL		**$ 1,006,000**	**per year**
							Total $/ML		**$ 638**	**per kL**

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Ocean Shores- Brunswick Valley STP Feasibility Study
BVSTP Operating Cost Estimate at Design Flow & Load

Option 2: OD **25,000 EP (Nominal) Capacity Augmentation**
Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)
Includes new Aerobic Digester
5.70 ML/d Design ADWF
628 L/s PWWF (nominal) augmentation

	ITEM				Qty/Yr	Unit	Rate	Total		Comments
1.0	**Staff Expenses**								**$ 180,000**	
1.1	Operator salary (Includes O'heads)				1	no.	$ 120,000	$ 120,000		One FTE full-time operators
1.2	Other staff costs				0.5	no.	$ 120,000	$ 60,000		Part-time of one FTE for support staff (collectively)
2.0	**Chemical Expenses**	Ave L/d	SG kg/L	Ave kg/d					**$ 224,000**	
2.1	Alum	671	1.31	879	321	tonne	$ 271	$ 86,984		
2.2	Polymer			5.6	2.1	tonne	$ 9,000	$ 18,478		
2.3	Sodium Hydroxide	177	1.50	265	97	tonne	$ 660	$ 63,926		
2.4	Ferric Sulphate	150	1.58	237	87	tonne	$ 623	$ 53,979		
3.0	**Electricity Expenses**	Design EP	Ave kW	Hrs/yr	kWh/(EP.y)	$/kWh	kWh/Yr		**$ 214,000**	
	Total plant power	25,000	128	8,760	45.0	$ 0.190	1,124,266	$ 213,611		
4.0	**Sludge Disposal Expenses**	Ave. g/(EP/d)	Cake ds	Ave. kg/d ds					**$ 153,000**	
4.1	Contractor sludge disposal	50	12%	1250	3802	wet tonne	$ 40	$ 152,083		Conservative estimate, range ~$20 to $35/ wet tonne based on information supplied by Byron Shire Council for current disposal costs
5.0	**Other Operating Costs**								**$ 85,000**	
5.1	Allowance (for various)							$ 85,000		
6.0	**Maintenance Expenses**								**$ 226,000**	
6.1	Civil maintenance (new)	Total Civils	$ 13,825,000			-	0.4%	$ 55,300		Civil maintenance costs assumed to be 0.4% of capital costs (new structures)
6.2	M&E maintenance (new)	Total M&E	$ 6,058,000			-	2.4%	$ 145,392		M&E/I maintenance costs assumed to be 2.4% of capital costs (new M&E/I)
6.3	Lagoon/ wetland maintenance	Allowance			1	no.	$ 25,000	$ 25,000		Approx. wetland maintenance costs (2013-14) at Byron STP
							TOTAL		**$ 1,082,000**	**per year**
							Total $/ML		**$ 520**	**per kL**

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Ocean Shores- Brunswick Valley STP Feasibility Study

BVSTP Operating Cost Estimate at Flow & Load in year 2035-36 (projected)

Option 2: OD 18,000 EP (Nominal) Capacity Augmentation
Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration); one new clarifier deferred
Includes new Aerobic Digester
4.32 ML/d Design ADWF
628 L/s PWWF (nominal) augmentation

	ITEM				Qty/Yr	Unit	Rate	Total		Comments
1.0	**Staff Expenses**								**$ 180,000**	
1.1	Operator salary (Includes O'heads)				1	no.	$ 120,000	$ 120,000		One FTE full-time operators
1.2	Other staff costs				0.5	no.	$ 120,000	$ 60,000		Part-time of one FTE for support staff (collectively)
2.0	**Chemical Expenses**	Ave L/d	SG kg/L	Ave kg/d					**$ 170,000**	
2.1	Alum	509	1.31	666	243	tonne	$ 271	$ 65,925		
2.2	Polymer			4.3	1.6	tonne	$ 9,000	$ 14,043		
2.3	Sodium Hydroxide	134	1.50	201	73	tonne	$ 660	$ 48,449		
2.4	Ferric Sulphate	114	1.58	180	66	tonne	$ 623	$ 40,911		
3.0	**Electricity Expenses**	Design EP	Ave kW	Hrs/yr	kWh/(EP.y)	$/kWh	kWh/Yr		**$ 159,000**	
	Total plant power	19,000	95	8,760	44.0	$ 0.190	835,442	$ 158,734		
4.0	**Sludge Disposal Expenses**	Ave. g/(EP/d)	Cake ds	Ave. kg/d ds					**$ 116,000**	
4.1	Contractor sludge disposal	50	12%	950	2890	wet tonne	$ 40	$ 115,583		Conservative estimate, range ~$20 to $35/ wet tonne based on information supplied by Byron Shire Council for current disposal costs
5.0	**Other Operating Costs**								**$ 85,000**	
5.1	Allowance (for various)							$ 85,000		
6.0	**Maintenance Expenses**								**$ 215,000**	
6.1	Civil maintenance (new)	Total Civils	$ 12,556,000			-	0.4%	$ 50,224		Civil maintenance costs assumed to be 0.4% of capital costs (new structures)
6.2	M&E maintenance (new)	Total M&E	$ 5,790,000			-	2.4%	$ 138,960		M&E/I maintenance costs assumed to be 2.4% of capital costs (new M&E/I)
6.3	Lagoon/ wetland maintenance	Allowance			1	no.	$ 25,000	$ 25,000		Approx. wetland maintenance costs (2013-14) at Byron STP
							TOTAL		**$ 925,000**	**per year**
							Total $/ML		**$ 587**	**per kL**

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Ocean Shores- Brunswick Valley STP Feasibility Study
BVSTP Operating Cost Estimate at Design Flow & Load

Option 3: OD **25,000 EP (Nominal) Capacity Augmentation**
Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration); decreased wet weather storage volume
Includes new Aerobic Digester
5.70 ML/d Design ADWF
628 L/s PWWF (nominal) augmentation

	ITEM				Qty/Yr	Unit	Rate	Total		Comments
1.0	**Staff Expenses**								**$ 180,000**	
1.1	Operator salary (Includes O'heads)				1	no.	$ 120,000	$ 120,000		One FTE full-time operators
1.2	Other staff costs				0.5	no.	$ 120,000	$ 60,000		Part-time of one FTE for support staff (collectively)
2.0	**Chemical Expenses**	Ave L/d	SG kg/L	Ave kg/d					**$ 224,000**	
2.1	Alum	671	1.31	879	321	tonne	$ 271	$ 86,984		
2.2	Polymer			5.6	2.1	tonne	$ 9,000	$ 18,478		
2.3	Sodium Hydroxide	177	1.50	265	97	tonne	$ 660	$ 63,926		
2.4	Ferric Sulphate	150	1.58	237	87	tonne	$ 623	$ 53,979		
3.0	**Electricity Expenses**	Design EP	Ave kW	Hrs/yr	kWh/(EP.y)	$/kWh	kWh/Yr		**$ 214,000**	
	Total plant power	25,000	128	8,760	45.0	$ 0.190	1,124,266	$ 213,611		
4.0	**Sludge Disposal Expenses**	Ave. g/(EP/d)	Cake ds	Ave. kg/d ds					**$ 153,000**	
4.1	Contractor sludge disposal	50	12%	1250	3802	wet tonne	$ 40	$ 152,083		Conservative estimate, range ~$20 to $35/ wet tonne based on information supplied by Byron Shire Council for current disposal costs
5.0	**Other Operating Costs**								**$ 85,000**	
5.1	Allowance (for various)							$ 85,000		
6.0	**Maintenance Expenses**								**$ 223,000**	
6.1	Civil maintenance (new)	Total Civils	$ 13,082,000			-	0.4%	$ 52,328		Civil maintenance costs assumed to be 0.4% of capital costs (new structures)
6.2	M&E maintenance (new)	Total M&E	$ 6,058,000			-	2.4%	$ 145,392		M&E/I maintenance costs assumed to be 2.4% of capital costs (new M&E/I)
6.3	Lagoon/ wetland maintenance	Allowance			1	no.	$ 25,000	$ 25,000		Approx. wetland maintenance costs (2013-14) at Byron STP
							TOTAL		**$ 1,079,000**	**per year**
							Total $/ML		**$ 519**	**per kL**

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Ocean Shores- Brunswick Valley STP Feasibility Study

BVSTP Operating Cost Estimate at Design Flow & Load

Option 4: OD **25,000 EP (Nominal) Capacity Augmentation**

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration); major plant process capacity upgrade deferred (to 2032-33)

Includes new Aerobic Digester

5.70 ML/d Design ADWF

628 L/s PWWF (nominal) augmentation

ITEM					Qty/Yr	Unit	Rate	Total		Comments
1.0	**Staff Expenses**								**$ 180,000**	
1.1	Operator salary (Includes O'heads)				1	no.	$ 120,000	$ 120,000		One FTE full-time operators
1.2	Other staff costs				0.5	no.	$ 120,000	$ 60,000		Part-time of one FTE for support staff (collectively)
2.0	**Chemical Expenses**	Ave L/d	SG kg/L	Ave kg/d					**$ 224,000**	
2.1	Alum	671	1.31	879	321	tonne	$ 271	$ 86,984		
2.2	Polymer			5.6	2.1	tonne	$ 9,000	$ 18,478		
2.3	Sodium Hydroxide	177	1.50	265	97	tonne	$ 660	$ 63,926		
2.4	Ferric Sulphate	150	1.58	237	87	tonne	$ 623	$ 53,979		
3.0	**Electricity Expenses**	Design EP	Ave kW	Hrs/yr	kWh/(EP.y)	$/kWh	kWh/Yr		**$ 214,000**	
	Total plant power	25,000	128	8,760	45.0	$ 0.190	1,124,266	$ 213,611		
4.0	**Sludge Disposal Expenses**	Ave. g/(EP/d)	Cake ds	Ave. kg/d ds					**$ 153,000**	
4.1	Contractor sludge disposal	50	12%	1250	3802	wet tonne	$ 40	$ 152,083		Conservative estimate, range ~$20 to $35/ wet tonne based on information supplied by Byron Shire Council for current disposal costs
5.0	**Other Operating Costs**								**$ 85,000**	
5.1	Allowance (for various)							$ 85,000		
6.0	**Maintenance Expenses**								**$ 226,000**	
6.1	Civil maintenance (new)	Total Civils	$ 13,825,000			-	0.4%	$ 55,300		Civil maintenance costs assumed to be 0.4% of capital costs (new structures)
6.2	M&E maintenance (new)	Total M&E	$ 6,058,000			-	2.4%	$ 145,392		M&E/I maintenance costs assumed to be 2.4% of capital costs (new M&E/I)
6.3	Lagoon/ wetland maintenance	Allowance			1	no.	$ 25,000	$ 25,000		Approx. wetland maintenance costs (2013-14) at Byron STP
							TOTAL		**$ 1,082,000**	**per year**
							Total $/ML		**$ 520**	**per kL**

Ocean Shores- Brunswick Valley STP Feasibility Study

BVSTP Operating Cost Estimate at Flow & Load in year 2035-36 (projected)

Option 4: OD **18,000 EP (Nominal) Loading in year 2035-36 on Existing plant (~114% of Existing Design Load)**

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)

