AGENDA FOR ORDINARY MEETING
TO BE HELD IN CIVIC CENTRE SUPPER ROOM, BUNDABERG
ON TUESDAY 25 AUGUST 2020, COMMENCING AT 10.00 AM

T4 Specialised Supplier - Solus Library App

T5 Specialised Supplier Arrangement with LTech Australia Pty Ltd

T6 Specialised Supplier Arrangement with Task Exchange Pty Ltd

T7 Request to reduce the development application fee – Development Permit for Material Change of Use for Motor Sport Facility at 2359 Bucca Road, Bullyard (Lot 226 on CK386) – Bundy Turfburners Mower Racing Club.

T8 Purchase of Lot 1 on SP225014

8 General Business

9 Meeting Close

Item

25 August 2020

Item Number:	File Number:	Part:
F1	.	FINANCE

Portfolio:

Organisational Services

Subject:

Financial Summary as at 31 July 2020

Report Author:

Anthony Keleher, Chief Financial Officer

Authorised by:

Amanda Pafumi, General Manager Organisational Services

Link to Corporate Plan:

Our People, Our Business - 3.1 A sustainable financial position - 3.1.2 Apply responsible fiscal principles for sustainable financial management.

Background:

In accordance with section 204 of the *Local Government Regulation 2012* a financial report must be presented to Council on a monthly basis. The attached financial report contains the financial summary and associated commentary at 31 July 2020.

Associated Person/Organization:

Nil

Consultation:

Financial Services Team

Chief Legal Officer's Comments:

Pursuant to section 204 of the *Local Government Regulation 2012* the Local Government must prepare and the Chief Executive Officer must present, the financial report. The financial report must state the progress that has been made in relation to the Local Government's budget for the period of the financial year up to a day or as near as practicable to the end of the month before the meeting is held.

Policy Implications:

There appears to be no policy implications.

Financial and Resource Implications:

There appears to be no financial or resource implications.

Risk Management Implications:

There appears to be no risk management implications.

Human Rights:

There appears to be no human rights implications.

Attachments:

⇩1 Financial Summary as at 31 July 2020

Recommendation:

That the financial summary as at 31 July 2020 be noted by Council.

Financial Summary
as at 31 Jul 2020

	Council			General			Waste			Wastewater			Water		
Progress check - 9%	Actual YTD	Adopted Budget	% Act/ Bud	Actual YTD	Adopted Budget	% Act/ Bud	Actual YTD	Adopted Budget	% Act / Bud	Actual YTD	Adopted Budget	% Act/ Bud	Actual YTD	Adopted Budget	% Act/ Bud
Recurrent Activities															
Revenue															
Rates and Utility Charges	79,841,654	158,077,593	51%	41,662,812	83,461,322	50%	7,844,732	15,702,071	50%	14,850,778	30,236,858	49%	15,483,332	28,677,342	54%
Less: Pensioner Remissions	(830,711)	(1,713,674)	48%	(487,693)	(1,042,901)	47%	(118,408)	(228,169)	52%	(131,554)	(255,237)	52%	(93,056)	(187,367)	50%
	79,010,943	**156,363,919**	**51%**	**41,175,119**	**82,418,421**	**50%**	**7,726,324**	**15,473,902**	**50%**	**14,719,224**	**29,981,621**	**49%**	**15,390,276**	**28,489,975**	**54%**
Fees and Charges	1,691,668	23,576,503	7%	982,012	15,067,769	7%	478,099	5,971,134	8%	97,130	917,000	11%	136,427	1,620,600	8%
Interest Revenue	141,934	2,255,970	6%	49,677	785,338	6%	21,290	374,465	6%	24,129	394,114	6%	46,838	702,053	7%
Grants, Subsidies and Donations	710,327	12,177,757	6%	708,755	12,017,757	6%	1,572	160,000	1%	-	-		-	-	
Sale of Developed Land Inventory	178,076	-		178,076	-		-	-		-	-		-	-	
Total Recurrent Revenue	**81,732,948**	**194,374,149**	**42%**	**43,093,639**	**110,289,285**	**39%**	**8,225,285**	**21,979,501**	**37%**	**14,840,483**	**31,292,735**	**47%**	**15,573,541**	**30,812,628**	**51%**
less *Expenses*															
Employee Costs	4,590,775	76,683,859	6%	3,475,865	59,384,503	6%	387,918	6,371,763	6%	358,349	5,576,413	6%	368,643	5,351,180	7%
Materials and Services	4,734,118	67,411,695	7%	2,626,359	39,598,624	7%	1,180,377	11,740,594	10%	383,068	7,075,701	5%	544,314	8,996,776	6%
Finance Costs	296,662	4,291,551	7%	75,388	1,531,258	5%	74,688	901,259	8%	134,047	1,608,563	8%	12,539	250,471	5%
Depreciation	4,270,454	51,245,441	8%	3,064,250	36,770,998	8%	135,097	1,621,162	8%	554,836	6,658,033	8%	516,271	6,195,248	8%
Total Recurrent Expenditure	**13,892,009**	**199,632,546**	**7%**	**9,241,862**	**137,285,383**	**7%**	**1,778,080**	**20,634,778**	**9%**	**1,430,300**	**20,918,710**	**7%**	**1,441,767**	**20,793,675**	**7%**
Operating Surplus	**67,840,939**	**(5,258,397)**		**33,851,777**	**(26,996,098)**		**6,447,205**	**1,344,723**		**13,410,183**	**10,374,025**		**14,131,774**	**10,018,953**	
less *Transfers to*															
Restricted Capital Cash	-	-		-	-		-	-		-	-		-	-	
NCP Transfers	-	-		-	(15,826,731)		-	22,073		-	8,069,947		-	7,734,711	
Fund Capital Expenditure (Capital Account)	-	-		-	-		-	-		-	-		-	-	
Total Transfers	-	-		-	**(15,826,731)**		-	**22,073**		-	**8,069,947**		-	**7,734,711**	
Movement in Unallocated Surplus	**67,840,939**	**(5,258,397)**		**33,851,777**	**(11,169,367)**		**6,447,205**	**1,322,650**		**13,410,183**	**2,304,078**		**14,131,774**	**2,284,242**	
Unallocated Surplus/(Deficit) brought forward	43,985,040	43,985,040		(24,947,334)	(24,947,334)		17,805,028	17,805,028		14,703,877	14,703,877		36,423,469	36,423,469	
Unallocated Surplus/(Deficit)	**111,825,979**	**38,726,643**		**8,904,443**	**(36,116,701)**		**24,252,233**	**19,127,678**		**28,114,060**	**17,007,955**		**50,555,243**	**38,707,711**	
Capital Activities															
Council Expenditure on Non-Current Assets	**4,403,315**	**83,282,016**	**5%**	**4,031,262**	**60,034,951**	**7%**	**9,314**	**874,312**	**1%**	**64,176**	**2,333,753**	**3%**	**298,563**	**20,039,000**	**1%**
Loan Redemption	-	7,509,801	0%	-	4,362,494	0%	-	700,376	0%	-	2,110,234	0%	-	336,697	0%
Total Capital Expenditure	**4,403,315**	**90,791,817**	**5%**	**4,031,262**	**64,397,445**	**6%**	**9,314**	**1,574,688**	**1%**	**64,176**	**4,443,987**	**1%**	**298,563**	**20,375,697**	**1%**
Cash															
Opening balance	**136,689,730**	**111,433,879**													
Movement - increase/(decrease)	**(11,230,801)**	**(22,097,558)**													
Closing balance	**125,458,929**	**89,336,321**													

Further to the Financial Summary Report as at 31 July 2020, the following key features are highlighted.

Recurrent Revenue

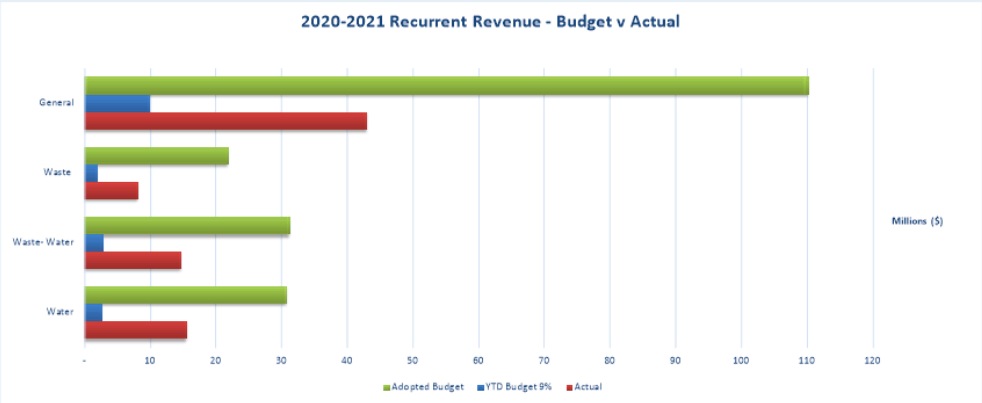
- Rates and Utility Charges have been levied for the first half year period and pensioner remissions applied. Water is higher than budget with a conservative budget formulated for water consumption.

- Fees and charges are slightly lower than the year-to-date budget. Fees and charges will be monitored in the coming months with the opening of the remainder of Council facilities.

- Interest Revenue is lower than the year-to-date budget. Current investment rates continue to fall with the outlook in future earnings likely to be less than forecast.

- Grants, Subsidies and Donations are lower than the year-to-date budget. This reflects the payment cycle of many grants which are paid quarterly.

- Council has settled parcels of Land Developed for Sale this financial year. These parcels represent historic land developments at Kinkuna Waters. Council does not generally provide for an annual budget for these sales unless it has unconditional contracts at the time the budget is formulated.



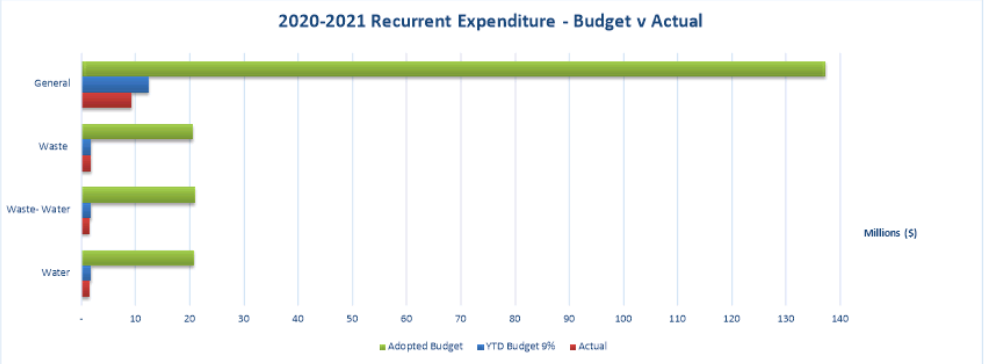
Recurrent Expenditure

- Employee Costs are lower than the year-to-date budget. This is partly due to the workers compensation premium not yet being paid and deferral of Payroll Tax payments until the second half of the financial year.

- Materials and Services are slightly lower than the year-to-date budget. The variance in the Waste Fund is due to the quarterly advance of the Waste Levy covering domestic waste not being received at the reporting date.

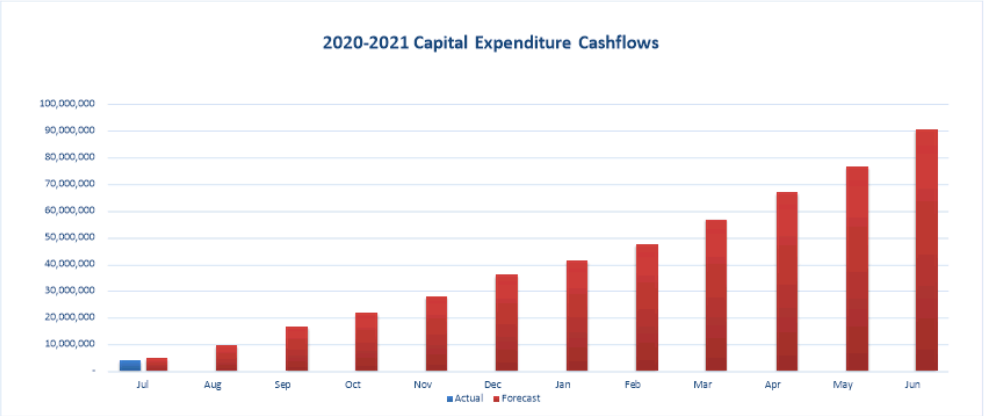
- Finance Costs are slightly lower than the year-to-date budget. The timing in the recognition of any bad debts can affect the level of finance costs over a financial year.

- Depreciation is in accordance with the adopted budget. Depreciation will be reviewed in the first half of the financial year with the application of asset valuations applied in June last financial year.

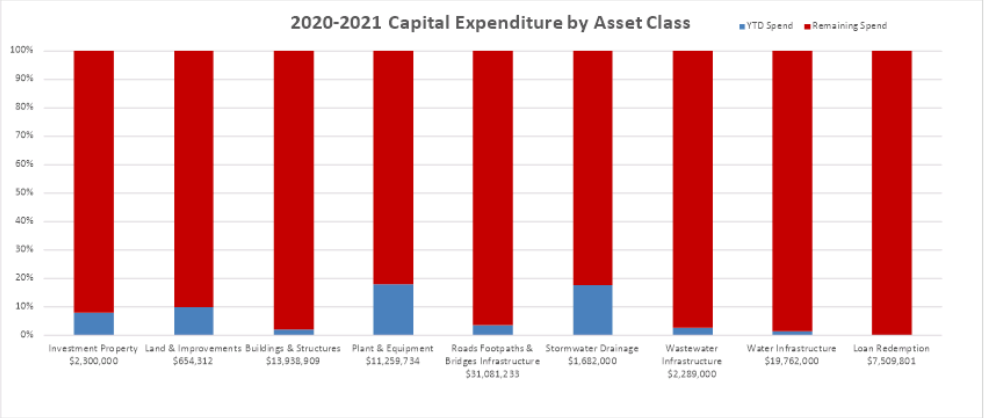


Capital Expenditure and Capital Grants

- Council has delivered 5% of this year's capital program during July. The majority of spend is in relation to projects that were in progress last financial year including the delivery of several significant fleet items.



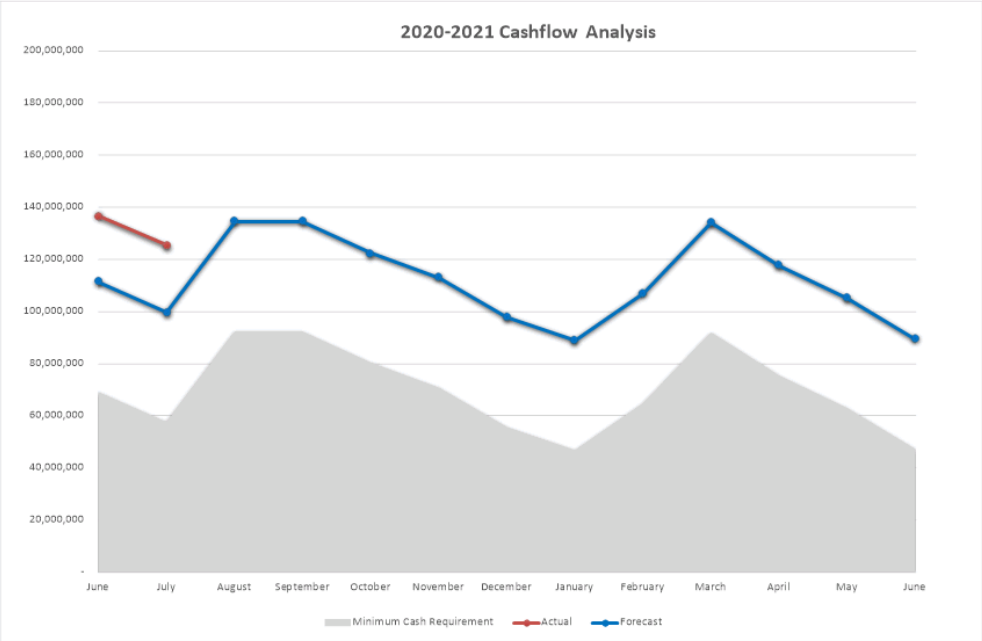
- The spend by asset class this financial year is shown below.



- Capital grants are on track with all milestones having been met and any variations to funding agreements approved. Council has had its latest round of Works for Queensland Funding projects approved and approval for the application of Drought Funding on the Recreational Precinct Upgrade. It's awaiting advice on its project submission for the Local Roads and Community Infrastructure Program.

Cash

- The cash balance as at 31 July 2020 was $125.5 million, a decrease of $11.2 million from the last report at 30 June 2020 reflecting outlays on operations and capital programs.
- No short-term liquidity issues are foreseeable.
- The actual and forecast cash movement is shown below. The higher than expected opening cash balance is a result of the timing in delivery of the capital program last financial year.



Rates Debtor

- Rates outstanding at 31 July 2020 were $83.8 million after the issuing of the rate notices. Comparatively, this time last year the rates outstanding totalled $80.9 million. The due date for payment of the current levy is 3rd September 2020.

Other Debtors

- Infringements outstanding total $399,000 with the number of infringements increasing to 2,891. Infringements continue to be recovered via the State Penalties, Enforcement Registry.

- Sundry Debtors outstanding for more than 90 days total $245,500 across 62 accounts. There were a number of overdue accounts settled during the month of July.

Item

25 August 2020

Item Number:	File Number:	Part:
F2	.	FINANCE

Portfolio:

Organisational Services

Subject:

Capital Reprovisions for the period ending 30 June 2020 into the 2020/2021 financial year.

Report Author:

Anthony Keleher, Chief Financial Officer

Authorised by:

Amanda Pafumi, General Manager Organisational Services

Link to Corporate Plan:

Our People, Our Business - 3.1 A sustainable financial position - 3.1.2 Apply responsible fiscal principles for sustainable financial management.

Background:

At the 30 June 2020 there were several capital projects in progress. This budget amendment seeks to carry over the balance of these projects into the current financial year.

All budget amendments are required to have the full suite of budget documents including the recertification of the Revenue Statement and Revenue Policy.

Recurrent

This budget amendment is limited to the reprovision of capital projects, however it will have a minor impact on Council's long-term financial forecast including interest revenue, finance costs and depreciation.

The long-term financial forecast continues to project positive Operating Surplus Ratio's within the target range.

Capital

Capital revenue has decreased slightly with adjustments relating to timing of capital income. Capital expenditure has increase by $15.27 million to $106.07 million.

Significant capital reprovisions include:

- Gin Gin Streetscape $3,230,000
- Gin Gin Service Centre and Library $505,000
- Buss Street Burnett Heads Upgrade $1,275,000
- Delivery of Fleet $3,370,000

Associated Person/Organization:

N/A

Consultation:

Executive Leadership Team

Managers and Supervisors

Chief Legal Officer's Comments:

There appears to be no legal implications.

Policy Implications:

The amended budget must include the Revenue Policy and Revenue Statement which have already been adopted by Council and remain unchanged.

Financial and Resource Implications:

Council's capital budget has been amended to accommodate projects still being delivered. Amendments to the current budget have been processed and potential impacts to forecast periods and sustainability ratios assessed.

Risk Management Implications:

There appears to be no risk management implications.

Human Rights:

There appears to be no human rights implications.

Attachments:

⇩1 FY 2020/2021 Budgeted Financial Statements
⇩2 Revenue Policy
⇩3 Revenue Statement

Recommendation:

That:

1. **Pursuant to section 170(3) and section 173 of the *Local Government Regulation 2012*, Council adopt the amended budget as tabled; and**
2. **Council endorse the following policies:**
    a. **Revenue Policy, version 4;**
    b. **Revenue Statement, version 3;**

BUNDABERG REGIONAL COUNCIL
Budgeted Statement of Income and Expenditure
For the period ending 30 June 2021

	Council					General			Waste Management			Wastewater			Water		
	Estimated Actuals	Original Budget	Proposed Budget	Forecast	Forecast	Proposed Budget	Forecast	Forecast	Proposed Budget	Forecast	Forecast	Proposed Budget	Forecast	Forecast	Proposed Budget	Forecast	Forecast
	2019/20	2020/21	2020/21	2021/22	2022/23	2020/21	2021/22	2022/23	2020/21	2021/22	2022/23	2020/21	2021/22	2022/23	2020/21	2021/22	2022/23
	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$
Operating Income																	
Rates and utility charges*	160,684,986	158,077,593	158,077,593	162,351,894	166,370,026	83,461,322	85,908,216	88,428,487	15,702,071	16,096,193	16,500,207	30,236,858	31,526,756	32,476,500	28,677,342	28,820,729	28,964,832
Less: Discounts and pensioner remissions	(9,048,950)	(1,713,674)	(1,713,674)	(1,722,242)	(1,730,854)	(1,042,901)	(1,048,116)	(1,053,356)	(228,169)	(229,310)	(230,456)	(255,237)	(256,513)	(257,795)	(187,367)	(188,304)	(189,245)
Net rates and utility charges	151,636,036	156,363,919	156,363,919	160,629,652	164,639,173	82,418,421	84,860,101	87,375,131	15,473,902	15,866,883	16,269,751	29,981,621	31,270,243	32,218,704	28,489,975	28,632,425	28,775,587
Fees and charges	22,028,839	18,075,333	18,075,333	22,048,930	22,713,154	11,565,369	15,342,853	15,805,056	5,454,564	5,618,883	5,788,152	435,000	448,104	461,604	620,400	639,090	658,342
Interest	3,657,456	2,255,970	2,255,970	2,606,640	2,440,329	785,338	981,106	921,026	374,465	433,567	399,962	394,114	455,654	458,172	702,053	736,313	661,168
Sales, contract and recoverable works	5,916,152	5,501,170	5,501,170	5,632,615	5,767,201	3,502,400	3,586,086	3,671,772	516,570	528,913	541,551	482,000	493,517	505,309	1,000,200	1,024,099	1,048,569
Grants and subsidies	13,411,877	11,916,757	11,916,757	12,131,259	12,349,621	11,916,757	12,131,259	12,349,621	-	-	-	-	-	-	-	-	-
Donations and other contributions	445,099	261,000	261,000	265,698	270,481	101,000	102,818	104,669	160,000	162,880	165,812	-	-	-	-	-	-
Profit on sale of developed land held for resale	-	-	-	370,000	197,500	-	370,000	197,500	-	-	-	-	-	-	-	-	-
TOTAL OPERATING REVENUE	197,095,459	194,374,149	194,374,149	203,684,793	208,377,458	110,289,285	117,374,222	120,424,776	21,979,501	22,611,126	23,165,227	31,292,735	32,667,519	33,643,789	30,812,628	31,031,926	31,143,666
Operating Expenditure																	
Employee benefits, materials and services	(142,905,122)	(144,095,554)	(144,095,554)	(146,080,302)	(149,610,689)	(98,983,127)	(100,138,124)	(102,213,216)	(18,112,357)	(18,463,536)	(18,830,565)	(12,652,114)	(12,520,524)	(12,810,935)	(14,347,956)	(14,958,118)	(15,755,974)
Finance costs	(4,433,076)	(4,291,551)	(4,291,551)	(3,993,763)	(4,185,959)	(1,531,258)	(1,352,576)	(1,664,868)	(901,259)	(864,660)	(821,295)	(1,608,563)	(1,523,479)	(1,438,201)	(250,471)	(253,048)	(261,596)
Depreciation	(49,209,537)	(51,245,440)	(51,245,440)	(52,474,578)	(54,016,998)	(36,770,997)	(37,604,305)	(38,735,848)	(1,621,162)	(1,659,971)	(1,681,288)	(6,658,033)	(6,778,917)	(6,965,228)	(6,195,248)	(6,431,386)	(6,634,636)
TOTAL OPERATING EXPENDITURE	(196,547,735)	(199,632,545)	(199,632,545)	(202,548,643)	(207,813,646)	(137,285,382)	(139,095,004)	(142,613,929)	(20,634,778)	(20,988,168)	(21,333,148)	(20,918,710)	(20,822,920)	(21,214,363)	(20,793,675)	(21,642,552)	(22,652,205)
Estimated Costs of Significant Business and Commercial Business Activities																	
Community service obligations	-	-	-	-	-	(2,276,221)	(2,311,270)	(2,344,156)	698,339	715,205	729,433	800,015	817,261	834,978	777,867	778,804	779,745
Competitive neutrality adjustments	-	-	-	-	-	251,664	222,815	252,146	(153,562)	(150,832)	(166,199)	(162,497)	(143,143)	(143,578)	64,395	71,160	57,631
Internal tax equivalents paid	-	-	-	-	-	7,145,209	7,301,876	7,331,959	(566,850)	(599,061)	(623,982)	(3,331,284)	(3,569,974)	(3,710,079)	(3,247,075)	(3,132,841)	(2,997,898)
Return on capital	-	-	-	-	-	10,706,079	11,238,668	11,019,180	-	-	-	(5,376,181)	(6,264,120)	(6,587,523)	(5,329,898)	(4,974,548)	(4,431,657)
	-	-	-	-	-	15,826,731	16,452,089	16,259,129	(22,073)	(34,688)	(60,748)	(8,069,947)	(9,159,976)	(9,606,202)	(7,734,711)	(7,257,425)	(6,592,179)
Operating surplus/(deficit)	547,724	(5,258,396)	(5,258,396)	1,136,150	563,811	(11,169,366)	(5,268,692)	(5,930,025)	1,322,650	1,588,270	1,771,331	2,304,078	2,684,623	2,823,224	2,284,242	2,131,949	1,899,282
Capital Activities																	
Grants and subsidies	22,965,698	20,315,774	19,815,774	12,918,969	23,380,095	19,815,774	12,918,969	23,380,095	-	-	-	-	-	-	-	-	-
Contributions from developers	10,850,000	9,412,500	9,412,500	9,412,500	9,412,500	6,112,500	6,112,500	6,112,500	-	-	-	2,150,000	2,150,000	2,150,000	1,150,000	1,150,000	1,150,000
Other capital income	105,905	136,527	136,527	145,162	147,891	136,527	145,162	147,891	-	-	-	-	-	-	-	-	-
Capital expenses	-	(7,648,577)	(7,311,645)	(7,704,011)	(7,767,118)	(5,804,476)	(6,170,618)	(6,207,044)	-	-	-	(745,419)	(758,389)	(771,585)	(761,750)	(775,004)	(788,490)
TOTAL CAPITAL ACTIVITIES	33,921,603	22,216,225	22,053,157	14,772,619	25,173,368	20,260,325	13,006,013	23,433,442	-	-	-	1,404,582	1,391,611	1,378,415	388,250	374,996	361,510
Net result	34,469,327	16,957,828	16,794,761	15,908,770	25,737,179	9,090,959	7,737,321	17,503,417	1,322,650	1,588,270	1,771,331	3,708,660	4,076,234	4,201,639	2,672,492	2,506,945	2,260,792

*Change in Total Rates and Utility Charges Levied 3.09%

BUNDABERG REGIONAL COUNCIL

Budgeted Statement of Financial Position

For the period ending 30 June 2021	Estimated Actuals	Original Budget	Proposed Budget	Forecast	Forecast
	2019/20	2020/21	2020/21	2021/22	2022/23
	$	$	$	$	$
Current Assets					
Cash and cash equivalents	111,433,879	89,336,321	73,896,136	53,122,049	44,713,255
Trade and other receivables	15,855,574	15,790,535	15,790,535	16,496,561	16,910,106
Inventories	6,173,928	6,173,928	6,173,928	6,048,928	5,986,428
Non-current assets held for sale	1,942,834	971,417	971,417	-	-
	135,406,215	112,272,202	96,832,017	75,667,537	67,609,789
Non-Current Assets					
Investment property	7,584,851	7,721,379	7,721,379	7,866,541	8,014,432
Property, plant and equipment	2,204,244,890	2,253,718,488	2,268,995,605	2,341,932,786	2,416,359,053
Intangible assets	6,352,659	6,057,405	6,057,405	5,762,152	5,466,898
	2,218,182,401	2,267,497,272	2,282,774,389	2,355,561,479	2,429,840,383
TOTAL ASSETS	2,353,588,616	2,379,769,474	2,379,606,406	2,431,229,016	2,497,450,173
Current Liabilities					
Trade and other payables	11,746,321	11,877,991	11,877,991	12,041,742	12,332,543
Borrowings	7,489,118	6,541,817	6,541,817	7,590,546	8,608,004
Provisions	12,389,143	12,389,143	12,389,143	12,389,143	12,389,143
Unearned revenue	3,805,876	673,662	673,662	673,662	673,662
	35,430,458	31,482,612	31,482,612	32,695,093	34,003,353
Non-Current Liabilities					
Borrowings	70,058,336	63,495,837	63,495,837	77,648,312	95,002,252
Provisions	19,397,219	19,422,907	19,422,907	19,138,595	19,388,595
	89,455,555	82,918,744	82,918,744	96,786,907	114,390,847
TOTAL LIABILITIES	124,886,013	114,401,356	114,401,356	129,482,000	148,394,200
NET COMMUNITY ASSETS	2,228,702,602	2,265,368,118	2,265,205,050	2,301,747,016	2,349,055,973
Community Equity					
Asset revaluation surplus	546,124,994	565,832,680	565,832,680	586,465,877	608,037,654
Retained surplus	1,682,577,609	1,699,535,437	1,699,372,369	1,715,281,139	1,741,018,319
TOTAL COMMUNITY EQUITY	2,228,702,602	2,265,368,118	2,265,205,050	2,301,747,016	2,349,055,973

BUNDABERG REGIONAL COUNCIL

Budgeted Statement of Cash Flow

For the period ending 30 June 2021	Estimated Actuals	Original Budget	Proposed Budget	Forecast	Forecast
	2019/20	2020/21	2020/21	2021/22	2022/23
	$	$	$	$	$
Cash Flows from Operating Activities					
Receipts from customers	177,630,080	179,860,423	179,860,423	187,485,814	192,585,180
Payments to suppliers and employees	(150,963,982)	(148,040,411)	(148,040,411)	(147,178,423)	(150,055,144)
	26,666,098	31,820,012	31,820,012	40,307,391	42,530,036
Recurrent grants, subsidies, contributions and donations	14,515,505	12,187,795	12,187,795	12,378,940	12,601,761
Interest received	3,657,456	2,255,970	2,255,970	2,606,640	2,440,329
Proceeds from sale of developed land held for resale	-	-	-	495,000	260,000
Borrowing costs	(3,403,076)	(3,186,551)	(3,186,551)	(2,878,829)	(3,061,561)
Net Cash Inflow/(Outflow) from Operating Activities	41,435,983	43,077,226	43,077,226	52,909,143	54,770,565
Cash Flow from Investing Activities :					
Proceeds from sale of property, plant and equipment	900,000	1,093,000	1,429,932	1,100,000	1,100,000
Proceeds from sale of non-current assets held for sale	-	971,417	971,417	971,417	-
Capital grants, subsidies, contributions and donations	25,921,603	23,028,274	22,528,274	15,631,469	26,092,595
Payments for property, plant and equipment	(103,713,915)	(82,757,674)	(98,034,791)	(106,587,321)	(108,743,352)
Payments for intangible assets	(595,444)	-	-	-	-
Net Cash Inflow/(Outflow) from Investing Activities	(77,487,756)	(57,664,983)	(73,105,168)	(88,884,435)	(81,550,757)
Cash Flow from Financing Activities :					
Proceeds from borrowings	7,500,000	-	-	21,700,000	25,900,000
Repayment of borrowings	(7,292,658)	(7,509,801)	(7,509,801)	(6,498,795)	(7,528,601)
Net Cash Inflow/(Outflow) from Financing Activities	207,342	(7,509,801)	(7,509,801)	15,201,205	18,371,399
Net Increase/(Decrease) in Cash Held	(35,844,430)	(22,097,557)	(37,537,742)	(20,774,087)	(8,408,794)
Cash at beginning of reporting period	147,278,309	111,433,879	111,433,879	73,896,136	53,122,049
Cash at end of Reporting Period	111,433,879	89,336,321	73,896,136	53,122,049	44,713,255