4.32 ML/d Design ADWF

628 L/s PWWF (nominal) augmentation (by-pass of flows >314 L/s to wet weather storage)

	ITEM				Qty/Yr	Unit	Rate	Total		Comments
1.0	**Staff Expenses**								**$ 180,000**	
1.1	Operator salary (Includes O'heads)				1	no.	$ 120,000	$ 120,000		One FTE full-time operators
1.2	Other staff costs				0.5	no.	$ 120,000	$ 60,000		Part-time of one FTE for support staff (collectively)
2.0	**Chemical Expenses**	Ave L/d	SG kg/L	Ave kg/d					**$ 171,000**	
2.1	Alum	509	1.31	666	243	tonne	$ 271	$ 65,925		
2.2	Polymer			4.7	1.7	tonne	$ 9,000	$ 15,374		
2.3	Sodium Hydroxide	134	1.50	201	73	tonne	$ 660	$ 48,449		
2.4	Ferric Sulphate	114	1.58	180	66	tonne	$ 623	$ 40,911		
3.0	**Electricity Expenses**	Design EP	Ave kW	Hrs/yr	kWh/(EP.y)	$/kWh	kWh/Yr		**$ 167,000**	
	Total plant power	20,000	100	8,760	43.9	$ 0.190	878,518	$ 166,918		
4.0	**Sludge Disposal Expenses**	Ave. g/(EP/d)	Cake ds	Ave. kg/d ds					**$ 127,000**	
4.1	Contractor sludge disposal	52	12%	1040	3163	wet tonne	$ 40	$ 126,533		Conservative estimate, range ~$20 to $35/ wet tonne based on information supplied by Byron Shire Council for current disposal costs
5.0	**Other Operating Costs**								**$ 85,000**	
5.1	Allowance (for various)							$ 85,000		
6.0	**Maintenance Expenses**								**$ 61,000**	
6.1	Civil maintenance (new)	Total Civils	$ 4,899,000			-	0.5%	$ 24,495		Civil maintenance costs assumed to be 0.5% of capital costs (new structures)
6.2	M&E maintenance (new)	Total M&E	$ 361,000			-	3.0%	$ 10,830		M&E/I maintenance costs assumed to be 3.0% of capital costs (new M&E/I)
6.3	Lagoon/ wetland maintenance	Allowance			1	no.	$ 25,000	$ 25,000		Approx. wetland maintenance costs (2013-14) at Byron STP
							TOTAL		**$ 791,000**	**per year**
							Total $/ML		**$ 502**	**per kL**

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Ocean Shores- Brunswick Valley STP Feasibility Study
BVSTP Operating Cost Estimate at Design Flow & Load

Option 5: OD **25,000 EP (Nominal) Capacity Augmentation**
Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration); indefinitely defer/ eliminate wet weather storage
Includes new Aerobic Digester
5.70 ML/d Design ADWF
628 L/s PWWF (nominal) augmentation

	ITEM				Qty/Yr	Unit	Rate	Total		Comments
1.0	**Staff Expenses**								**$ 180,000**	
1.1	Operator salary (Includes O'heads)				1	no.	$ 120,000	$ 120,000		One FTE full-time operators
1.2	Other staff costs				0.5	no.	$ 120,000	$ 60,000		Part-time of one FTE for support staff (collectively)
2.0	**Chemical Expenses**	Ave L/d	SG kg/L	Ave kg/d					**$ 224,000**	
2.1	Alum	671	1.31	879	321	tonne	$ 271	$ 86,984		
2.2	Polymer			5.6	2.1	tonne	$ 9,000	$ 18,478		
2.3	Sodium Hydroxide	177	1.50	265	97	tonne	$ 660	$ 63,926		
2.4	Ferric Sulphate	150	1.58	237	87	tonne	$ 623	$ 53,979		
3.0	**Electricity Expenses**	Design EP	Ave kW	Hrs/yr	kWh/(EP.y)	$/kWh	kWh/Yr		**$ 214,000**	
	Total plant power	25,000	128	8,760	45.0	$ 0.190	1,124,266	$ 213,611		
4.0	**Sludge Disposal Expenses**	Ave. g/(EP/d)	Cake ds	Ave. kg/d ds					**$ 153,000**	
4.1	Contractor sludge disposal	50	12%	1250	3802	wet tonne	$ 40	$ 152,083		Conservative estimate, range ~$20 to $35/ wet tonne based on information supplied by Byron Shire Council for current disposal costs
5.0	**Other Operating Costs**								**$ 85,000**	
5.1	Allowance (for various)							$ 85,000		
6.0	**Maintenance Expenses**								**$ 213,000**	
6.1	Civil maintenance (new)	Total Civils	$ 11,284,000			-	0.4%	$ 45,136		Civil maintenance costs assumed to be 0.4% of capital costs (new structures)
6.2	M&E maintenance (new)	Total M&E	$ 5,916,000			-	2.4%	$ 141,984		M&E/I maintenance costs assumed to be 2.4% of capital costs (new M&E/I)
6.3	Lagoon/ wetland maintenance	Allowance			1	no.	$ 25,000	$ 25,000		Approx. wetland maintenance costs (2013-14) at Byron STP
							TOTAL		**$ 1,069,000**	**per year**
							Total $/ML		**$ 514**	**per kL**

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Ocean Shores- Brunswick Valley STP Feasibility Study
BVSTP Operating Cost Estimate at Design Flow & Load

Option 6: OD **25,000 EP (Nominal) Capacity Augmentation**
Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration); indefinitely defer/ eliminate wetland
Includes new Aerobic Digester
5.70 ML/d Design ADWF
628 L/s PWWF (nominal) augmentation

	ITEM				Qty/Yr	Unit	Rate	Total		Comments
1.0	**Staff Expenses**								**$ 180,000**	
1.1	Operator salary (Includes O'heads)				1	no.	$ 120,000	$ 120,000		One FTE full-time operators
1.2	Other staff costs				0.5	no.	$ 120,000	$ 60,000		Part-time of one FTE for support staff (collectively)
2.0	**Chemical Expenses**	Ave L/d	SG kg/L	Ave kg/d					**$ 224,000**	
2.1	Alum	671	1.31	879	321	tonne	$ 271	$ 86,984		
2.2	Polymer			5.6	2.1	tonne	$ 9,000	$ 18,478		
2.3	Sodium Hydroxide	177	1.50	265	97	tonne	$ 660	$ 63,926		
2.4	Ferric Sulphate	150	1.58	237	87	tonne	$ 623	$ 53,979		
3.0	**Electricity Expenses**	Design EP	Ave kW	Hrs/yr	kWh/(EP.y)	$/kWh	kWh/Yr		**$ 214,000**	
	Total plant power	25,000	128	8,760	45.0	$ 0.190	1,124,266	$ 213,611		
4.0	**Sludge Disposal Expenses**	Ave. g/(EP/d)	Cake ds	Ave. kg/d ds					**$ 153,000**	
4.1	Contractor sludge disposal	50	12%	1250	3802	wet tonne	$ 40	$ 152,083		Conservative estimate, range ~$20 to $35/ wet tonne based on information supplied by Byron Shire Council for current disposal costs
5.0	**Other Operating Costs**								**$ 85,000**	
5.1	Allowance (for various)							$ 85,000		
6.0	**Maintenance Expenses**								**$ 198,000**	
6.1	Civil maintenance (new)	Total Civils	$ 12,921,000			-	0.4%	$ 51,684		Civil maintenance costs assumed to be 0.4% of capital costs (new structures)
6.2	M&E maintenance (new)	Total M&E	$ 6,058,000			-	2.4%	$ 145,392		M&E/I maintenance costs assumed to be 2.4% of capital costs (new M&E/I)
							TOTAL		**$ 1,054,000**	**per year**
							Total $/ML		**$ 507**	**per kL**

Ocean Shores- Brunswick Valley STP Feasibility Study
BVSTP Operating Cost Estimate at Design Flow & Load

Option 7: OD **25,000 EP (Nominal) Capacity Augmentation**
Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration); indefinitely defer/ eliminate new sludge dewaterting facilities
Includes new Aerobic Digester
5.70 ML/d Design ADWF
628 L/s PWWF (nominal) augmentation

	ITEM				Qty/Yr	Unit	Rate	Total		Comments
1.0	**Staff Expenses**								**$ 180,000**	
1.1	Operator salary (Includes O'heads)				1	no.	$ 120,000	$ 120,000		One FTE full-time operators
1.2	Other staff costs				0.5	no.	$ 120,000	$ 60,000		Part-time of one FTE for support staff (collectively)
2.0	**Chemical Expenses**	Ave L/d	SG kg/L	Ave kg/d					**$ 224,000**	
2.1	Alum	671	1.31	879	321	tonne	$ 271	$ 86,984		
2.2	Polymer			5.6	2.1	tonne	$ 9,000	$ 18,478		
2.3	Sodium Hydroxide	177	1.50	265	97	tonne	$ 660	$ 63,926		
2.4	Ferric Sulphate	150	1.58	237	87	tonne	$ 623	$ 53,979		
3.0	**Electricity Expenses**	Design EP	Ave kW	Hrs/yr	kWh/(EP.y)	$/kWh	kWh/Yr		**$ 214,000**	
	Total plant power	25,000	128	8,760	45.0	$ 0.190	1,124,266	$ 213,611		
4.0	**Sludge Disposal Expenses**	Ave. g/(EP/d)	Cake ds	Ave. kg/d ds					**$ 153,000**	
4.1	Contractor sludge disposal	50	12%	1250	3802	wet tonne	$ 40	$ 152,083		Conservative estimate, range ~$20 to $35/ wet tonne based on information supplied by Byron Shire Council for current disposal costs
5.0	**Other Operating Costs**								**$ 85,000**	
5.1	Allowance (for various)							$ 85,000		
6.0	**Maintenance Expenses**								**$ 208,000**	
6.1	Civil maintenance (new)	Total Civils	$ 13,318,000			-	0.4%	$ 53,272		Civil maintenance costs assumed to be 0.4% of capital costs (new structures)
6.2	M&E maintenance (new)	Total M&E	$ 5,384,000			-	2.4%	$ 129,216		M&E/I maintenance costs assumed to be 2.4% of capital costs (new M&E/I)
6.3	Lagoon/ wetland maintenance	Allowance			1	no.	$ 25,000	$ 25,000		Approx. wetland maintenance costs (2013-14) at Byron STP
							TOTAL		**$ 1,064,000**	**per year**
							Total $/ML		**$ 511**	**per kL**

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Ocean Shores STP (Values here from GHD (2014b) Planning Study; *except Maintenance costs adjusted to align with the BVSTP Transfer Feasibility Study here*)

Operating Cost Estimate at Design Flow & Load

Option 2: **OD** **New 5-stage 'Phoredox' Oxidation Ditch Process**

With Anaerobic, Secondary Anoxic & Secondary Aerobic Reactors

Excludes Effluent Filtration, but includes Effluent Storage (in modified existing IAT), and Aerobic Digester (modified existing DAT)