BUNDABERG REGIONAL COUNCIL

Budgeted Statement of Changes in Equity

For the period ending 30 June 2021	Estimated Actuals	Original Budget	Proposed Budget	Forecast	Forecast
	2019/20	2020/21	2020/21	2021/22	2022/23
	$	$	$	$	$
Opening Balance - Retained Surplus	1,648,108,282	1,682,577,609	1,682,577,609	1,699,372,369	1,715,281,139
Net result	34,469,327	16,957,828	16,794,761	15,908,770	25,737,179
Closing Balance - Retained Surplus	1,682,577,609	1,699,535,437	1,699,372,369	1,715,281,139	1,741,018,318
Opening Balance - Asset Revaluation Surplus	514,957,398	546,124,994	546,124,994	565,832,680	586,465,877
Increase in asset revaluation surplus	31,167,596	19,707,687	19,707,687	20,633,197	21,571,777
Closing Balance - Asset Revaluation Surplus	546,124,994	565,832,680	565,832,680	586,465,877	608,037,654
Total Community Equity	2,228,702,602	2,265,368,117	2,265,205,049	2,301,747,016	2,349,055,972

BUNDABERG REGIONAL COUNCIL

Long-Term Financial Forecast

Income and Expenditure

For the period ending 30 June 2021

	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
	$	$	$	$	$	$	$	$	$	$
Operating Income										
Rates and utility charges	158,077,593	162,351,894	166,370,026	171,085,408	175,936,766	180,928,051	186,063,329	191,346,784	196,782,725	202,375,583
Less: Discounts & pensioner remissions	(1,713,674)	(1,722,242)	(1,730,854)	(1,739,508)	(1,748,205)	(1,756,946)	(1,765,731)	(1,774,560)	(1,783,433)	(1,792,350)
Net rates and utility charges	156,363,919	160,629,652	164,639,173	169,345,900	174,188,561	179,171,105	184,297,598	189,572,225	194,999,292	200,583,233
Fees and charges	18,075,333	22,048,930	22,713,154	23,397,387	24,102,234	24,828,313	25,576,266	26,346,751	27,140,447	27,958,053
Interest	2,255,970	2,606,640	2,440,329	2,379,568	2,505,625	3,009,346	3,808,845	4,978,093	5,981,404	7,391,362
Sales, contract and recoverable works	5,501,170	5,632,615	5,767,201	5,905,002	6,046,096	6,190,562	6,338,479	6,489,931	6,645,001	6,803,777
Grants and subsidies	11,916,757	12,131,259	12,349,621	12,571,914	12,798,209	13,028,577	13,263,091	13,501,827	13,744,860	13,992,267
Donations and other contributions	261,000	265,698	270,481	275,349	280,306	285,351	290,487	295,716	301,039	306,458
Profit on sale of developed land held for resale	-	370,000	197,500	135,000	370,000	197,500	135,000	370,000	197,500	135,000
TOTAL OPERATING REVENUE	194,374,149	203,684,793	208,377,458	214,010,122	220,291,030	226,710,753	233,709,767	241,554,543	249,009,543	257,170,150
Operating Expenditure										
Employee benefits, materials and services	(144,095,554)	(146,080,302)	(149,610,689)	(153,161,700)	(158,394,134)	(162,455,723)	(169,588,404)	(174,950,883)	(180,264,607)	(184,839,504)
Finance costs	(4,291,551)	(3,993,763)	(4,185,959)	(4,559,112)	(4,673,162)	(4,622,214)	(4,851,596)	(5,037,978)	(5,104,106)	(5,570,116)
Depreciation	(51,245,440)	(52,474,578)	(54,016,998)	(55,662,951)	(57,202,364)	(57,991,925)	(59,125,204)	(60,279,225)	(61,564,121)	(62,406,306)
TOTAL OPERATING EXPENDITURE	(199,632,545)	(202,548,643)	(207,813,646)	(213,383,763)	(220,269,660)	(225,069,862)	(233,565,203)	(240,268,087)	(246,932,835)	(252,815,926)
Operating surplus/(deficit)	(5,258,396)	1,136,150	563,811	626,358	21,369	1,640,891	144,563	1,286,456	2,076,708	4,354,224
Capital Activities										
Grants and subsidies	19,815,774	12,918,969	23,380,095	11,350,000	11,200,000	15,100,000	10,100,000	5,100,000	2,600,000	5,100,000
Contributions from developers	9,412,500	9,412,500	9,412,500	9,412,500	9,412,500	9,412,500	9,412,500	9,412,500	9,412,500	9,412,500
Other capital income	136,527	145,162	147,891	150,671	153,504	156,390	159,330	162,325	165,377	168,486
Capital expenses	(7,311,645)	(7,704,011)	(7,767,118)	(8,330,906)	(8,395,384)	(8,460,562)	(8,526,450)	(8,593,057)	(8,660,393)	(8,728,469)
TOTAL CAPITAL ACTIVITIES	22,053,157	14,772,619	25,173,368	12,582,265	12,370,620	16,208,328	11,145,380	6,081,769	3,517,484	5,952,517
Net result	16,794,761	15,908,770	25,737,179	13,208,624	12,391,989	17,849,219	11,289,943	7,368,224	5,594,192	10,306,741

BUNDABERG REGIONAL COUNCIL

Long-Term Financial Forecast

Assets, Liabilities and Equity

For the period ending 30 June 2021

	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
	$	$	$	$	$	$	$	$	$	$
Current Assets										
Cash and cash equivalents	73,896,136	53,122,049	44,713,255	23,037,394	32,647,921	42,088,689	55,596,300	75,068,168	88,115,243	107,312,084
Trade and other receivables	15,790,535	16,496,561	16,910,106	17,335,701	17,869,759	18,370,184	18,884,870	19,361,184	19,958,683	20,518,667
Inventories	6,173,928	6,048,928	5,986,428	5,941,428	5,816,428	5,753,928	5,708,928	5,583,928	5,521,428	5,476,428
Non-current assets held for sale	971,417	-	-	-	-	-	-	-	-	-
	96,832,017	75,667,537	67,609,789	46,314,523	56,334,109	66,212,801	80,190,098	100,013,280	113,595,354	133,307,179
Non-Current Assets										
Investment property	7,721,379	7,866,541	8,014,432	8,165,103	8,318,607	8,474,997	8,634,327	8,796,652	8,962,029	9,130,515
Property, plant and equipment	2,268,995,605	2,341,932,786	2,416,359,053	2,480,676,093	2,504,781,501	2,537,886,730	2,558,469,447	2,567,588,585	2,591,785,898	2,609,870,939
Intangible assets	6,057,405	5,762,152	5,466,898	5,171,645	4,876,391	4,841,698	4,841,698	7,341,698	7,091,698	6,841,698
	2,282,774,389	2,355,561,479	2,429,840,383	2,494,012,841	2,517,976,500	2,551,203,425	2,571,945,472	2,583,726,935	2,607,839,625	2,625,843,152
TOTAL ASSETS	2,379,606,406	2,431,229,016	2,497,450,173	2,540,327,365	2,574,310,608	2,617,416,226	2,652,135,569	2,683,740,215	2,721,434,979	2,759,150,331
Current Liabilities										
Trade and other payables	11,877,991	12,041,742	12,332,543	12,590,557	13,055,770	13,390,266	13,977,194	14,379,242	14,856,085	15,232,821
Borrowings	6,541,817	7,590,546	8,608,004	7,800,035	7,196,348	7,346,328	7,382,096	7,797,628	8,483,089	8,941,249
Provisions	12,389,143	12,389,143	12,389,143	12,389,143	12,389,143	12,389,143	12,389,143	12,389,143	12,389,143	12,389,143
Unearned revenue	673,662	673,662	673,662	673,662	673,662	673,662	673,662	673,662	673,662	673,662
	31,482,612	32,695,093	34,003,353	33,453,397	33,314,923	33,799,399	34,422,095	35,239,675	36,401,980	37,236,875
Non-Current Liabilities										
Borrowings	63,495,837	77,648,312	95,002,252	102,494,925	100,816,226	104,509,685	106,163,812	103,890,561	108,470,384	108,123,989
Provisions	19,422,907	19,138,595	19,388,595	19,638,595	19,888,595	16,999,937	13,451,872	13,926,872	14,401,872	14,801,872
	82,918,744	96,786,907	114,390,847	122,133,520	120,704,821	121,509,622	119,615,684	117,817,433	122,872,256	122,925,861
TOTAL LIABILITIES	114,401,356	129,482,000	148,394,200	155,586,916	154,019,744	155,309,022	154,037,779	153,057,108	159,274,235	160,162,736
NET COMMUNITY ASSETS	2,265,205,050	2,301,747,016	2,349,055,973	2,384,740,448	2,420,290,864	2,462,107,204	2,498,097,790	2,530,683,107	2,562,160,743	2,598,987,596
Community Equity										
Asset revaluation surplus	565,832,680	586,465,877	608,037,654	630,513,506	653,671,933	677,639,053	702,339,696	727,556,788	753,440,232	779,960,344
Retained surplus	1,699,372,369	1,715,281,139	1,741,018,319	1,754,226,942	1,766,618,932	1,784,468,151	1,795,758,094	1,803,126,319	1,808,720,511	1,819,027,252
TOTAL COMMUNITY EQUITY	2,265,205,050	2,301,747,016	2,349,055,973	2,384,740,448	2,420,290,864	2,462,107,204	2,498,097,790	2,530,683,107	2,562,160,743	2,598,987,596

BUNDABERG REGIONAL COUNCIL
Financial Sustainability Ratios

For the period ending 30 June 2021	Target	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
Net Financial Liabilities Ratio Total liabilities less current assets divided by operating revenue	< 60%	9.0%	26.4%	38.8%	51.1%	44.3%	39.3%	31.6%	22.0%	18.3%	10.4%
Operating Surplus Ratio Operating surplus divided by total operating revenue	0% -10%	-2.7%	0.6%	0.3%	0.3%	0.0%	0.7%	0.1%	0.5%	0.8%	1.7%
Asset Sustainability Ratio Capital expenditure on replacement assets divided by depreciation expense	> 90%	53.1%	40.9%	56.0%	54.9%	42.1%	53.7%	45.2%	51.0%	50.1%	47.7%

BUNDABERG REGIONAL COUNCIL

Estimated Activity Statement

For the period ending 30 June 2021	Water	Wastewater	Waste Management	Council's Holiday Parks	Bundaberg Airport
	2020/21	2020/21	2020/21	2020/21	2020/21
	$	$	$	$	$
Estimated revenue payable to Council	1,787,542	495,834	295,669	-	-
Estimated revenue payable to external clients	28,285,400	30,495,524	21,309,367	2,315,116	3,152,810
Community service obligations	777,867	800,015	698,339	-	-
	30,850,809	31,791,373	22,303,375	2,315,116	3,152,810
Less: Estimated expenses	(20,561,949)	(19,215,021)	(20,398,409)	(2,436,235)	(3,441,733)
Estimated surplus/(deficit)	10,288,860	12,576,352	1,904,966	(121,119)	(288,923)
Description of estimated CSO's provided to business activities					
Pension remissions	187,367				
Provision of water allocations to unlicensed sporting clubs free of charge	225,000				
Internal bulk water provisions	97,000				
Water leak relief	99,000				
Infrastructure charges incentives	169,500				
Pension remissions		255,237			
Providing pedestal discount for community and aged care facilities		332,225			
Providing pedestal discount for not-for-profit sporting clubs		50,053			
Infrastructure charges incentives		162,500			
Pension remissions			228,169		
Provision of bins and waste disposal for community events			24,620		
In-kind assistance for charities			95,550		

BUNDABERG REGIONAL COUNCIL

10 Year Capital Investment Summary

For the period ending 30 June 2021

	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	Total
Expenditure Type											
New	19,423,361	36,034,369	49,274,537	37,384,683	16,923,813	20,369,904	12,335,478	5,655,866	23,492,246	13,139,835	234,034,092
Upgrade	45,939,695	39,732,936	26,255,000	36,444,029	17,394,247	21,905,138	18,036,095	14,489,760	8,506,809	17,548,806	246,252,515
Renewal	33,196,047	31,654,327	33,513,815	25,911,080	26,131,416	30,619,518	31,160,219	29,103,703	30,264,329	25,811,063	297,365,516
Loan Redemption	7,509,801	6,494,746	7,506,615	8,524,598	7,733,080	7,104,880	7,255,707	7,302,088	7,680,046	8,383,401	75,494,962
	106,068,904	113,916,378	116,549,967	108,264,390	68,182,556	79,999,440	68,787,499	56,551,416	69,943,430	64,883,104	853,147,086
Asset Class											
Land	476,148	-	-	-	-	-	-	-	950,075	1,135,345	2,561,568
Land Restoration	524,312	834,312	300,000	300,000	300,000	3,438,658	4,098,065	75,000	75,000	150,000	10,095,347
Investment Property	2,724,464	-	-	-	-	-	-	-	-	-	2,724,464
Buildings & Structures	15,001,809	32,865,156	40,979,161	31,127,330	25,475,586	25,996,633	28,198,900	18,093,235	15,803,418	9,530,496	243,071,722
Plant & Equipment	15,869,889	12,435,213	12,554,179	7,317,196	7,289,168	6,128,227	7,375,423	6,179,334	6,484,587	6,110,333	87,743,549
Transport Infrastructure	40,115,836	36,379,015	33,821,012	26,436,961	17,951,320	18,796,551	16,659,315	16,973,510	32,144,193	23,223,725	262,501,437
Stormwater Drainage	2,283,060	3,834,000	2,220,000	14,351,031	2,436,720	2,373,587	944,916	1,981,250	901,006	7,428,969	38,754,539
Sewerage Infrastructure	3,025,327	9,793,000	9,521,000	9,569,290	4,261,682	11,427,000	2,289,984	1,779,000	2,128,190	7,202,837	60,997,310
Water Infrastructure	18,538,258	11,280,936	9,648,000	10,637,984	2,735,000	4,733,904	1,965,190	1,668,000	3,776,915	1,718,000	66,702,187
Intangibles	-	-	-	-	-	-	-	2,500,000	-	-	2,500,000
Loan Redemption	7,509,801	6,494,746	7,506,615	8,524,598	7,733,080	7,104,880	7,255,707	7,302,088	7,680,046	8,383,401	75,494,962
	106,068,904	113,916,378	116,549,967	108,264,390	68,182,556	79,999,440	68,787,499	56,551,416	69,943,430	64,883,104	853,147,086
Funding Sources											
Grants & Subsidies	33,544,791	13,335,427	17,080,095	16,398,902	11,200,000	15,100,000	11,600,000	5,100,000	2,600,000	5,100,000	131,059,215
Loans	-	21,700,000	25,900,000	15,250,000	5,500,000	11,000,000	9,000,000	5,500,000	13,000,000	8,550,000	115,400,000
Infrastructure Charges	10,030,000	3,350,000	3,950,000	4,709,255	1,167,493	2,100,000	500,000	1,478,891	2,331,800	500,000	30,117,439
Asset Sales	1,429,932	1,100,000	1,100,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	7,829,932
Reserves	1,274,312	834,312	300,000	300,000	300,000	3,438,658	4,098,065	75,000	75,000	150,000	10,845,347
General Revenue	59,789,868	73,596,639	68,219,872	71,006,233	49,415,064	47,760,782	42,989,434	43,797,525	51,336,630	49,983,104	557,895,153
	106,068,904	113,916,378	116,549,967	108,264,390	68,182,556	79,999,440	68,787,499	56,551,416	69,943,430	64,883,104	853,147,086

Revenue Policy

HEAD OF POWER

- *Local Government Regulation 2012*, section 169(2)(c) and section 193
- Corporate Plan, Outcome 3.1 – A sustainable financial position

INTENT

The purpose of this policy is to achieve compliance with section 169(2)(c) and section 193 of the *Local Government Regulation 2012* and to outline the principles applied by Council.

SCOPE

This policy applies to all staff and Councillors.

POLICY STATEMENT

1. Principles used for the making and levying of Rates and Charges

a) Equity – ensuring the fair and consistent application of lawful rating and charging principles without bias, taking account of all relevant considerations;
b) Transparency – openness in the processes involved in the making of rates and charges;
c) Simplicity – a rating regime that is simple and cost effective to administer;
d) Consistency – by scheduling the issue of rates notices on a regular basis;
e) Fiscal responsibility – levying an amount sufficient to allow Council to meet its budgetary responsibilities;
f) Clarity – by providing meaningful information on rate notices to enable ratepayers to clearly understand their responsibilities;
g) Flexibility – responding where possible to unforeseen changes in the local economy and providing a wide range of payment options; and
h) Sustainability – revenue decisions supporting the financial strategies for the delivery of infrastructure and services identified in Council's long-term planning.

2. Principles used for granting Concessions for Rates and Charges

In considering the application of concessions Council will be guided by the principles of:
a) The same treatment for ratepayers with similar circumstances;
b) Transparency by making clear the requirements necessary to receive concessions; and
c) Flexibility to allow Council to respond to local economic issues.

Consideration may be given by Council to granting a class concession in the event all or part of the Bundaberg Regional Council area is declared a natural disaster area by the State Government or impacted by a Pandemic called by the Australian Government.

2.1 Council will apply concessions for the following groups, for the purposes outlined:

a) Concession for rates and charges for pensioners – Council acknowledges that certain classes of pensioners have a reduced capacity to pay on demand and to the full quantum; and

b) Concessions for rates and charges for community, sporting and welfare groups – Council acknowledges the contribution of non-profit community, sporting and welfare groups based on the level of their community assistance and economic value to the region and community.

3. Principles used for the recovery of overdue Rates and Charges

a) Transparency and clarity – making the obligations clear to ratepayers and the processes used by Council to assist ratepayers to meet these obligations;

b) Simplicity – making the processes used to recover outstanding rates and charges clear and simple to administer and cost effective;

c) Flexibility – by responding where necessary to changes in the local economy; and

d) Equity – having regard to providing the same treatment for ratepayers with similar circumstances.

4. Principles used in Cost-recovery methods

a) Fiscal responsibility – through full cost recovery, endeavouring to recover the full cost of the service for which the fee is remitted to minimise the effect on ratepayers;

b) Simplicity – to make the levying of cost-recovery fees simple, efficient, and inexpensive to administer; and

c) Clarity – in the method of calculating the amounts payable by the recipient of the service.

5. The extent to which physical and social infrastructure costs for a new development are to be funded by charges for the development

In setting infrastructure charges, Council seeks to achieve a balance between affordability and sustainability, with infrastructure charges below the State Government cap. By levying infrastructure charges for new development, Council intends to fund the physical and social costs of providing trunk infrastructure to service development within the Bundaberg Region.

Council's infrastructure charges aim to provide a reasonable and equitable distribution of costs between Council and developers of land, managing the impact of infrastructure costs of new development on existing ratepayers. To encourage development and longer-term job generating businesses, Council may discount certain types of infrastructure charges payable for new development applications in accordance with the terms of the relevant Policy at that time.

Council's infrastructure charging framework has been established in accordance with the legislative requirements of the *Planning Act 2016*.

ASSOCIATED DOCUMENTS

- *Local Government Act 2009*
- *Planning Act 2016*
- Revenue Statement

DOCUMENTS CONTROLS

Council will review this policy annually or in response to changes to law or best practice.

POLICY OWNER

The Chief Financial Officer, Financial Services is the responsible person for this policy.

BUNDABERG REGIONAL COUNCIL

Revenue Statement

HEAD OF POWER

- *Local Government Regulation 2012,* sections 169(2)(b) and 172
- *Corporate Plan, Outcome 3.1 - A sustainable financial position*

INTENT

The purpose of the Revenue Statement is to achieve compliance with sections 169(2)(b) and 172 of the *Local Government Regulation 2012* and to provide an explanation of the rates and charges, cost recovery fees, and concessions adopted by Bundaberg Regional Council (Council).

SCOPE

The Revenue Statement applies to all staff and Councillors.

Definitions

Rateable land is defined by section 93(2) of the *Local Government Act 2009* as any land or building unit, in the local government area, that is not exempted from rates.

Primary Council land use code means a code recorded in Council's rating files as a Council code which identifies the principal use of the land or the potential predominant use by virtue of its improvements or activities conducted upon the land.

Secondary Council land use code means a code used in conjunction with the Primary Council land use code to indicate a particular land use or the potential predominant use by virtue of its improvements or activities conducted upon the land.

Strata title residential and commercial property and Strata title residential and commercial use means – Lots, which have a primary Council land use code of 1008 or 1009, created under the provisions of the *Building Units and Group Titles Act 1980* or the *Body Corporate and Community Management Act 1997*.

Subdivided land is defined in chapter 2, part 2, subdivision 3, sections 49 to 51 of the *Land Valuation Act 2010 as* follows:
Subdivision applies to a parcel (the relevant parcel) if:
a) the relevant parcel is one of the parts into which land has been subdivided; and
b) the person who subdivided the land (the "subdivider") is the owner of the parcel; and
c) the relevant parcel is not developed land.

POLICY STATEMENT

Pursuant to sections 169(2)(b) and 172 of the *Local Government Regulation 2012*, Council is required to incorporate a Revenue Statement within its budget for each financial year that outlines the rates and charges, cost recovery fees, and concessions that the Council intends to apply as detailed below.

1. The Measures Adopted for Revenue Raising

Council for any financial year will, as properly planned to meet requirements, make and levy:

- Differential General Rates;
- Minimum General Rates;
- Separate Rates and Charges (for a specific purpose benefitting the Region);
- Special Rates and Charges (generally across specific benefited or serviced areas of the Region); and
- Utility Charges.

In respect of utility charges, Council will, as properly planned to meet requirements, make and levy such charges for supplying:

- Water services;
- Sewerage services;
- Waste and recycling collection services; and
- Trade waste processing services.

Council's rate-setting and charging structures will be based on the principles outlined in its Revenue Policy including equity, transparency, simplicity, consistency, fiscal responsibility, clarity, flexibility and sustainability.

2. General Rates / Differential General Rates

General rates are levied on all rateable properties in the regional area, and are calculated on the basis of the value of land. The value of land is determined by the Department of Natural Resources, Mines & Energy according to:

- in the case of rural land, its unimproved capital value; and
- in all other cases, its site value.

Council will make and levy differential general rates for the financial year ending 30 June 2021, on all rateable land in the Local Government area.

Where Council makes a determination that a parcel of land is intended to be used for a particular purpose, or has the potential to be used for such a purpose, it will have regard to, amongst other things, any improvements to, or activities being undertaken on, the land.

Further, Council delegates to the Chief Executive Officer the power (contained in sections 81(4) and (5) of the *Local Government Regulation 2012*) to identify the rating category to which each parcel of rateable land in Council's area belongs.

In accordance with sections 88 and 90 of the *Local Government Regulation 2012*, owners of rateable land will be informed of the general rating category in which their land has been included and that they have the right of objection to the category to which their land is allocated. All objections shall be submitted to the Chief Executive Officer, Bundaberg Regional Council, and the only basis for objection shall be that at the date of issue of the rate notice, having regard to the descriptions adopted by Council, the land should be in another rating category.

3. Minimum General Rate

A Minimum General Rate will be set for each rating category for the purpose of:

- setting a minimum contribution to be made from all properties situated within the region; and
- ensure that general rate revenue from lower valued properties results in a more equitable contribution from such properties towards the cost of services funded from general rates.

In accordance with section 77(3) of the *Local Government Regulation 2012*, Minimum General Rates do not apply to subdivided land with a land use code of 1072.

4. Differential General Rates

In accordance with sections 92 and 94 of the *Local Government Act 2009* and sections 77 to 82 of the *Local Government Regulation 2012*, Council makes and levies differential general rates and corresponding Minimum General Rates for the year ending 30 June 2021, against rateable land categories as follows:

Category	Description	Identification (Land to which the Primary Land use Codes apply)	Rate in the Dollar of Property Value	Minimum General Rate
1	**Urban Residential Land** – *Land that is used, or has the potential to be used, for urban residential purposes, other than land included in category 5 or 7*	1001 - Vacant Land 1002 - Single Use Dwelling 1003 - Multi Unit Dwellings – Flats/Dual Occupancy 1006 - Outbuilding 1009 - Strata Title Residential Use 1021 - Residential Institution Non-Medical 1072 - Section 49 to 51 Valuation	1.1964	$1,024
2	**Rural Residential Land** – *Land that is used, or has the potential to be used, for rural residential purposes*	1003 - Multi Unit Dwellings – Flats/Dual Occupancy 1004 - Vacant Large Homesite 1005 - Dwelling Large Homesite 1006 - Outbuilding 1009 - Strata Title Residential Use 1021 - Residential Institution Non-Medical 1072 - Section 49 to 51 Valuation 1094 - Other Rural Land	1.0292	$1,028
3	*Intentionally left blank*			
4	*Intentionally left blank*			

Category	Description	Identification (Land to which the Primary Land use Codes apply)	Rate in the Dollar of Property Value	Minimum General Rate
5	**Coastal Towns -** *Land that is used, or has the potential to be used, for residential purposes and is located within the townships or areas of Bargara, Burnett Heads, Buxton, Coonarr, Coral Cove, Elliott Heads, Innes Park, Moore Park Beach, Walkers Point, Winfield and Woodgate Beach, and does not have frontage to the Pacific Ocean or frontage to a road which, in turn, has frontage to the Pacific Ocean.* ** Refer Differential Rating Maps 1-10*	1001 - Vacant Land 1002 - Single Unit Dwelling 1003 - Multi-Unit Dwelling, Flats, Dual Occupancy 1004 - Vacant Large Homesite 1005 - Dwelling Large Homesite 1006 - Outbuildings 1009 - Strata Title Residential Use 1021 - Residential Institution Non-Medical 1072 - Section 49 to 51 Valuation	0.9761	$1,137
6	*Intentionally left blank*			
7	**Urban Oceanfront –** *Land that is used, or has the potential to be used, for residential purposes and is located within the townships or areas of Bargara, Burnett Heads, Coonarr, Coral Cove, Elliott Heads, Innes Park, Moore Park Beach, Winfield and Woodgate Beach, and has frontage to the Pacific Ocean, or has frontage to a road which, in turn, has frontage to the Pacific Ocean* ** Refer Differential Rating Maps 1-10*	1001 - Vacant Land 1002 - Single Unit Dwelling 1003 - Multi Unit Dwelling, Flats, Dual Occupancy 1004 - Vacant Large Homesite 1005 - Dwelling Large Homesite 1006 - Outbuildings 1009 - Strata Title Residential Use 1021 - Residential Non-Medical 1072 - Section 49 to 51 Valuation	0.9196	$1,288
8	*Intentionally left blank*			

Category	Description	Identification (Land to which the Primary Land use Codes apply)	Rate in the Dollar of Property Value	Minimum General Rate
9	**Agricultural Land -** *Land that is used, or has the potential to be used, for agricultural purposes.*	1060 - Sheep Grazing 1061 - Sheep Breeding 1064 - Cattle Grazing & Breeding 1065 - Cattle Breeding & Fattening 1066 - Cattle Fattening 1067 - Goats 1068 - Milk Quota 1069 - Milk No Quota 1070 - Cream 1071 - Oil Seeds 1073 - Grains 1074 - Turf Farms 1075 - Sugar Cane 1076 - Tobacco 1077 - Cotton 1078 - Rice 1079 - Orchards 1080 - Tropical Fruits 1081 - Pineapple 1082 - Vineyards 1083 - Small Crops & Fodder Irrigation 1084 - Small Crops & Fodder Non Irrigation 1085 - Pigs 1086 - Horses 1087 - Poultry 1088 - Forestry & Logs 1089 - Animals – Special 1090 - Stratum	1.4077	$1,137
10	*Intentionally left blank*			
11	*Intentionally left blank*			

Category	Description	Identification (Land to which the Primary Land use Codes apply)	Rate in the Dollar of Property Value	Minimum General Rate
12	**Bundaberg Commercial Land –** *Land located within the area of Bundaberg City that is used, or has the potential to be used, for commercial purposes, other than land included in category 15.*	1007 - Guest House/Private Hotel 1008 - Strata Title Non Residential Use 1010 - Combines Multi Dwelling & Shops 1011 - Shop Single 1012 - Shop Group (more than 6 shops) 1013 - Shopping Group (2 to 6 shops) 1014 - Shopping Main Retail (CBD) 1015 - Shopping Secondary (Fringe CBD) 1016 - Drive in Shopping Centre 1017 - Restaurant 1018 - Tourist Attraction 1020 - Marina 1022-1 - Car Park Commercial 1023 - Retail Warehouse 1024 - Sales Area (Outdoor) 1025 - Offices 1026 - Funeral Parlour 1027 - Private Hospital/Convalescent Home (Medical Private) 1028-1 - Warehouse & Bulk Stores 1030 - Service Station 1038 - Advertising Hoarding 1041 - Child Care excluding Kindergarten 1042 - Tavern/Hotel 1043 - Motel 1044 - Nursery (Plants) 1045 - Theatres and Cinemas 1046 - Drive-In Theatre 1047 - Club – Sport (run as a business) 1049 - Caravan Park 1053 - Employment Agency/Training 1054 - Marketplace	2.2403	$1,352
13	*Intentionally left blank*			

Category	Description	Identification (Land to which the Primary Land use Codes apply)	Rate in the Dollar of Property Value	Minimum General Rate
14	**Other Commercial Land** – *Land located outside the area of Bundaberg City that is used, or has the potential to be used, for commercial purposes.*	1007 - Guest House/Private Hotel 1008 - Strata Title Non Residential Use 1010 - Combines Multi Dwelling & Shops 1011 - Shop Single 1012 - Shop Group (more than 6 shops) 1013 - Shopping Group (2 to 6 shops) 1014 - Shopping Main Retail (CBD) 1015 - Shopping Secondary (Fringe CBD) 1016 - Drive in Shopping Centre 1017 - Restaurant 1018 - Tourist Attraction 1020 - Marina 1022-1 - Car Park Commercial 1023 - Retail Warehouse 1024 - Sales Area (Outdoor) 1025 - Offices 1026 - Funeral Parlour 1027 - Private Hospital/Convalescent Home (Medical Private) 1028-1 - Warehouse & Bulk Stores 1030 - Service Station 1038 - Advertising Hoarding 1041 - Child Care excluding Kindergarten 1042 - Tavern/Hotel 1043 - Motel 1044 - Nursery (Plants) 1045 - Theatres and Cinemas 1046 - Drive-In Theatre 1047 - Club – Sport (run as a business) 1049 - Caravan Park 1053 - Employment Agency/Training 1054 - Marketplace	1.4505	$1,352
15	**Major Shopping Centre** – *Land that is used, or has the potential to be used for the purposes of a shopping centre with a gross floor area of more than 20,000m²*	1016-16 - Drive In Shopping Centre with more than 20,000m² gross floor area.	3.8360	$549,346

Category	Description	Identification (Land to which the Primary Land use Codes apply)	Rate in the Dollar of Property Value	Minimum General Rate
16	**Industrial Land** – *Land that is used, or has the potential to be used for industrial purposes and which is not included in category 18 or 19.*	1028-2 - Warehouse & Bulk Stores 1029 - Transport Terminal 1031 - Oil/Fuel Depot and Refinery 1032 - Wharves, Jetties, Barge Landing 1033 - Outdoor Service Area 1034 - Cold Stores – Iceworks 1035 - General Industry 1036 - Light Industry 1037 - Noxious/Offence Industry 1039 - Harbour Industry 1091 - Transformers and Substations 1200 - Solar Farm	1.7124	$1,642
17	*Intentionally left blank*			
18	**Extractive Industry -** *Land that is used, or has the potential to be used, for extractive industry*	1040 - Extractive Industry	2.2951	$2,574
19	**Heavy Industry –** *Land that is used, or has the potential to be used, for a sugar mill, co-generation plant or any heavy industrial purpose.*	1251 - Co-generation plant 1252 - Sugar Cane/Sugar Mill 1253 - Heavy Industry Purpose	1.9774	$109,978
20	**Other Land –** *Land that is not included in any other rating category*	1019 - Walkway 1022-2 - Car Parks – Ancillary Use 1050 - Other Clubs (Non Business) 1051 - Religious 1052 - Cemetery 1055 - Library 1056 - Showgrounds, Racecourse, Airfield 1057 - Parks, Gardens 1058 - Educational – including Kindergarten 1059 - Local Authority (secondary use only) 1092 - Defence Force Establishments 1095 - Reservoirs, Dams, Bores, Channels 1097 - Welfare Homes/Institutions 1099 - Community Purposes 1100 - Driver Education Centre	1.1049	$1,028

Where the rateability of any land alters during the year, adjustment to the differential general rate shall be made from the date such changes become effective.

Subdivisions have a primary land use code of 1072 and will be placed into the general rating category in which they would normally be situated. The value of subdivisions will be discounted by 40% for rating purposes in accordance with Section 50(2) of the *Land Valuation Act 2010*.

5. Separate Rates and Charges

5.1 Community and Environment Charge

Pursuant to section 103 of the *Local Government Regulation 2012*, Council will make and levy a separate charge in the sum of $50 per assessment for the purposes of assisting with the maintenance and improvements of community facilities, upgrades and enhancements of parks, reserves and natural areas within the region.

6. Special Rates and Charges

6.1 Rural Fire Levy

Pursuant to section 94 of the *Local Government Regulation 2012* and section 128A of the *Fire and Emergency Services Act 1990* Council will make and levy a special charge to be known as the "Special (Rural Fire Services) Charge" of $30 on each assessment in the local government area which is situated within a Class E Levy Area under the *Fire and Emergency Services Regulation 2011*. Multiple charges will apply on one assessment if it comprises multiple rural fire brigade areas, with one charge of $30 per rural fire brigade area.

The special charge shall fund the ongoing provision and maintenance of rural firefighting equipment for the rural fire brigades that operate throughout Class E Levy areas under the *Fire and Emergency Services Regulation 2011*.

Land within the local government area which is situated within a Class E Levy area under the *Fire and Emergency Services Regulation 2011* is not serviced by urban firefighting services and, as such, specially benefits from the fire emergency response capability that is provided by the rural fire brigades.

The overall plan for the special charge will be as follows:

a) The land to which the plan applies is each assessment in the local government area which is situated within a Class E Levy area under the *Fire and Emergency Services Regulation 2011*;
b) The service, facility or activity for which the plan is made is the ongoing provision and maintenance of rural firefighting equipment for the rural fire brigades that operate throughout Class E Levy areas under the *Fire and Emergency Services Regulation 2011*;
c) The time for implementing the overall plan is one year; and
d) The estimated cost of implementing the overall plan is $395,000.

7. State Emergency Management Levy

In accordance with the *Fire and Emergency Services Act 1990*, Council is required to collect a State Emergency Management Levy on all properties on behalf of the Queensland Fire and Emergency Services. The Levy is not a Council charge and the funds collected are remitted to the Queensland Fire and Emergency Services. However, Council is entitled to an administration fee for collecting this Levy, as prescribed by the *Fire and Emergency Services Regulation 2011*. Rate assessments with multiple properties are levied per parcel, in accordance with the State's legislation, excluding contiguous agricultural parcels in the same ownership.

8. Utility Charges

In setting Utility Charges, Council will take into consideration factors such as:

- Legislative requirements including National Competition Policy;
- Council policy objectives;
- Recovery of sufficient revenue to cover costs and a return on assets;
- Other sources of revenue where appropriate; and
- Future capital investment planning.

8.1 Water

8.1.1 Declared service area – water

For the financial year 1 July 2020 to 30 June 2021, the declared service areas (water) to which water charges apply, shall be as per the declared service area (water) maps which, in accordance with section 163 of the *Water Supply (Safety & Reliability) Act 2008*, are available for inspection at Council offices or on Council's website at www.bundaberg.qld.gov.au.

8.1.2 Service provider (water)

The service provider within the declared service area/s (water) shall be Bundaberg Regional Council.

8.1.3 Water charges

Council levies water charges on properties in the defined water supply areas to recover the full costs of the water supply operation including a return to the community on the assets employed.

Pursuant to sections 92(4) and 94 of the *Local Government Act 2009* and Sections 99 to 102 the *Local Government Regulation 2012*, the following water charges will be made and levied for the financial year 1 July 2020 to 30 June 2021:

a) Water access charge

A common access charge, for same sized meters, applies in all areas receiving a potable and non-potable water supply.

Vacant lands situated in the water area and not serviced with a water connection are charged a Vacant or Non-Metered Access charge. The reason for this is that the major portion of Council's costs associated with providing a water service is in the provision

and maintenance of capital infrastructure and these costs must be financed whether or not a property is actually connected to the water system.

Single residential properties are levied a charge based on the size of the water meters serving the property, since the meter size determines the potential volume of water used.

Where multiple lots are included on one assessment, Council will levy a water access charge for:

- house and vacant lot together – based on the size of the water meters servicing the property;
- multiple vacant lots on the one assessment without a water connection, a Vacant or Non-metered Access charge; and
- multiple vacant lots on the one assessment with a water connection, based on the size of the water meters servicing the property.

Non Strata Flats/Separate Dwellings/Dual Occupancy
Where water consumption is not separately metered for each unit, will be levied with a water access charge based on the size of the meters servicing the property.
Where water consumption is separately metered for each unit, will be levied with a water access charge for each of the sub metered units, based on the size of each meter.

Properties with multiple connections
Properties with multiple connections are levied a water access charge based on the size of the water meters servicing the property.

Community Title Schemes with a shared water meter(s)
Lots in a community titles scheme, where water consumption is not separately metered for each lot, each lot will be levied a percentage of a 20mm access charge as per the following table:

Number of Lots not separately metered	Percentage of 20mm Access Charge	Annual Charge per Lot
1 to 5	95%	$395
6 to 10	90%	$374
11 to 20	85%	$354
21 to 30	80%	$333
31 to 40	75%	$312
41 to 50	70%	$291
51 to 60	65%	$270
Above 60	60%	$250

Lots in a community titles scheme, where water consumption is separately metered for each lot, will be levied a single water access charge based on the size of the meter connected to that lot.

Concessional situations
A concessional water access charge equal to a 20mm Access is levied for each registered dedicated fire service connection even though the actual size of the connection is usually larger.

Council will charge unlicensed/restricted licensed sporting clubs a water access charge for their largest connection on each assessment and no access charge will be levied for additional meters.

Section 95 of the *Housing Act 2003* provides that all government portfolio properties are deemed to be non-rateable in accordance with section 93 of the *Local Government Act 2009*. Services to State land that are capped are deemed to be disconnected and will not attract the relevant vacant service charges.

For the reduced water service areas of Burnett Downs and Sylvan Woods the following special arrangements will apply:

- Burnett Downs – Council identifies Burnett Downs Yard water supply properties as a separate class of consumers, where consumers are provided with water and services at an amount below full cost as per the declared service area (water) map which, in accordance with section 163 of the *Water Supply (Safety and Reliability) Act 2008*, is available for inspection at Council offices or on Council's website.
- Sylvan Woods – Council identifies Sylvan Woods non–potable constant flow water supply properties as a separate class of consumers, where consumers are provided with water and services which are restricted in volume and pressure of supply as per the declared service area (water) map which, in accordance with section 163 of the *Water Supply (Safety and Reliability) Act 2008*, is available for inspection at Council offices or on Council's website.

An Access Charge shall apply to all premises or metered connection for the period 1 July 2020 to 30 June 2021, according to the water meter size/s serving the premises in accordance with the following, unless otherwise specified:

Water Access Charge Description	Potable Water Unrestricted	Non–potable Water / Restricted Flow
Vacant and non–metered	$416	$333
20mm meter connection	$416	$333
25mm meter connection	$650	$520
32mm meter connection	$1,065	$852
40mm meter connection	$1,664	$1,331
50mm meter connection	$2,600	$2,080
80mm meter connection	$6,656	$5,325
100mm meter connection	$10,400	$8,320
150mm meter connection	$23,400	$18,720

b) Water consumption charge

Water consumption is levied half–yearly for the readings undertaken prior to the 31 December 2020, and prior to the 30 June 2021. Generally, the consumption within each six month reading period will be levied on a two tiered charging system as set out hereunder:

(i) Charge per Kilolitre
1st Tier: $1.16 per kilolitre – for the first 150 kilolitres of consumption per half year;
2nd Tier: $1.90 per kilolitre – for each kilolitre of consumption over 150 kilolitres per half year.

(ii) Charge per kilolitre for the Burnett Downs Yard water supply reticulation group or service area, and Sylvan Woods non–potable supply:
1st Tier: $0.93 per kilolitre – for the first 150 kilolitres of consumption per half year;
2nd Tier: $1.52 per kilolitre – for each kilolitre of consumption over 150 kilolitres per half year.

For land, other than land in a community titles scheme, which has multiple water meters the consumption charge shall be determined as follows:

- where the land is being used for a single use, the consumption recorded by each of the meters shall be totalised and the applicable tariff for that use shall be applied; and
- where the land is being used for two or more discrete uses, and the water is separately metered for each use, the applicable tariff for each use shall be applied.

For land in a community titles scheme, Council will charge for water consumption as per the provisions of the *Body Corporate and Community Management Act 1997*.

For measurement of water use for charging purposes for the period 1 July 2020 to 30 June 2021, section 102 of the *Local Government Regulation 2012* shall apply to the reading of meters based on the nominal initial meter reading date of period ending 30 June 2020 and nominal final reading date of period ending 30 June 2021.

Council reserves the right to read and levy water consumption at intervals other than six monthly for specific connections as required.

8.1.4 Dedicated fire services

Water from registered dedicated fire services is for fire emergencies and testing purposes only and no charge will be levied for the first 10 kilolitres in each six month reading period.

However to prevent misuse of these services, Council will impose a penalty charge per kilolitre for consumption greater than 10 kilolitres in each six month reading period of 10 times the 2nd Tier charge per kilolitre applicable to its area, unless evidence is provided proving that the water was used in a fire emergency, in which case charges will be at the normal level.

8.1.5 Community service obligations

Pursuant to sections 120 to 122 of the *Local Government Regulation 2012*, Council will grant concessions for water charges in the circumstances set out below.

a) Restricted sporting clubs

Pursuant to section 120(1)(b)(i) of the *Local Government Regulation 2012*, Council grants the following rating concessions to not-for-profit sporting clubs, which either have no liquor license or a restricted Community Other Liquor License in terms of section 80 of the *Liquor Act 1992*:

(i) A water access charge for its largest connection on each assessment and no access charge will be levied for additional meters. For water meters above 20mm, or restricted license sporting clubs reduce their current largest water meter size to a smaller size, their Water Access Charge will be reduced to the Water Access Charge applicable to the revised water meter size. Where it is impractical to do so, Council will charge the equivalent of 40% of the 40mm Water Access Charge;

(ii) 4,000 kilolitres of water per annum per hectare of playing surface, free of consumption charges. The Water Consumption concession is over the playing area, therefore if a club only used the playing area for seasonal sport, they will receive a concession equal to 75% of the calculation per hectare. However, if there is more than one club sharing the playing area, they will receive no more than the 100% combined concession based on the playing area;

(iii) Those restricted sporting clubs that do not have playing fields (e.g. indoor facility, tracks) shall receive a concession for water consumption charges of up to the equivalent of the cost of 350 kilolitres per annum;

(iv) Council may require eligible organisations to develop and implement a Water Efficiency Management Plan to ensure the efficient and safe use of water;

(v) Where an eligible organisation is requested to implement a Water Efficiency Management Plan and fails to do so to Council's satisfaction, Council may resolve to reduce or remove the water charge concessions granted to that organisation;

(vi) Water consumption per assessment in excess of these entitlements be levied for the first 300 kilolitres at the 1st tier rate, and any consumption in excess of 300 kilolitres will be levied at the 2nd tier rate; and

(vii) Unused entitlements are not carried forward into the following financial year.

b) The Gin Gin Agricultural, Pastoral and Industrial Society

The Gin Gin Agricultural, Pastoral and Industrial Society will be entitled to 4,800 kilolitres of water per annum, free of consumption charges, with the expectation that the allowance be used only on the main arena.

Water consumption per assessment in excess of these entitlements be levied for the first 300 kilolitres at the 1st tier rate, and any consumption in excess of 300 kilolitres per annum will be levied at the 2nd tier rate. Unused entitlements are not carried forward into the following financial year.

c) Moore Park Beach Rural Fire Brigade

Council recognises the Moore Park Beach Rural Fire Brigade as providing a community service in protecting the community against fire and related hazards. As such, Council will charge the Moore Park Beach Rural Fire Brigade the equivalent of a 20mm Water Access

Charge for its largest meter connection regardless of the size of the Brigade's water meter connection.

8.1.6 Water meters registering inaccurately

If Council is satisfied that a water meter ceases to register, or is reported to be out of order or registering inaccurately (through no fault of the ratepayer), or Council is unable to read the meter, Council will apply a water consumption charge equal to the quantity of water used during the immediately prior corresponding accurate period of water use measurement and, if applicable, remit the difference between the actual charge and the charge based on the prior water consumption. If the immediately prior corresponding accurate period cannot be determined, Council will use the daily average for the same period.

Council grants this concession on the basis that, to require the ratepayer to pay full charges for consumption in circumstances where a water meter registers inaccurately (through no fault of the ratepayer), would result in hardship.

8.1.7 Extended area of application of charges

These charges apply to the declared service areas (water) maps and to:

- All new lots created under a development approval for which all approval conditions have been completed, and which as part of their conditions of approval included a requirement for connection to a reticulated water supply;
- Any other lot which is connected to a reticulated water supply; and
- Any other lot, where Council resolves that the lot becomes capable, by reason of extension of the water supply system, of being connected to a reticulated water supply; i.e. to all lots within any extension of any of the areas serviced by reticulated water supply where such areas are approved by Council. The charges apply in every case where service is provided or available, regardless of whether, or the time at which, formal amendment is made to the declared service area.

8.1.8 Service connections outside declared service areas (water)

Any approved water service connections, which are located outside the declared service area (water), will have access and use charges applied in the same manner and at equivalent charges to the use as would apply were they to be situated within the declared service area to which they are connected.

8.2 Sewerage

8.2.1 Declared service area – sewerage

For the financial year 1 July 2020 to 30 June 2021, the declared service areas (sewerage) to which sewerage charges apply, shall be as per declared service area (sewerage) maps which, in accordance with Section 163 of the *Water Supply (Safety and Reliability) Act 2008*, are available for inspection at Council offices or on Council's website at www.bundaberg.qld.gov.au.

8.2.2 Service Provider (Sewerage)

The service provider within the declared service area/s (sewerage) shall be Bundaberg Regional Council.

8.2.3 Sewerage Charges

Sewerage charges are levied on all properties within the defined sewerage area to cover the cost of:

- Sewage collection and treatment; and
- The disposal of effluent and bio-solids.

The same sewerage charge is levied to connected properties and non–connected properties within the defined sewerage area. The reason for this is that the major portion of Council's costs associated with providing a sewerage service is in the provision and maintenance of capital infrastructure and these costs must be financed whether or not a property is actually connected to the sewerage system.

Where there is more than one structure on land capable of separate occupation, a charge will be made for each structure.

Pursuant to sections 99 and 100 of the *Local Government Regulation 2012*, Council will make and levy a Sewerage Charge of $782 for the financial year 1 July 2020 to 30 June 2021 as set out below:

- Single residential properties are levied one sewerage charge. No additional charges apply for extra pedestals;
- Each residential flat, unit, granny flat, dual occupancy dwelling, separate dwelling or strata title unit is levied one sewerage charge. No additional charges apply for extra pedestals;
- Where multiple residential lots are included on the one rate assessment, Council will levy one sewerage charge for:
  - house and vacant lot together
  - multiple vacant lots on the one rate assessment.
- Non-residential properties that are not body corporate/strata title entities will be charged one sewerage charge per pedestal;
- Non-residential body corporate/strata title properties are levied a minimum of one sewerage charge to each strata unit, regardless of whether they have an individual sewer connection. Where units have more than one pedestal, a sewerage charge will be levied for each pedestal serving the unit. Each unit owner is levied separately for sewerage charges;
- Where a non-residential property incorporates a residential dwelling used to manage a business run from that property, the residential dwelling will be levied one sewerage charge and no additional charges will apply for extra pedestals within the residence; and
- Waste dump points at caravan parks are levied one sewerage charged per dump point.

8.2.4 Multi accommodation self-contained residential units for the aged under the control of charitable/church organisations

Pursuant to sections 120 to 122 of the *Local Government Regulation 2012*, multi accommodation self-contained residential units for the aged under the control of charitable/church organisations (excluding care centres); and pedestals installed in Department of Housing & Public Works units for the aged, including those identified in the table below, be granted a rebate of 60% of the sewerage charges.

Property Owner and Location
The State of Queensland (Represented by Department of Housing & Public Works), 11 Mulgrave Street, Bundaberg West
The State of Queensland (Represented by Department of Housing & Public Works), 30 Sugden Street, Bundaberg South
East Haven, 1 Ann Street, Bundaberg East
East Haven, 47-49 Victoria Street, Bundaberg East
East Haven, 51 Victoria Street, Bundaberg East
The Corporation of The Synod of The Diocese of Brisbane, 4 Mezger Street, Kalkie
The Baptist Union of Queensland, 28 Jocumsen Street, Kepnock
Churches of Christ Care, 71 & 83 Dr Mays Road, Svensson Heights
The State of Queensland (Represented by the Department of Housing & Public Works), 9 Griffith Street, Bundaberg South
The Uniting Church in Australia Property Trust (Q), (balance) 341 Bourbong Street, Millbank
The Uniting Church in Australia Property Trust (Q), (part) 1 River Terrace, Millbank
The State of Queensland (Represented by Department of Housing & Public Works), 181 Barolin Street, Avenell Heights
The State of Queensland (Represented by Department of Housing & Public Works), 147 Barolin Street, Avenell Heights
Forest View Childers Inc., 3 Morgan Street, Childers
Forest View Childers Inc., 4 Morgan Street, Childers
Kolan Centenary Seniors Village, 3 Tirroan Road, Gin Gin

Council grants this concession on the basis that multi accommodation self-contained residential units for the aged, under the control of charitable/church organisations, are entities whose objects do not include the making of a profit.

Council delegates to the Chief Executive Officer the power, pursuant to part 5, chapter 7 of the *Local Government Act 2009,* to determine applications made for this concession.

8.2.5 Restricted sporting clubs and Gin Gin Agricultural Pastoral and Industrial Society

Pursuant to section 120(1)(b)(i) of the *Local Government Regulation 2012*, Council grants a 50% concession on sewerage charges to not-for-profit sporting clubs and to the Gin Gin Agricultural Pastoral and Industrial Society, which either have no liquor license or hold a restricted Community Other Liquor License in terms of section 80 of the *Liquor Act 1992*.

8.2.6 Extended area of application of charges

These charges apply to the declared service areas (sewerage) maps and to:

- All new lots created under a development approval for which all approval conditions have been completed and which, as part of their conditions of approval, included a requirement for connection to the reticulated sewerage system;
- Any other lot which is connected to the reticulated sewerage system;
- Any other lot, where Council resolves that the lot becomes able, by reason of extension of the sewerage system, to be connected to the reticulated sewerage system.

That is, to all lots within any extension of any of the areas serviced by reticulated sewerage system where such areas are approved by Council. The charges apply in every case where service is provided or available, regardless of whether, or the time at which, formal amendment is made to the declared service area.

8.3 Trade Waste Charge

Pursuant to section 99 of the *Local Government Regulation* 2012, trade waste charge/s be made and levied by the Council upon all non-residential ratepayers discharging trade waste to Council's sewer.

The following be adopted as the basis for making and levying the trade waste charge:

(i) The volume of trade waste effluent discharged into Council's sewerage system;
(ii) The content/strength of the trade waste; and
(iii) The type or capacity of the pre-treatment device required by the ratepayer to treat trade waste before it is discharged into Council's sewerage system.

The content/strength level of the trade waste will be based on the level of Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Fats Oils and Grease (FOG) and Suspended Solids which are defined in Appendix 2 – sewer admission limits - of Council's Trade Waste Management Plan. The level of BOD_5, COD, FOG and Suspended Solids determines, in accordance with section 5 of Council's Trade Waste Environmental Management Plan, if the trade waste discharge is a category 1, 2, 3, 4 or 5 in terms of concentration and volume.

The trade waste charges determined for the financial year 1 July 2020 to 30 June 2021 have been discounted by 50% to what would otherwise would have been charged to recognise the impact of the COVID-19 pandemic on the ratepayers required to pay this charge. This charge will be levied in the 1 January 2021 to 30 June 2021 levy period.

Discharge category criteria is determined by level and strength of content of trade waste, as shown below along with the associated charge:

Category	Description	Base Charge	Tier Charge (in addition to the Base Charge)*	
1	Minor discharge with no pre-treatment or monitoring required.	$125	N/A	
2	Compliant pre-treatment, or pre-treatment not required. Low risk with annual discharge generally less than 100kL.	$212	N/A	
3	Low Strength/Risk discharge with pre-treatment, or pre-treatment not required. Annual discharge generally less than 500kL.	$355	N/A	
4	Medium Strength/Risk discharge with pre-treatment required. Annual discharge generally less than 500kL.	$618	Tier A Tier B Tier C	$263 $525 $788
5	High Strength/Risk discharge with pre-treatment required, and/or annual discharge generally greater than 500kL.	$1,587	Tier A Tier B Tier C	$525 $1,051 $1,576

** At the Chief Executive Officer's discretion for categories 4 and 5, a Tier Charge loading may be applied in addition to the base charge to reflect the actual or perceived load on the sewerage network, based on volume, risk, or strength.*

Trade Waste Equivalent Arrestor Charges 2020/21* # are shown below:

Category	Description	Annual Charge
EAC 1	500 - 999L	$578
EAC 2	1000 - 1999L	$946
EAC 3	2000 - 3999L	$1,576

** Where Council require that a pre-treatment device be installed but cannot be installed due to site specific or other constraints, charges will apply to cover additional treatment costs.*

 # Equivalent Arrestor Charges are applied in addition to other applicable trade waste charges.

8.4 Waste

8.4.1 Declared service area (waste)

The declared service areas (waste) to which Waste Collection Charges apply, shall be as per the declared service area (waste) maps which are available for inspection at Council offices or on Council's website at www.bundaberg.qld.gov.au.

8.4.2 Service provider (waste)

The service provider within the declared service area/s (waste) shall be Bundaberg Regional Council.

Council makes and levies utility charges for the provision of waste management services, which are calculated to recover the full cost of providing the service. Waste management utility charges incorporate the cost of providing and maintaining refuse tips and transfer stations and the cost of implementing waste management and environment protection strategies. The type or level of service to be supplied to each property in the waste area will be determined by Council as is appropriate to the premises, and in accordance, where relevant, with the *Environmental Protection Act 1994*, *Environmental Protection Regulation 2008*, *Waste Reduction & Recycling Regulation 2011*, *Waste Reduction & Recycling (Waste Levy) Amendment Regulation 2019*, Bundaberg Regional Council's Planning Scheme and Planning Scheme Policies and Bundaberg Regional Council *Local Law No 8 (Waste Management) 2017*.

Council will levy a waste and recycling collection charge of $356 per annum to the owner of residential property and/or structure within the waste collection areas, regardless of whether ratepayers choose to use the domestic general waste collection and/or recycling services provided by Council. Council will refer to the Building Classification Code for determination, if required. The service is available to non-residential properties on application. Requests for services to a body corporate common area will need to comprise a written agreement between the service provider (Council) and the body corporate as per the *Body Corporate & Community Management Act 1997*.

Where there is more than one structure on land capable of separate occupation a charge of $356 will be made for each structure. A waste collection charge of $356 will apply to each house, strata titled unit, granny flat, flat, secondary dwelling, dual occupancy or other dwelling designed for separate residential occupation, whether it is occupied or not.

Waste collections for Non-Residential Properties attract the State Government Waste Levy applicable under the *Waste Reduction and Recycling (Waste Levy) Amendment Regulation 2019*. Council will recover this levy on behalf of the State through its waste charges for Non-Residential Properties.

Retirement Villages may be residential or non-residential enterprises and as such waste services requirements will be reviewed on an individual basis by Council's Waste & Recycling Section.

A summary of the waste and recycling services/levies is as follows:

Service level – Removal, transport and disposal of waste	2020/2021 Levy
Residential Properties	
240 litre refuse weekly/240 litre recycling fortnightly (minimum service)	$356
Additional Services	
240 litre refuse weekly/240 litre recycling fortnightly	$356
240 litre refuse weekly – only available if in receipt of a minimum service	$257
240 litre recycling fortnightly – only available if in receipt of a minimum service	$52
Non-Residential Properties	
240 litre refuse/240 litre recycling (minimum service)	$417
240 litre refuse weekly service	$318
240 litre recycling fortnightly service	$99

Note: The bin sizes mentioned above may be substituted by Council however the service and levy will remain the same as a 240 litre refuse/240 litre recycling bin service.

Where insufficient space is available for the storage of multiple bins at strata titled properties, these properties may apply to Council for approval to make private arrangements to receive an alternative service, in which case a Council waste collection charge will not apply.

The charges for the service are annual charges and are not reduced for periods of time when the premises are unoccupied. These charges apply if Council approves an extension to the Waste Declared Area regardless of if, or the time at which, formal amendment is made to the declared service area.

9. Concessions and Rebates

Part 10 of the *Local Government Regulation 2012* empowers Council to grant a concession in certain circumstances.

In addition to the specific concessions mentioned at paragraphs 8.1.3(a) ("Concessional situations") 8.1.5, 8.2.4 and 8.2.5 above, Council grants the following concessions.

9.1 Pensioners

Council's Pensioner Rate Concession Policy provides an annual rate rebate to approved pensioners. A copy of this policy, together with the necessary application forms, are available from Council offices or www.bundaberg.qld.gov.au. The definition of pensioner is an 'approved pensioner' as provided under the State Government Pensioner Rebate Subsidy Scheme, that is a pensioner who is either a registered owner or life tenant of their principal place of residence and who holds a Queensland Pensioner Concession Card or a DVA Health Card (All Conditions within Australia) or a DVA Health Card (Totally &

Permanently Incapacitated) issued by either Centrelink or the Department of Veteran Affairs.

The pensioner concession will only apply to freehold land owned and occupied by the pensioner.

For the 2020/2021 financial year, Council grants a total rebate of up to $165 per annum ($82.50 per half year levy) on rates and charges for approved pensioners. This rebate is provided in addition to any Pension Subsidy Scheme operated by the Queensland Government.

Where the property is in joint ownership, a pro rata rebate shall be granted in proportion to the share of ownership, except where the co-owners are an approved pensioner and his/her spouse, (including de facto relationships as recognised by Commonwealth Legislation), in which case a full rebate will apply. However, in the case where the pensioner/s has/have rights to exclusive occupancy (life tenancy by way of a valid will which must be provided to Council by way of proof) a full rebate will be granted.

The State Government Pensioner Rate Subsidy is not a Council rebate. This subsidy is provided by the State Government and does not affect the rates and charges determination. The subsidy is a 20% rebate of Council rates and charges up to a maximum of $200 per annum, calculated at $100 per half year, plus 20% rebate of the State Emergency Management Levy.

9.2 Community Service Obligations

Council will grant a rebate of up to a maximum $1,700 per annum for the financial year 2020/2021, towards the payment of rates and charges, except for water consumption charges, for the following:

- Bucca Hall
- Bullyard Hall
- Drinan Hall
- Gin Gin & District Historical Society Hall
- Pine Creek Hall
- Sharon Social Club Inc
- Tegege Hall
- Avenell Heights Progress Association Hall
- Burnett Heads Progress Hall
- Kepnock Progress Association Hall
- North Bundaberg Progress Association Hall
- Pacifique Surfriders Club
- CWA Hall Bundaberg
- CWA Hall Yandaran
- CWA Hall Childers
- CWA Oakwood
- CWA Wallaville
- Bundaberg Kindergarten, Electra Street
- Burnett Heads Kindergarten
- Isis Community Preschool & Kindergarten
- Forestview Community Kindergarten
- Gin Gin Kindergarten
- South Kolan Kindergarten
- Wallaville Kindergarten
- Trustees Booyal Memorial Hall
- Bundaberg & District Air Sea Rescue
- Sandy Hook Ski Club
- Tegege Combined Sport & Recreation Club
- Bundaberg Railway Historical Society
- Bundaberg Central Men's Shed Association Incorporated
- Childers District Men's Shed Association
- Woodgate Men's Shed Incorporated
- Bundaberg Players Incorporated
- Peirson Memorial Trust
- Legacy Inc. (Lot 2 RP 94171)

Council will grant a full concession for all rates and charges, except water consumption charges, for the following properties:

- Bundaberg Surf Life Saving Club
- Elliott Heads Surf Life Saving Club
- Moore Park Surf Life Saving Club

Council will grant a full concession, for all rates and charges, to all Rural Fire Brigade properties.

These community service obligations are applicable to the 2020/2021 financial year.

9.3 Hardship

Council's adopted Hardship Policy (available at www.bundaberg.qld.gov.au) has been prepared to assist residential ratepayers who own their property as their principal place of residence, and who experience difficulty in paying their rates due to personal or financial circumstances, pursuant to section 120(1)(c) of the *Local Government Regulation 2012*. A concession by way of time to make payment, free of interest charges, and free from active debt recovery action may be granted where Council is satisfied that payment of the rates and charges will cause them hardship.

10. Cost-Recovery Fees

Council fixes cost-recovery fees for services and facilities supplied by Council in accordance with section 97 of the *Local Government Act 2009*.

The criteria, used to determine the amount of cost-recovery fees, are the costs of the service or facility being provided, which comprise labour, material, equipment, and overhead costs. In determining the level of all cost-recovery fees, Council places an emphasis on user-pays principles, whilst acknowledging that cost-recovery fees must not be fixed at an amount that is more than the cost to Council of taking the action for which the fee is charged.

11. Limitation of Increase in Rates and Charges Levied

In the 2020/2021 financial year, Council will not, pursuant to section 116 of the *Local Government Regulation 2012*, be limiting any increases to proposed rates or charges.

12. Recovery of Overdue Rates

Council's adopted Rates Recovery Policy (available at www.bundaberg.qld.gov.au) has been prepared in respect of the recovery of overdue rates, to reinforce Council's practice and intentions in this regard. Council will not refer any accounts to its debt recovery specialists from 1 July 2020 to 31 December 2020 in consideration of the impacts of COVID-19. However, from 1 January 2021, Council will actively pursue all available options under the *Local Government Act 2009*, to ensure that overdue rates are not a burden on the region's ratepayers. The sale of land for arrears of rates process may commence at any time during the financial year.