2.30 ML/d Design ADWF

232 L/s PWWF

ITEM					Qty/Yr	Unit	Rate	Total		Comments
1.0	**Staff Expenses**								**$ 120,000**	
1.1	Operator salary (Includes O'heads)				0.5	no.	$ 120,000	$ 60,000		One FTE full-time operators
1.2	Other staff costs				0.5	no.	$ 120,000	$ 60,000		Part-time of one FTE for support staff (collectively)
2.0	**Chemical Expenses**	Ave L/d	SG kg/L	Ave kg/d					**$ 68,000**	
2.1	Alum	271	1.31	355	130	tonne	$ 271	$ 35,099		After upgrading, 2 mgP/L removal; Before upgrading, 4.5 mgP/L using alum
2.2	Polymer			2.0	0.7	tonne	$ 9,000	$ 6,726		Assuming 4.5 kg poly/ t d.s. biosolids procecessed
2.3	Sodium Hydroxide	71	1.50	107	39	tonne	$ 660	$ 25,795		To match alkalinity loss from alum dosing (see above)
3.0	**Electricity Expenses**	Design EP	Ave kW	Hrs/yr	kWh/(EP.y)	$/kWh	kWh/Yr		**$ 85,000**	
	Total plant power	9,100	47	8,760	45.0	$ 0.190	409,233	$ 77,754		After upgrading
					71.5					Before upgrading
		ADWF, ML/d	Ave kW	Hrs/yr	kWh/ML					
	Effluent transfer	2.18	12	2,920	45.0	$ 0.190	35,872	$ 6,816		
4.0	**Sludge Disposal Expenses**	Ave. g/(EP/d)	Cake ds	Ave. kg/d ds					**$ 141,000**	
4.1	Contractor sludge disposal	50	12%	455	1384	wet tonne	$ 40	$ 55,358		supplied by Byron Shire Council for current disposal costs
5.0	**Other Operating Costs**								**$ 85,000**	
5.1	Allowance (for various)							$ 85,000		
5.0	**Maintenance Expenses**								**$ 265,000**	After plant upgrade
5.1	Civil maintenance (new)	Total Civils	$ 10,346,000			-	0.5%	$ 51,730		Civil maintenance costs assumed to be 0.5% of capital costs (new structures)
5.2	M&E maintenance (new)	Total M&E	$ 6,146,000			-	3.0%	$ 184,380		M&E/I maintenance costs assumed to be 3.0% of capital costs (new M&E/I)
5.3	Civil maintenance (existing)	Civils	$ 1,600,000				0.5%	$ 8,000		Civil maintenance costs assumed to be 0.5% of replacment capital cost
5.4	Lagoon/ wetland maintenance	Allowance			1	no.	$ 20,000	$ 20,000		Approx. 80% of wetland maintenance costs (2013-14) at Byron STP
							TOTAL		**$ 764,000**	**per year**
							Total $/ML		**$ 910**	**per kL**

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Appendix L Net Present Value Analysis

Ocean Shores - Brunswick Valley STP Feasibility Study

Net Present Value Estimate

Option 1: **Concept Design Option** **NO DEFERMENT OF CAPITAL ITEMS** **Construction Year**

15,800 EP (Nominal) Capacity (existing @ 240 L/EP/d) **2020-21**

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)

DISCOUNT RATE: **4.5%**
BASE DATE: 2016
RESIDUAL DATE: 2046

5.70 ML/d Design ADWF

628 L/s PWWF (nominal) capacity (existing)

CAPITAL COSTS

Year	Description	Capacity	Estimated Life (years)	Direct Job Cost ($)	Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2020	BVSTP (Stage 2) Augmentation Works - Civil	8,333 EP	50	13,825,000	21,429,000	17,969,531	2,746,341
2020	Raw sewage transfer system OS to BVSTP - Civil		50	1,555,000	2,411,000	2,021,771	308,994
2020	BVSTP (Stage 2) Augmentation Works - M&E	8,333 EP	20	6,058,000	9,390,000	7,874,091	0
2020	Raw sewage transfer system OS to BVSTP - M&E		20	0	0	0	0
2030	BVSTP Replace Stage 1 M&E	16,667 EP	20	6,710,000	10,401,000	5,616,258	555,413
2040	BVSTP Replace Stage 2 M&E	8,333 EP	20	6,058,000	9,390,000	3,264,936	1,754,991

OPERATING COSTS at projected ADWF

Year	Description	Power ($/yr)	Alum ($/yr)	Caustic soda ($/yr)	Ferric sulphate ($/yr)	Polymer ($/yr)	Other Operating ($/yr)	Sludge Disposal ($/yr)	Maintenance ($/yr)	Staff ($/yr)	Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2016	"	107,773	24,233	17,809	9,602	4,890	85,000	40,250	260,000	120,000	669,558	669,558	
2017	"	108,264	24,848	18,261	9,846	5,015	85,000	41,272	260,000	120,000	672,507	643,547	
2018	"	108,755	25,464	18,714	10,090	5,139	85,000	42,295	260,000	120,000	675,455	618,535	
2019	"	109,246	26,079	19,166	10,334	5,263	85,000	43,317	260,000	120,000	678,404	594,483	
2020	"	185,953	53,858	39,581	35,568	10,869	85,000	89,457	349,822	180,000	1,030,108	863,809	
2021	"	186,792	54,714	40,210	36,134	11,042	85,000	90,880	349,822	180,000	1,034,594	830,211	
2022	"	187,632	55,571	40,840	36,700	11,215	85,000	92,303	349,822	180,000	1,039,082	797,907	
2023	"	188,474	56,428	41,470	37,265	11,388	85,000	93,725	349,822	180,000	1,043,572	766,846	
2024	"	189,318	57,284	42,099	37,831	11,561	85,000	95,148	349,822	180,000	1,048,064	736,983	
2025	"	190,163	58,141	42,729	38,397	11,733	85,000	96,571	349,822	180,000	1,052,557	708,270	
2026	"	191,011	58,998	43,358	38,963	11,906	85,000	97,994	349,822	180,000	1,057,052	680,665	
2027	"	191,860	59,855	43,988	39,528	12,079	85,000	99,417	349,822	180,000	1,061,549	654,125	
2028	"	192,711	60,711	44,617	40,094	12,252	85,000	100,840	349,822	180,000	1,066,048	628,610	
2029	"	193,564	61,568	45,247	40,660	12,425	85,000	102,263	349,822	180,000	1,070,549	604,081	
2030	"	194,418	62,425	45,877	41,226	12,598	85,000	103,686	349,822	180,000	1,075,052	580,499	
2031	"	195,275	63,281	46,506	41,791	12,771	85,000	105,109	349,822	180,000	1,079,556	557,829	
2032	"	196,133	64,138	47,136	42,357	12,944	85,000	106,532	349,822	180,000	1,084,062	536,035	
2033	"	196,993	64,995	47,765	42,923	13,117	85,000	107,955	349,822	180,000	1,088,570	515,086	
2034	"	197,855	65,851	48,395	43,489	13,289	85,000	109,378	349,822	180,000	1,093,080	494,947	
2035	"	198,719	66,708	49,025	44,055	13,462	85,000	110,801	349,822	180,000	1,097,591	475,588	
2036	"	199,584	67,565	49,654	44,620	13,635	85,000	112,224	349,822	180,000	1,102,105	456,980	
2037	"	200,451	68,421	50,284	45,186	13,808	85,000	113,647	349,822	180,000	1,106,620	439,093	
2038	"	201,320	69,278	50,913	45,752	13,981	85,000	115,070	349,822	180,000	1,111,137	421,900	
2039	"	202,191	70,135	51,543	46,318	14,154	85,000	116,493	349,822	180,000	1,115,656	405,374	
2040	"	203,064	70,992	52,173	46,883	14,327	85,000	117,916	349,822	180,000	1,120,176	389,489	
2041	"	203,938	71,848	52,802	47,449	14,500	85,000	119,339	349,822	180,000	1,124,699	374,222	
2042	"	204,815	72,705	53,432	48,015	14,673	85,000	120,762	349,822	180,000	1,129,223	359,547	
2043	"	205,693	73,562	54,061	48,581	14,845	85,000	122,185	349,822	180,000	1,133,749	345,443	
2044	"	206,572	74,418	54,691	49,146	15,018	85,000	123,607	349,822	180,000	1,138,276	331,888	
2045	"	207,454	75,275	55,321	49,712	15,191	85,000	125,030	349,822	180,000	1,142,806	318,860	
2046	"	208,338	76,132	55,950	50,278	15,364	85,000	126,453	349,822	180,000	1,147,337	306,339	
												53,853,336	5,365,739

NET PRESENT VALUE: $ 48,490,000

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18/11/2016

Ocean Shores - Brunswick Valley STP Feasibility Study

Net Present Value Estimate

Option 2: **Concept Design Option** **DEFER ONE NEW CLARIFIER** **Construction Years**

15,800 EP (Nominal) Capacity (existing @ 240 L/EP/d) **2020-21 / 2035-36**

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)

5.70 ML/d Design ADWF

628 L/s PWWF (nominal) capacity (existing)

DISCOUNT RATE:	4.5%
BASE DATE:	2016
RESIDUAL DATE:	2046

CAPITAL COSTS

Year	Description	Capacity	Estimated Life (years)	Direct Job Cost ($)	Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2020	BVSTP (Stage 2a) Augmentation Works - Civil	4,167 EP 4th clarifier deferred	50	12,556,000	19,462,000	16,320,081	2,494,250
2020	Raw sewage transfer system OS to BVSTP - Civil		50	1,555,000	2,411,000	2,021,771	308,994
2020	BVSTP (Stage 2a) Augmentation Works - M&E	4,167 EP 4th clarifier deferred	20	5,790,000	8,975,000	7,526,088	0
2020	Raw sewage transfer system OS to BVSTP - M&E		20	0	0	0	0
2030	BVSTP Replace Stage 1 M&E	16,667 EP	20	6,710,000	10,401,000	5,616,258	555,413
2035	BVSTP (Stage 2a) Augmentation Works - Civil	8,333 EP Add 4th clarifier	50	1,269,000	1,967,000	852,305	409,647
2035	BVSTP (Stage 2a) Augmentation Works - M&E	8,333 EP Add 4th clarifier	20	268,000	415,000	179,820	49,862
2040	BVSTP Replace Stage 2a M&E	4,167 EP	20	5,790,000	8,975,000	3,120,639	1,677,428

OPERATING COSTS at projected ADWF

Year	Description	Power ($/yr)	Alum ($/yr)	Caustic soda ($/yr)	Ferric sulphate ($/yr)	Polymer ($/yr)	Other Operating ($/yr)	Sludge Disposal ($/yr)	Maintenance ($/yr)	Staff ($/yr)		Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2016	"	107,773	24,233	17,809	9,602	4,890	85,000	40,250	260,000	120,000		669,558	669,558	
2017	"	108,264	24,848	18,261	9,846	5,015	85,000	41,272	260,000	120,000		672,507	643,547	
2018	"	108,755	25,464	18,714	10,090	5,139	85,000	42,295	260,000	120,000		675,455	618,535	
2019	"	109,246	26,079	19,166	10,334	5,263	85,000	43,317	260,000	120,000		678,404	594,483	
2020	"	171,966	53,858	39,581	35,568	10,869	85,000	89,457	341,022	180,000		1,007,321	844,700	
2021	"	172,805	54,714	40,210	36,134	11,042	85,000	90,880	341,022	180,000		1,011,807	811,925	
2022	"	173,645	55,571	40,840	36,700	11,215	85,000	92,303	341,022	180,000		1,016,295	780,409	
2023	"	174,487	56,428	41,470	37,265	11,388	85,000	93,725	341,022	180,000		1,020,785	750,102	
2024	"	175,330	57,284	42,099	37,831	11,561	85,000	95,148	341,022	180,000		1,025,276	720,959	
2025	"	176,176	58,141	42,729	38,397	11,733	85,000	96,571	341,022	180,000		1,029,770	692,937	
2026	"	177,023	58,998	43,358	38,963	11,906	85,000	97,994	341,022	180,000		1,034,265	665,992	
2027	"	177,873	59,855	43,988	39,528	12,079	85,000	99,417	341,022	180,000		1,038,762	640,084	
2028	"	178,724	60,711	44,617	40,094	12,252	85,000	100,840	341,022	180,000		1,043,261	615,173	
2029	"	179,576	61,568	45,247	40,660	12,425	85,000	102,263	341,022	180,000		1,047,762	591,222	
2030	"	180,431	62,425	45,877	41,226	12,598	85,000	103,686	341,022	180,000		1,052,264	568,194	
2031	"	181,288	63,281	46,506	41,791	12,771	85,000	105,109	341,022	180,000		1,056,769	546,054	
2032	"	182,146	64,138	47,136	42,357	12,944	85,000	106,532	349,822	180,000		1,070,075	529,119	
2033	"	183,006	64,995	47,765	42,923	13,117	85,000	107,955	349,822	180,000		1,074,583	508,467	
2034	"	183,868	65,851	48,395	43,489	13,289	85,000	109,378	349,822	180,000		1,079,093	488,614	
2035	"	198,719	66,708	49,025	44,055	13,462	85,000	110,801	349,822	180,000		1,097,591	475,588	
2036	"	199,584	67,565	49,654	44,620	13,635	85,000	112,224	349,822	180,000		1,102,105	456,980	
2037	"	200,451	68,421	50,284	45,186	13,808	85,000	113,647	349,822	180,000		1,106,620	439,093	
2038	"	201,320	69,278	50,913	45,752	13,981	85,000	115,070	349,822	180,000		1,111,137	421,900	
2039	"	202,191	70,135	51,543	46,318	14,154	85,000	116,493	349,822	180,000		1,115,656	405,374	
2040	"	203,064	70,992	52,173	46,883	14,327	85,000	117,916	349,822	180,000		1,120,176	389,489	
2041	"	203,938	71,848	52,802	47,449	14,500	85,000	119,339	349,822	180,000		1,124,699	374,222	
2042	"	204,815	72,705	53,432	48,015	14,673	85,000	120,762	349,822	180,000		1,129,223	359,547	
2043	"	205,693	73,562	54,061	48,581	14,845	85,000	122,185	349,822	180,000		1,133,749	345,443	
2044	"	206,572	74,418	54,691	49,146	15,018	85,000	123,607	349,822	180,000		1,138,276	331,888	
2045	"	207,454	75,275	55,321	49,712	15,191	85,000	125,030	349,822	180,000		1,142,806	318,860	
2046	"	208,338	76,132	55,950	50,278	15,364	85,000	126,453	349,822	180,000		1,147,337	306,339	
													52,541,759	5,495,595