13. Interest on Overdue Rates

Council reviews the interest rate as part of the Budget deliberations and determines the rate to apply in accord with the provisions of section 133 of the *Local Government Regulation 2012*. For the financial year 1 July 2020 to 30 June 2021 Council will charge compound interest at 8.53% per annum on overdue rates and charges from 1 January 2021, calculated on daily rests as from the seventh day following the due date stated on the rate notice. To assist all ratepayers in the recovery from COVID-19 pandemic, for the calculation of interest for the financial year 1 July 2020 – 30 June 2021 only, interest will only be applied to overdue rates and charges from 1 January 2021 onwards.

14. Levying and payment of Rates and Charges

Council currently levies rates twice in each financial year. The first rates levy is issued as soon as possible after the annual budget has been approved by Council. The second rates levy is issued as soon as possible in the second half of the financial year after 1 January. Rates are due and payable by the due date stated on the rate notice, within 35 days from the issue date stated on the rate notice.

15. Payment in Advance

Ratepayers can prepay their rates at any time. Interest is not paid by Council to ratepayers on any credit balances.

16. Business Activity Fees

Council has the power to conduct business activities and make business activity fees for services and facilities it provides on this basis. Business activity fees are made where Council provides a service and the other party to the transaction can choose whether or not to avail itself of the service. Business activity fees are a class of charge, which are purely commercial in application and are usually subject to the Commonwealth's Goods and Services Tax.

Business activity fees include but are not confined to rents, plant hire, private works and hire of facilities as contained in Council's statement of fees and charges.

ASSOCIATED DOCUMENTS

- *Body Corporate and Community Management Act 1997*
- *Environmental Protection Act 1994*
- *Environmental Protection Regulation 2008*
- *Fire and Emergency Services Act 1990*
- *Fire and Emergency Services Regulation 2011*
- *Housing Act 2003*
- *Land Valuation Act 2010*
- *Local Government Act 2009*
- *Local Government Regulation 2012*
- Revenue Policy
- Rate Recovery Policy
- Trade Waste Management Plan
- Declared Service Area Map(Water)
- Reduced Service Area Map(Water)
- Declared Service Area Map(Sewerage)
- Declared Service Area Map(Waste)
- *Waste Reduction and Recycling Regulation 2011*
- *Waste Reduction & Recycling (Waste Levy) Amendment Regulation 2019*
- *Water Supply (Safety and Reliability) Act 2008*

DOCUMENTS CONTROLS

Pursuant to sections 169(b) and 172 of the *Local Government Regulation 2012*, as part of its annual budget preparation to be adopted for the next financial year.

POLICY OWNER

The Chief Financial Officer, Financial Services is the responsible person for this policy.

BUNDABERG REGIONAL COUNCIL

Item

25 August 2020

Item Number:	File Number:	Part:
G1	.	GOVERNANCE

Portfolio:

Organisational Services

Subject:

Christmas Closedown 2020

Report Author:

Jon Rutledge, Manager People, Safety & Culture

Authorised by:

Amanda Pafumi, General Manager Organisational Services

Link to Corporate Plan:

Our People, Our Business - 3.2 Responsible governance with a customer-driven focus - 3.2.2 Provide friendly and responsive customer service, in keeping with Council values and community expectations.

Background:

In past years, Council has agreed to the closure of Council administration offices, service centres and depots for three business days over the Christmas/New Year period. It is proposed that Council offices will close from Friday 25 December 2020 and reopen on Monday 4 January 2021.
During this period, employees will take the following leave:

- Friday 25 December 2020 – Public Holiday
- Monday 28 December 2020 – Public Holiday
- Tuesday 29 to Thursday 31 December 2020 – Employees will be offered the alternative of taking leave, accrued Rostered Days Off (RDO's) or Time Off In Lieu (TOIL) or any combination of these.
- Friday 1 January 2021 – Public Holiday

Council will maintain an employee listing who will attend to critical business during this period

Associated Person/Organization:

N/A

Consultation:

Executive Leadership Team

Chief Legal Officer's Comments:

There appears to be no legal implications.

Policy Implications:

There appears to be no policy implications.

Financial and Resource Implications:

There appears to be no financial or resource implications.

Risk Management Implications:

There appears to be no risk management implications.

Human Rights:

There appears to be no human rights implications.

Attachments:

Nil

Recommendation:

That:

1. **Council's Administration Office, Auswide Offices, Service Centres, Libraries, Arts Centres and Depots (and other administrative and depot areas as applicable) be closed for general business on the three working days over the Christmas/New Year period, namely Tuesday 29, Wednesday 30 and Thursday 31 December 2020, with offices and depots reopening on Monday 4 January 2021;**
2. **employees be offered the alternative of taking the subject three days from leave, or a combination of leave and accrued rostered days off;**
3. **the Chief Executive Officer advertise the closure and telephone numbers of Council officers who will attend to critical business over this period.**

Item

25 August 2020

Item Number:	File Number:	Part:
K1	N/A	PLANNING

Portfolio:

Planning & Development Services

Subject:

Planning Scheme Policy for Agricultural Buffers

Report Author:

Hugh Byrnes, Strategic Planning Officer

Authorised by:

Stephen Johnston, Chief Executive Officer

Link to Corporate Plan:

Our Environment - 2.3 Sustainable built and natural environment - 2.3.3 Review and consistently enforce local laws, the planning scheme, and other associated environment and public health legislation to ensure they meet community standards.

Background:

The agricultural industry is a key contributor to the Bundaberg Region's economy. The State Planning Policy recognises the importance of agriculture and agricultural land resources to the Queensland economy by ensuring this state interest is protected and appropriately integrated within local planning instruments.

The Planning Scheme currently addresses this state interest through a number of mechanisms, including the mapping of agricultural land and through requiring vegetated buffers between an existing agricultural use and any encroaching urban development. While the requirement for developers to provide agricultural buffers is specified within the current Planning Scheme it puts the onus of design on the developer, which has resulted in inconsistent standards across the region. This has become a source of frustration for the agricultural sector, the development industry, and Council.

To address these concerns, Council's Development Group engaged consultants Place Design Group to undertake a planning study and recommend fit for purpose outcomes for the design, construction, and maintenance of agricultural buffers.

The development of the draft policy involved targeted consultation with key stakeholders to ensure industry concerns would be addressed. Consultation was undertaken with:

1. UDIA Bundaberg Branch
2. Bundaberg Fruit and Vegetable Growers (incorporating Isis producers)
3. Bundaberg Canegrowers (including a representative from Bundaberg Sugar)

4. Childers Canegrowers (including a representative from the Isis Mill)

All stakeholders acknowledged that issues existed with the interface between agriculture and residential development, irrespective of residential density. Off-farm impacts discussed included dust, noise, spray drift, smell, light, smoke and ash, and visual amenity issues. These consultation sessions were valuable in raising key issues and practical realities that face the agricultural industry in relation to complaints and conflicts with neighbouring residential uses.

Engagement with Council's asset managers was also undertaken to ensure a full understanding of Council's obligations relating to ongoing maintenance and other matters were addressed.

The draft policy identifies varying buffer treatments for different situations. Three different buffer treatments are proposed:

a) Buffer type A is intended to provide a suitable buffer to adjacent sugar cane and horticultural crops;

b) Buffer Type B is intended to provide a suitable buffer to taller horticulture crops such as orchards/tree crops;

c) Buffer Type C is intended to provide a permanent visual buffer to cane railway tram lines to assist in mitigating light and dust. This buffer type is also proposed to be used as a transitional buffer.

The draft policy also proposes a number of other measures to ensure the buffers are effectively constructed and maintained, including:

a) Introduction of non-invasive bamboo which allows for quicker establishment of vegetation;

b) Allows for the establishment of 'transitional' buffers in growth areas where it is expected the adjacent agricultural land will be developed for urban or residential uses in the foreseeable future;

c) Introduction of an establishment period to ensure the vegetation is properly established prior to handing over of ownership;

d) Prioritises buffers to be located within private properties, rather than Council ownership; and

e) Uses covenants to ensure protection and maintenance of the buffers.

The draft policy is supported by agricultural science and landscape architecture technical reports. These reports will be made available during public consultation.

It is a requirement of the Planning Act and the Minister's Guidelines and Rules that Council publicly consult on the proposed Planning Scheme Policy. Consultation must be for a minimum of 20 days. Key industry stakeholders that were previously consulted will be contacted again as part of consultation on the proposed policy.

Following consultation, it will be necessary for Council to review any properly made submissions and decide whether to adopt the proposed policy (with or without changes in response to submissions).

Associated Person/Organization:

Queensland Treasury (Planning Group); Treasurer and Minister for Infrastructure and Planning (Cameron Dick MP).

Consultation:

Public consultation of the proposed planning scheme amendment will be undertaken in accordance with requirements of the *Planning Act 2016* and the Minister's Guidelines and Rules. As part of public consultation, key development and agricultural industry stakeholders will be engaged with.

Chief Legal Officer's Comments:

The current recommendation does not in itself present any legal implications. However, the *Planning Act 2016* identifies circumstances where a landowner may be entitled to compensation for reduced value of interest in land (arising from a change to the Council's planning scheme). It is unlikely that the proposed planning scheme policy would give rise to any such compensation.

Policy Implications:

The proposed policy will provide clearer guidance for the design, construction, maintenance and ownership of vegetated agricultural buffers for urban and residential development that adjoins agricultural land or existing agricultural uses.

Financial and Resource Implications:

Council's 2020/21 budget includes appropriate allocation of resources to undertake the proposed planning scheme policy amendment.

Risk Management Implications:

There appears to be no risk management implications.

Human Rights:

There appears to be no human rights implications.

Attachments:

⇩1 Draft Planning Scheme Policy for Agricultural Buffers
⇩2 Supporting Technical Report
⇩3 Supporting Agricultural Science Technical Report
⇩4 Supporting Landscape Technical Report

Recommendation:

That pursuant to the *Planning Act 2016* and the Minister's Guidelines and Rules – Council:-

a. decide to make a Planning Scheme Policy for Agricultural Buffers; and

b. approve the proposed Planning Scheme Policy for public consultation.

Contents of Schedule SC6.6

SC6.6 Planning scheme policy for agricultural buffers

SC6.6.1 Purpose

(1) The purpose of this planning scheme policy is to:-

(a) Provide guidance for the design, construction and ongoing maintenance of agricultural buffers to minimise conflicts between agricultural operations and sensitive land uses (e.g. residential uses and urban development).

(b) Inform the design of new residential development proposed adjacent to agricultural land uses in order to limit impact on lawful agricultural operations.

(c) Provide appropriate design considerations and maintenance advice to ensure buffers are effective in mitigating off-farm impacts adjacent to sensitive land uses.

(d) ~~To~~ Ssupport applicants in satisfying the requirements of the planning scheme, and to assist development assessment officers in their assessment of new development applications that require agricultural buffers.

SC6.6.2 Application

(1) This policy applies to development that requires the establishment of an agricultural buffer to satisfy the requirements of the *State Planning Policy Guideline: State Interest–Agriculture*.

(2) This policy provides supporting requirements to assist in achieving acceptable outcomes within the Bundaberg Regional Council Planning Scheme (planning scheme) and is read in conjunction with the planning scheme.

SC6.6.3 What is an agricultural buffer?

Separation areas and buffers are commonly used as part of effective land use planning and conflict management against incompatible land uses. Agricultural buffers provide an area of separation between conflicting agricultural, residential and sensitive land uses and are typically vegetated to form a physical and visual barrier.

Agricultural operations are regulated by specific environmental laws and codes. Regulations vary between agricultural industries and seek to protect specific environmental values. While these regulations do deal with mitigating impacts to surrounding environments, they are not specific to management of impact to interfacing residential and sensitive land uses. It is therefore necessary to consider how the land use regulatory framework provides guidance on how to manage this type of impact between uses. The requirement for vegetated buffers on the encroaching land use is an effective method of mitigation.

Agricultural operations can generate various off-farm impacts such as dust, smoke, ash, noise, smell, light, contaminants, chemical spray drift and irrigation overspray. These agricultural activities can be intermittent, seasonal, or continual.

Where development for a residential or sensitive land use is introduced into an area where agricultural operations exist then the residential or sensitive land use should include an appropriate buffer that mitigates the risk to amenity, health and safety that may arise from the interface with the established agricultural activities.

Agricultural buffers are incorporated into the design of the proposed development to limit impact to the existing agricultural activity.

Agricultural buffer design, size and suitability will vary depending on the agricultural operations and impacts it is mitigating. This policy provides design considerations and provisions to ensure an agricultural buffer is suitable and effective for its context.

SC6.6.3.1 Agricultural buffer characteristics and design considerations

SC6.6.3.1.1 General

(1) Buffer design is influenced by the critical farming operations that can generate off-farm impacts on adjacent urban land.

(2) Various agricultural practices and industries have divergent off-farm impacts that need to be considered when designing buffers that are suitable and effective.

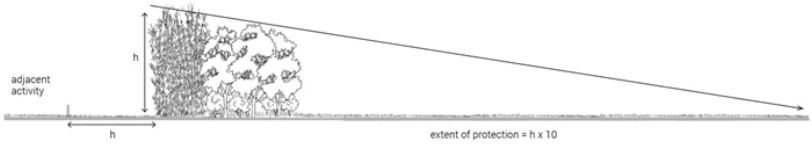
(3) This section outlines the general attributes that need to be considered when designing and implementing a buffer, including buffer height, width, density and length.

SC6.6.3.1.2 Buffer height

(1) The height of a buffer determines the level of protection given to the leeward side of the buffer. The height of the buffer will offer protection downwind for approximately ten (10) times the buffers height.

(2) Due to the potential for the buffer to cast shade or draw away water and nutrients from the production area, the height of the buffer will typically influence the distance it should be located away from the production area.

Figure SC6.6.3A Buffer height effect (indicative only - not to scale)



SC6.6.3.1.3 Buffer width

(1) The width of a buffer includes the overall distance of planting and maintenance access, between the property boundary (production area) and the protected zone (sensitive land use).

(2) The buffer width should provide adequate room to facilitate multiple rows of vegetation to effectively mitigate pollutants.

(3) The vegetation is made up from two components:

(a) Rows of quick growing vegetation to establish an initial screen; and

(b) Multi-layered rows of longer-term trees and shrubs that give a thicker and more effective buffer to the adjacent sensitive land use.

(4) The overall buffer width is dependent on the density of planting which relates specifically to the agricultural use of the adjacent production area.

SC6.6.3.1.4 Buffer density

(1) The density of planting within a buffer is relative to the agricultural use located on the adjacent land and what potential off-farm impacts are being produced.

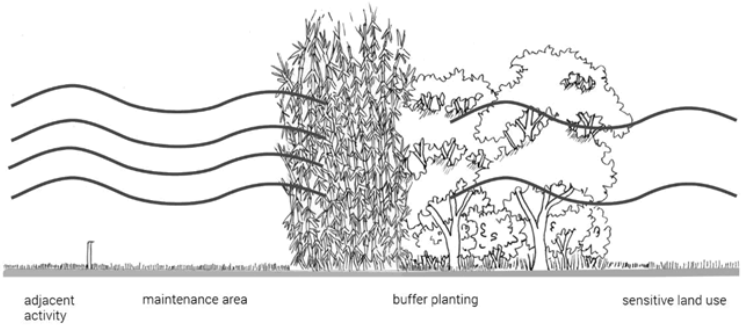
(2) Density of planting should be multi-layered to ensure particulate matter within the air is effectively captured by foliage. Layering of planting decreases the risk of undesirable wind tunnels through the buffer.

(3) The buffer should be permeable and planted to allow air flow to pass through. Appropriate permeability reduces undesirable turbulence on the leeward side of the buffer.

(4) Permeability of approximately 50% is desired to provide adequate protection of downwind areas.

(5) Density of the planting will influence the eventual growth height of the buffer. Vegetation that is planted closer together (denser) will compete against each other for access to light and nutrients, and will therefore grow taller, increasing the buffer's effectiveness.

Figure SC6.6.3B Buffer density effect (indicative only - not to scale)



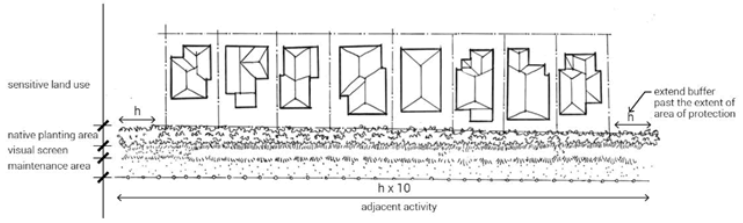
SC6.6.3.1.5 Buffer length

(1) Buffer length refers to the linear length of the buffer to its furthest extent.

(2) Vegetated buffers act as windbreaks. Longer windbreaks are more effective than shorter, as there is an increased level of turbulence at each end of a windbreak. Where practicable, the buffer should extend past any area that is requiring protection.

(3) The length and height of the buffer determines the overall extent of the protection area. It is optimal for the buffer to be at least ten (10) times longer than its height, where possible.

Figure SC6.6.3C Buffer length effect (indicative only - not to scale)



SC6.6.3.2 Buffer types

Selecting the most appropriate and effective buffer type depends on the stage of development, land use, and type of agricultural production that is occurring on the adjacent land. Generally, agricultural buffers fall into two main categories: Static buffers and Transitional buffers.

SC6.6.3.2.1 Static buffer

A Static buffer is:-

(1) Located on a defined urban edge, as a permanent buffer between agricultural uses and an urban settlement area.

(2) Multi-layered with staggered rows of trees and shrubs to provide protection from the agricultural production area and increase the visual amenity and aesthetic of the buffer.

(3) Comprised of various species of trees and shrubs. Planting should be established at a density relative to the adjacent agricultural use.

SC6.6.3.2.2 Transitional buffer

A Transitional buffer is:-

(1) Located on a transitional development front rather than a defined urban edge.

(2) Used to provide interim buffering and separation between staged urban development and an existing agricultural production area.

(3) To protect continuing agricultural operations until the agricultural land is developed for urban uses.

(4) Temporary and requires vegetation to be established quickly to provide effective protection to the sensitive land use from the adjacent agricultural use.

(5) Comprised of fast-growing species (i.e. clumping bamboo) to establish a visual screen and physical barrier to mitigate against amenity impacts and airborne particulates from the agricultural production area.

SC6.6.3.3 Agricultural buffer classifications

Specific design considerations and provisions have been provided for Static and Transitional buffers as they relate to development situations, agricultural uses and off-farm impacts requiring mitigation. The buffer classification, buffer type, design features and context in which to implement the buffer, are specified in **Table SC6.6.3.3.1 Agricultural buffer classifications** and their respective cross sections are shown in **section SC6.6.4.**

Buffers and separation distances associated with intensive Rural uses should be implemented in accordance with the setbacks specified in **Table 9.2.15.3.3** of the Rural uses code in the planning scheme.

Table SC6.6.3.3.1 Agricultural buffer classifications

Buffer classification	Applicable context	Design features
Static Buffers		
Buffer Type A	Adjacent to Cropping (Sugar Cane & Horticultural Crops) and/or; Boundary realignment or Reconfiguration of a lot to contain a Dwelling house in the Rural zone.	• Achieve a lower density of planting within the tree and shrub zone • Designed to achieve a minimum height of 8 to 10 metres • Achieve two staggered rows of planting to lessen competition between planting
Buffer Type B	Adjacent to Cropping (Orchards)	• Achieve a higher density of planting within the tree and shrub zone • Designed to achieve a minimum height of 10 to 12 metres • Achieve three staggered rows of planting to increase competition between planting
Buffer Type C	Adjacent to Cane Railway	• Achieve an appropriate visual screen • No requirement for additional planting but is accepted when static
Transitional Buffers		
Buffer Type C	All types, where not otherwise specified above.	• Uses a fast-growing plant species to establish a buffer • Achieves a visual screen and appropriate buffer to mitigate against off-farm impacts • No requirement for additional planting

Note –
It is possible to amend the characteristics of particular buffer types after their establishment if required. If buffer is established and the agricultural use changes or new practices and operational off-farm impacts occur, the buffer may evolve its design to provide effective mitigation. For example, a buffer may be established to mitigate off-farm impacts from sugar cane production and thus have a lower plant density. If the agricultural use changes from sugar cane to orchards, the buffer density should be increased to provide effective protection of the downwind areas (i.e. transitioning from Buffer Type A to Buffer Type B).

SC6.6.4 Buffer attributes and design

(1) The purpose of this section is to provide guidance on the design and construction of agricultural buffers under the planning scheme.

(2) The design and construction of an agricultural buffer should be undertaken in accordance with the applicable buffer classification specified in this policy.

(3) Where an alternate solution is proposed an applicant should demonstrate that the proposed solution effectively achieves the design features of the required buffer type, as specified in **Table SC6.6.3.3.1.**

SC6.6.4.1.1 Buffer attributes

Buffer attributes are the components that make up the vegetated buffer and its allocated setbacks. Buffer attributes are the elements of a buffer that are required to establish a complete and effective agricultural buffer.

(1) *Adjacent activity* refers to the land use and activity that is occurring adjacent to the encroaching sensitive land uses. This may include and agricultural production area, cane railway etc.

(2) *Maintenance area* refers to the 10 metre strip of turf and/or low grasses that is directly abutting the adjacent activity, and allows access to the boundary fencing and buffer for maintenance. This area also provides appropriate separation from the adjacent activity (agricultural use) which ensures that buffer planting does not compete with or impact on adjacent crops (e.g. shade, competing for water or nutrients) and assists in managing potential fire hazards.

(3) *Visual screen* refers to the two staggered rows of clumping bamboo that establish a fast growing visual screen.

(4) *Native planting area* refers to the multi-layered planting of mixed trees and shrubs that are slower growing and provide further mitigation and aesthetic value to the buffer.

(5) *No build area* refers to the area between the buffer and the sensitive land use (development) which is to remain free of infrastructure and any built structures above or below ground. This separation area is required to allow the uninhibited establishment of the buffer vegetation. This separation also mitigates potential impacts from the vegetated buffer on built infrastructure, including damage from invasive and aggressive root systems, or in instances where a tree may be compromised and falls in a storm, cyclone, flood etc. The no build area should also be used to provide access to the buffer for maintenance on the sensitive land use side.

It is recommended that no infrastructure, either above or below ground, is permitted within the whole extent of the buffer including the maintenance area and no build zone.

Design provisions for each attribute have been provided in the following sections by buffer classification.

SC6.6.4.2 Buffer Type A

Buffer Type A is intended to provide a suitable buffer to adjacent sugar cane and horticultural crops.

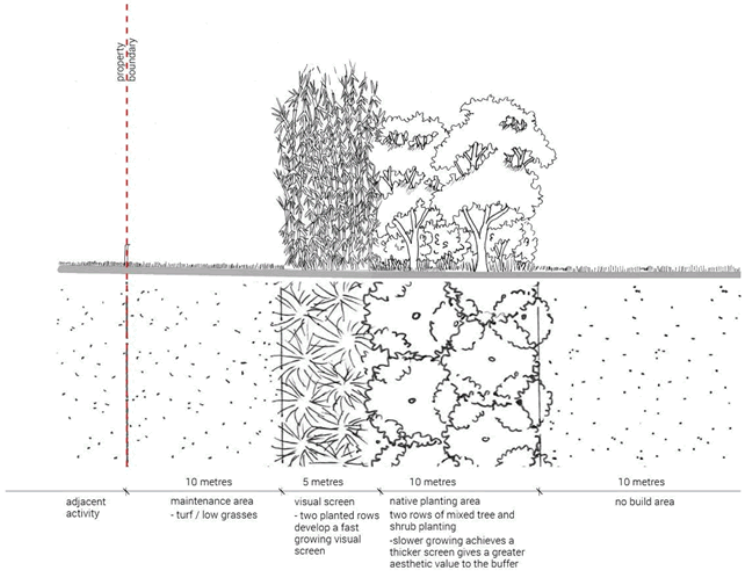
This buffer allows for lower density and a reduced height. Planting in conjunction with the bamboo screening should achieve appropriate mitigation from off-farm impacts.

Buffer Type A is to be designed, constructed and maintained in accordance with **Figure SC6.6.4A** and the provisions set out in **Table SC6.6.4.2.1**.

Table SC6.6.4.2.1 Buffer Type A requirements

Buffer classification	Buffer attributes	Minimum width
Buffer Type A	Maintenance area	10m
	Visual screen	5m 2 staggered rows of planting
	Native planting area	10m 2 staggered rows of planting
	No build area	10m

Figure SC6.6.4A Buffer Type A section (indicative only - not to scale)



SC6.6.4.3 Buffer Type B

Buffer Type B is intended to provide a suitable buffer to taller horticultural crops such as orchards.

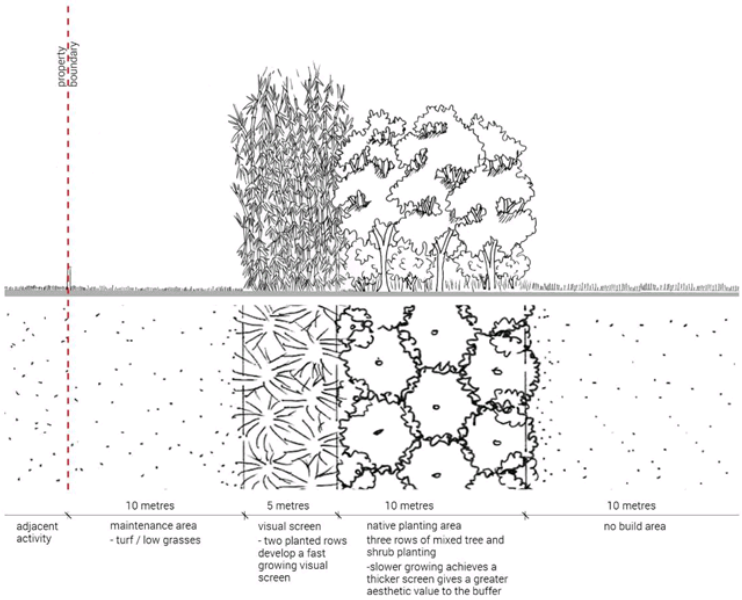
This buffer allows for a higher density of planting in the multi-layered tree and shrub zone to increase the overall height of the buffer.

Buffer Type B is to be designed, constructed and maintained in accordance with **Figure SC6.6.4B** and the provisions set out in **Table SC6.6.4.3.1**.

Table SC6.6.4.3.1 Buffer Type B requirements

Buffer classification	Buffer attributes	Minimum width
Buffer Type B	Maintenance area	10m
	Visual screen	5m 2 staggered rows of planting
	Native planting area	10m 3 staggered rows of planting
	No build area	10m

Figure SC6.6.4B Buffer Type B section (indicative only - not to scale)



SC6.6.4.4 Buffer Type C

Buffer Type C is intended to provide a permanent visual buffer to cane railway tram lines, to assist in mitigating light and dust.

Buffer Type C is also intended to be used for transitional development fronts where a temporary buffer is required due to future stages of development occurring.

This buffer allows for two rows of fast-growing planting to provide an initial physical barrier and visual screen to adjacent land uses. The screen should provide visual amenity whilst also mitigating against airborne particulates from adjacent agricultural uses. There is no requirement for additional planting of trees and shrubs, as they are slower to establish and will provide minimal mitigation from these adjacent uses in the temporary timeframe they are in place.

Where the planning scheme provisions for the requirement of acoustic attenuation relating to the cane railway, Buffer Type C may be used in conjunction with such infrastructure (i.e. acoustic fencing), not in lieu of one another.

In instances where a buffer is required near an intersection with a road, the buffer should not adversely impact upon the provision, operation and maintenance of infrastructure and should demonstrate compliance with safe intersection sight distance (Austroads).

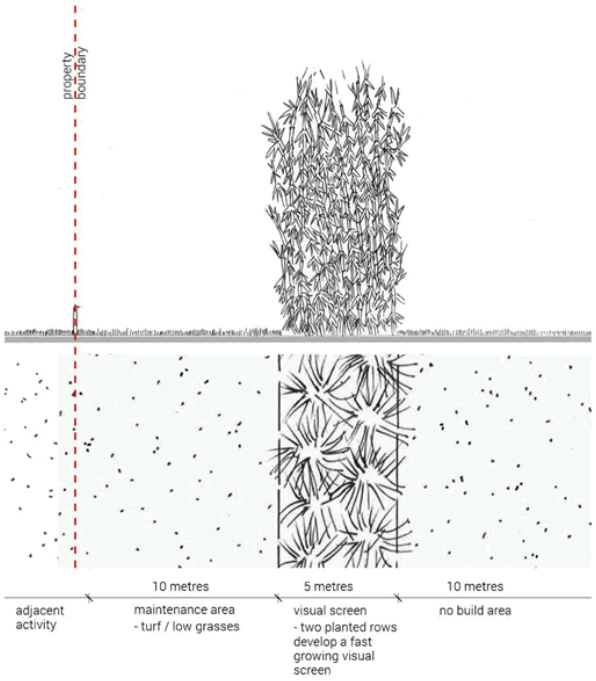
Buffer Type C is to be designed, constructed and maintained in accordance with **Figure SC6.6.4C** and the provisions set out in **Table SC6.6.4.4.1**.

Table SC6.6.4.4.1 Buffer Type C requirements

Buffer classification	Buffer attributes	Minimum width
Buffer Type C	Maintenance area	10m
	Visual screen	5m 2 staggered rows of planting

Buffer classification	Buffer attributes	Minimum width
	Native planting area	N/A
	No build area	10m

Figure SC6.6.4C Buffer Type C section (indicative only - not to scale)



SC6.6.5 General requirements

SC6.6.5.1 Recommended plant species

The recommended plant species are shown in **Appendix SC6.6A (Recommended buffer plant species).**

(1) The plant species of a buffer are related to the type of agricultural use, so that the off-farm impacts can be effectively mitigated.

(2) Using native species within an agricultural buffer is advised as these perform better in the local conditions and require less maintenance. Effective buffer growth resulting from the use of native species can also result in less pest and disease attack within these buffers due to their local adaptation.

(3) Species used for agricultural buffers must be able to achieve branching from their base through the full height of the plant to achieve the visual screen requirements.

(4) Plant species with insignificant flowers and fruits are preferred as they attract less amounts of birds, bats, or other wildlife that may in turn feed on, or adversely affect the adjacent crop.

(5) A mixture of species is recommended to be planted within buffers to provide a variety of plant shapes and increase buffer aesthetic. Varied plant shapes also reduce the likelihood of gaps within the buffer which mitigates infiltration of particulate matter.

SC6.6.5.2 Buffer establishment

An agricultural buffer is required to be planted and established in accordance with this policy before building approval is granted.

Buffer establishment includes:-

(1) Buffer planting should be mulched to a depth of 100mm with aged forest or sugar cane mulch to minimise moisture loss from the soil profile as well as suppress weed growth.

(2) Clumping bamboo should be established first and in two staggered rows ten (10) metres from the property boundary of the agricultural use. Each clump of bamboo will be two (2) to three (3) metres in diameter and should achieve a uniform screen.

(3) Tree and shrub planting would be installed as tube stock to promote maximum potential growth and establishment to allow the appropriate density to be achieved for the buffer classification.

(4) Lower density planting should establish two staggered rows of trees, with shrubs and groundcover planting.

(5) Higher density treatment requires three rows of staggered tree planting. Layered tree planting is to be inter-planted with shrubs.

(6) Groundcovers should be established on the outer edge to assist in the containment of weeds and other contaminants that may encroach into the planted area.

(7) Pioneer tree species are to be established in conjunction with the tree planting to achieve plant densities in less time. Over time, planting of additional trees and shrubs may be required to replace these pioneer species.

(8) Buffers are to be established in accordance with the recommended plant species shown in **Appendix SC6.6A (Recommended buffer plant species).**

SC6.6.5.3 Buffer maintenance

The establishment of buffer planting, like any other cover crop, requires watering, fertilising and weeding. Following establishment, maintenance is required to all buffer types for them to remain effective. Buffers should be appropriately designed and constructed to avoid time consuming and costly maintenance requirements, whilst achieving their maximum desired effect of mitigating land use conflicts.

Buffer maintenance includes:-

(1) Maintaining the required buffer characteristics such as height, width, length, and density of each buffer type is required to ensure the effectiveness of the buffer is maintained.

(2) Buffers require pruning and thinning on an annual basis to maintain a 50% density so that their effectiveness is maximised.

(3) Buffers are required to be watered during dry periods to maintain good buffer growth.

(4) Fertilising prior to the growing season will assist in maintaining the health and vigour of the buffer.

(5) Buffers require maintenance and management in terms of litter build up, noxious weed and pest control. Buffers should remain weed free to prevent the build-up of weed species that can cause infestation of agricultural production areas as well as other neighbouring land uses.

(6) Appropriate access strips are provisioned for on either side of the buffer to allow for maintenance activities to be carried out.

(7) Ongoing maintenance such as replanting may be required over time to maintain buffer characteristics.

SC6.6.5.4 Buffer aesthetics

The visual appearance of buffers can be enhanced by increasing the level of detail and interest within them, providing improved amenity to residential development.

Buffer aesthetics includes:-

(1) Clumping bamboo (initial visual screen) presents a relatively flat visual aesthetic. Multi-layered buffer planting used in conjunction with the bamboo presents an elevation with more variety and texture.

(2) The plant species recommended in **Appendix SC6.6A (Recommended buffer plant species)** achieve variety in colour, texture and form within the buffer.

(3) To achieve a greater aesthetic for buffers that are in highly visible areas, such as a road frontage, the layered planting should be orientated to face the road.

(4) Where a buffer is located along a property boundary, it is appropriate for the bamboo to be established ten (10) metres from the agricultural area property boundary and the layered planting to be orientated to the residential use to provide enhanced amenity.

SC6.6.6 Buffer tenure and responsibility

Once a buffer is established, they are to be protected by a defined tenure arrangement and responsibility for ongoing maintenance.

(1) The preferred tenure hierarchy of the ownership, management and responsibility of buffers are as follows:

(a) Developer owned (e.g. within a balance parcel);

(b) Owned by the sensitive land use (e.g. within private residential lot);

(c) Council trustee/ownership.

(2) Buffers should be protected by way of property covenant placed on the title of land and remain the responsibility of the landowner.

Editor's Note—Council has produced a standard covenant template, this document will be made available on request.

(3) Ongoing maintenance requirements should be imposed by way of development approval conditions and property covenant.

(4) Where buffers are proposed within land to be dedicated to Council (i.e. road reserve, open space or drainage corridor) they will be the responsibility of Council.

SC6.6.6.1 On-Establishment period

(1) The developer is responsible for the establishment of the agricultural buffer.

(2) The establishment and maintenance period for an agricultural buffer is two (2) to five (5) years.

(3) Annual inspections are to be undertaken by Council officers to ensure ongoing establishment and maintenance requirements are being carried out.

(4) After initial planting, the buffer is to be put 'On-Establishment' for a minimum period of two (2) years. During this time, the buffer must be maintained in accordance with **SC6.6.5.2 Buffer establishment** and **SC6.6.5.3 Buffer maintenance** to ensure it is establishing well, actively growing, and kept fertilised, watered and weeded as necessary.

(5) Six (6) monthly monitoring reports and maintenance log books should be submitted to Council, including photos of both sides of the buffer.

(6) A final inspection should be undertaken by Council at the end of the two (2) year 'on-establishment' period. Prior to the buffer being accepted On-Maintenance:

(a) Ensures minimum of 40% permeability has been achieved by the buffer. Permeability measurements will be taken at heights of 2 metres and 4 metres.

(b) Ensures weediness of buffer is no more than 10%.

SC6.6.6.2 On-Maintenance period

(1) Once Council has confirmed criteria in **SC6.6.6.1 On-Establishment period** has been met, the buffer can be declared On-Maintenance.

(2) The On-Maintenance period will be a maximum of three (3) years.

(3) Prior to the buffer being accepted Off-Maintenance:

(a) Ensures minimum 50% permeability has been achieved by the buffer. Permeability measurements will be taken at heights of 2 metres and 4 metres.

(b) Ensures weediness of buffer is no more than 1%.

(c) Ensures any dead, dying or underperforming plants are replaced.

SC6.6.6.3 Off-Maintenance procedure

(1) Once Council has confirmed criteria in **SC6.6.6.2 On-Maintenance period** has been met, the buffer can be declared Off-Maintenance.

(2) Covenant conditions over the buffer for its protection and maintenance should be complied at all times. This is a matter that may be enforced by Council, particularly where buffers are not maintained and their effectiveness is diminished, often leading to complaints.

Appendix SC6.6A Recommended plant species for buffers

The following is a list of recommended plant species for agricultural buffers in the Bundaberg Regional Council area.

Table SC6.6A.1 Recommended plant species for buffers

Botanical name	Common name	Spacing
Bamboo species		
Bambusa oldhamii	Sweet Shoot Bamboo	1 per 2.5m
Bambusa textilis gracilis	Slender Weaver's Bamboo	
Bambusa malingensis	Sea Breeze Bamboo	
Pioneer species (tree planting)		
Acacia disparrima	Hickory Wattle	1 per 3m
Acacia maidenii	Maiden's Wattlle	
Macaranga tanarius	Macaranga	
Shrub species		
Callistemon pallidus	Lemon Bottlebrush	1 per 5m to infill gaps between tree planting
Buckinghamis celcissima	Ivory Curl Tree	
Callistemon viminalis	Weeping Bottlebrush	
Callistemon pollandi	Gold Tipped Bottlebrush	
Corymbia ptychocarpa	Swamp Bloodwood	
Leptospermum polygalifolium	Wild May or Tantoon	
Groundcover species		
Lomandra longifolia	Spiny Headed Mat Rush	1 per 1m
Lomandra hystrix	Green or Creek Mat Rush	
Dianella caerullea	Paroo Lily	
Low density buffer tree planting		
Glochidion ferdinandi	Cheese Tree	1 per 4m Note: High density planting species can also be used in the low density planting area.
Jagera pseudorhus	Foam Bark	
Callistemon viminalis	Weeping bottlebrush	
High density buffer tree planting		
Casuarina equisetifolia	Coastal She-Oak	1 per 3m
Casuarina glauca	Swamp She-Oak	
Melaleuca dealbata	Blue Paperbark	
Melaleuca leucodendra	Weeping Paperbark	
Melaleuca viridifolia	Broad-leafed Paperbark	
Syzygium leumannii	Riberry	

Place Design Group Pty Ltd
ACN 82370063
131 Robertson Street
Fortitude Valley, QLD 4006 Australia

Phone +61 7 3852 3922
brisbane@placedesigngroup.com
placedesigngroup.com

Bundaberg Agricultural Buffers PSP

Supporting Technical Report

June 2020

Prepared for Bundaberg Regional Council

Disclaimer

This report has been prepared in accordance with the scope of services described in the contract or agreement between Place Design Group Pty Ltd ACN 082 370063 and the Client. The report relies upon data, surveys, measurements and results taken at or under the particular times and conditions specified herein. Any findings, conclusions or recommendations only apply to the aforementioned circumstances and no greater reliance should be assumed or drawn by the Client. Furthermore, the report has been prepared solely for use by the Client and Place Design Group accepts no responsibility for its use by other parties.

Approved by:	Amanda Taylor
Position:	Planning Manager
Date:	02/06/2020
Document Reference:	1119105
Report:	Agricultural Buffers PSP Technical Report

G:\Strat Planning\1119105 Bundaberg Ag Buffer PSP\P3. Reports & Documents\P3.05 Final PSP and Report_ISSUED Final Ag Buffer Policy 05062020\Final_BRC Ag BufferReport_05062020.docx

place design group.

Table of Contents

place design group.

place design group.

1 Introduction

Bundaberg Regional Council (**Council**) has identified the need for a policy to guide the inclusion of agricultural buffers as part of future assessable development. Council has sought the implementation of an Agricultural Buffer Planning Scheme Policy (herein referred to as **the policy**), to drive consistent outcomes across the region.

The content of this policy is to provide guidance for the design, construction, and ongoing maintenance of agricultural buffers to reduce conflicts between agricultural and sensitive land uses (urban development).

The purpose of this policy is to inform subsequent amendments to the Bundaberg Regional Council Planning Scheme 2015 v5.0 (the **planning scheme**).

A Planning Scheme Policy (PSP) provides guidance to applicants regarding technical advice and information to assist applicants in satisfying assessment criteria. A PSP may also be used to set out information Council may request as part of a development application.

Appropriate buffer zones and separation areas between sensitive land uses (urban development) and existing agricultural areas are essential to conflict management and effective land use planning. Buffers are typically used to prevent the unintended impacts of pollution or contaminants from agricultural practices on adjacent land uses.

Suitable buffer zones can limit potential effects from agricultural practices such as; dust, noise, odour, contaminants, chemical spray, ash, and light. A 'one size fits all' approach to buffers and separation zones does not apply, as the suitability and size of a buffer will typically depend on the environmental constraints (topography, wind direction etc.) and the agricultural practices being used.

1.1 Background and Context

The Bundaberg region is a local government area in the Wide Bay-Burnett region of Queensland, Australia. The region is centred around the city of Bundaberg and comprises various natural assets, rural landscapes and productive agricultural land.

The Bundaberg LGA and economy has always been heavily influenced by agriculture.

The total value of agricultural output for the Bundaberg area is approximately $613m, which represents approximately 4.5% of the total agricultural output of Queensland, based on FY15/16 ABS data. The breakdown of the value of the major industries as a percentage of the total value of regional output include:

- Sugarcane: 19%
- Vegetables: 39%
- Avocadoes: 11%
- Nuts: 11%
- Citrus: 6%

place design group.

From the late 1800's, the region was almost exclusively sugarcane production with tobacco and limited horticulture appearing as more migrants moved into the region in the early-mid 1900's. Over the past 40 years, the region has seen significant change in the agricultural landscape, with production increases initially in annual horticulture production including but not limited to;

- Tomatoes
- Melons
- Capsicums
- Potatoes
- Zucchini

During the past 20 years, the region has experienced significant growth in perennial horticulture crops including but not limited to;

- Avocadoes
- Citrus
- Macadamias
- Lychee

The sugar industry remains a significant user of agricultural land and a strong contributor to local employment and the economy in general. The changes in agricultural land-use has created new challenges, as traditional sugarcane country is moved into more intensive horticulture. These changes in land use have in turn influenced the off-farm impacts on neighbouring urban developments.

Within the region, buffers have been and still are an expected inclusion within new developments that are adjacent to agricultural uses. This is driven and underpinned by the State interest of Agriculture and subsequent State Planning Policies (SPP). Currently the planning scheme defaults applicants to refer to SPP guidance material for supporting information in satisfying buffer requirements.

Council identified the need to address the absence of localised policy provisions in the planning scheme which require and manage the inclusion of appropriate agricultural buffers as part of new residential developments adjacent to agricultural uses.

Council is also seeking clear and concise guidance material relating to the design, implementation and ongoing maintenance of agricultural buffers, to assist development assessment officers in their assessment of new development applications.

Council's existing policy, 'Burnett Shire Rural Buffer Zone Tree Planting Advice' outlines Council's approach and advice on visual, dust, shade, and windbreak plantings in conjunction with general tree planting advice. It is noted that this document is relatively dated and provides guidance that is generalised in nature. Council is seeking a revised policy for integration into the planning scheme that provides contemporary information and guidance for developers, applicants and assessment officers alike.

Recommendations made during this process may inform future planning scheme amendments as part of Council's scheme amendment program.

2 Statutory Planning Review

A review of statutory planning documentation has been undertaken to understand the current policy direction and provisions relating to the implementation of agricultural buffers at a state-wide and local level. The planning scheme has also been interrogated to determine where the policy may be triggered throughout.

2.1 State Planning Policy

The Queensland Government established the SPP to define the matters of state interest. The supplementary guidance material is prepared to support the implementation of the SPP and the interpretation of the defined state interest.

The state interest relating to this policy is **State interest – Agriculture**. Agriculture is a subsection under the economic growth theme. The current SPP guidance material relating to Agriculture (January 2019) outlines the state interest policies and how to appropriately integrate the policy.

The SPP guidance material emphasises the importance of effective land-use planning to ensure there are appropriate buffer zones and separation areas between new development (urban uses) and existing agricultural uses. Buffer zones refer to, and may be in the form of, a vegetated corridor or separation areas.

State interest policy 4(c)

> *'Growth in agricultural production and a strong agriculture industry is facilitated by:*
>
> *c) locating new development (such as sensitive land uses or land uses that present biosecurity risks for agriculture) in areas that avoid or minimise potential for conflict with existing agricultural uses through the provision of adequate separation areas or other measures.'*

The SPP stipulates that when new or larger buffer zones are required, they should be provided for within the new development, to ensure agricultural producers maintain their existing rights. As such, it is necessary that Council has complete and localised guidance to assist in assessment of development applications where a new buffer zone is required.

The SPP also articulates the requirement for agricultural buffers to be properly designed and managed, with clear responsibilities for maintenance. The guidance material notes the various ways planning instruments can achieve this. It is recommended that the policy provides specific guidance regarding the maintenance and management responsibilities of the agricultural buffer.

The previous SPP guidance material for Agriculture (April 2016) provided more detailed guidance relating to agricultural buffers. Part E provided comprehensive supporting information in relation to separation areas between agriculture and non-agricultural land uses.

Further, the original guidance material was contained in the *Department of Natural Resources Planning Guidelines – Separating Agricultural and Residential Land Uses*. It is important to note the significance this longstanding guide has, being the most familiar to many in the industry. The broader policy intent of these original planning guidelines has been incorporated into the SPP. However, specific guidance on how to satisfy the policy intent has been reduced in the current SPP guidance material. Whilst this information and guidance is aligned with a performance-based approach, it does not provide clarity or a level of certainty for the development industry on what a desired outcome may be.

Whilst the material contained in the *Department of Natural Resources Planning Guidelines – Separating Agricultural and Residential Land Uses* and previous SPP guidance material for Agriculture

(April 2016) will be used to inform the policy, it is the intention of the policy to provide further clarity for developers within the Bundaberg Region on suitable and effective buffer design.

2.2 Planning Scheme Review

2.2.1 Strategic framework

The strategic framework sets the policy direction for the planning scheme and forms the basis for ensuring appropriate development occurs in the planning scheme area for the life of the planning scheme. It is noted that the strategic framework aligns directly with the intent and subsequent provisions of the SPP relating to the state interest of Agriculture.

The strategic framework includes eight (8) themes that collectively represent the policy intent of the scheme. Agricultural land is dealt with within **3.3 Settlement Pattern theme, 3.4 Economic development theme, 3.9 Natural resources theme** and important agricultural areas are conceptually identified on **Strategic Framework Map SFM-005 (Natural resource elements).**

Table 1: Strategic Framework review

Section in the Strategic Framework	Policy Direction
3.3 Settlement pattern theme Strategic outcomes Element 10 – Managing land use conflicts	Adequate separation and buffers are provided between urban and rural residential development and important agricultural areas and agricultural land classification (ALC) Class A and Class B land.
3.4 Economic development theme Element 4 – Rural enterprise and industry	Traditional agricultural and farming activities that underpin the character and identity of the region continue as viable and sustainable businesses that are recognised for their stewardship of the land for future generations.
3.6 Infrastructure and service theme Element 3 – Energy infrastructure	Development for renewable energy projects is facilitated and encouraged where appropriately located and sensitively designed to respect agricultural land and regional landscape values and avoid adverse amenity impacts.
3.7 Natural environment and landscape character theme Element 2 – Landscape and scenic amenity	Development maintains, protects and enhances:- (vi) the scenic value of agricultural land and other rural land.
3.9 Natural resources theme Element 2 – Rural resources	Rural areas are retained predominantly for rural production, natural habitat and landscape purposes. Development ensures that important agricultural areas identified conceptually on Strategic Framework Map SFM-005 (Natural resource elements) and agricultural land classification (ACL) Class A and Class B land

Section in the Strategic Framework	Policy Direction
	is protected and remains available for productive and sustainable agricultural and rural pursuits, unless:- (i) there is no overriding need in terms of public benefit; and (ii) there is no alternative site suitable for the particular purpose; and (iii) the impact on productive agricultural land has been avoided and minimised. In such instances, adverse impacts on important agricultural areas and agricultural land classification (ACL) Class A and Class B land are minimised and measures established to mitigate any loss of agricultural land. To help maintain the productive capacity of existing and potential future rural activities and avoid or minimise land use conflicts, effective separation distances and buffers are established and maintained between incompatible or sensitive land uses and important agricultural areas and agricultural land classification (ALC) Class A and Class B land or areas of intensive rural activity. Infrastructure supporting the rural sector, including sugar cane railway network identified on Strategic Framework Map SFM-005 (Natural resources elements), is not adversely impacted by development.
Relevant strategic framework maps Important agricultural areas identified conceptually on Strategic Framework Map SFM-005 (Natural resource elements)	Development ensures that important agricultural areas identified conceptually on Strategic Framework Map SFM-005 (Natural resource elements) and agricultural land is protected and remains available for productive and sustainable agricultural and rural pursuits.

2.2.2 Zone codes

The following zone codes from the Residential zones category and Other zones category have been reviewed and interrogated to understand the current provisions relating to agricultural buffers. Furthermore, the zone codes have been reviewed to identify any areas of refinement or where amendments could be made to reference the policy.

- Low density residential zone code
- Emerging community zone code
- Rural residential zone code
- Rural zone code

The residential zone codes that have reference to buffering or separation areas are the Low density residential zone code, Emerging community zone code and the Rural residential zone code.

The Low density residential zone code has line of sight from its purpose and overall outcomes (OO's) to its assessment benchmarks. The purpose and OO's highlight the requirement for development for sensitive purposes to incorporate appropriate buffering. The assessment benchmarks note that new development in newly developing greenfield areas, must provide buffers between potentially conflicting land uses.

Similarly, the Emerging community zone code also stipulates an OO directly relating to the provisions of appropriate buffers between development for residential uses and potentially conflicting land uses.

The Rural residential zone code and its provisions relate more directly to the protection and maintenance of rural land for agricultural purposes. The OO's and respective assessment benchmarks stipulate that development for residential uses adjacent to rural land must not interfere with the existing or ongoing use of the rural land for rural purposes. These provisions directly align with the SPP.

2.2.3 Local plans

The current version of the planning scheme (Version 5.0) was adopted by Council on 21 January 2020 and took effect from 10 February 2020. Version 5.0 of the planning scheme incorporates planning scheme amendment No.5 (Major Amendment) and planning scheme amendment No.6 (Mon Repos / Sea Turtle Amendment). The Hughes and Seaview Bargara Masterplan Area PSP was rescinded in the current version, with guidance material regarding buffers and separation incorporated into the local plan codes. As such, the local plans reviewed include:

- Central coastal urban growth area local plan code
- Kalkie-Ashfield local development area local plan code

The Central coastal urban growth area local plan code has specific OO provisions articulating the need for appropriate physical separation, landscape buffering and/or acoustic attenuation to minimise land use conflicts, and to maintain the productive use of agricultural land surrounding the Central coastal urban growth area.

The local plan code has a robust regulatory line of sight, integrating numerous assessment benchmarks regarding buffering and separation between incompatible land uses. Acceptable outcomes detail specific design provisions relating to buffers widths, setbacks etc. and also references the requirement of an assessment report to be prepared by an appropriately qualified consultant that demonstrates compliance with the provisions.

The local plan code also provides specific provisions relating to the design of temporary buffer treatments and separation areas, including for staged development.

Figure 7.2.1 (Central coastal urban growth area structure plan concept) identifies the indicative locations where agricultural land buffers will be required. Figure 7.2.1C (Temporary agricultural land buffer concept) provides design guidance relating to the establishment of temporary buffers relating to staged urban development.

Further, the Kalkie-Ashfield local development area local plan code articulates some of the outcomes that were previously included in The Hughes and Seaview Bargara Master Plan Area PSP. These provisions are consistent with the assessment benchmarks included within the Central coastal urban growth area local plan code, including the same figures as mentioned above.

The local plan codes will need to be reviewed and amended to reflect the new planning scheme

policy. It is recommended that if an agricultural buffer is established in accordance with the policy, it will achieve the existing provisions stipulated within the planning scheme. As such, a report prepared by a qualified consultant would not be required where a buffer is proposed as per the guidance within the planning scheme policy but may be required if an alternative outcome is proposed.

2.2.4 Overlay codes

Overlays identify areas that reflect state and local level interests. All overlay codes have been reviewed to understand the current assessment benchmarks relating to agricultural buffers and where provisions can be strengthened, or where there is room for the policy to be referenced or reinforced. The following overlay codes currently provide provisions relating to appropriate use of buffering and separation areas:

- Agricultural land overlay code
- Infrastructure overlay code

The Agricultural land overlay code has specific OO's and provisions relating to the avoidance or mitigation of land use conflicts between farming activities and sensitive land uses by establishing effective separation buffers. Currently the overlay code draws upon the *SPP Guideline: State Interest – Agriculture* to demonstrate compliance with the assessment benchmarks.

The Infrastructure overlay code stipulates the requirement of appropriate buffering in the assessment benchmarks relating to State controlled roads, railway and cane railway corridors. This is important to note, as there is an opportunity for the policy to address specific buffer design recommendations relating to an interface with cane railway corridors.

2.2.5 Development codes

Development and use codes have been reviewed to determine any applicable assessable development that would require additional guidance relating to the design and construction of agricultural buffers.

The following use codes and other development codes have been reviewed:

- Rural uses code
- Landscaping code
- Reconfiguring a lot code

The Rural uses code facilitates the sustainable development of rural uses, whilst conserving and protecting environmental and landscape values. Specifically, the rural uses code provides the siting and setback requirements for intensive rural uses. As such, buffers associated with intensive agriculture near or adjacent to urban uses is not to be addressed by the policy.

The Landscaping code ensures that landscaping across the region is consistent and in keeping with the desired character and amenity of the locality. The code articulates various assessment benchmarks relating to landscape buffers. The performance outcome articulates the requirement of providing separation between incompatible land uses, with the acceptable outcomes providing specific provisions relating to the design, construction and implementation of landscape buffers, were required by higher order codes.

The purpose of the Reconfiguring a lot code is to ensure new lots are configured in a manner which ensures the protection of productive rural land and the minimisation of conflict between rural activities and other uses. The code provides specific assessment benchmarks relating to provision of *buffers to sensitive land, incompatible uses and infrastructure*.

Assessment benchmarks relate specifically to appropriate separation areas for any part of a lot that is included in a residential zone, the Emerging community zone or the Rural residential zone and is adjacent to rural land. The assessment benchmarks reference the SPP guidance material as compliance with the acceptable outcome.

2.2.6 Planning Scheme Policies

The existing planning scheme policies contained within the planning scheme have also been reviewed to understand any current guidance material provided relating to the implementation of agricultural buffers. Of relevance are the following PSP's:

- Development Works PSP

The Development Works PSP details the relevant landscaping requirements, including acceptable and unacceptable plant species. The species list provided in section SC6.3.7.4 and SC6.3.7.5 and relevant appendices of the planning scheme should be referenced and utilised to inform the planting and species advice within the policy to ensure consistency throughout the scheme.

The Hughes and Seaview Bargara Masterplan Area PSP was rescinded in the current version of the planning scheme (Version 5.0) which took effect from 10 February 2020, incorporating planning scheme amendment No.5 (Major Amendment). The guidance material relating to buffering and separation to mitigate environment, visual and land use conflict, and key outcomes were incorporated into the Central coastal urban growth area local plan code (refer to Section 2.2.3).

2.3 Key Observations

- The planning scheme sets a clear policy direction relating to the importance of appropriate buffering between sensitive uses and agricultural practices and protecting agricultural land.
- Current provisions within the zone codes, overlay codes and development codes provide adequate reference to agricultural buffers.
- The strategic framework and assessment benchmarks have a clear line of sight to the SPP guidance material.
- There is opportunity to strengthen and reinforce reference to the policy within the planning scheme provisions.
- As part of Major Amendment 5, the Central coastal urban growth area local plan code and the Kalkie/ Ashfield local plan code were integrated into the planning scheme providing guidance on adequate buffering and separation from urban growth areas to surrounding local rural production areas, to minimise land use conflicts.
- The current planning scheme (Version 5) with the addition of the local plan codes, provides significantly more guidance material and provisions relating to agricultural buffers than the superseded planning scheme. Particularly, within the Central coastal urban growth area local plan code.
- As such, it is envisioned that the future planning scheme policy will appropriately integrate into the current planning scheme (inclusive of minor amendments).

3 Development assessment review

3.1 Development applications

A strategic review of recent development applications and approvals where agricultural buffers were required, was undertaken to ascertain how buffers are being sought, designed, and implemented across the region. The most common development applications that sought or required an agricultural buffer were applications for boundary realignments.

In reviewing the development applications, it was noted that a typical set of conditions and advice relating to agricultural buffers was given in the decision notice/condition package (refer to **section 3.2 Standard conditions**).

Key observations –

- Standard conditions no longer serve as a 'one size fits all' solution due to the varying crops/species and agricultural practices which have varied impacts;
- There are specific provisions that relate directly to development adjacent to cane tramlines, particularly relating to acoustic fencing attenuation, vegetated buffers to mitigate lighting emitted by cane trains, and to improve visual amenity of the cane tramline;
- The Hughes Seaview PSP has been utilised by assessment officers to provide guidance on temporary buffers within urban growth areas;
- Various approvals called upon buffers to be established in accordance with the 'Department of Natural Resources Planning Guidelines – Separating Agricultural and Residential Land Uses';
- To deal with transitional buffers, and concerns from Council that past buffers were not implemented due to the growth of vegetation lagging, conditions now stipulate –

'No residential development being established within 100m of an agricultural or horticultural use until the landscaped buffers in the Clause are established to the reasonable satisfaction of Council'.

3.2 Standard conditions

A sample of various condition packages have been reviewed to see the variances in standard conditions provided in relation to the requirement of agricultural buffers, as part of new development applications. For more information refer to **Appendix 1**.

Standard conditions across majority of applications include –

- Majority of applications required an agricultural buffer with a minimum total width of 40 metres,
  - Except for a few applications which were granted a minimum total width of 30 metres;
- Require varied forms of plantings of a variety of tree and shrub species of differing growth habits, at spacings of 4 – 5 metres;
  - Some applications required larger widths of dense plantings and vegetation;
- Provide a permeable barrier which allows air to pass through the buffer. A porosity of 0.5 is acceptable (approximately 50% of the screen should be air space);
- Foliage is from the base to the crown;
- Include species which are fast growing and hardy;
- Have a mature height 1.5 times the spray release height or target vegetation height,

whichever is higher;

- Have mature height and width dimensions which do not detrimentally impact upon adjacent cropped land;
- Include an area of at least 10m clear of vegetation or flammable material to either side of the vegetated area;
    - Various conditions only required a 5m clear strip of vegetation
- Majority of condition packages provide commentary relating to the timing of maintenance such as; 'agricultural buffer is to be maintained in perpetuity or until such other time as is agreed to in writing by the Assessment Manager;
- Various condition packages also provided advice notes referring to the 'Burnett Shire Rural Buffer Zone Tree Planting Advice' providing useful information regarding the choice of species, site preparation and planning of agricultural buffers.

Reasons for variances to standard conditions –

- Conditions relating to spray release were not applicable, or extreme in some cases due to the neighbouring crop species. For example, the standard provision of '1.5 times the spray release height' is extreme in the case of macadamia trees and a reduction was granted;
- Standard conditions relating to buffer widths were altered and reduced in various instances, particularly when the assessment manger deemed the distance from the habitable use to the boundaries as already appropriate;
- Building exclusion areas were utilised to ensure lots adjoining rural productive land were not used for habitable uses.

4 Amendment scoping

The purpose of this task is to begin to map out the statutory framework and logical structure for developing and implementing the policy.

4.1 Planning scheme policy objectives

The following objectives for the policy have been identified:

- Ensure development assessment officers have simplified and consistent guidance material to assist in assessment of development applications requiring an agricultural buffer and to drive consistent decision-making;
- Address the needs for design, constructability, and on-going maintenance of agricultural buffers across the region;
- To provide an assortment of example buffers (such as permanent buffer treatments, transitional buffer treatments) to provide solutions suited to different circumstances;
- Identify contemporary farming practices and provide detailed information relating to their potential impacts;
- Guidance on variations to buffer design including but not limited to:
  - Types of adjacent crops, agriculture, rural activity or rural infrastructure, and potential resultant impacts (e.g. noise, dust, spray drift, odour, hours of activity, etc.)
  - Type and scale of sensitive land use
  - Environmental conditions, including prevailing breezes and soil types
- Provide contemporary and relevant guidance on appropriate and suitable plant species;
- Provide information and advice to applicants relating to maintenance requirements, or circumstances where Council may take ownership;
- Provide information regarding particular requirements that need to be included within a covenant (for circumstances where the buffer is be included within freehold land of residents or others).

4.2 Applicable development

Applicable types of development that the policy is intended to apply for:

- **Material change of use**, for sensitive land uses within Low density residential zone, Emerging community zone, Rural residential zone, Rural zone, or Community facilities zone.
- **Reconfiguring a lot**, within Low density residential zone, Emerging community zone, Rural residential zone, or the Rural zone.

4.3 Application of the policy

The policy aims to assist with satisfying the assessment benchmarks within the Planning Scheme that relate to the implementation of agricultural buffers, as outlined in **Table 1: Planning Scheme Application**. The strategic review of the planning scheme revealed that provisions reasonably refer to the concept of appropriate buffering within new developments. However, there is room to reinforce reference to the policy within the existing provisions, and through the addition of new assessment benchmarks if required. It is considered that the majority of the strategic framework adequately contemplates the requirement of appropriate buffers in new developments adjacent to agricultural uses (refer to **Table 1: Strategic Framework** review).

Table 2: Planning Scheme Application

Section in the Planning Scheme	Assessment benchmark reference
Strategic Framework	
3.3 Settlement pattern theme Strategic outcomes Element 10 – Managing land use conflicts	
3.4 Economic development theme Element 4 – Rural enterprise and industry	
3.6 Infrastructure and service theme Element 3 – Energy infrastructure	
3.7 Natural environment and landscape character theme Element 2 – Landscape and scenic amenity	
3.9 Natural resources theme Element 2 – Rural resources	
Relevant strategic framework maps Important agricultural areas identified conceptually on Strategic Framework Map SFM-005 (Natural resource elements)	
Part 6 Zone Codes	
Low density residential zone code	OO (g) (v) PO12 (c)
Emerging community zone code	OO (h) PO11
Rural residential zone code	OO (d) PO5
Rural zone code	OO (d) PO5 PO6
Part 7 Local Plans	
Central coastal urban growth area local plan code	OO (q) (i) (ii) PO1 (f) PO20 | AO20 PO21 | AO21
Kalkie-Ashfield local development area local plan code	OO (r) (i) (ii) (iii) (iv) PO1 (f) PO14 PO18 | AO18 PO19 | AO19 PO20
Part 8 Overlay Codes	
Agricultural land overlay code	OO (a) (ii) PO2 PO4 (c)
Infrastructure overlay code	PO10
Part 9 Development Codes	
Reconfiguring a lot code	OO (d) (iii) PO12 | AO12 PO15 | AO15.1
Landscaping code	PO8 (c) | AO8

place design group.