NET PRESENT VALUE: $ 47,050,000

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BVSTP Upgrade Cost Estimate_ddh2, NPV - OS-BVSTP Opt2
18/11/2016

Ocean Shores - Brunswick Valley STP Feasibility Study

Net Present Value Estimate

Option 3: **Concept Design Option** **SMALLER/ DEFERRED WET WEATHER STORAGE** **Construction Year**

15,800 EP (Nominal) Capacity (existing @ 240 L/EP/d) **2020-21 / 2035-36**

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)

DISCOUNT RATE: **4.5%**

BASE DATE: 2016

RESIDUAL DATE: 2046

5.70 ML/d Design ADWF

628 L/s PWWF (nominal) capacity (existing)

CAPITAL COSTS

Year	Description	Capacity	Estimated Life (years)	Direct Job Cost ($)	Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2020	BVSTP (Stage 2) Augmentation Works - Civil	8,333 EP	50	13,082,000	20,278,000	17,004,347	2,598,829
2020	Raw sewage transfer system OS to BVSTP - Civil		50	1,555,000	2,411,000	2,021,771	308,994
2020	BVSTP (Stage 2) Augmentation Works - M&E	8,333 EP	20	6,058,000	9,390,000	7,874,091	0
2020	Raw sewage transfer system OS to BVSTP - M&E		20	0	0	0	0
2030	BVSTP Replace Stage 1 M&E	16,667 EP	20	6,710,000	10,401,000	5,616,258	555,413
2035	Additional Wet Weather Storage - Civil		50	743,000	1,151,000	498,730	239,707
2040	BVSTP Replace Stage 2 M&E	8,333 EP	20	6,058,000	9,390,000	3,264,936	1,754,991

OPERATING COSTS at projected ADWF

Year	Description	Power ($/yr)	Alum ($/yr)	Caustic soda ($/yr)	Ferric sulphate ($/yr)	Polymer ($/yr)	Other Operating ($/yr)	Sludge Disposal ($/yr)	Maintenance ($/yr)	Staff ($/yr)		Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2016	"	107,773	24,233	17,809	9,602	4,890	85,000	40,250	260,000	120,000		669,558	669,558	
2017	"	108,264	24,848	18,261	9,846	5,015	85,000	41,272	260,000	120,000		672,507	643,547	
2018	"	108,755	25,464	18,714	10,090	5,139	85,000	42,295	260,000	120,000		675,455	618,535	
2019	"	109,246	26,079	19,166	10,334	5,263	85,000	43,317	260,000	120,000		678,404	594,483	
2020	"	185,953	53,858	39,581	35,568	10,869	85,000	89,457	347,422	180,000		1,027,708	861,796	
2021	"	186,792	54,714	40,210	36,134	11,042	85,000	90,880	347,422	180,000		1,032,194	828,285	
2022	"	187,632	55,571	40,840	36,700	11,215	85,000	92,303	347,422	180,000		1,036,682	796,064	
2023	"	188,474	56,428	41,470	37,265	11,388	85,000	93,725	347,422	180,000		1,041,172	765,083	
2024	"	189,318	57,284	42,099	37,831	11,561	85,000	95,148	347,422	180,000		1,045,664	735,295	
2025	"	190,163	58,141	42,729	38,397	11,733	85,000	96,571	347,422	180,000		1,050,157	706,655	
2026	"	191,011	58,998	43,358	38,963	11,906	85,000	97,994	347,422	180,000		1,054,652	679,120	
2027	"	191,860	59,855	43,988	39,528	12,079	85,000	99,417	347,422	180,000		1,059,149	652,647	
2028	"	192,711	60,711	44,617	40,094	12,252	85,000	100,840	347,422	180,000		1,063,648	627,195	
2029	"	193,564	61,568	45,247	40,660	12,425	85,000	102,263	347,422	180,000		1,068,149	602,726	
2030	"	194,418	62,425	45,877	41,226	12,598	85,000	103,686	347,422	180,000		1,072,652	579,203	
2031	"	195,275	63,281	46,506	41,791	12,771	85,000	105,109	347,422	180,000		1,077,156	556,589	
2032	"	196,133	64,138	47,136	42,357	12,944	85,000	106,532	347,422	180,000		1,081,662	534,849	
2033	"	196,993	64,995	47,765	42,923	13,117	85,000	107,955	347,422	180,000		1,086,170	513,950	
2034	"	197,855	65,851	48,395	43,489	13,289	85,000	109,378	347,422	180,000		1,090,680	493,860	
2035	"	198,719	66,708	49,025	44,055	13,462	85,000	110,801	347,422	180,000		1,095,191	474,548	
2036	"	199,584	67,565	49,654	44,620	13,635	85,000	112,224	347,422	180,000		1,099,705	455,985	
2037	"	200,451	68,421	50,284	45,186	13,808	85,000	113,647	347,422	180,000		1,104,220	438,141	
2038	"	201,320	69,278	50,913	45,752	13,981	85,000	115,070	347,422	180,000		1,108,737	420,988	
2039	"	202,191	70,135	51,543	46,318	14,154	85,000	116,493	347,422	180,000		1,113,256	404,502	
2040	"	203,064	70,992	52,173	46,883	14,327	85,000	117,916	347,422	180,000		1,117,776	388,655	
2041	"	203,938	71,848	52,802	47,449	14,500	85,000	119,339	347,422	180,000		1,122,299	373,423	
2042	"	204,815	72,705	53,432	48,015	14,673	85,000	120,762	347,422	180,000		1,126,823	358,783	
2043	"	205,693	73,562	54,061	48,581	14,845	85,000	122,185	347,422	180,000		1,131,349	344,712	
2044	"	206,572	74,418	54,691	49,146	15,018	85,000	123,607	347,422	180,000		1,135,876	331,188	
2045	"	207,454	75,275	55,321	49,712	15,191	85,000	125,030	347,422	180,000		1,140,406	318,190	
2046	"	208,338	76,132	55,950	50,278	15,364	85,000	126,453	347,422	180,000		1,144,937	305,698	
													53,354,386	5,457,934

NET PRESENT VALUE: $ 47,900,000

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Ocean Shores - Brunswick Valley STP Feasibility Study

Net Present Value Estimate

Option 4:

Concept Design Option **DEFER MAJOR PROCESS AUGMENTATION**

15,800 EP (Nominal) Capacity (existing @ 240 L/EP/d)

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)

5.70 ML/d Design ADWF

628 L/s PWWF (nominal) capacity (existing)

Construction Years 2020-21 / 2035-36

DISCOUNT RATE: **4.5%**

BASE DATE: 2016

RESIDUAL DATE: 2046

CAPITAL COSTS

Year	Description	Capacity	Estimated Life (years)	Direct Job Cost ($)	Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2020	BVSTP (Stage 2a) Augmentation Works - Civil	4,167 EP Major Process augmentation deferred	50	4,899,000	7,594,000	6,368,035	973,247
2020	Raw sewage transfer system OS to BVSTP - Civil		50	1,555,000	2,411,000	2,021,771	308,994
2020	BVSTP (Stage 2a) Augmentation Works - M&E	4,167 EP Major Process augmentation deferred	20	361,000	560,000	469,594	0
2020	Raw sewage transfer system OS to BVSTP - M&E		20	0	0	0	0
2030	BVSTP Replace Stage 1 M&E	16,667 EP	20	6,710,000	10,409,000	5,620,578	555,841
2035	BVSTP (Stage 2b) Augmentation Works - Civil	8,333 EP Major Process augmentation	50	8,926,000	13,835,000	5,994,730	2,881,277
2035	BVSTP (Stage 2b) Augmentation Works - M&E	8,333 EP Major Process augmentation	20	5,697,000	8,830,000	3,826,055	1,060,925
2040	BVSTP Replace Stage 2a M&E	4,167 EP	20	361,000	560,000	194,714	104,664