5 Stakeholder engagement findings

A key component of this project is the engagement with key internal and external stakeholders. This section provides a brief overview, findings and observations from the consultation undertaken with key stakeholders, as part of the development of the policy.

A targeted consultation and face-to-face engagement program was undertaken over two days, from the 28th – 29th of January. Below is a list of stakeholders and industry representatives who were consulted as part of the engagement program:

- Childers Canegrowers and Bundaberg Canegrowers;
- Isis Mill;
- Bundaberg Sugar;
- Bundaberg Fruit and Vegetable Growers Association (perishable vegetable growers, heavy produce growers, orchardists);
- UDIA Bundaberg.

Engagement with the various stakeholder groups was considered successful, with participants openly sharing their views as to the current constraints and future opportunities relating to agricultural buffer policy across the region.

Over the cross section of stakeholder groups, it was possible to identify matters of agreement, and for certain matters there was variation in opinion, predominately associated with divergent agricultural practices and issues. The key issues have been summarised and ranked by each stakeholder group and have been provided in full in Appendix 2.

5.1 Key observations

- All stakeholders accepted that there are known issues with the interface between agriculture and residential development (irrespective of the density).
- It was also acknowledged that provision of an updated and clear policy recommendation for buffers would assist with this issue but that this should be coupled with better practice in communication of the issues and impacts where residential uses are adjoining agricultural areas.
- Notwithstanding the type of agriculture being undertaken and their variances in operation and activities, common impact issues identified were:
  - Dust
  - Noise
  - Spray drift
  - Smell
  - Light
  - Smoke & ash
  - Visual
- Specific to the Bundaberg region, the stakeholders identified the key areas/land use scenarios across the region where buffers are required. Broadly these areas were categorised into three key environments:
  - Farm reconfiguration and rural residential subdivisions
  - Urban edge
  - Transitional or development fronts

– The stakeholder sessions were valuable in raising key issues and practical realities that are faced by the industry, in relation to complaints and conflicts with neighbouring urban areas. However, these realities expressed a need to clearly delineate what the policy can and can't deal with.

6 Supplementary technical information

Based on the key outcomes and findings from the stakeholder engagement, Agricultural and Landscape specialists have provided key technical reporting that have analysed the identified issues, and sought to present technical recommendations on potential typologies and design of possible buffer outcomes to manage and mitigate off-farm impacts. These technical inputs will be used to drive Bundaberg's policy direction and form the basis of the PSP's content.

6.1 Agriculture/ Operational Technical Report

PeritusAg as part of the project team have prepared an Agricultural Buffers Technical Report, 25th February 2020, providing a summary of the industry stakeholder sessions, the key outcomes and findings of these meetings and the critical farming operational impacts that need to be considered when designing buffer zones between agricultural land and urban developments. A full copy of the technical report has been provided as **Appendix 3**. Without duplicating the content provided in this technical report, the following key findings and observations have been summarised below, as they relate to key inputs into the policy.

6.1.1 Typical buffer environments

Instances in which an agricultural buffer may be required, due to urban uses being exposed to existing agricultural practices, can be categorised into three (3) distinct environments. These environments will ultimately determine the buffer type and the design of the buffer to respond to the individual and specific circumstance in which it is required.

1. Farm reconfiguration and rural residential subdivisions
2. Urban edge
3. Transitional development fronts

These three areas may require divergent buffer design to respond to their individual circumstances and environments.

Rural Residential subdivision

This buffer environment refers to:

- larger lot subdivisions in rural residential zone (ranging from 2000m² to 4ha)
- subdivision of a single dwelling on an agricultural property, including through a rural boundary realignment.

Urban edge

This buffer environment refers to:

- an urban settlement area with a defined boundary and setback to rural zoned land (agricultural uses)
- dwellings within the residential zones of these settlement areas

Transitional

This buffer environment refers to:

- an urban settlement area that is adjacent to land that is zoned for future urban uses (Emerging community zoned land), however is still operating as an agricultural production area in the interim
- instances where residential uses will continue to encroach on existing agricultural production areas

6.1.2 Impacts and rank by sector

The report also details the potential impacts to neighbouring non-rural owners and ranks them from largest impact (1) through to least impact (highest number), by the three key stakeholder groups/ industries. These tables have been included below:

Sugar Industry

Table 3: Potential off-farm impacts from sugarcane

Off-Farm Impact	Impact Ranking
Dust and mud	1
Noise	2
Chemical drift/spray & smell	3
Light	4
Smoke and ash	5
Irrigation overspray	6

Sugar Mills and Infrastructure

Table 4: Potential off-farm impacts from sugar mills and associated infrastructure

Off-Farm Impact	Impact Ranking
Noise	1
Dust	2
Light	3

Horticulture Industry

Table 5: Potential off-farm impacts from sugarcane production

Off-Farm Impact	Impact Ranking
Chemical drift/spray	1
Dust	2
Noise (machinery)	3
Noise (gas guns)	3
Noise (ultrasonic bird scarers)	3
Lights	4
Smell	5
Noise (firearms)	6

The report then merges these rankings into a cross tabulated 'regional industry impacts' matrix (refer to Table 6).

Key regional industry impacts

Table 6: Summary for off-farm impacts of farm operations by stakeholder and impact ranking

Off-Farm Impact	Sugar Industry Impact Ranking	Sugar Mill Impact Ranking	Horticulture Industry Impact Ranking
Dust	1	2	2
Noise	2	1	3
Chemical spray drift	3		1
Smell	3		5
Light	4	3	4
Smoke and ash	5		
Irrigation overspray	6		

As informed by Table 6 the comparative exercise of off-farm impacts determined the top three impacts that were affecting the region (as informed by the stakeholder engagement). These top three impacts are:

1. Dust
2. Noise
3. Chemical spray drift

The report outlines the important consideration, that over time, the expectation is that the region will continue to move towards higher value crop production including more perennial crops and this may come at the expense of sugarcane production (and to a lesser extent annual horticulture cropping).

As such, when considering long term crop production trends and off-farm impacts, the potential issues raised by the horticulture industry (perennial crops) are likely to become more relevant as a result of ongoing conversion of land from sugar or lower value crops.

6.2 Landscape Technical Report

Place Design Group as part of the project team have prepared a technical report providing a summary of buffer characteristics, buffer design, and associated information relating to tree species, planting and maintenance. A full copy of the reporting has been provided in Appendix 4.

Without duplicating the content provided in this technical report, a high-level summary has been provided below. Some additional key findings, justification and supporting information from previous reporting has also been included within this section.

6.2.1 The role of agricultural buffers

- Overtime and in certain physical environments buffers have also been used to manage impacts between land uses, in particular where residential activity interfaces with a productive area.
- In this circumstance buffers need to mitigate a variety of impacts including physical effects; dust and mud, noise, chemical drift/spray/smell, light, smoke and ash and irrigation overspray.
- A buffer to provide protection against spray drift, dust and other particulate matter that is primarily airborne is partly achieved by creating a windbreak.
- The buffer should provide visual screening as well as protection from possible windborne contaminants particularly given that activities or matters that provoke the greatest response are often those that are most visible, irrespective of whether they create any significant environmental nuisance. This point of view is consistent with the agricultural specialist recommendations, the visual role of any buffer can mitigate many undesirable aspects of rural production as the activities causing these are unseen.
- Buffers whether within the agricultural area or the adjacent development must be a permanent structural element of the land use to provide mitigation.
- Buffers to agricultural land have also been used to assist in the management of water and nutrient loss from agricultural production areas. Whilst this is not the primary objective on including buffers within the Bundaberg region, it is considered to be a positive consequence of implementing agricultural buffers to deal with incompatible land uses.

6.2.2 Buffer characteristics

There are distinct characteristics that make up the overall design of a buffer, and what can contribute to the buffers effectiveness at mitigating off-farm impacts. The key characteristics that the policy should provide guidance on are:

- Buffer height
- Buffer width
- Buffer density
- Buffer length

Specific details of recommendations for each buffer characteristic is provided in **Appendix 4.**

6.2.3 Buffer types

Agricultural buffers can be divided into two key categories based on the buffer environment they relate to (refer to **section 6.1.1**). These two categories are static (permanent) buffers and transitional (temporary) buffers. The descriptions of these two categories of buffer type have been extrapolated in **section 7.2** for incorporation into the policy.

6.2.4 Plant species

- The species make-up of the buffer planting should be related to the type of agricultural production being undertaken. The policy has recommended two key components of the buffers, including a bamboo screen and a native planting layer.
- Clumping bamboo has been recommended to establish a fast-growing visual screen and provide a 'safety net' when/if the native planting layer is compromised. Whilst it is noted that the use of clumping bamboo may not be preferred by some, the species has been recommended to address the likelihood of native species being damaged in weather events such as cyclones, storms and floods. Native species are also more sensitive to deterioration when not effectively maintained. The clumping bamboo will ensure that a windbreak is maintained during these circumstances, which is vital to the ongoing effectiveness of the buffer. In the instance where a windbreak is compromised, off-farm impacts (dust, spray drift etc.) will funnel through the windbreak and will have an intensified impact.
- Using native species within the vegetated planting area of the agricultural buffer is advised as these perform better in the local conditions and require less maintenance. Effective buffer growth resulting from the use of native species can also result in less pest and disease attack within these buffers.
- Tree species have been recommended that have insignificant flowers and fruits so as not to attract large numbers of birds or bats, that may in turn feed on the adjacent crop.
- Using a mixture of native species in the native planting area is recommended as it results in a variety of plant shapes, which reduces the likelihood of gaps within the buffer (allowing physical impacts to infiltrate).

6.2.5 Buffer maintenance

- The establishment of buffer planting, like any other cover crop, requires watering, fertilising and weeding. Following establishment, maintenance is required to all buffer types for them to remain effective.
- Buffer attributes must be maintained, as height, width, length and density all contribute to the ongoing effectiveness of the buffer.

- Buffers need to be pruned and possibly thinned on an annual basis to maintain a 50% density so that their effectiveness is maximised.
- Watering of a buffer is required during dry periods to maintain good buffer growth. Fertilising prior to the growing season will assist in maintaining the health and vigour of the buffer.
- Buffers need to be maintained weed free to prevent the build-up of weed species that can cause infestation of agricultural production areas as well as other neighbouring land uses.

place design group.

7 Summary of Key Policy Matters

In order to formulate a clear scope for the PSP drafting key policy matters and technical matters have been presented. This material has been included as it will form the basis of the structure of the policy and key matters for inclusion.

Key policy matters are presented under the following headings:

- Buffer characteristics
- Buffer types
- Agricultural use and buffer classifications
- General advice/requirements

7.1 Buffer characteristics

The key characteristics that the policy should provide guidance on are:

- Buffer height
- Buffer width
- Buffer density
- Buffer length

Key items from the technical reporting that provide important policy guidance relating to buffer characteristics have been listed below. Key guidance includes, but is not limited to:

Buffer height

- The height of a buffer determines the level of protection given to the leeward side of the buffer. The height of the buffer will offer protection downwind for approximately ten times their height.
- Note: Building height to any habitable building within 100m does not need to be limited. This indicates that effects of the adjacent activity will decrease the further you are away from it. The buffer being on the sensitive land use side affords the greatest protection from the adjacent activity. No land use can be totally protected from an adjacent activity, measures can only be put in place to minimise these effects. There will always be some environmental and local characteristics that cannot be overcome.
- The height of the buffer will determine the distance it should be located away from the production area, due to the potential for the buffer to cast shade onto the production area and compete/ draw away water and nutrients from it.
- Note: This 10m separation area is not only necessary for maintenance access, but to prevent nutrient and moisture loss from the adjoining use as well as minimise shading from the buffer that can affect the level of productivity along this boundary.

Buffer width

- The buffer is made up of two components: the initial quickly to establish screen (for immediate relief); and the more long-term component of multi-layered trees and scrubs to give a thicker and more effective buffer to the land use.
- The slower growing component of the buffer is then planted adjacent to this area, the density of this being related to the type of production located adjacent.

Buffer density

- The buffer should allow air flows to pass through so that they are decreased in intensity. By doing this, particulate matter within the air is captured by the foliage of the buffer. This buffer permeability also reduces turbulence on the leeward side of the buffer. Permeability of around 50% has been found in a number of studies to provide adequate protection of

the downwind areas.

- Buffers should be multi-layered to decrease the likelihood of large gaps between vegetation allowing wind tunnels to occur and therefore, wind borne particulate matter, to pass through.
- The density of the planting within the fixed buffer widths, will influence the eventual growth height of the vegetation. Vegetation that is planted closer together, more dense planting, will compete against each other for access to light and nutrients and therefore grow taller.
- If a buffer is planted with a lower density, and the adjacent land use changes, the buffer density can be increased to provide more protection to the areas down wind from the use. In this way, it is possible to amend the characteristics of buffer types if required after their establishment.

Buffer length

- Longer windbreaks/buffers are more effective than shorter ones. There is an increased level of turbulence around the ends of a windbreak/buffer so it is important that the buffer extends past any areas requiring protection.
- The length of the protection buffer combined with the height determines the overall extent of the protection area. To get the maximum benefit of the buffer structure, it should be at least ten times longer than its height.

7.2 Buffer types

Agricultural buffer can be divided into two key categories: Static and Transitional. It is understood from technical reporting that these buffer types often relate directly the buffer environment (development front) in which they are established. However, the project team deliberated the notion to include information regarding buffer environment in the policy and agreed that is added an additional layer of information that may be confusing to applicants. It is considered that the inclusion of the two buffer types and a description of each is sufficient for the policy.

The characteristics of both buffer types are described under the following headings.

Static Buffer

- Static buffers refer to permanent agricultural buffers and are typically used in areas where the common boundary of agricultural uses and urban purposes or sensitive uses is established and will not move.
- In these environments, the buffers are static so would be able to be a minimum width of ten metres as they will be maintained in perpetuity and should have enough time in place to reach their recommended height of 10 metres.
- An estimate of time required for a buffer to reach a mature height would be around 5 years.

Transitional Buffer

- Transitional buffers refer to agricultural buffers that are temporary and are used to provide either buffering or separation to agricultural land that is expected to be developed for urban purposes in the foreseeable future.
- Transitional buffers should be utilised when a static buffer is not appropriate or is unreasonable as the planting would not be able to reach maturity before being removed, and effectiveness would be compromised.
- The effectiveness of buffers is dictated by the combination of the height and linear length of the buffer, as transitional buffers are less likely to have an overall height as high as a static buffer, the width of transitional buffers becomes more important.
- Cost of temporary buffer treatment would need to be considered appropriate for the

development industry (as it is an interim solution).

7.3 Buffer attributes

Buffer attributes and design features are the components of the buffer (including setbacks) that are required to establish a complete and effective agricultural buffer. Buffer attributes will need to be defined upfront in the policy and consistent terminology used throughout. Providing a glossary of terms is not consistent with the existing drafting style of the planning scheme policies. As such, it is proposed the buffer attributes are defined within the body of the policy.

The buffer attributes have been illustrated below:

Adjacent activity	Maintenance area	Visual screen	Native planting area	No build area	Sensitive Land Use
	Buffer setback	*Required buffer*		*Buffer setback*	

The buffer attributes have been defined below:

Adjacent activity refers to the land use and activity that is occurring adjacent to the encroaching urban uses. This may include and agricultural production area, a cane railway etc.

Maintenance area refers to the 10 metre strip of turf and/or low grasses that is directly abutting the adjacent activity, and allows access to the boundary fencing and buffer for maintenance. The maintenance area also provides appropriate separation from the adjacent activity (agricultural use) which ensures that buffer planting does not compete with or impact on adjacent crops (e.g. shade, competing for water or nutrients). This separation also assists in managing potential fire hazards.

Visual screen refers to the two staggered rows of clumping bamboo (or other approved species) that establish a fast growing visual screen.

Native planting area refers to the multi-layered planting of mixed trees and shrubs that are slower growing and provide further mitigation and aesthetic value to the buffer.

No build area refers to the area between the buffer itself and the adjacent sensitive land use which is to remain free of infrastructure and any built structures above or below ground. This area is required to provide appropriate separation from any infrastructure to allow the uninhibited establishment of the buffer vegetation. This separation also mitigates potential impacts from the vegetated buffer on built infrastructure, including damage from invasive and aggressive root systems. The separation may also limit damage to built infrastructure in the instance where the integrity of a tree is compromised and falls in a storm, cyclone, flood etc. The no build area should also be used to provide access to the buffer for maintenance on the sensitive land use side.

It is recommended that no infrastructure, either above or below ground, is permitted within the whole extent of the buffer including the maintenance area and no build zone.

7.4 Agricultural uses and buffer classification

Agricultural practices and operations vary by agricultural industry across the Bundaberg region. These agricultural uses can result in varying off-farm impacts (dust, noise, spray draft, odour) of varying levels of severity and for varying durations of time.

The buffer characteristics that make up the overall design of a buffer can relate directly to the

impact that it is trying to mitigate. These off-farm impacts and related buffer characteristics have been prioritised below to assist in forming an overall buffer classification system for the policy.

Table 7: Buffer characteristics relating to off-farm impacts by priority.

Off-Farm Impact	Buffer characteristics (by priority)
Sugar cane	
Dust and mud	1. Buffer height 2. Planting density 3. Buffer width
Noise	1. Visual screen 2. Buffer width
Chemical/ Irrigation spray	1. Buffer height 2. Planting density 3. Visual screen
Light	1. Planting density 2. Buffer height 3. Visual screen
Smoke and ash	1. Buffer height 2. Planting density 3. Visual screen
Sugar mill and infrastructure	
Noise	1. Visual screen 2. Buffer width 3. Planting density
Dust	1. Buffer height 2. Planting density 3. Buffer width
Light	1. Planting density 2. Buffer height 3. Visual screen
Horticulture	
Chemical drift/spray	1. Buffer height 2. Planting density 3. Visual screen
Dust	1. Buffer height 2. Planting density 3. Buffer width
Noise	1. Visual screen 2. Buffer width
Lights	1. Planting density 2. Buffer height 3. Visual screen
Smell	1. Visual screen 2. Buffer width

place design group.

Off-Farm Impact	Buffer characteristics (by priority)
	3. Planting density

The project team undertook an exercise to determine the suitable design of various buffers that appropriately respond to different agricultural uses, rather than a one size fits all approach.

Specifically with agricultural buffers, it is important that the design of the buffer responds to the agricultural use of the adjacent land, the subsequent off-farm impacts that requires mitigation, and the buffer type that is required (permanent or temporary) to achieve a buffer that is suitable to its individual context.

This classification has been summarised in the Table 8 below. The buffer attributes column refers specifically to the design provisions of each buffer.

Table 8: Buffer classification and design attributes.

Agricultural use	Buffer classification	Buffer type	Buffer attributes				Total buffer width
Sugar Cane & Horticultural Crops	*Buffer Type A*	Static	10m width maintenance area	5m width bamboo screen - 2 staggered rows of planting	10 m width native planting area - 2 staggered rows	10m width no build area	35m
Orchards	*Buffer Type B*	Static	10m width maintenance area	5m width bamboo screen - 2 staggered rows of planting	10 m width native planting area - 3 staggered rows	10m width no build area	35m
Cane Railway	*Buffer Type C*	Static	10m width maintenance area	5m width bamboo screen - 2 rows of planting		10m width no build area	25m
All Types *where not specified above.	*Buffer Type C*	Transitional	10m width maintenance area	5m width bamboo screen - 2 rows of planting		10m width no build area	25m

It is recommended that each buffer classification (Buffer Type A, Buffer Type B, and Buffer Type C) have their own table of provisions in conjunction with a diagram/cross-section to provide clear design guidance to applicants.

Buffer Type C

Buffer Type C is recommended in circumstances when sensitive land uses and development is proposed adjacent to Cane Railway.

The Infrastructure overlay code provides clear provisions relating to the location, design and construction of sensitive land uses in proximity to State controlled roads, railway corridors and cane railway corridors. The planning scheme stipulates that Council may require an impact assessment report prepared by a suitably qualified consultant to demonstrate compliance with performance outcome PO9; which states

> *'Sensitive land uses are located, designed and constructed to ensure that noise emissions from State controlled roads, railway corridors and cane railway corridors do not adversely affect:-*
>
> *(a) the development's primary function;*
>
> *(b) the wellbeing of occupants including their ability to sleep, work or otherwise undertake quiet enjoyment without unreasonable interference from road traffic and railway noise.'*

The establishment of Buffer Type C is not recommended in lieu of complying with the existing requirements within the Infrastructure overlay code, of providing an impact assessment report. Where an impact assessment demonstrates the requirement of acoustic fencing or similar mechanism to achieve appropriate acoustic attenuation, this will still be required. In instances

where Buffer Type C is used within urban or rural residential estates where an acoustic report is requested, reporting will still be required.

The implementation of Buffer Type C should be used in conjunction with any relevant infrastructure required as regulated by the planning scheme. The primary objective of Buffer Type C is to mitigate other impacts, beyond noise, that arise from the Cane Railway (that were identified as part of stakeholder engagement) including providing a visual screen and mitigating dust and light. It is considered that the existing provisions within the planning scheme relating to noise attenuation for cane railway corridors have, and will continue to, provide appropriate mitigation of noise nuisance.

In the instance of the Kalkie-Ashfield local development area local plan code which also stipulates specific provisions relating to the interface between development and the sugar cane rail network, the Buffer Type C could be an appropriate buffer treatment when referred to as an 'amenity buffer'. For example, an 'amenity buffer' is provisioned in PO20:

> *'Development provides for an acoustic and amenity buffer to be established and maintained adjacent to the major roads and the sugar cane rail network so as to:-*
>
> *(a) protect the amenity and wellbeing of prospective residents and other sensitive receptors within the local plan area;*
>
> *(b) protect the function of the road network and sugar cane rail network; and*
>
> *(c) enhance roadside amenity and contribute to the visual amenity of the development area.*
>
> *Note—Figure 7.2.2 (Kalkie-Ashfield local development area structure plan concept) identifies the indicative locations where acoustic and amenity buffers will be required along major roads and the sugar cane rail network. The acoustic and amenity buffer area may be provided in a variety of forms including but not limited to:*
>
> - *private freehold land forming a component of a residential lot outside of a designated building envelope;*
> - *common property in a community titles scheme;*
> - *private landscape and recreation space;*
> - *existing or new road reserve; or*
> - *public open space reserve.'*

It was considered that Buffer Type A may also be used as an appropriate alternative to Buffer Type C (where static). Buffer Type C has been recommended as it effectively mitigates dust and provides a robust visual screen, requires less space, is quicker to establish and provides better foliage coverage from the base of the bamboo to the top. Unfortunately, there is no native species that grows tall enough and has enough foliage to the ground (as a hedge). If Council accepts that the use of native species would require a wider buffer and that would take longer to establish, the policy can be amended to recommend Buffer Type A in situations where the buffer is static.

7.5 Buffer tenure and maintenance

A preferred tenure hierarchy of ownership, management and responsibility of agricultural buffers is recommended to be included in the policy. Detailed criteria have been incorporated into the policy to articulate quantifiable metrics to assess the efficiency and effectiveness of buffer maintenance and if the agricultural buffer is acceptable to go Off-Maintenance. The establishment of this criteria ensures that there is no subjectivity in the assessment of the buffer to determine Off-Maintenance.

It is recommended that these metrics are also used by Council to establish covenant criteria to ascertain appropriate maintenance of the buffer by the developer/ landowner.

An On-Establishment period and On-Maintenance period has been provided to give the developer ample opportunity to ensure the agricultural buffer is complete and effective. The biannual inspections in conjunction with the assessment criteria stipulated in the policy, gives Council the opportunity to fast-track developers that have executed well-established buffers that meet the criteria in an earlier time frame than five years.

It is understood that buffer establishment timeframes can be impacted by weather patterns in the Bundaberg region (dry summers, heavy rain fall etc.). As such, strict timeframes would not be the most effective way to measure or assess buffer establishment.

Notably, this On-Establishment and On-Maintenance periods have been used by other local government authorities such as the City of Gold Coast to ensure developers have sufficient opportunity to establish an effective buffer that minimises the need for time consuming and costly ongoing maintenance.

8 Summary and recommendations

This section provides a summary of high-level recommendations to inform subsequent amendments to the planning scheme. It is understood that these recommendations will be considered by Council when drafting future amendment packages.

No recommendations have been provided for the Strategic Framework. It is considered that the Strategic Framework adequately contemplates the requirement of separation areas and buffers within the region to mitigate impacts from conflicting land uses. It is considered that the content is sufficient and aligns with the proposed policy. As further outlined below, terminology may need to be reviewed dependent on final amendments to the planning scheme.

Recommendations have been made for relevant zone codes, local plan codes, overlay codes, and development codes. These recommendations have been provided at a high-level to inform future amendments. As this policy has been drafted at point in time whereby further drafting of the amendment package is yet to be undertaken, Council may still need to be conscious of some key considerations when finalising drafting. A few of these considerations have been detailed below:

- Nominated outcomes will need to be consistent in terminology throughout the planning scheme. There will need to be consistent reference to agricultural buffers. The planning scheme currently references 'agricultural land buffers', which differ from 'landscape buffers'.
- How Council wishes to call up the policy and what the highest order code is that triggers the policy.
- Consistent reference to the policy throughout the assessment benchmarks (such as, for further guidance, or for compliance with this performance outcome etc.)
- The Landscaping code sets out requirements for landscape buffers. AO8 specifies the design provisions relating to Landscape buffers. Drafting will need to be clear on the difference of Landscape buffers versus Agricultural buffers and how these different buffers are triggered and referenced within the planning scheme i.e. Landscape buffers are required adjacent to existing areas of environmental significance whilst Agricultural buffers are used when sensitive uses are adjacent to existing agricultural land uses.
- The Landscaping code is also called up when requiring a buffer between agricultural uses and sensitive land uses (as well as directing applicants to the SPP). Council will need to consider if the policy is intended to override this link to the Landscaping code (based on Council's decision relating to the above point).

Table 9: Recommendations for amendments

Section in the Planning Scheme	Assessment benchmark reference	Recommendation
Strategic Framework		
3.3 Settlement pattern theme Strategic outcomes Element 10 – Managing land use conflicts		
3.4 Economic development theme Element 4 – Rural enterprise and industry		
3.6 Infrastructure and service theme Element 3 – Energy infrastructure		
3.7 Natural environment and landscape character theme Element 2 – Landscape and scenic amenity		
3.9 Natural resources theme Element 2 – Rural resources		
Relevant strategic framework maps Important agricultural areas identified conceptually on Strategic Framework Map SFM-005 (Natural resource elements)		

Section in the Planning Scheme	Assessment benchmark reference	Recommendation
Part 6 Zone Codes		
Low density residential zone code	OO (g) (v) PO12 (c)	Recommendation: Add reference note to policy. It is considered that the overall outcome and performance outcome adequately covers the requirement of appropriate buffers within new developments (for sensitive uses) adjacent to conflicting land uses. It is recommended a reference note to the drafted policy is added to PO12.
Emerging community zone code	OO (h) PO11	Recommendation: Minor amendment. There is an opportunity to amend PO11 to include reference to agricultural buffers to align terminology and mechanism of management i.e. 'through suitable buffers'. It is recommended a reference note to the drafted policy is added for applicants to seek further guidance.
Rural residential zone code	OO (d) PO5	Recommendation: Minor amendment. There is an opportunity to amend overall outcome (d) to incorporate specific terminology relating to the use of agricultural buffers.
Rural zone code	OO (2) (d) PO5 PO6	Recommendation: Minor amendment. There is opportunity to amend performance outcome 5 to incorporate reference to the establishment of agricultural buffers, with an accompanying reference note to the policy.
Part 7 Local Plans		
Central coastal urban growth area local plan code	OO (q) (i) (ii) PO1 (f) PO20 | AO20 PO21 | AO21	Recommendation: Amendment. The Central coastal urban growth area local plan code will need to be amended to reflect the new policy. Whilst the current overall outcomes adequately contemplate the requirement and benefit of appropriate establishment of buffers, it is recommended that terminology is reviewed to ensure consistency. Overall outcome (q) only references 'landscape buffering'. It is recommended the amendment considers the addition of 'agricultural buffers'. It is recommended that a reference note to the policy is added to PO1. It is recommended that wholesale amendments are made to PO20/AO20 and PO21/AO21 to reflect the policy.
Kalkie-Ashfield local development area local plan code	OO (r) (i) (ii) (iii) (iv) PO1 (f) PO14 PO18 | AO18 PO19 | AO19 PO20	Recommendation: Amendment. As per above, Kalkie-Ashfield local development area local plan code will need to be amended to reflect the new policy. Whilst the current overall outcomes adequately contemplate the requirement and benefit of appropriate establishment of buffers, it is recommended that terminology is reviewed to ensure consistency. Overall outcome (r) only references 'landscape buffering'. It is recommended the amendment considers the addition of 'agricultural buffers'. It is recommended that a reference note to the policy is added to PO14. It is recommended that wholesale amendments are made to PO18/AO18, PO19/AO19, PO20,

Section in the Planning Scheme	Assessment benchmark reference	Recommendation
		PO21/AO21 and PO22 to reflect the policy and ensure alignment and limit conflicts.
Part 8 Overlay Codes		
Agricultural land overlay code	OO (a) (ii) PO2 PO4 (c)	Recommendation: Minor amendment. The overall outcomes specifically discuss the establishment of effective buffers. Terminology will need to be reviewed for consistency. It is recommended that performance outcome 2 is supplemented with an additional reference note to the policy for compliance with the performance outcome and further guidance for applicants. It is recommended that no amendments are required to the performance outcome 4 as it relates directly to reconfiguration of the agricultural land (not residential land uses).
Infrastructure overlay code	PO10	Recommendation: No amendment.
Part 9 Development Codes		
Reconfiguring a lot code	OO (d) (iii) PO12 | AO12 PO15 | AO15.1	Recommendation: Amendment. There is an opportunity to amend overall outcome (d) (iii) to include the provision of agricultural activities and land uses. It is recommended that performance outcome and acceptable outcome 12 are amended to reference the policy.
Landscaping code	PO8 (c) | AO8	Recommendation: Amendment. As mentioned above, Council will need to consider the consistency of how Landscape buffers are triggered within the planning scheme and in what context they are necessary/ required. It is recommended that assessment benchmarks (PO8 and AO8) are amended to provide clear delineation and direction to applicants regarding which buffer and subsequent design provisions are appropriate for their individual context. I.e. fulfilling PO8(a) requires a Landscape buffer, compliance with PO8(c) may require an Agricultural buffer (if adjacent to agricultural land use) and thus should be in accordance with the policy. In this case, a reference note to the policy should be added.

Appendix 1 – Condition Package Review

Subject Site	40m Buffer	Contain random plantings of a variety of tree and shrub species of differing growth habits, at spacings of 4-5m	Permeable barrier 0.5 acceptable	Foliage is from the base to the crown	Include species which are fast growing and hardy	Mature tree height 1.5 times the spray release height or target vegetation height, whichever is higher	Mature height and width dimensions which do not detrimentally impact upon adjacent cropped land	Include an area of at least 10m clear of vegetation	Burnett Shire Rural Buffer Zone Tree Planting Advice' provides useful information regarding the choice of species, site preparation and planning of agricultural buffers
Schmidts Road, North Isis	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benerayby Road– Riverstone Rise	×	15-20m dense vegetation, 15-20m tree and fire-retardant understory	NA	NA	NA	NA	NA	NA	NA
101 Booloongie Road, Gooburrum	20m	×	×	×	×	×	×	Include an area of at least 5.0m clear of vegetation	NA
135 Sauers Road	×	×	×	×	×	×	×	×	×
27 Kirbys Road	×	×	×	×	×	×	×	×	×
71 Rainbows Road, South Isis	×	×	×	×	×	×	×	×	×
76 Conlons Road, Horton	30m	Contain dense plantings for a min width of 10m	×	×	×	×	×	×	×
Belle Eden Estate Pty Ltd – Kepnock Road Ashfield	A landscaped buffer to the full southern boundary that adjoins Lots 1 on R.P. 61334 of the land It shall comprise the following: - 20m Clear strip (road reserve) 25m fully vegetated – to include a mound 2m high and 9m wide	Plant species is to be selected from the following list ensuring plants chosen include a broad range of leaf morphology (size and shape). Plant species are available from Forestry Nursery.	NA	NA	NA	Min height of 2m	NA	5.0m clear strip	NA

Subject Site	40m Buffer	Contain random plantings of a variety of tree and shrub species of differing growth habits, at spacings of 4-5m	Permeable barrier 0.5 acceptable	Foliage is from the base to the crown	Include species which are fast growing and hardy	Mature tree height 1.5 times the spray release height or target vegetation height, whichever is higher	Mature height and width dimensions which do not detrimentally impact upon adjacent cropped land	Include an area of at least 10m clear of vegetation	Burnett Shire Rural Buffer Zone Tree Planting Advice' provides useful information regarding the choice of species, site preparation and planning of agricultural buffers
	5m clear strip See notes for extended description								
Belle Eden Estate Pty Ltd stage 2 – Gum Nut Drive	NA	A vegetated landscaped buffer to mitigate lighting emitted by cane trains on residential lots and to improve the visual amenity of the cane tramline is required to be provided within the road reserves and parkland at the time of constructing stages adjoining the cane tramline.	NA	NA	NA	NA	3m high acoustic barriers to be implemented for 5 lots, or 1.8m high solid aluminium to comply where tramlines running through the site that must be fenced.	NA	NA
8 Meadowvale Road	30m	×	×	×	×	×	×	×	NA
216-266 & 268-272 David Low Way Bli Bli	×	Staggered planting as opposed to a pattern of planting needs to be adopted as grid formations with plants, such as trees planted in rows, promotes shading through overlapping canopies and will not present a natural appearance	NA	NA	The average height of shrub species must be 1.0 metres The average height of tree species must be 2.0 metres The ground surface must not display any area devoid of vegetation greater than 1.0 m^2 within any 10.0 m^2 sample	NA	NA	NA	NA

Appendix 2 – Stakeholder Engagement Summary

A key component of this project is the engagement with key internal and external stakeholders. A targeted consultation and face-to-face engagement program was undertaken over two days, from the **28th – 29th of January**. Below is a list of stakeholders and industry representatives who were consulted as part of the engagement program:

- Childers Canegrowers and Bundaberg Canegrowers;
- Isis Mill;
- Bundaberg Sugar;
- Bundaberg Fruit and Vegetable Growers Association (perishable vegetable growers, heavy produce growers, orchardists);
- UDIA Bundaberg.

The key issues have been summarised and ranked by each stakeholder group below.

Canegrowers Isis

Table 3: Canegrowers Isis stakeholder attendees.

Attendees (28th January)
Paul Nicol – Isis Central Mill 0438 888 590 Paul.nicol@ississugar.com.au
Angela Williams – Canegrowers CEO 0427 210 077 Angela_williams@canegrowers.com.au
Mark Mammino – Canegrowers 0427 139 323

Table 4: Canegrowers Isis stakeholder issues and off-farm impacts.

Issue	Rank	Comments/Common Issues
Dust and Mud	1	Activity: – Mud on road during harvest (haulouts/trucks) (Mud) – Fallow ground preparation ready for planting (Dust) – Ground cover die off in drought (Dust) – Harvesting/haul outs (Dust and mud) – Mulching (Dust) – Mill mud (Dust and mud) Timing: – Harvesting (June – Dec) – Ground preparation (Jan – Dec) – Mill mud (Jun – Dec) night-time
Noise	2	Activity: – Harvesting – Locos – Irrigation pumps (often not Canegrowers/Mill) – Machinery – Road transport (truck pads / brakes) – Mill operations, including making sleepers – Ground preparation / general machinery maintenance – Harvesting contractors (on farm) maintenance in sheds near urban

place design group.

Issue	Rank	Comments/Common Issues
		areas – Private motorbikes using railway and operating corridors Timing: – Loco (Jun – Dec, 24hrs at peak) – Harvesting 3am – 10pm (June – Dec) – Road 24hrs – use of siding pads (June – Dec) – Irrigation (Jan - Dec) – Less intense, irrigation at night – Mill – day and night year round – General prep (Feb – March) (Jul – Aug)
Spray Drift/Smell	3	Activity: – Aerial and ground spray (odour) – Mill mud spreading (odour) – Insecticide/fungicide use – (Possible emerging issue) Use of treated effluent on farm Timing: – Early AM/PM – Cane (Dec-Jan) – Peanuts & Soybeans (Dec-April)
Light	4	Activity: – Trucks/trains/harvesting at night – Night-time spray with high clearance self propelled sprayers Timing: – Jun – Dec – Truck/train use 24/7 – Harvest (Jun – Dec) – Mill mud (Jun – Dec)
Smoke & Ash	5	Activity: – 1 – 2 % of cane crop burnt – Trash burn worse than cane fire due to being smokey and longer lasting Timing: – Jun – Dec – Erratic timing (previously had knowledge or time) – Trash burnt at night – smoke holds in air
Irrigation Overspray	6	– Required by law to be contained within boundary – Legal risk to farmer if irrigated water on road (particularly as certain roads become more urban)
Common Affected locations	N/A	– Parklands Estate – Price Street – Goodwood Rd – Cordalba – Childers carwash next to siding – Kentucky bluegrass
Ideas & Solutions	N/A	– 4PVMA setbacks – reef run off new requirements – Focus on effectiveness/not just tokenistic buffers – Need to manage firebreaks – Rural residential solution different to urban residential – Distance not just vegetation – Align with DNR farms policies and requirements – Engage with locals - communicate practice and timing – Drainage into buffer zones – practices include run off into buffers and

place design group.

Issue	Rank	Comments/Common Issues
		urban areas (also considered in reef requirement) – Relationship between buffers and native corridors
Car Park Matters (Non-project specific but to be reported to Council)	N/A	– Protection of prime ag land and continued ability to operate and agricultural business – Irrigation channels (Sunwater) urban encroachment, cutting fences and drowning risk. – Farm shed subdivisions – issue due to complaints e.g. harvest sheds close to urban areas – Council regulations impacting businesses who are actively relocating to mitigate complaints – Covenant use to provide info – adjacent to ag use – possible impact – Regularly receive incorrect business complaints (i.e. Mill instead of adjacent industrial uses) – Dust is a common issue with this – New incompatible neighbouring businesses to agricultural areas (Gave Childers car wash example next to rail siding) – Overland water flow changes with changing land use

place design group.

Bundaberg Fruit & Vegetable Growers

Table 5: Bundaberg Fruit & Vegetable Growers stakeholder attendees.

Attendees (28th January)
Bree Grima 0403 616 702 bree.grima@bfvg.com.au
Andreas Rehberger 0418 714 572 andreas.rehberger@hotmail.com
Thomas Redfern 0429 396 333 manager@edenfarms.com.au
Dale Schneider 0427 350 200 dale@simpsonfarms.com

Table 6: Bundaberg Fruit & Vegetable Growers issues and off-farm impacts.

Issue	Rank	Comments/Common Issues
Spray Drift	1	Activity – Spray booms(with or without droppers) – Spraying of small crops on windy days – Trees are better to manage with this issue – Irrigation overspray limited issue as managed carefully being a finite resource Timing – Mango, every 14 days (Aug – Jan) – Avocado, every 24 days (Jan – Dec) – Vegetables, weekly (Jan – Dec) – Cane Noted that visual que of the spraying often triggers a spike in complaints
Dust	2	Activity – Transition from cane to new crop – Land levelling (water truck often used to manage) – New orchard crop land preparation (short term issue) – Macadamia harvesting – Road transport (Particularly at key intersections & roads) – Land preparation, lifting plastic or crop harvesting with workers Timing – Year round
Noise (Machinery)	3	Activity – Orchard/Mango spray rig fan (110dba) – Road transport/particularly refrigerated trucks – Orchard pruning/mulching wood chip – Composting increases traffic, noise & smells – Vegetable & small crop tractor spraying, workers in harvest area early morning – Irrigation pumps (often diesel) limited use compared to cane – Tend to use electric pumps for surface water Timing – Night-time spraying due to better wind conditions & to manage spray drift – Trucks midday to midnight, year-round, multiple trucks/7days – Orchard pruning (day time impact after harvest) (Jan-Sept)
Noise (Gas guns)	3	Activity – Use for bird and flying fox management

place design group.

Issue	Rank	Comments/Common Issues
		– Undertake use in accordance with EPA agreed frequency – Use digital timer to manage – Required to be minimum 300m from a dwelling – Move the location and orientation of the gas gun regularly Timing – Can use day and night/but evening often too difficult due to complaints
Noise (Ultrasonic system)	3	Activity – High frequency noise for lorikeets – Complex system to set up and manage – System rotates through a range of frequencies to deter birds – Specific frequencies the main issue with complaints
Lights	4	Activity – Night-time spray – Flying fox management in lychees – Cannabis & flower farms (lighting for day sensitive plants) Timing – Year round – Oct-Feb for Lychees
Smell	5	Activity – Composting organic material for soil ameleoration – Raw crop inputs (manures, composts etc) – Manures placed under plastic less of an issue – Crop waste – Herbicides (smell in the absence of physical drift) – Cannabis (possible scent) Timing – Year round
Noise (Firearms)	6	Activity – Animal management to keep out of fruit – Managed/limited use due to regulation – Often a trespasser using firearm Timing – Mangoes and lychees (Nov – Feb) – Year round/24hrs
Beehive health	N/A	– Emerging practice – Bee moving from primary property and dying due to chemical & lack of plant diversity
Common Affected locations	N/A	– Parklands Rural Res – Within 1 km of farms – St Marys Farm – Palm Spring Drive
Ideas & Solutions	N/A	– Generally, growers operate farms to avoid impact to neighbouring properties – Emphasis on managing neighbour relationships and regular communication – Use of planted screens within farm limit reduces visual triggers of complaint – People often 'smell with their eyes'
Impacts from Neighbours onto Farms	N/A	1. Trespass 2. Theft 3. Domestic animals 4. Dumping of waste

place design group.

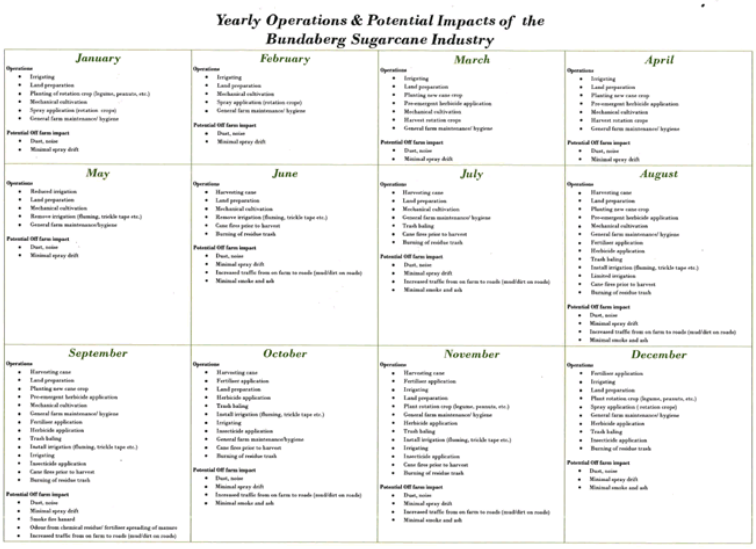
Bundaberg Canegrowers

Table 7: Bundaberg Canegrowers stakeholder attendees.

Attendees (29th January)
Dale Holliss – Bundaberg Canegrowers 0417 009 236 Dale_holliss@bdbcanegrowers.com.au
David Barrett – Bundaberg Sugar 0428 757 238 djbarrett@bundysugar.com.au
Tanya Howard Tanya_howard@bdbcanegrowers.com.au

Table 8: Bundaberg Canegrowers issues and off-farm impacts.

Issue	Rank	Comments/Common Issues
Buffers issues	N/A	Bushfire and pests
Ideas & Solutions	N/A	– Consider there should be a right to farm as required in agricultural areas – No regulated noise limit set on rural/agricultural properties (rural areas often have 0 background noise which makes it impossible to operate within the noise guidelines e.g. a diesel pump) – Farmers operate in accordance with best practice agricultural regulation and actions that minimise impact – This is also advanced by peak industry bodies – Recommended Victoria Dept of Ag example leaflet that is given to people buying in rural areas – Very sensitive to the use of 2,4D and manage it very carefully in accordance with regulation – Harvesting at night often attracts complaint but practice is to do areas farthest away from dwellings – Need to manage buffers along cane rail to ensure visibility is maintained



place design group.

Issue	Rank	Comments/Common Issues
Impacts from Neighbours onto Farms	N/A	– Damage to fences – Access to Sunwater Channels (contact Darren Lodge 4132 6226) – Recommended buffer and double fences

UDIA

Table 9: UDIA stakeholder attendees.

Attendees (29th January)
Nathan Freeman – UDIA nathan@insitesjc.com.au

Table 10: UDIA issues, ideas and solutions.

Issue	Rank	Comments/Common Issues
Common issues	N/A	– Aware of examples where water will be sprayed and complaint of chemical smell – Use of old policy SPP1/92 and a Warwick example policy (provided to team) – Farm house subdivision common issue with being required to provide buffers (regularly try to argue against providing) – In new rest or transition areas provide 100m of clear space or 40m of vegetated buffer – Currently protected by property note but people often don't know it exists when house is purchased – Cost of installing buffer big impact on development (~$30k, particularly if lot is only selling for ~$100k) – Preference for transitional open buffer in place of planned areas that will experience future growth. – Mentioned buffer requirement around non-res uses (solar farm example)
Ideas & Solutions	N/A	– Acknowledged that there are known issues with the buffers, and that people will complain irrespective of whether they are there – Noted link with visual sight of activity and complaints – Needs to be better practice and communication of the issues and impacts where res is adjoining agricultural areas – Preference for a property note over a covenant – Recommended providing an off-shelf buffer design option

Bundaberg Regional Council

Table 11: Bundaberg Regional Council stakeholder attendees.

Attendees (29th January)	
Hugh Byrnes 0428 525 810 Hugh.byrnes@bundaberg.qld.gov.au	Senior Strategic Planner
Bethany Williams-Holthouse	Strategic Planner
Hannes Bezuidenhout	Manager Infrastructure Planning
Geordie Lascelles	Branch Manger Parks, Sport, & Natural Areas
Sarah Watts	Principal Planner
Ross Maguir	Operational Supervisor Parks – Operations & Maintenance
Carla Colasimone	Operational Supervisor Parks – Projects & Planning
Brett Kronk	Coordinator Parks – Planning & Policy
Dennis Eriksen	Technical Officer – Corridor Management

Table 12: Bundaberg Regional Council common issues and complaints.

Issue	Rank	Comments/Common Issues
Common issues	N/A	– Regular complaint that buffers have snakes/pests/leaf litter and fire risk – Where in public land Council are often asked to remove/or residents will remove themselves – New buffers are now mostly delivered in private land – Still a public expectation that Council maintain regardless if public or private – Key issue with applying buffers for the rural lot subdivision – Consistently request 40m buffer (5 each site for access and 30m planted) In some instances will reduce the planting to 20m – Consideration of return to management of buffers by covenant – Possible integrated design outcomes with ecological areas – Comment on non-residential buffers are for landscape/amenity purpose/not ag separation (refer to UDIA flagged issue) – Current Planning Scheme Species list a good guide to consider for use in buffer PSP recommendations – Installation of buffer is not required as part of OPW so needs to be clear on what's required – Family lot subdivision key issue with these matters
Ideas & Solutions	N/A	– Possible approach to require management through: ○ Separation ○ Planting ○ Barrier (fencing) ○ Building attenuation

Appendix 3 – PeritusAg Agricultural Buffer Technical Report

place design group.

Appendix 4 – Place Design Group Landscape Technical Report

place design group.

PeritusAg

Agricultural Buffers Technical Report Bundaberg Regional Council

Date: 23/04/2020

CONTENTS

TABLES

1. OVERVIEW OF PROJECT

1.1 The objective of this project is to produce a Planning Scheme Policy and associated documents to better inform the design and construction of buffers associated with urban encroachment in the Bundaberg Regional Council (BRC) area.

1.2 A critical strategy of the project was targeted stakeholder engagement with the agricultural industry groups, Urban Development Industry of Australia (UDIA) and BRC staff within the council region.

1.3 This technical report only relates to the agriculture industry stakeholder feedback and insights related directly to agricultural production impacts.

1.4 The stakeholder engagement provided the most relevant and up-to-date information around agricultural operations. This was to ensure that the policy meets the required level of farm operational detail to support its implementation.

1.5 This technical report provides a summary of these agriculture industry stakeholder sessions, the key outcomes and findings of these meetings, and the critical farming operational impacts that need to be considered when designing buffer zones between agricultural land and urban developments.

2. BACKGROUND TO AGRICULTURE IN THE REGION

2.1 The BRC area and economy have always been heavily influenced by agriculture.

2.2 The total value of agricultural output for the BRC area is approximately $613 million, which represents approximately 4.5 percent of the total agricultural output of QLD (based on FY15/16 ABS data).

2.3 The breakdown of the value of the major industries as a percentage of the total value of regional output include:

i) Sugarcane: 19%

ii) Vegetables: 39%

iii) Avocados: 11%

iv) Nuts: 11%

v) Citrus: 6%

2.4 From the late 1800s, the region was almost exclusively sugarcane production with tobacco and limited horticulture appearing as more migrants moved into the region in the early-mid 1900s.

2.5 Over the past 40 years, the region has seen significant change in the agricultural landscape, with production increases initially in annual horticulture including, but not limited to:

- Tomatoes
- Melons
- Capsicums
- Potatoes

- Zucchini

2.6 During the past 20 years, the region has experienced significant growth in perennial horticulture crops including, but not limited to:

- Avocados
- Citrus
- Macadamias
- Lychee

2.7 The sugar industry remains a significant user of agricultural land and a strong contributor to local employment and the economy in general. However, changes in agricultural land use have created new challenges, as traditional sugarcane country moved into more intensive horticulture. These changes in land use have, in turn, influenced the off-farm impacts on neighbouring urban developments.

3. TYPES OF PROPERTY DEVELOPMENT AND BUFFER ENVIRONMENTS

3.1 There are currently three main types of urban exposure to agriculture in the BRC area, including:

Farm reconfiguration and rural residential subdivisions

- Larger subdivisions with lots ranging in area between 2000m2 to 4ha (depending on precinct)
- Single subdivision of a Rural-zoned agricultural property. This is most commonly associated with a family member of a farming business subdividing the house, a shed and some land area off from the family farm during succession planning or retirement. The principle issue is this development is typically with the second or third owners of the property and not the original family member.

Urban edge

- Represents the extent of the township/urban settlement area (i.e. Residential zone or Emerging Community zone adjacent to Rural zone) as it interfaces with surrounding rural areas.
- This area will typically have a boundary against farming land that has little prospect of being developed for urban house lots. This results in the ongoing interface between farming operations and their urban neighbours.

Transitional or development fronts

- Represents the land zoned for urban use but which is adjacent to an ongoing agricultural production area. For example, development on land zoned Low Density Residential that is adjacent to an existing farm that is zoned Emerging Community (i.e. possibility for development in the future).
- This area can also consist of a large parcel of land that is zoned for development, but the developer chooses to slowly develop the entire area and continue to farm the remaining land until such time as the property market requires additional dwellings.

4. STAKEHOLDER AND INDUSTRY FEEDBACK

Stakeholder Engagement Process

4.1 The purpose of the stakeholder engagement process was to meet with the key farming groups and obtain the following information:

- Clear description of farming operations for an industry
- Agricultural/farming business view for the potential of off-farm impact on farm operations
- Causes of complaints from current urban neighbours
- Solutions to avoiding or managing complaints

4.2 To capture industry and regional variations, the agricultural stakeholder engagement process was broken down into meetings with three separate industry groups.

4.3 At each meeting, there was a range of stakeholders representing the breadth of the industry. The stakeholder meetings were broken into the following industry groups:

- Childers Canegrowers and Isis Mill
  - Isis Canegrowers CEO
  - Canegrower representatives
  - Isis Mill representatives
- Bundaberg Canegrowers and Bundaberg Sugar
  - Bundaberg Canegrowers CEO
  - Canegrower representatives
  - Bundaberg Sugar representatives
- Bundaberg Fruit and Vegetable Growers (BFVG) (incorporating Isis producers)
  - BFVG Managing Director
  - Vegetable grower representatives
  - Orchard grower representatives

4.4 The documented notes from each meeting were distributed to each group to enable the outcomes to be circulated to a wider audience within each industry/region. This process ensured that the information captured was accurate and more broadly relevant than just to the representatives present during the engagement sessions.

Sugar Industry Potential Off-Farm Impacts

4.5 ***Table 4.1*** summarises the main off-farm impacts to neighbouring non-rural owners that can occur as part of sugarcane production. The impacts are ranked from the largest (1) to the least (6).

Table 4.1: Potential off-farm impacts from sugarcane production

Off-Farm Impact	Impact Ranking
Dust and mud	1
Noise	2
Chemical drift/spray & smell	3
Light	4
Smoke and ash	5
Irrigation overspray	6

4.6 ***Tables 4.2, 4.3, 4.4, 4.5, 4.6 and 4.7*** summarise the specific on-farm activities that can cause the off-farm impacts listed in ***Table 4.1.*** In the following sections we have provided greater detail of each issue identified.

Dust and mud

Table 4.2: Operational activities creating dust and mud

Activities	Timing
Ground preparation	Jan - Dec (main operations Feb - April and July - Sept)
Crop planting (sugarcane)	March - April and Aug - Sept (every 4-5yrs/block location)
Crop planting (rotation crops)	Nov – Jan (every 4-5yrs/block location)
Tillage (in-crop and post-harvest)	Jan - Dec (main operations post planting and post-harvest)
Crop input spreading	Jan - Dec (main operations Feb - March and July - Aug)
Crop harvesting (sugarcane)	June - Dec
Crop harvesting (rotation crops)	March – April
Cane trash baling	June - Dec and post-harvest only

4.7 Dust can be created when any ground engaging operation occurs or machinery movements are necessary, with some tillage operations more significant in the creation of dust compared to others, such as weed spraying.

4.8 Mud can be left on roads when cane hauling equipment leaves a farm and enters a public roadway. This is typically only an issue during the harvesting process.

4.9 Operations such as harvesting only occur once on each block per year so off-farm impact from this operation is only for a short period of time.

4.10 Land preparation and cane planting operations typically occur once every four to five years.

4.11 Other operations tend to not create as much dust as either harvesting or planting but will potentially occur throughout the year, every year.

Noise

Table 4.3: Operational activities creating noise

Activities	Timing
General machinery operation	Jan - Dec
Crop planting	March - April and Aug - Sept (every 4-5yrs/block location)
Crop harvesting	June - Dec
Irrigation pumps	Jan - Dec
Road transport	June - Dec

4.12 All types of machinery used on sugarcane farms create noise where, for most of the year, the operations are typically during daylight hours.

4.13 There are times of the year when operations run 24/7, such as harvesting, road transport or irrigation pumps.

4.14 New neighbours moving into a farming area during a period of the year when there are little farm operations occurring often assume a low noise environment is normal. This initial opinion can result in unrealistic expectations about what to expect living in that environment. Normal equipment noise can also appear more intrusive during times of the year when farms are busy or in peak season when most of the year noise levels are low.

Spray drift and smell

Table 4.4: Operational activities creating chemical spray drift and smell

Activities	Timing
Aerial or ground rig chemical applications	Jan - Dec (main operations Oct - Feb)
Mill mud spreading	June - Dec
Insecticide/fungicide use	Feb - April and July - Sept
Use of treated effluent water for irrigation	Jan - Dec

4.15 All operators of spray equipment are required to have completed a ChemCert course (chemical accreditation training), with all applications requiring documentation for reporting purposes.

4.16 Spray operations should only be completed when the weather conditions (wind, air temperature and humidity) are suitable to maximise efficacy of the product and limit off-farm impacts. Compliance with weather conditions can result in some spray operations occurring outside daylight hours.

4.17 Complaints from spray drift are often linked to the smell of chemical or the visual observation of the activity and not the physical drift of spray droplets. Chemical products can often emit aromatic compounds for 24 to 48 hours after application and although these smells may be unpleasant, they typically are not the active ingredient of the applied chemical.

4.18 Many products used on sugarcane crops create a smell and, although this impact is typically short lived, it can be made worse during periods of showery rainfall, high temperatures and high humidity. Product applications (mill mud, fertiliser or herbicide sprays) are typically only an annual application.

Light

Table 4.5: Operational activities creating light

Activities	Timing
Crop harvesting	June - Dec
Road transport	June - Dec
High clearance sprayers	Jan - Dec (main operations Oct - Feb)
Mill mud spreading	June - Dec

4.19 Most of the farm operations throughout the year are performed during daylight hours.

4.20 Harvesting operations can operate 24/7 during the crushing season, although this only occurs once on each block each year. This results in potential short-term impacts on neighbours from lights.

Smoke and ash

Table 4.6: Operational activities creating smoke and ash

Activities	Timing
Burning standing sugarcane (<7%)	June - Dec
Burning trash post-harvest	June - Dec

4.21 Prior to 30 years ago, 100 percent of all sugarcane was burnt before harvesting. Across the region, the practice of burning cane fields prior to harvest is limited to less than 7 percent as crop management practices and equipment has allowed for most sugarcane fields to be harvested green/un-burnt.

4.22 Cane fires are typically very short and burn very hot, resulting in off-farm impacts being short-lived.

4.23 The practice of burning trash post-harvest is also no longer a common occurrence. However, due to the nature of the fire being very slow and a much cooler burn than a cane fire, it can result in more smoke for a longer period.

4.24 There are very specific reasons why a cane field is burnt including:

- Soil is not suitable for green harvest resulting in crop loss if left unburnt
- Block is being ploughed out and replanted without a fallow period
- The block is being used for an annual horticulture crop where trash residue can impact the following crop's performance

Irrigation overspray

Table 4.7: Operational activities creating irrigation overspray

Activities	Timing
Travelling irrigator	Jan - Dec
Centre pivot end spray	Jan - Dec
Lateral move wind drift	Jan - Dec

4.25 Irrigation water supply is heavily regulated and is a major cost to sugarcane producers, and irrigation has enabled the sugar industry in the BRC area to remain viable.

4.26 As a result of the terrain of the region, overhead irrigation systems are often the most appropriate but can be impacted by wind or changes in wind speed or direction.

4.27 All overhead irrigation systems have a risk of water landing off-site which can be impactful if operating near roads or urban neighbours and especially when weather conditions change suddenly and after the unit has been setup and commenced operation.

Sugar Mills and Infrastructure Potential Impacts

4.28 ***Table 4.8*** summarises the main impacts on neighbouring non-rural owners that can occur as part of the movement of sugarcane from the farm locations to the central sugar mills via train or road transport. The impacts are ranked from the largest (1) to the least (3).

Table 4.8: Potential off-farm impacts from sugar mills and associated infrastructure

Off-Farm Impact	Impact Ranking
Noise	1
Dust	2
Light	3

4.29 ***Tables 4.9, 4.10 and 4.11*** summarise the specific activities that can cause the impacts listed in ***Table 4.8.***

Noise

Table 4.9: Operational activities creating noise

Activities	Timing
Cane trains (engine and bin noise)	June - Dec
Cane trains (sounding horn)	June - Dec
Cane unloading sidings	June - Dec
Road transport	June - Dec
Track repairs	Jan - Dec

4.30 Cane trains operate within the BRC area for both the Isis Mill and Bundaberg Sugar milling districts. The trains pulling rakes of cane bins operate 24/7 during the cane harvesting season. By state law, the loco must sound a horn as it approaches any road intersection regardless of the time of the day.

4.31 As sugar mills operate 24hrs/day, the movement of sugarcane to be crushed also moves 24hrs/day resulting in both road and rail networks creating noise at loading/unloading locations across the region.

4.32 The mills operate a train track repair team that runs five days/week during non-harvest season, but these crews can operate at any hour of the day during harvesting season should repairs or maintenance be required on the rail network.

4.33 Specific development planning legislation currently deals with rail-lines that operate within proximity of urban developments, with specific sound barriers and house design specifications that need to be met to comply with reducing the impact of noise.

Dust

Table 4.10: Operational activities creating dust

Activities	Timing
Cane unloading sidings (train network)	June - Dec
Cane unloading sidings (truck network)	June - Dec
Track repairs	Jan - Dec

4.34 There are strategically placed cane unloading sidings around the sugar growing region to enable the efficient movement of harvested sugarcane from the farms to the rail or road network. The sidings at times can have high traffic movement of large equipment that creates dust.

4.35 During track repairs, dust can be created from vehicles or equipment used by the staff. These operations are usually short in duration unless major rebuilding of a track is taking place.

Light

Table 4.11: Operational activities creating light

Activities	Timing
Cane trains	June - Dec
Cane unloading sidings	June - Dec
Road transport	June - Dec
Track repairs (harvest period)	June - Dec

4.36 During the 24-hour road and rail movement of harvested cane, the operations at night can be very well lit for operational efficiency and safety.

4.37 Cane trains are always required by law to have certain lights operating during low light conditions.

Horticulture Industry Potential Off-Farm Impacts

4.38 ***Table 4.12*** summarises the main off-farm impacts on neighbouring non-rural owners that can occur as part of horticulture production. The impacts are ranked from the largest (1) to the least (6).

Table 4.12: Potential off-farm impacts from sugarcane production

Off-Farm Impact	Impact Ranking
Chemical drift/spray	1
Dust	2
Noise (machinery)	3
Noise (gas guns)	3
Noise (ultrasonic bird scarers)	3
Lights	4
Smell	5
Noise (firearms)	6

4.39 ***Tables 4.13, 4.14, 4.15, 4.16, 4.17, 4.18, 4.19 and 4.20*** summarise the specific on-farm activities that can cause the off-farm impacts listed in ***Table 4.12***.

Spray drift

Table 4.13: Operational activities creating chemical spray drift

Activities	Timing
Spray booms (annual crops)	Jan - Dec
Air blast sprayers (orchards)	Jan - Dec

4.40 All operators of spray equipment are required to have completed a ChemCert course (chemical accreditation training), with all applications requiring documentation for reporting purposes.

4.41 Spray operations should only be completed when the weather conditions (wind, air temperature and humidity) are suitable to maximise efficacy of the product and limit off-farm impacts. This can result in some operations occurring outside daylight hours.

4.42 Farming businesses have managed complaints relating to spray drift in the past and most will take the approach of managing the operation to create the least amount of impact for urban neighbours. Although this approach is not always successful, the industry as a whole is aware of the challenges and actively works towards mitigating the risk of drift and subsequent complaints.

4.43 Controlling insect and disease in a crop is an expensive and time-consuming task which can often have difficult time pressures associated with how often, or by when, an application needs to be completed.

4.44 Annual horticulture crops require regular applications of pesticides to prevent crop loss resulting from insects or disease. The spray is directed at the crop or a specific part of the plant to maximise the efficacy of the operation.

4.45 Orchard sprayers are designed to direct the spray evenly over the entire tree to ensure that there is adequate coverage and pest control from the bottom to the top.