OPERATING COSTS at projected ADWF

Year	Description	Power ($/yr)	Alum ($/yr)	Caustic soda ($/yr)	Ferric sulphate ($/yr)	Polymer ($/yr)	Other Operating ($/yr)	Sludge Disposal ($/yr)	Maintenance ($/yr)	Staff ($/yr)	Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2016	"	107,773	24,233	17,809	9,602	4,890	85,000	40,250	260,000	120,000	669,558	669,558	
2017	"	108,264	24,848	18,261	9,846	5,015	85,000	41,272	260,000	120,000	672,507	643,547	
2018	"	108,755	25,464	18,714	10,090	5,139	85,000	42,295	260,000	120,000	675,455	618,535	
2019	"	109,246	26,079	19,166	10,334	5,263	85,000	43,317	260,000	120,000	678,404	594,483	
2020	"	141,661	80,786	59,371	35,568	11,521	85,000	94,824	320,597	180,000	1,009,329	846,384	
2021	"	142,499	82,072	60,315	36,134	11,704	85,000	96,332	320,597	180,000	1,014,654	814,210	
2022	"	143,339	83,357	61,260	36,700	11,888	85,000	97,841	320,597	180,000	1,019,981	783,239	
2023	"	144,181	84,642	62,204	37,265	12,071	85,000	99,349	320,597	180,000	1,025,310	753,427	
2024	"	145,025	85,927	63,149	37,831	12,254	85,000	100,857	320,597	180,000	1,030,640	724,731	
2025	"	145,870	87,212	64,093	38,397	12,437	85,000	102,366	320,597	180,000	1,035,973	697,111	
2026	"	146,718	88,497	65,037	38,963	12,621	85,000	103,874	320,597	180,000	1,041,307	670,526	
2027	"	147,567	89,782	65,982	39,528	12,804	85,000	105,382	320,597	180,000	1,046,643	644,940	
2028	"	148,418	91,067	66,926	40,094	12,987	85,000	106,891	320,597	180,000	1,051,981	620,315	
2029	"	149,271	92,352	67,871	40,660	13,170	85,000	108,399	320,597	180,000	1,057,320	596,616	
2030	"	150,125	93,637	68,815	41,226	13,354	85,000	109,907	320,597	180,000	1,062,662	573,808	
2031	"	150,982	94,922	69,759	41,791	13,537	85,000	111,416	320,597	180,000	1,068,005	551,860	
2032	"	151,840	96,207	70,704	42,357	13,720	85,000	112,924	320,597	180,000	1,073,350	530,739	
2033	"	152,700	97,492	71,648	42,923	13,904	85,000	114,432	320,597	180,000	1,078,697	510,414	
2034	"	153,562	98,777	72,593	43,489	14,087	85,000	115,941	320,597	180,000	1,084,045	490,856	
2035	"	198,719	66,708	49,025	44,055	13,462	85,000	110,801	435,278	180,000	1,183,047	512,616	
2036	"	199,584	67,565	49,654	44,620	13,635	85,000	112,224	435,278	180,000	1,187,560	492,413	
2037	"	200,451	68,421	50,284	45,186	13,808	85,000	113,647	435,278	180,000	1,192,076	473,001	
2038	"	201,320	69,278	50,913	45,752	13,981	85,000	115,070	435,278	180,000	1,196,592	454,347	
2039	"	202,191	70,135	51,543	46,318	14,154	85,000	116,493	435,278	180,000	1,201,111	436,424	
2040	"	203,064	70,992	52,173	46,883	14,327	85,000	117,916	435,278	180,000	1,205,632	419,202	
2041	"	203,938	71,848	52,802	47,449	14,500	85,000	119,339	435,278	180,000	1,210,154	402,655	
2042	"	204,815	72,705	53,432	48,015	14,673	85,000	120,762	435,278	180,000	1,214,678	386,757	
2043	"	205,693	73,562	54,061	48,581	14,845	85,000	122,185	435,278	180,000	1,219,204	371,481	
2044	"	206,572	74,418	54,691	49,146	15,018	85,000	123,607	435,278	180,000	1,223,732	356,804	
2045	"	207,454	75,275	55,321	49,712	15,191	85,000	125,030	435,278	180,000	1,228,262	342,703	
2046	"	208,338	76,132	55,950	50,278	15,364	85,000	126,453	435,278	180,000	1,232,793	329,156	
												41,808,335	5,884,947

NET PRESENT VALUE: $ 35,920,000

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Ocean Shores - Brunswick Valley STP Feasibility Study

Net Present Value Estimate

Option 5: **Concept Design Option** **DEFER/ ELIMINATE WET WEATHER STORAGE** **Construction Year**

15,800 EP (Nominal) Capacity (existing @ 240 L/EP/d) **2020-21**

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)

5.70 ML/d Design ADWF

628 L/s PWWF (nominal) capacity (existing)

DISCOUNT RATE: **4.5%**
BASE DATE: 2016
RESIDUAL DATE: 2046

CAPITAL COSTS

Year	Description	Capacity	Estimated Life (years)	Direct Job Cost ($)	Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2020	BVSTP (Stage 2) Augmentation Works - Civil	8,333 EP No Wet Weather Storage	50	11,284,000	17,491,000	14,667,276	2,241,647
2020	Raw sewage transfer system OS to BVSTP - Civil		50	1,555,000	2,411,000	2,021,771	308,994
2020	BVSTP (Stage 2) Augmentation Works - M&E	8,333 EP No Wet Weather Storage	20	5,916,000	9,170,000	7,689,608	0
2020	Raw sewage transfer system OS to BVSTP - M&E		20	0	0	0	0
2030	BVSTP Replace Stage 1 M&E	16,667 EP	20	6,710,000	10,401,000	5,616,258	555,413
2040	BVSTP Replace Stage 2 M&E	8,333 EP No Wet Weather Storage	20	5,916,000	9,170,000	3,188,441	1,713,873

OPERATING COSTS at projected ADWF

Year	Description	Power ($/yr)	Alum ($/yr)	Caustic soda ($/yr)	Ferric sulphate ($/yr)	Polymer ($/yr)	Other Operating ($/yr)	Sludge Disposal ($/yr)	Maintenance ($/yr)	Staff ($/yr)	Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2016	"	107,773	24,233	17,809	9,602	4,890	85,000	40,250	260,000	120,000	669,558	669,558	
2017	"	108,264	24,848	18,261	9,846	5,015	85,000	41,272	260,000	120,000	672,507	643,547	
2018	"	108,755	25,464	18,714	10,090	5,139	85,000	42,295	260,000	120,000	675,455	618,535	
2019	"	109,246	26,079	19,166	10,334	5,263	85,000	43,317	260,000	120,000	678,404	594,483	
2020	"	185,953	53,858	39,581	35,568	10,869	85,000	89,457	339,422	180,000	1,019,708	855,088	
2021	"	186,792	54,714	40,210	36,134	11,042	85,000	90,880	339,422	180,000	1,024,194	821,866	
2022	"	187,632	55,571	40,840	36,700	11,215	85,000	92,303	339,422	180,000	1,028,682	789,921	
2023	"	188,474	56,428	41,470	37,265	11,388	85,000	93,725	339,422	180,000	1,033,172	759,204	
2024	"	189,318	57,284	42,099	37,831	11,561	85,000	95,148	339,422	180,000	1,037,664	729,670	
2025	"	190,163	58,141	42,729	38,397	11,733	85,000	96,571	339,422	180,000	1,042,157	701,272	
2026	"	191,011	58,998	43,358	38,963	11,906	85,000	97,994	339,422	180,000	1,046,652	673,968	
2027	"	191,860	59,855	43,988	39,528	12,079	85,000	99,417	339,422	180,000	1,051,149	647,717	
2028	"	192,711	60,711	44,617	40,094	12,252	85,000	100,840	339,422	180,000	1,055,648	622,478	
2029	"	193,564	61,568	45,247	40,660	12,425	85,000	102,263	339,422	180,000	1,060,149	598,212	
2030	"	194,418	62,425	45,877	41,226	12,598	85,000	103,686	339,422	180,000	1,064,652	574,883	
2031	"	195,275	63,281	46,506	41,791	12,771	85,000	105,109	339,422	180,000	1,069,156	552,455	
2032	"	196,133	64,138	47,136	42,357	12,944	85,000	106,532	339,422	180,000	1,073,662	530,893	
2033	"	196,993	64,995	47,765	42,923	13,117	85,000	107,955	339,422	180,000	1,078,170	510,165	
2034	"	197,855	65,851	48,395	43,489	13,289	85,000	109,378	339,422	180,000	1,082,680	490,238	
2035	"	198,719	66,708	49,025	44,055	13,462	85,000	110,801	339,422	180,000	1,087,191	471,082	
2036	"	199,584	67,565	49,654	44,620	13,635	85,000	112,224	339,422	180,000	1,091,705	452,668	
2037	"	200,451	68,421	50,284	45,186	13,808	85,000	113,647	339,422	180,000	1,096,220	434,966	
2038	"	201,320	69,278	50,913	45,752	13,981	85,000	115,070	339,422	180,000	1,100,737	417,951	
2039	"	202,191	70,135	51,543	46,318	14,154	85,000	116,493	339,422	180,000	1,105,256	401,595	
2040	"	203,064	70,992	52,173	46,883	14,327	85,000	117,916	339,422	180,000	1,109,776	385,873	
2041	"	203,938	71,848	52,802	47,449	14,500	85,000	119,339	339,422	180,000	1,114,299	370,761	
2042	"	204,815	72,705	53,432	48,015	14,673	85,000	120,762	339,422	180,000	1,118,823	356,236	
2043	"	205,693	73,562	54,061	48,581	14,845	85,000	122,185	339,422	180,000	1,123,349	342,275	
2044	"	206,572	74,418	54,691	49,146	15,018	85,000	123,607	339,422	180,000	1,127,876	328,856	
2045	"	207,454	75,275	55,321	49,712	15,191	85,000	125,030	339,422	180,000	1,132,406	315,958	
2046	"	208,338	76,132	55,950	50,278	15,364	85,000	126,453	339,422	180,000	1,136,937	303,562	
												50,149,288	4,819,927

NET PRESENT VALUE: $ 45,330,000

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Ocean Shores - Brunswick Valley STP Feasibility Study

Net Present Value Estimate

Option 6: **Concept Design Option** **DEFER/ ELIMINATE WETLAND** **Construction Year**

15,800 EP (Nominal) Capacity (existing @ 240 L/EP/d) **2020-21**

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)

DISCOUNT RATE: **4.5%**

BASE DATE: 2016

RESIDUAL DATE: 2046

5.70 ML/d Design ADWF

628 L/s PWWF (nominal) capacity (existing)

CAPITAL COSTS			Estimated Life	Direct Job Cost	Total Cost	Discounted Value	Discounted Residual Value
Year	Description	Capacity	(years)	($)	($)	($)	($)
2020	BVSTP (Stage 2) Augmentation Works - Civil	8,333 EP No wetland	50	12,921,000	20,028,000	16,794,707	2,566,789
2020	Raw sewage transfer system OS to BVSTP - Civil		50	1,555,000	2,411,000	2,021,771	308,994
2020	BVSTP (Stage 2) Augmentation Works - M&E	8,333 EP	20	6,058,000	9,390,000	7,874,091	0
2020	Raw sewage transfer system OS to BVSTP - M&E		20	0	0	0	0
2030	BVSTP Replace Stage 1 M&E	16,667 EP	20	6,710,000	10,401,000	5,616,258	555,413
2040	BVSTP Replace Stage 2 M&E	8,333 EP	20	6,058,000	9,390,000	3,264,936	1,754,991

OPERATING COSTS at projected ADWF		Power	Alum	Caustic soda	Ferric sulphate	Polymer	Other Operating	Sludge Disposal	Maintenance	Staff	Total Cost	Discounted Value	Discounted Residual Value
Year	Description	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)	($/yr)			
2016	"	107,773	24,233	17,809	9,602	4,890	85,000	40,250	260,000	120,000	669,558	669,558	
2017	"	108,264	24,848	18,261	9,846	5,015	85,000	41,272	260,000	120,000	672,507	643,547	
2018	"	108,755	25,464	18,714	10,090	5,139	85,000	42,295	260,000	120,000	675,455	618,535	
2019	"	109,246	26,079	19,166	10,334	5,263	85,000	43,317	260,000	120,000	678,404	594,483	
2020	"	185,953	53,858	39,581	35,568	10,869	85,000	89,457	327,422	180,000	1,007,708	845,025	
2021	"	186,792	54,714	40,210	36,134	11,042	85,000	90,880	327,422	180,000	1,012,194	812,236	
2022	"	187,632	55,571	40,840	36,700	11,215	85,000	92,303	327,422	180,000	1,016,682	780,706	
2023	"	188,474	56,428	41,470	37,265	11,388	85,000	93,725	327,422	180,000	1,021,172	750,386	
2024	"	189,318	57,284	42,099	37,831	11,561	85,000	95,148	327,422	180,000	1,025,664	721,231	
2025	"	190,163	58,141	42,729	38,397	11,733	85,000	96,571	327,422	180,000	1,030,157	693,197	
2026	"	191,011	58,998	43,358	38,963	11,906	85,000	97,994	327,422	180,000	1,034,652	666,241	
2027	"	191,860	59,855	43,988	39,528	12,079	85,000	99,417	327,422	180,000	1,039,149	640,323	
2028	"	192,711	60,711	44,617	40,094	12,252	85,000	100,840	327,422	180,000	1,043,648	615,402	
2029	"	193,564	61,568	45,247	40,660	12,425	85,000	102,263	327,422	180,000	1,048,149	591,441	
2030	"	194,418	62,425	45,877	41,226	12,598	85,000	103,686	327,422	180,000	1,052,652	568,403	
2031	"	195,275	63,281	46,506	41,791	12,771	85,000	105,109	327,422	180,000	1,057,156	546,254	
2032	"	196,133	64,138	47,136	42,357	12,944	85,000	106,532	327,422	180,000	1,061,662	524,959	
2033	"	196,993	64,995	47,765	42,923	13,117	85,000	107,955	327,422	180,000	1,066,170	504,487	
2034	"	197,855	65,851	48,395	43,489	13,289	85,000	109,378	327,422	180,000	1,070,680	484,804	
2035	"	198,719	66,708	49,025	44,055	13,462	85,000	110,801	327,422	180,000	1,075,191	465,882	
2036	"	199,584	67,565	49,654	44,620	13,635	85,000	112,224	327,422	180,000	1,079,705	447,692	
2037	"	200,451	68,421	50,284	45,186	13,808	85,000	113,647	327,422	180,000	1,084,220	430,205	
2038	"	201,320	69,278	50,913	45,752	13,981	85,000	115,070	327,422	180,000	1,088,737	413,394	
2039	"	202,191	70,135	51,543	46,318	14,154	85,000	116,493	327,422	180,000	1,093,256	397,235	
2040	"	203,064	70,992	52,173	46,883	14,327	85,000	117,916	327,422	180,000	1,097,776	381,701	
2041	"	203,938	71,848	52,802	47,449	14,500	85,000	119,339	327,422	180,000	1,102,299	366,768	
2042	"	204,815	72,705	53,432	48,015	14,673	85,000	120,762	327,422	180,000	1,106,823	352,415	
2043	"	205,693	73,562	54,061	48,581	14,845	85,000	122,185	327,422	180,000	1,111,349	338,618	
2044	"	206,572	74,418	54,691	49,146	15,018	85,000	123,607	327,422	180,000	1,115,876	325,357	
2045	"	207,454	75,275	55,321	49,712	15,191	85,000	125,030	327,422	180,000	1,120,406	312,610	
2046	"	208,338	76,132	55,950	50,278	15,364	85,000	126,453	327,422	180,000	1,124,937	300,358	
												52,375,217	5,186,187

NET PRESENT VALUE: $ 47,190,000

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Ocean Shores - Brunswick Valley STP Feasibility Study

Net Present Value Estimate

Option 7: **Concept Design Option** **DEFER/ ELIMINATE NEW SLUDGE DEWATERING** **Construction Year**

15,800 EP (Nominal) Capacity (existing @ 240 L/EP/d) **2020-21**

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)

DISCOUNT RATE: **4.5%**
BASE DATE: 2016
RESIDUAL DATE: 2046

5.70 ML/d Design ADWF

628 L/s PWWF (nominal) capacity (existing)

Year	Description (CAPITAL COSTS)	Capacity	Estimated Life (years)	Direct Job Cost ($)	Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2020	BVSTP (Stage 2) Augmentation Works - Civil	8,333 EP No New Sludge Dewatering Facilties	50	13,318,000	20,643,000	17,310,422	2,645,607
2020	Raw sewage transfer system OS to BVSTP - Civil		50	1,555,000	2,411,000	2,021,771	308,994
2020	BVSTP (Stage 2) Augmentation Works - M&E	8,333 EP No New Sludge Dewatering Facilties	20	5,384,000	8,346,000	6,998,633	0
2020	Raw sewage transfer system OS to BVSTP - M&E		20	0	0	0	0
2030	BVSTP Replace Stage 1 M&E	16,667 EP	20	6,710,000	10,401,000	5,616,258	555,413
2040	BVSTP Replace Stage 2 M&E	8,333 EP No Wet Weather Storage	20	5,384,000	8,346,000	2,901,933	1,559,867

OPERATING COSTS at projected ADWF

Year	Description	Power ($/yr)	Alum ($/yr)	Caustic soda ($/yr)	Ferric sulphate ($/yr)	Polymer ($/yr)	Other Operating ($/yr)	Sludge Disposal ($/yr)	Maintenance ($/yr)	Staff ($/yr)	Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2016	"	107,773	24,233	17,809	9,602	4,890	85,000	40,250	260,000	120,000	669,558	669,558	
2017	"	108,264	24,848	18,261	9,846	5,015	85,000	41,272	260,000	120,000	672,507	643,547	
2018	"	108,755	25,464	18,714	10,090	5,139	85,000	42,295	260,000	120,000	675,455	618,535	
2019	"	109,246	26,079	19,166	10,334	5,263	85,000	43,317	260,000	120,000	678,404	594,483	
2020	"	185,953	53,858	39,581	35,568	10,869	85,000	89,457	335,422	180,000	1,015,708	851,733	
2021	"	186,792	54,714	40,210	36,134	11,042	85,000	90,880	335,422	180,000	1,020,194	818,656	
2022	"	187,632	55,571	40,840	36,700	11,215	85,000	92,303	335,422	180,000	1,024,682	786,849	
2023	"	188,474	56,428	41,470	37,265	11,388	85,000	93,725	335,422	180,000	1,029,172	756,265	
2024	"	189,318	57,284	42,099	37,831	11,561	85,000	95,148	335,422	180,000	1,033,664	726,857	
2025	"	190,163	58,141	42,729	38,397	11,733	85,000	96,571	335,422	180,000	1,038,157	698,580	
2026	"	191,011	58,998	43,358	38,963	11,906	85,000	97,994	335,422	180,000	1,042,652	671,393	
2027	"	191,860	59,855	43,988	39,528	12,079	85,000	99,417	335,422	180,000	1,047,149	645,252	
2028	"	192,711	60,711	44,617	40,094	12,252	85,000	100,840	335,422	180,000	1,051,648	620,119	
2029	"	193,564	61,568	45,247	40,660	12,425	85,000	102,263	335,422	180,000	1,056,149	595,955	
2030	"	194,418	62,425	45,877	41,226	12,598	85,000	103,686	335,422	180,000	1,060,652	572,723	
2031	"	195,275	63,281	46,506	41,791	12,771	85,000	105,109	335,422	180,000	1,065,156	550,388	
2032	"	196,133	64,138	47,136	42,357	12,944	85,000	106,532	335,422	180,000	1,069,662	528,915	
2033	"	196,993	64,995	47,765	42,923	13,117	85,000	107,955	335,422	180,000	1,074,170	508,272	
2034	"	197,855	65,851	48,395	43,489	13,289	85,000	109,378	335,422	180,000	1,078,680	488,427	
2035	"	198,719	66,708	49,025	44,055	13,462	85,000	110,801	335,422	180,000	1,083,191	469,349	
2036	"	199,584	67,565	49,654	44,620	13,635	85,000	112,224	335,422	180,000	1,087,705	451,009	
2037	"	200,451	68,421	50,284	45,186	13,808	85,000	113,647	335,422	180,000	1,092,220	433,379	
2038	"	201,320	69,278	50,913	45,752	13,981	85,000	115,070	335,422	180,000	1,096,737	416,432	
2039	"	202,191	70,135	51,543	46,318	14,154	85,000	116,493	335,422	180,000	1,101,256	400,141	
2040	"	203,064	70,992	52,173	46,883	14,327	85,000	117,916	335,422	180,000	1,105,776	384,482	
2041	"	203,938	71,848	52,802	47,449	14,500	85,000	119,339	335,422	180,000	1,110,299	369,430	
2042	"	204,815	72,705	53,432	48,015	14,673	85,000	120,762	335,422	180,000	1,114,823	354,962	
2043	"	205,693	73,562	54,061	48,581	14,845	85,000	122,185	335,422	180,000	1,119,349	341,056	
2044	"	206,572	74,418	54,691	49,146	15,018	85,000	123,607	335,422	180,000	1,123,876	327,689	
2045	"	207,454	75,275	55,321	49,712	15,191	85,000	125,030	335,422	180,000	1,128,406	314,842	
2046	"	208,338	76,132	55,950	50,278	15,364	85,000	126,453	335,422	180,000	1,132,937	302,494	
												51,760,791	5,069,882
											NET PRESENT VALUE:	**$**	**46,690,000**

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Ocean Shores STP

Net Present Value Estimate **Concept Design Option**

From Previous Planning Study (GHD, 2014b), Option 2 :

15,800 EP (Nominal) Capacity (existing @ 240 L/EP/d)

With Anaerobic, Secondary Anoxic & Secondary Aerobic Reactors

2.30 ML/d Design ADWF

232 L/s PWWF (nominal) capacity (existing)

Construction Year

2020-21

DISCOUNT RATE: **4.5%**

BASE DATE: 2016

RESIDUAL DATE: 2046

CAPITAL COSTS

Year	Description	Capacity	Estimated Life (years)	Direct Job Cost ($)	Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2020	Stage 2 Works - Civil	10,700 EP (at 215 L/EP/d as originally planned) (or 9,600 EP at 240 L/EP/d)	50	11,056,000	18,353,000	15,390,116	2,352,121
2020	Effluent reuse pipeline to BVSTP - Civil	See above	50	1,003,000	1,556,000	1,304,801	199,417
2020	Stage 2 Works - M&E	See above	20	6,374,000	10,581,000	8,872,818	0
2040	Replace Stage 2 M&E	See above	20	6,374,000	10,581,000	3,679,050	1,977,589

OPERATING COSTS at projected ADWF

Year	Description	Power ($/yr)	Alum ($/yr)	Caustic soda ($/yr)	Ferric sulphate ($/yr)	Polymer ($/yr)	Other Operating ($/yr)	Sludge Disposal ($/yr)	Maintenance ($/yr)	Staff ($/yr)		Total Cost	Discounted Value	Discounted Residual Value
2016	"	108,051	58,996	43,357	0	5,291	85,000	43,551	265,000	120,000		729,246	729,246	
2017	"	108,605	59,538	43,756	0	5,340	85,000	43,952	265,000	120,000		731,191	699,705	
2018	"	109,159	60,081	44,155	0	5,389	85,000	44,353	265,000	120,000		733,136	671,355	
2019	"	109,712	60,624	44,554	0	5,438	85,000	44,754	265,000	120,000		735,082	644,150	
2020	"	110,266	61,167	44,953	0	5,486	85,000	45,155	265,000	120,000		737,027	618,042	
2021	"	102,655	27,427	20,156	0	5,535	85,000	45,555	265,000	120,000		671,328	538,708	
2022	"	103,209	27,668	20,334	0	5,584	85,000	45,956	265,000	120,000		672,750	516,602	
2023	"	103,763	27,909	20,511	0	5,632	85,000	46,357	265,000	120,000		674,172	495,401	
2024	"	104,317	28,151	20,688	0	5,681	85,000	46,758	265,000	120,000		675,594	475,068	
2025	"	104,871	28,392	20,866	0	5,730	85,000	47,158	265,000	120,000		677,016	455,567	
2026	"	105,425	28,633	21,043	0	5,778	85,000	47,559	265,000	120,000		678,438	436,865	
2027	"	105,979	28,874	21,220	0	5,827	85,000	47,960	265,000	120,000		679,860	418,929	
2028	"	106,533	29,116	21,398	0	5,876	85,000	48,361	265,000	120,000		681,283	401,728	
2029	"	107,086	29,357	21,575	0	5,925	85,000	48,762	265,000	120,000		682,705	385,231	
2030	"	107,640	29,598	21,752	0	5,973	85,000	49,162	265,000	120,000		684,127	369,410	
2031	"	108,194	29,840	21,930	0	6,022	85,000	49,563	265,000	120,000		685,549	354,237	
2032	"	108,748	30,081	22,107	0	6,071	85,000	49,964	265,000	120,000		686,971	339,686	
2033	"	109,302	30,322	22,284	0	6,119	85,000	50,365	265,000	120,000		688,393	325,731	
2034	"	109,857	30,564	22,462	0	6,168	85,000	50,766	265,000	120,000		689,815	312,349	
2035	"	110,411	30,805	22,639	0	6,217	85,000	51,166	265,000	120,000		691,237	299,514	
2036	"	110,965	31,046	22,816	0	6,265	85,000	51,567	265,000	120,000		692,660	287,206	
2037	"	111,519	31,287	22,994	0	6,314	85,000	51,968	265,000	120,000		694,082	275,403	
2038	"	112,073	31,529	23,171	0	6,363	85,000	52,369	265,000	120,000		695,504	264,083	
2039	"	112,627	31,770	23,348	0	6,411	85,000	52,769	265,000	120,000		696,926	253,228	
2040	"	113,181	32,011	23,526	0	6,460	85,000	53,170	265,000	120,000		698,348	242,818	
2041	"	113,735	32,253	23,703	0	6,509	85,000	53,571	265,000	120,000		699,771	232,835	
2042	"	114,289	32,494	23,880	0	6,558	85,000	53,972	265,000	120,000		701,193	223,262	
2043	"	114,844	32,735	24,058	0	6,606	85,000	54,373	265,000	120,000		702,615	214,081	
2044	"	115,398	32,977	24,235	0	6,655	85,000	54,773	265,000	120,000		704,038	205,277	
2045	"	115,952	33,218	24,412	0	6,704	85,000	55,174	265,000	120,000		705,460	196,834	
2046	"	116,506	33,459	24,590	0	6,752	85,000	55,575	265,000	120,000		706,882	188,738	
							85,000						41,318,075	4,529,127
							85,000						**NET PRESENT VALUE:**	**$ 36,790,000**

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BVSTP Upgrade Cost Estimate_ddh2, NPV - OSSTP Opt2_No Filters
18/11/2016

Brunswick Valley STP Feasibility Study
Net Present Value Estimate

BVSTP Status quo | **Construction Year**

No upgrade of BVSTP | **15,800 EP (Nominal) Capacity (existing @ 240 L/EP/d)** | **2010**

Ox. Ditch with Anaerobic Reactor ('3-Stage Phoredox' process configuration)

3.80 ML/d Design ADWF
314 L/s PWWF (nominal) capacity (existing)

DISCOUNT RATE: **4.5%**
BASE DATE: 2016
RESIDUAL DATE: 2046

CAPITAL COSTS Year Description	Capacity	Estimated Life (years)	Direct Job Cost ($)	Total Cost ($)	Discounted Value ($)	Discounted Residual Value ($)
2030 BVSTP Replace Stage 1 M&E	16,667 EP	20	6,710,000	10,401,000	5,616,258	555,413

OPERATING COSTS at projected ADWF

Year	Description	Power ($/yr)	Alum ($/yr)	Caustic soda ($/yr)	Ferric sulphate ($/yr)	Polymer ($/yr)	Other Operating ($/yr)	Sludge Disposal ($/yr)	Maintenance ($/yr)	Staff ($/yr)	Total Cost	Discounted Value	Discounted Residual Value
2016	"	107,773	24,233	17,809	9,602	4,890	85,000	40,250	260,000	120,000	669,558	669,558	
2017	"	108,264	24,848	18,261	9,846	5,015	85,000	41,272	260,000	120,000	672,507	643,547	
2018	"	108,755	25,464	18,714	10,090	5,139	85,000	42,295	260,000	120,000	675,455	618,535	
2019	"	109,246	26,079	19,166	10,334	5,263	85,000	43,317	260,000	120,000	678,404	594,483	
2020	"	109,737	26,694	19,618	10,578	5,387	85,000	44,339	260,000	120,000	681,353	571,357	
2021	"	110,228	27,310	20,070	10,821	5,511	85,000	45,361	260,000	120,000	684,303	549,119	
2022	"	110,720	27,925	20,523	11,065	5,636	85,000	46,383	260,000	120,000	687,252	527,738	
2023	"	111,211	28,541	20,975	11,309	5,760	85,000	47,406	260,000	120,000	690,201	507,179	
2024	"	111,703	29,156	21,427	11,553	5,884	85,000	48,428	260,000	120,000	693,151	487,413	
2025	"	112,194	29,771	21,879	11,797	6,008	85,000	49,450	260,000	120,000	696,100	468,409	
2026	"	112,686	30,387	22,332	12,041	6,132	85,000	50,472	260,000	120,000	699,050	450,138	
2027	"	113,178	31,002	22,784	12,285	6,257	85,000	51,494	260,000	120,000	702,000	432,571	
2028	"	113,670	31,618	23,236	12,528	6,381	85,000	52,516	260,000	120,000	704,950	415,683	
2029	"	114,162	32,233	23,689	12,772	6,505	85,000	53,539	260,000	120,000	707,900	399,448	
2030	"	114,654	32,849	24,141	13,016	6,629	85,000	54,561	260,000	120,000	710,850	383,839	
2031	"	115,146	33,464	24,593	13,260	6,753	85,000	55,583	260,000	120,000	713,800	368,835	
2032	"	115,639	34,079	25,045	13,504	6,878	85,000	56,605	260,000	120,000	716,750	354,411	
2033	"	116,131	34,695	25,498	13,748	7,002	85,000	57,627	260,000	120,000	719,700	340,545	
2034	"	116,624	35,310	25,950	13,991	7,126	85,000	58,650	260,000	120,000	722,651	327,217	
2035	"	117,116	35,926	26,402	14,235	7,250	85,000	59,672	260,000	120,000	725,601	314,404	
2036	"	117,609	36,541	26,854	14,479	7,374	85,000	60,694	260,000	120,000	728,552	302,089	
2037	"	118,102	37,156	27,307	14,723	7,499	85,000	61,716	260,000	120,000	731,502	290,251	
2038	"	118,595	37,772	27,759	14,967	7,623	85,000	62,738	260,000	120,000	734,453	278,873	
2039	"	119,088	38,387	28,211	15,211	7,747	85,000	63,760	260,000	120,000	737,404	267,936	
2040	"	119,581	39,003	28,664	15,455	7,871	85,000	64,783	260,000	120,000	740,355	257,424	
2041	"	120,074	39,618	29,116	15,698	7,995	85,000	65,805	260,000	120,000	743,306	247,321	
2042	"	120,567	40,233	29,568	15,942	8,119	85,000	66,827	260,000	120,000	746,257	237,610	
2043	"	121,060	40,849	30,020	16,186	8,244	85,000	67,849	260,000	120,000	749,208	228,277	
2044	"	121,553	41,464	30,473	16,430	8,368	85,000	68,871	260,000	120,000	752,160	219,308	
2045	"	122,047	42,080	30,925	16,674	8,492	85,000	69,894	260,000	120,000	755,111	210,687	
2046	"	122,540	42,695	31,377	16,918	8,616	85,000	70,916	260,000	120,000	758,062	202,403	
												17,782,865	555,413
												NET PRESENT VALUE:	**$ 17,230,000**

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BVSTP Upgrade Cost Estimate_ddh2, NPV - BVSTP_Statusquo
18/11/2016

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0	D de Haas	P Ochre	[signature]	P Ochre	[signature]	23.11.16

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REPORT

OCEAN SHORES TO BRUNSWICK VALLEY STP TRANSFER FEASIBILITY STUDY - PEER REVIEW

Prepared for Byron Shire Council

7/2/17

QUALITY STATEMENT

PROJECT MANAGER	PROJECT TECHNICAL LEAD
Paul Flint	Cameron Staib

PREPARED BY		
Cameron Staib	………………………………………	6/2/17
CHECKED BY		
Shane O'Brien	………………………………………	6/2/17
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REVISION SCHEDULE

Rev No.	Date	Description	Signature or Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by
0	3/2/17	Draft for Prelim Discussion	CS			
1	6/2/17	Complete Draft	CS	S.O'B.	S.O'B.	CS
2	7/2/17	Final incorporating BSC comments	CS	S.O'B.	S.O'B.	CS

Byron Shire Council

Ocean Shores to Brunswick Valley STP Transfer Feasibility Study - Peer Review

CONTENTS

1 Introduction

Byron Shire Council (BSC) have engaged MWH to provide a Peer Review of the Ocean Shores to Brunswick Valley STP Transfer Feasibility Study Report, prepared by GHD and dated November 2016.

The purpose of this feasibility study was to compare the option of closing Ocean Shores (OSSTP) and transferring flows to Brunswick Valley STP (BVSTP) and upgrading BVSTP as required, to the previously identified option of upgrading OSSTP. The Feasibility Study concluded that transferring flows to BVSTP and shutting OSSTP is preferred to upgrading OSSTP.

The purpose of the Peer Review is to provide an opinion based on the information provided in the report as to whether the conclusion that BSC should proceed with planning to close OSSTP, transfer flows to BVSTP and upgrade BVSTP is justified.

1.1 Scope

The scope of this work is to provide a Peer Review of the Ocean Shores to Brunswick Valley STP Transfer Feasibility Study Report dated November 2016. The Peer Review, based on the information presented in the Feasibility Study Report, is to provide an opinion as to whether the conclusion that the option of closing OSSTP and transferring flows should be preferred over the option of upgrading the OSSTP. It is noted that the previous Planning Reports for the OSSTP upgrade were provided as background information, however these were not reviewed. .

In developing this Peer Review report MWH has:

- reviewed the inputs approaches, outputs and conclusions presented in the Study Report and provided opinion on the appropriateness or otherwise of these, based on experience of conducting similar studies;
- reviewed the Cost Estimates presented, looking for any omissions, and comparing the values presented to MWH expectations, based on experience, recent projects and other high level cost estimates.

In developing this Peer Review report MWH has:

- not reviewed the earlier work that identified the preferred option for an upgrade at OSSTP, and as such provides no opinion on the OSSTP upgrade option compared to alternatives to OSSTP upgrade;
- not separately conducted process calculations, or checked the results of calculations presented in the Study Report;
- not separately developed cost estimates to those presented in the report.

1.2 Methodology

The methodology used in for the Peer Review was to read the Feasibility Study Report, then for each of the following areas, provide an opinion as to whether the approach and outputs are reasonable, conservative, aggressive, or if there are any other concerns with the information provided in the report. The areas considered were:

- Project Inputs:
  - Assumptions (Feasibility Study Report Section 1)
  - Population and flow projections (Feasibility Study Report Section 2)
  - Licence requirements (Feasibility Study Report Section 3)
- BVSTP assessment:
  - Existing plant capacity (Feasibility Study Report Section 4)
  - Existing Plant performance (Feasibility Study Report Section 5)
- Upgrade development:
  - Process modelling (Feasibility Study Report Section 6)
  - Augmentation Strategy (Feasibility Study Report Section 7)
  - Augmentation requirements (Feasibility Study Report Section 8)
  - Safety in Design (Feasibility Study Report Section 9)

- Layout (Feasibility Study Report Section 10)
- Options Assessment
  - Cost Estimate (Feasibility Study Report Section 11)
  - Conclusions (Feasibility Study Report Section 12)
- Recommendations (Feasibility Study Report Section 13).

2 Peer Review

2.1 Project Inputs

2.1.1 Assumptions

The assumptions identified in Section 1.5 are a reasonable basis for an assessment of this type. Some specific assumptions are discussed in subsequent Sections.

BSC's attention is drawn to the assumption that the existing environmental licence requirements on BVSTP effluent will hold. As this is a relatively typical coastal licence this is a reasonable assumption, however if moving to a single plant did trigger a tighter effluent quality this may impact BSC's decision to proceed with this option.

2.1.2 Population and Flow Projections

The report details that the assumption of peak population projects from the Strategic Business Plan (2016) were adopted following agreement with BSC. It is noted, as pointed out in the report that there is a slight discrepancy in the populations used for the previous OSSTP upgrade strategy compared to those used for the option of diversion to BVSTP. However, the report states that the new values are higher, so if there is any significant difference that should disadvantage the option of transfer to BVSTP.

The approach to developing the flow projects appears reasonable. The report notes in Section 2.2.2 that the dry weather day definition used impacts the calculation of ADWF. It is suggested that the impact of this may have been understated in the report, that is, that the ADWFs are over estimated. However, for the purposes of this study, that would potentially disadvantage the transfer option.

Basing the assessment of simultaneous Peak Wet Weather Flows (PWWF), interpreted as all pump stations operating at maximum, is a conservative approach which again would disadvantage the transfer option. As such this is reasonable in the context of the assessment BDC require, however, in actual implementation of a transfer scheme should be reviewed when finalising the design basis.

2.1.3 Licence Requirements

The point noted above around the PWWF impacts on Section 3.1 of the report where it is identified that the maximum daily flow will need revision and trigger a new licence. An opportunity in implementing a transfer scheme would be to consider storage/balancing and reviewing pump station options to determine if this new maximum limit of 33 ML/d is actually needed.

Section 3.2 uses the existing BVSTP licence mass load limits and assesses the concentrations required at the increased flows to meet those mass load limits. The report states that these back calculated concentrations (with the exception of Oil and Grease) are within the envelope of licence and design concentrations and/or current performance. Whilst that statement is correct, it is important that BSC is aware that for BOD, TN and TP the concentrations required for a plant receiving OSSTP loads to meet the existing mass load licence are well below existing 90%iles concentration licence limits, and would require the plant to produce effluent quality matching that during the process proving period.

This is a significant issue for BSC to consider, that is, can increased mass load limits be negotiated, or will BSC accept that the plant must achieve concentrations significantly lower than the concentration limits.

2.2 BVSTP Assessment

Whilst not affecting the recommendation and outcomes, the structure of the report relating to existing capacity, process modelling and augmentation strategy is a little hard to follow. In particular it is implied that the modelling confirmed the design capacity of BVSTP but this is not explicit.

2.2.1 Existing plant Capacity

The assessment relating to hydraulic capacity that there is < 0.2m between the feed channel downstream of the inlet works and the bioreactor outlet channel has a significant impact on the assessment in terms of not including a bioreactor bypass. However, if anything this disadvantages the BVSTP option therefore is a conservative approach.

The review of the clarifier capacity is justified and appropriate.

2.2.2 Existing Plant Performance

The sludge settleability discussion and conclusions are appropriate.

2.3 Upgrade Development

2.3.1 Process modelling

Bioreactor modelling results are partially summarised in Section 6.5, and are included in Appendix E as a spreadsheet, so are a little hard to follow. The report structure at this point is also a little hard to follow because the augmented plant solution is modelled here although it has not yet been introduced. However, for this level of assessment:

- The approach used, including the inputs are reasonable
- Using steady-state spreadsheet model for preliminary planning sizing is appropriate
- Key modelling parameters used are reasonable assumptions for this level of assessment.

The approach used does not initially consider options of pushing BVSTP beyond the original design parameters (for example lower sludge ages), this is raised later. For developing a conservative solution to use as the basis of comparison to the OSSTP upgrade option this is reasonable, however it is agreed with subsequent statements that the upgrade could be deferred, or optimised.

The clarifier modelling approach is appropriate, in particular using a more conservative SSVI value than the original BVSTP design, based on the actual plant data. However, alternatives to the full PWWF being received by the bioreactor and clarifiers should be considered in further development of the BVSTP solution.

Whilst under the heading of process modelling, some of the main augmentation requirements are introduced in Section 6.5.2, and as such are commented on in this section of this Peer Review Report.

- This section also introduces the need to provide a new raw influent flow splitter upstream of inlet works. This could have an impact on both the existing BVSTP catchment pumps and the transfer pumps to pump to a higher level than existing inlet works. It is noted subsequently in Section 8.1.1 on SPS5009, that there is a high point earlier in the rising main that governs the hydraulics, so this should not be a factor for this pump station. The assessment does include an upgrade of SPS5004 which appears justified.
- The proposed new RAS flow splitter and removal of RAS screening at the inlet works and replacement with dedicated RAS screening is reasonable, but conservative and RAS screening may not be required.

2.3.2 Augmentation Strategy

Without understanding the OSSTP catchment in detail, it is assumed that the reason diversion to BVSTP prior to OSSTP has not been considered is that it isn't feasible. Assuming that it isn't feasible, then the considerations of two options for the transfer system are reasonable. For this study proceeding with Option A is a sound approach, the potential for Option B and flow balancing to reduce the peak flow to the upgraded BVSTP has not been explored and should be considered at further project stages.

Subject to the comments made above in the Process Modelling section of this Peer Review Report, the features of Option A detailed inspection 7.2.1 are reasonable. As detailed in the introduction of this Peer Review report, no assessment of the preferred option for the upgrade at OSSTP has been conducted as this was earlier work than this transfer feasibility study.

2.3.3 Augmentation Requirements

The Sewerage transfer system requirements presented in Section 8.1 are discussed above.

2.3.4 Safety in Design

This section is not particularly relevant, but agree that at this preliminary stage specific safety issues would not be detailed.

2.3.5 Layout

The preliminary BVSTP upgrade layout plan presented in the report and used as the basis for cost estimating appears reasonable. It is noted that the layout would result in some tree removal, this is not explicitly discussed. It is recommended that BSC should confirm that there are no significant issues with removing trees that would potentially cause a layout change that may change the upgrade costs.

2.4 Options Assessment

2.4.1 Cost Estimate

The approach and methodology detailed in the report for developing the cost estimate are reasonable for a study of this type. Specifically in terms of the basis of estimate it is noted that:

- The report states that BSC directed that the decommissioning costs for OSSTP be excluded. It should be noted that recent experience elsewhere (e.g Unitywater's Suncoast STP closure and conversion to pump station) is that even when not selling the land, is there are making 'safe costs', Tweed Shire Council also have experience of decommissioning costs for the Tweed West STP.
- Power supply upgrade can be a significant cost, therefore it is recommended that BSC confirm that they will not incur significant costs.

A significant assumption in the comparison is that for the retention and upgrade of OSSTP options, the effluent would still be transferred to BVSTP to add to recycled water supplies. It is assumed that BSC has confirmed that this is required and is part of the baseline. If not required, the change to the project costing is not expected to change the Feasibility Study recommendations.

In terms of the BVSTP capital cost estimates:

- Raw sewage rising main: the estimate is about 25% lower than the high level planning costs used by MWH and some of our clients. The estimate equates to $738/m, MWH (and several clients) would use $1000-1050/m. It is unclear how the comparison to the effluent rising main for the OSSTP option is included in the comparison.
- Upgrade SPS 5004 – Estimate appears reasonable
- Complete 1.9 ML/d upgrade (approx. 8,000 EP) – the estimate equates to around $3900/EP, which is quite high, however based on the comparison with the OSSTP estimate this in no way advantages the BVSTP option hence does not impact on the recommendation.

- The capital deferment estimates, in terms of difference to the complete upgrade estimate are reasonable.

In terms of the OSSTP Cost estimates, STP upgrade estimate is virtually the same as the BVSTP upgrade in terms of total capital, or nearly $3000/EP.

In comparing the capital costs of the BVSTP and OSSTP upgrades, the differences presented in the following table stand out as significant, whilst they increase the cost of the OSSTP option compared to the BVSTP option, at a higher level based on $/EP the BVSTP upgrade appears more conservative. As such whilst these are brought to BSC's attention, they are not significant enough to change the recommendation of the Feasibility Study to proceed with the transfer to BVSTP.

Item	OSSTP Scope	OSSTP Cost	BVSTP Scope	BVSTP Cost	Justification
Bioreactors	190 kL Anaerobic Tank, 2320 kL ditch, 190kL each secondary anoxic and aerobic tanks,	$4.38m	1885 kL anaerobic tank, 1665 kL ditch.	$2.46m	OSSTP slightly larger, more complex process, more expensive
Clarifiers	2 no. 21m diameter	$2.27m	2 no. 23m diameter	$2.25m	Potentially higher construction costs at OSSTP
UV Disinfection	1 no. 240 L/s	$1.06m	1 no. 314 L/s	$0.75m	The difference are likely due to OSSTP being a new system compared to expansion at BVSTP.
Aerobic Digester	Modify existing tank, new diffused aeration system and decanter	$0.47m	New 0.25ML digester and aeration system	$0.43	Unclear why costs are similar, expect that BVSTP would be more expensive
Switch Room and Blower Room		$0.8m		$0.4m	Unclear as to why the OSSTP cost would be double the BVSTP cost.

For the operational costs basis of estimate:
- The saving of 0.5 FTE by closing OSSTP is a reasonable to conservative assumption;
- Power cost assumptions appear reasonable;
- Biosolids disposal cost whilst based on current BSC costs, appears low compared to costs to other utilities. However, the comparison is unlikely to be sensitive to increases in these costs;
- Maintenance cost approach for existing assets is a little confusing, but if these have been checked against BSC actual costs then there is no issue.

2.4.2 Conclusions

The conclusions are reasonable and justified based on the information presented. However there are a number of discrepancies between the capital cost estimate for BVSTP compared to OSSTP upgrade, that could be perceived as inflating the OSSTP estimate relative to the BVSTP estimate that are not fully justified in the Feasibility Study Report. Whilst they are not likely to be significant enough to change the recommendation, the NPV comparison would be closer.

2.5 Recommendations

The study recommendations are reasonable and justified based on the information presented.

3 Peer Review Conclusions and Recommendations

This Peer Review has concluded that the majority of assumptions, approaches, outcomes and conclusions of the Feasibility Study are justified. However, several items are brought to the attention to BSC.

This Peer Review has concluded that the BVSTP upgrade estimate is reasonable, if slightly at the higher end of expectations, based on $/EP comparison. The OSSTP upgrade estimate is also in the high range based on $/EP. Whilst some minor discrepancies between the capital cost estimates for BVSTP and OSSTP are noted in this Peer Review, if addressed these are highly unlikely to change the Study recommendations.

Even if the BVSTP upgrade was more expensive, or the OSSTP estimate was less expensive by comparison, it is unlikely that the relative NPV (assuming there is significant capital deferment in the BVSTP option) would change to favour the OSSTP upgrade option.

The Peer Review agrees that the BVSTP upgrade approach is quite conservative, and therefore there is significant potential to defer capital spend at BVSTP and/or optimise the upgrade approach.

Other issues to which BSC's attention is drawn are:

- the assumption that the existing environmental licence requirements on BVSTP effluent will hold;
- if the BVSTP mass load limits in the licence are not increased, with the additional OSSTP loads, the BVSTP would need to achieve BOD, TN and TP concentrations significantly lower than the concentration limits;
- the cost estimate is based on a layout that requires significant tree removal at BVSTP;
- the exclusion of decommissioning costs at OSSTP;
- exclusion of power upgrade costs;
- the rising main cost estimate is around 25% lower than expectation based on high level costing, however the rising main is only around 10% of the project cost, hence a 25% increase in the rising main is unlikely to change the outcome.

MWH now part of Stantec

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