Dust

Table 4.14: Operational activities creating dust

Activities	Timing
Ground preparation	Jan - Dec
Land levelling	Jan - Dec (every 5-10yrs/block location)
Tillage (annual crops)	Jan - Dec
Tillage (orchards)	Once at conversion from sugar or annual cropping land
Harvesting (annual crops)	Jan - Dec
Harvesting (macadamias)	Feb - June

4.46 Dust can be created when any ground engaging operation occurs, or machinery movements are necessary. Tillage operations are more significant in the creation of dust compared to other operations such as weed spraying.

4.47 Land-levelling operations are typical for annual cropping land and for the preparation of blocks for orchards. This process can create significant amounts of dust but is usually only for a short period of time.

4.48 Planting of annual crops typically occurs twice per year in each block with most growers only performing major land preparation and tillage once per year per block, as the second planting typically utilises the pre-formed beds from the first crop.

4.49 Land preparation for orchards will often create dust during the initial stages until the young trees are planted and ground cover is established, after which time dust is often not significant.

4.50 Harvesting annual crops can create dust from the movement of produce in trucks or tractor-drawn trailers and the large movement of people to do the picking.

4.51 Orchards typically do not create dust except for macadamias that are machine harvested. Macadamia blocks are harvested six to eight times each year and dust creation at any one location is typically short.

Noise (machinery and bird/flying fox management)

Table 4.15: Operational activities creating noise (machinery)

Activities	Timing
Irrigation pumps	Jan - Dec
General machinery operations (annual crops)	Jan - Dec
Crop spraying	Jan - Dec (typically at night due to weather conditions)
Orchard sprayers	Jan - Dec
Refrigerated road transport	Jan - Dec (main impact April - Aug and Oct - Jan)
Crop harvesting workers	Jan - Dec
Orchard pruning	Jan - Sept

4.52 All types of machinery used on horticulture farms create noise where, for most of the year, the operations are typically during daylight hours.

4.53 There are times of the year where operations run 24/7, such as ground preparation, road transport or irrigation pumps.

4.54 Farming areas, in general, can be very quiet places to live, however, farming operations inherently use powered equipment that do make noise. In areas where most of the year noise impacts are low, the periods where noise is created can result in complaints from urban neighbours.

4.55 Many operations are conducted at night for operational safety reasons or to suit weather conditions (spraying operations and preparation for the following days harvest), while other operations occur after sunset to enable the required tasks to be completed on-time, due to seasonal workload (packing sheds and the movement of packed fruit/vegetables).

4.56 Irrigation pumps during peak irrigation periods can often operate 24/7 to maintain adequate moisture under the crops to maintain health and yield potential. Irrigation pumps located near bodies of water (dams, channels, creeks or rivers) can result in noise moving much greater distances.

4.57 As farming areas are quieter during the night than urban ones, with less wind, noise can travel further or be more noticeable at night than during daylight hours.

Table 4.16: Operational activities creating noise (gas guns)

Activities	Timing
Bird control (annual crops)	Jan - Dec
Bird control (orchards)	Sept - Jan

4.58 The dispersal of flocks of birds to reduce loss is necessary for many crops that have specific species (lorikeets) that can cause considerable damage.

4.59 The use of bird scarers in horticulture is common and the setup and management of these gas guns is legislated. This includes:

- Location of gas guns
- Timing of blasts
- Scheduling of blasts
- Number of blasts/day
- Hours of operation

Table 4.17: Operational activities creating noise (ultrasonic bird scarer)

Activities	Timing
Bird control	Jan - Dec

4.60 An ultrasonic bird scarer uses a range of frequencies and timing of sound to disturb or scare off birds that may cause crop damage.

4.61 There are typically 1-3 of the set frequencies that can cause some people discomfort and result in complaints, however, these frequencies are often critical to the success of this type of unit.

4.62 The setup and management of these devices is legislated.

Light

Table 4.18: Operational activities creating light

Activities	Timing
Spray applications	Jan - Dec
Flying fox management (lychee)	Oct - Feb
Flower farms and light sensitive crops	Jan - Dec

4.63 Due to weather conditions, many spray operations are conducted at night to ensure the applications are effective and the operator can comply with the regulation for weather conditions. This creates the situation where the risk of spray drift may be reduced but the risk of noise or light impacts and complaints can be increased.

4.64 An effective control method for flying foxes is to shine bright lights across the top of a fruit tree orchard, such as lychees or mangoes.

4.65 Flower farms and industrial cannabis operations manage day-length sensitive plants with lights to avoid the plants coming into flower prematurely.

Smell

Table 4.19: Operational activities creating smell

Activities	Timing
Composting operations	Jan - Dec
Spreading manures/compost	Jan - Dec
Crop waste	Jan - Dec
Chemical applications	Jan - Dec

4.66 Many products used on horticulture operations create a smell and, although this impact is typically short lived, it can be made worse during periods of showery rainfall, high temperatures and high humidity.

4.67 Product applications that can create smell (mill mud, composts, manures and broadcast fertilisers) are typically only an annual application.

4.68 Growers are usually selective as to where they dump waste produce as there is a risk of disease or insects spreading to crops from the waste product. For this reason, waste produce is either fed to livestock or dumped in a remote location.

Noise (firearms)

Table 4.20: Operational activities creating noise (firearms)

Activities	Timing
Bird control	Jan - Dec
Flying fox control	Nov - Feb

4.69 Permits for the use of firearms to control birds and flying foxes is legislated.

4.70 The use of firearms is typically limited to times of the year when fruit is hanging on trees and although the use of firearms may occur daily, it is for a short period of time. For this reason, the noise impacts of firearms are not considered a significant complaint issue.

5. KEY REGIONAL INDUSTRY IMPACTS

5.1 ***Table 5.1*** summarises the identified off-farm impacts that occur across the three stakeholder groups. The impacts are ranked from the largest (1) to the least (6).

Table 5.1: Summary for off-farm impacts of farm operations by stakeholder and impact ranking

Off-Farm Impact	Sugar Industry Impact Ranking	Sugar Mill Impact Ranking	Horticulture Industry Impact Ranking
Dust	1	2	2
Noise	2	1	3
Chemical spray drift	3		1
Smell	3		5
Light	4	3	4
Smoke and ash	5		
Irrigation overspray	6		

5.2 When comparing the three stakeholder groups, the top three impacts ranked highest were:

- Dust
- Noise
- Chemical spray drift

5.3 There is also an important consideration that over time, the expectation is that the region will continue to move more towards higher value crop production, including more perennial crops such as avocados and macadamias.

5.4 This change in land-use is likely to come at the expense of sugarcane production and, to a lesser extent, annual horticulture cropping. This has been the regional trend for the past 40 to 50 years.

5.5 When considering long-term crop production trends and off-farm impacts, the potential issues raised by the horticulture industry (perennial crops) are likely to become more relevant as a result of ongoing conversion of land from sugar or lower value crops.

5.6 For this reason, any considerations of buffer zone design should focus on horticulture cropping more than sugarcane production.

5.7 During the stakeholder sessions, the following practical realities were raised by the participants:

i) Noise complaints were difficult to manage as they mostly related to irrigation pumps that needed to remain operational.

ii) Where urban neighbours had a clear line of sight to a farming operation, the complaints were more common than when there was a visual screen or vegetation buffer blocking the view.

iii) Good communication with urban neighbours helped limit the number of complaints, with the main source coming from serial complainers who were new to the area.

iv) Urban neighbours who grew up in the region or were the first or second owners of the property were less likely to complain.

v) The second or third owners of the property who had recently moved to the region were more likely to be the source of complaints.

6. AG BUFFER OPTIONS FOR EACH DEVELOPMENT ENVIRONMENT

Farm reconfiguration and rural residential subdivisions

6.1 The first or second owner of these properties will typically have a direct connection with the neighbouring farming business with no desire for any type of buffer between their dwelling and the surrounding farming operation.

6.2 The land allowance and buffer design need to suit the second or third owner who may have little or no connection to the farming business and see off-farm impacts as an imposition to their quality of living.

6.3 If the first owner of the subdivided block does not wish to have a living buffer, then land allowance and a covenant over the buffer zone should be implemented to ensure this area is designated as a living buffer for future property owners.

Urban Edge

6.4 As this situation is likely to remain an interface between urban dwellings and farming operations, the buffer area needs to provide:

- A visual screen from farming neighbours
- Mitigation of dust and spray drift movement

6.5 Utilising a remnant living nature strip to provide the buffer is preferable as this is likely to be wider than a planned buffer zone and, as a result, provide additional suppression of noise impacts as well as dust and spray drift.

6.6 The second option would be a well-designed living buffer with the following characteristics:

i) Mix of tall and medium height species

ii) Maximum height of 10m

iii) Evergreen plant species

iv) Drought tolerant

v) Able to be mechanically pruned

vi) Leaf cover from the ground to the top of the plants

Transitional or development fronts

6.7 This interface environment being temporary should provide the following:

i) Fast-growing dense screen

ii) A visual screen from neighbouring farming operations

iii) Ability to limit dust or spray drift preferable but not essential

6.8 This buffer design does not need to be as wide or as complex as a permanent buffer as the primary value is to provide a visual screen as its primary function.

7. CONCLUSION

7.1 Where a planning scheme allows for the mixing of urban developments or any type of farming operations, there will always be the risk of off-farm impacts resulting from normal farming operations and complaints from urban neighbours.

7.2 The feedback from stakeholder sessions clearly highlights that most ongoing complaints came from:

i) Specific individuals or dwellings

ii) Neighbours unfamiliar with farming businesses

iii) People new to the region

iv) Urban neighbours who could "see" an operation taking place

7.3 In most complaint cases raised from the stakeholder sessions, the ability of the urban neighbour to see the farming operation was the primary driver of the complaint.

7.4 The issue of noise complaints is more complex to manage, as in certain situations, noise can carry long distances and be unavoidable (e.g. Irrigation motors running 24/7 or crop spraying at night) as timely crop management is critical to farming business success.

7.5 Farming businesses on the whole strive to avoid off-farm impacts of their operational activities as they do not want the complaints nor the movement of pesticides (spray drift), irrigation water or soil (dust) from their cropped land as these have a direct cost to their business.

7.6 Well-designed and strategically placed buffer zones between urban developments and farming operations are a critical step to avoid complaints. More effort needs to be placed on communication to homeowners bordering farming operations and the likely impacts they may need to accept when purchasing property. All stakeholders (sugar industry, horticulture industry, sugar mills, BRC and UDIA) should collectively create a long-term communication strategy that:

i) Informs the community of what to expect living in the region

ii) Brings the community together to embrace its farming history and future, and the prosperity it brings to the region

Yours sincerely,

PeritusAg Pty Ltd

PeritusAg

Email: admin@peritusag.com.au
Office: 07 3493 5993

PeritusAg Pty Ltd
PO Box 1032, Kenmore Qld 4069, Australia
ABN: 50 633 579 209

Trusted agribusiness advisors who deliver the clarity our clients need to make intelligent investment and development decisions.

place design group.

Bundaberg Agricultural Buffers

Landscape Technical Input

Issue C

Project reference number: 1119105

05 June 2020

place
design
group.

Australia
China
South East Asia

Follow us on

placedesigngroup.com

Report title	Bundaberg Agricultural Buffers - Landscape Technical Input
Document number	1119105
Prepared for	Bundaberg Regional Council
Author	Cathy Dibden
Revision number	C
Revision issue date	5 June 2020
Approved	Amanda Taylor
Reason for revision	Response to further discussion & Council feedback

Contents

why buffers?

Introduction

In agricultural areas, many activities create undesirable effects, that can move along ground surfaces in overland flows as well as those that are airborne moving through air currents. When the neighbouring property is a different use that is sensitive to these effects, like a residential development, mitigation is required.

Buffers to agricultural areas are generally a vegetated area set aside from the main cropping regime to benefit native biota, water and air quality, socio-economics and yield (Hadaway et al, 2018). Buffers to differing land uses are employed to promote separation between one use and another. Where adjoining land uses differ from one another, separation may be required to mitigate an effect of one land use on the adjoining use.

Effects requiring mitigation

Buffers to agricultural land have been used primarily to assist in the management the external effects of agricultural production. These include water and nutrient loss (Hadaway, et al, 2018 & Stutter, et al 2012) as well as light emissions, dust, chemical and irrigation overspray, light, smoke and ash, noise and odour. By intercepting the flow path of the particular effect with a buffer, these effects can be mitigated. Buffers can take the form of vegetated areas as well as changes to landform.

Landform manipulation is used to manage overland flow to mitigate effects along the ground plane, preventing nutrient and sediment rich runoff from entering the storm water system. Mitigation of airborne agricultural effects requires the interruption of air flow from the production area to adjoining land uses. This is most practically achieved through the use of wind breaks.

In order to be effective, the buffer must be located between the source of potential impacts and the area to be mitigated. So perpendicular to the direction of overland flow and the prevailing breeze that will distribute these impacts. There are a number of characteristics of buffers that are key to their effectiveness. These include, their proximity to the site of mitigation, height, width, density and length.

Regular maintenance of these buffer areas is important to prevent the build-up of weed species, silt and vegetative material that may negatively impact both adjacent uses over time. Maintenance is also required to ensure that the quality of the buffer is maintained so that it continues to be effective in the mitigation of these effects.

place design group.
Place Design Group Pty Ltd
131 Robertson Street
Fortitude Valley, Brisbane, QLD
4006 Australia
T + 61 7 3852 3922
F + 61 7 3852 4766

Bundaberg Agricultural Buffers
Landscape Technical Information

DATE	PROJECT NO.	REVISION	DWG NO.
05/06/2020	1119105	C	SK01

buffer characteristics

Buffer height

The height of a buffer determines the level of protection given to the sensitive land use side of the buffer. The height of the buffer, will offer protection downwind for approximately ten times their height (Dept. Agriculture WA,). So a buffer height of 10 metres will offer protection of up to 100m on the leeward side of the buffer.

The height of the buffer can also affect the vigour of the adjacent growing area. The height of the buffer will determine the distance it should be located away from the adjacent activity. The buffer will produce an amount of shade over the adjacent activity and can also draw water and nutrients from it.

A planted buffer intended to reach a height of 10m should be planted minimum of 10 metres from the adjacent activity area to reduce the likelihood of competition between the two growing areas. A distance greater than ten metres between a buffer and the adjacent activity should be allowed if the buffer intended to be taller than 10m, it is possible that the buffer could grow taller that the recommended 10 metres. A height of ten metres has been nominated to minimise any shading to the adjoining adjacent activity area.

Buffer Width

The width of a buffer is the distance of planting and maintenance area between the adjacent activity and the sensitive land use. This width must be enough to facilitate the planting of enough vegetation to mitigate the impacts that will potentially affect the sensitive land use, Many species suitable for buffer planting will take a reasonable amount of time to establish so provision needs to be made for the establishment of a fast growing screen in the initial phase of buffer establishment to provide immediate relief. In this way the buffer is made up of two components: the initial quickly to establish screen; and the more long term component of multilayered trees and shrubs to give a thicker and more effective buffer to the land use.

The initial screen can be established quickly using species of bamboo suited to the local area (Refer to Appendix 1). These clumping bamboos generally require two metres of space per clump. If they are planted in two staggered rows, they will quickly establish to form a ten to twelve metre high visual screen. As bamboo has foliage for the full height of the plant, this screen is an effective means of capturing windborne particulate matter from the adjacent activity.

The slower growing component of the buffer, the native planting area, is then planted adjacent to the bamboo screen. The density of this being related to the type of adjacent acitivity. The width of this area has been fixed to ensure that the optimum density of planting can be achieved.

Buffer Density

The buffer should allow air flows to pass through so that they are decreased in intensity. By doing this, particulate matter within the air is captured by the foliage of the buffer. This buffer permeability also reduces turbulence on the lee side of the buffer. Permeability of around 50% has been found in a number of studies to provide adequate protection of the downwind areas.

Buffers should be multilayered to decrease the likelihood of large gaps between vegetation allowing wind tunnels to occur and therefore, wind borne particulate matter, to pass through. To be effective, a windbreak/buffer should have at least 2 or 3 rows of plants of variety of heights and shapes. Staggering the rows also helps to prevent gaps in the buffer but allows some permeability.

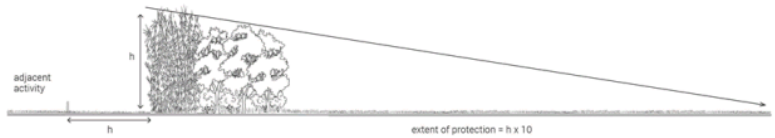
The density of the planting within the fixed buffer widths, will influence the eventual growth height of the vegetation. Vegetation that is planted closer together, more dense planting, will compete against each other for access to light and nutrients and therefore grow taller. Less dense planting, that planting that is planted with more space won't tend to grow as tall and will tend to spread out to its fullest extent prior to growing taller.

If a buffer is planted with a lower density, and the adjacent land use changes, the buffer density can be increased to provide more protection to the areas down wind from the use. In this way, it is possible to amend the characteristics of buffer types if required after their establishment.

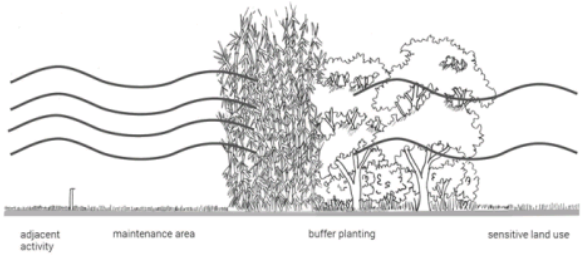
Buffer Length

Longer windbreaks/buffers are more effective than shorter ones. The optimal length of a windbreak/buffer is ten times its height. There is an increased level of turbulence around the ends of a windbreak/buffer so it is important that the buffer extends past any areas requiring protection. While this may not be possible or practical due to property boundaries and land tenure, where it is possible it should be undertaken to afford the best protection of the down-wind areas.

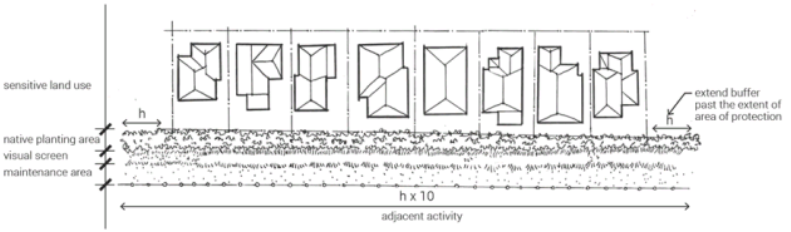
The length of the protection buffer combined with the height determines the overall extent of the protection area. To get the maximum benefit of the buffer structure, it should be at least ten times longer than it's height.



buffer height effect



buffer density effect



buffer length effect

place design group.
Place Design Group Pty Ltd
131 Robertson Street
Fortitude Valley, Brisbane, QLD
4006 Australia
T + 61 7 3852 3922
F + 61 7 3852 4766

Bundaberg Agricultural Buffers
Landscape Technical Information

DATE	PROJECT NO.	REVISION	DWG NO.
05/06/2020	1119105	C	**SK02**

buffer types, aesthetics & maintenance

Buffer type is dependant upon the type of production the sensitive land use is adjacent to and stage of the development that is occurring. Essentially, there are two classifications of buffer, a transitional buffer and a static buffer.

Transitional Buffer

A transitional buffer is one that is located on a moving development front, that is, future stages of a proposed development type will eventually extend beyond the buffer into the present agricultural production area. Anecdotally, these buffers are generally only in place for a few years between the various stages of a development. For this reason, a fast growing temporary buffer is required to provide initial protection to the development from the adjacent use.

The transitional buffer then, uses a fast growing screen of clumping bamboo. Two rows of clumping bamboo, planted in staggered rows at two metre centres will quickly grow to form a vegetative screen, providing visual relief and protection from airborne particulates from the adjacent production area. Three staggered rows of clumping bamboo will easily fit into a five metre width, alongside a ten metre grassed area to allow for ongoing maintenance to the buffer from the production side. An additional ten metre 'no build' area is located to the sensitive land use side of the bamboo planting to allow for maintenance of the buffer from the sensitive land use side.

This type of buffer will provide initial protection from the effects of all agricultural production types in the region. As it is fairly rapidly established, it is a realistic expectation on a developer to undertake the installation of this buffer type as the protection benefits are achievable in a relatively short period of time for a reasonable cost. When further stages of the development are approved, then a new transitional buffer will be required to be established between the new development edge and the receding production area.

Static buffers

A static buffer is one that is located along a permanent edge of development, that is, there is no future development proposed within the adjacent activity area. Where the adjacent activity area is a cropping production area, these types of buffers have the components of the transitional buffer with the addition of a multilayered area of shrubs and trees to provide both additional protection from the production area and a more favourable aesthetic to the buffer. Where the static buffer is located adjacent to a tram line, there is no requirement for the additional planting area as this will provide little mitigation from the effects of the tram line effects - buffer type c.

The tree and shrub planting that provide additional protection to adjacent development areas are installed at a density relative to the type of agricultural production adjacent to the buffer. A planted width of ten metres has been determined for this portion of the buffer to provide additional screening to complement the visual bamboo screen.

The density of planting within the shrub and tree planting zone will influences the ultimate height of the planting. Taller horticultural crops like orchards adjacent to development areas are planted at a higher density with three staggered rows of mixed trees and shrubs to achieve a height of ten to twelve metres - static buffer type b.

Other horticultural crops including sugar cane and horticultural crops require a tree and shrub layer of a lower density designed to achieve a minimum height of 8 to 10 metres. As these types of production have different ongoing maintenance and production activities, this lesser height for the shrub and tree planting alongside the bamboo, mitigation should be achieved. The same ten metre width of planting having two staggered rows of trees and shrubs has less competition between planting resulting in a lower overall height - buffer type a.

Buffer Aesthetics

The visual appearance of buffers can be enhanced by increasing the level of detail and interest within them. The initial rapid screening buffer component of clumping bamboo presents a relatively flat visual aesthetic, however the more layered buffer planting used alongside this in static buffer types a and b present an elevation with more variety and texture.

The variety of vegetation species and textures nominated in the tree and shrub planting components for static buffers a and b achieve variety in colour, texture and form within the buffer planting (refer to appendix a). To achieve a greater aesthetic outcome for buffers in higher zones of visibility, that is where buffers are to be located along road frontages for instance, the layered shrub and tree planting should be facing the road. Where a buffer is along a property boundary and there is no boundary road, it is entirely appropriate to have the bamboo portion and maintenance area facing the adjacent activity area, and the layered vegetation facing the sensitive land use.

Buffer Establishment

As previously discussed the transitional buffers and those adjacent to tram lines consist of the clumping bamboo layer, established as two staggered rows. Each clump will fill a two to three metre diameter space so should be spaced in this way to achieve a uniform screen.

The layered shrub and tree planting is planted according to the density for the adjoining land use, being two staggered rows of trees with shrub and groundcover planting for the lower density treatment. The higher density treatment required three rows of staggered tree planting. Both categories of layered shrub and tree planting are to be inter-planted with shrubs. These planted areas should also have a row of groundcovers planting to their outer edge to assist in the containment of weeds and other contaminants that may encroach into the planted buffer area. Planting lists are located in appendix a.

Pioneer tree species should be used in conjunction with the tree planting to help achieve plant densities more quickly. Over time, planting of additional trees and shrubs may be required to replace these pioneer species.

Buffer Maintenance

The establishment of buffer planting, like any other cover crop, requires watering, fertilising and weeding. Following establishment, maintenance is required to all buffer types for them to remain effective.

Buffer attributes described earlier must be maintained, as height, width, length and density all contribute as previously explained to the effectiveness of a buffer. To this end buffers need to be pruned and possibly thinned on an annual basis to maintain a 50% density so that their effectiveness is maximised.

Watering of a buffer is required during dry periods to maintain good buffer growth. Fertilising prior to the growing season will assist in maintaining the health and vigour of the buffer. Buffers also need to be maintained weed free to prevent the buildup of weed species that can cause infestation of agricultural production areas as well as other neighbouring land uses.

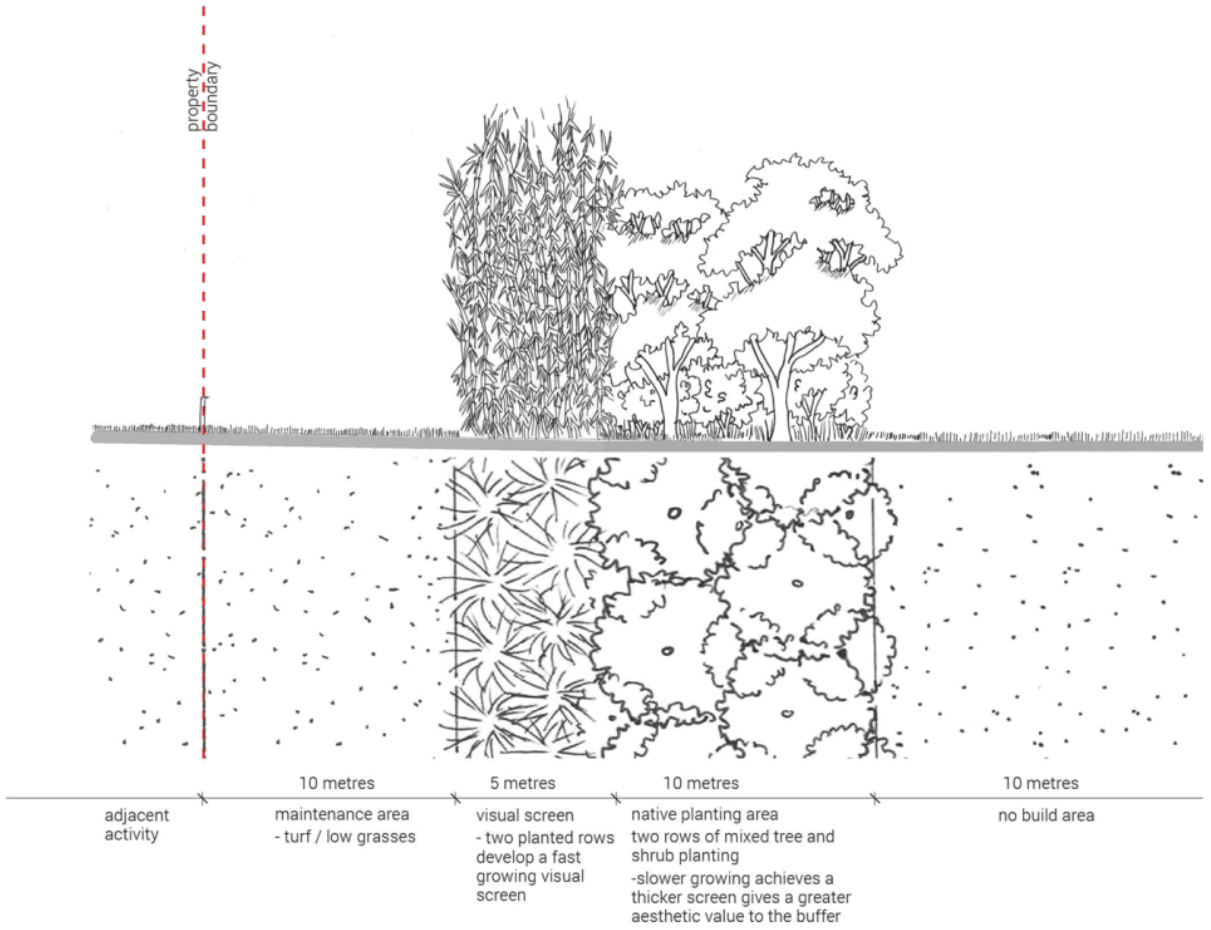
By having the ten metre 'no build' area on the development side of the buffer and a 10 metre grassed maintenance area on the adjacent activity side of the planting buffer, access is maintained for the required maintenance activities to be carried out by the landowner.

place design group.
Place Design Group Pty Ltd
131 Robertson Street
Fortitude Valley, Brisbane, QLD
4006 Australia
T + 61 7 3852 3922
F + 61 7 3852 4766

Bundaberg Agricultural Buffers
Landscape Technical Information

DATE	PROJECT NO.	REVISION	DWG NO.
05/06/2020	1119105	C	SK03

static buffer type a

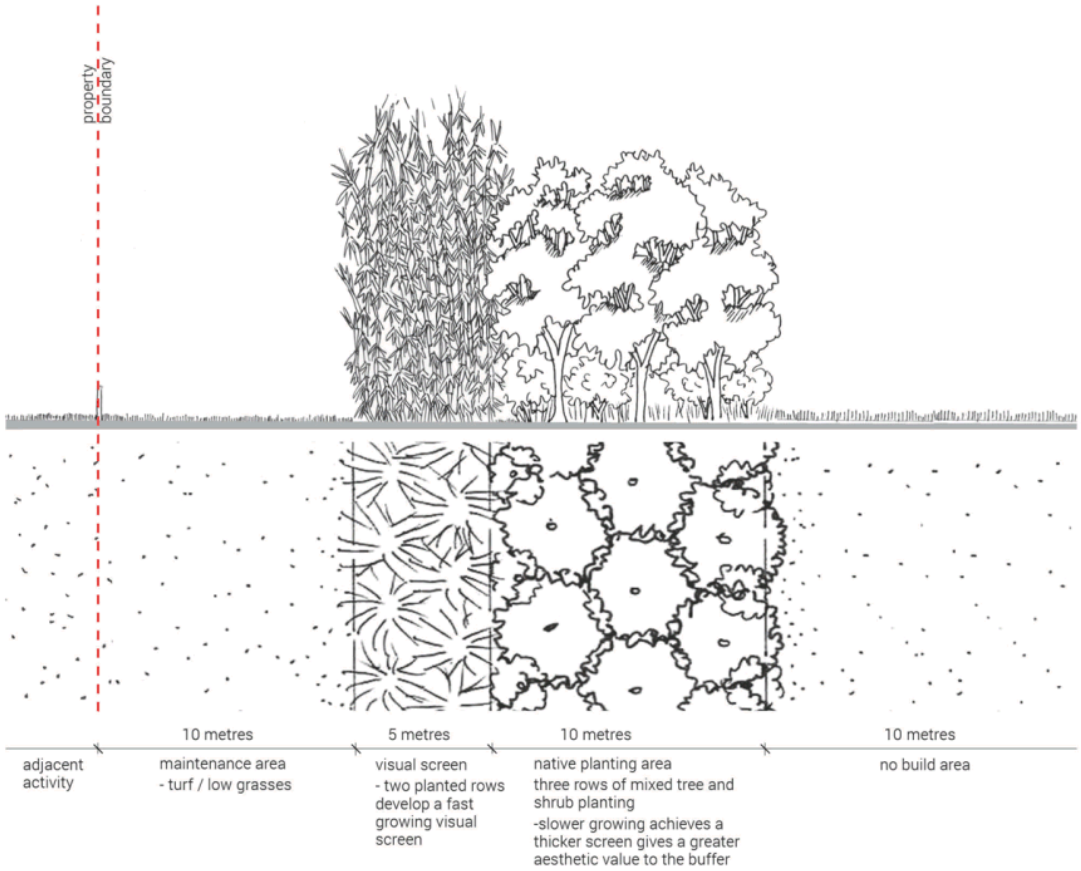


place design group.
Place Design Group Pty Ltd
131 Robertson Street
Fortitude Valley, Brisbane, QLD
4006 Australia
T + 61 7 3852 3922
F + 61 7 3852 4766

Bundaberg Agricultural Buffers
Landscape Technical Information

DATE	PROJECT NO.	REVISION	DWG NO.
05/06/2020	1119105	C	SK04

static buffer type b

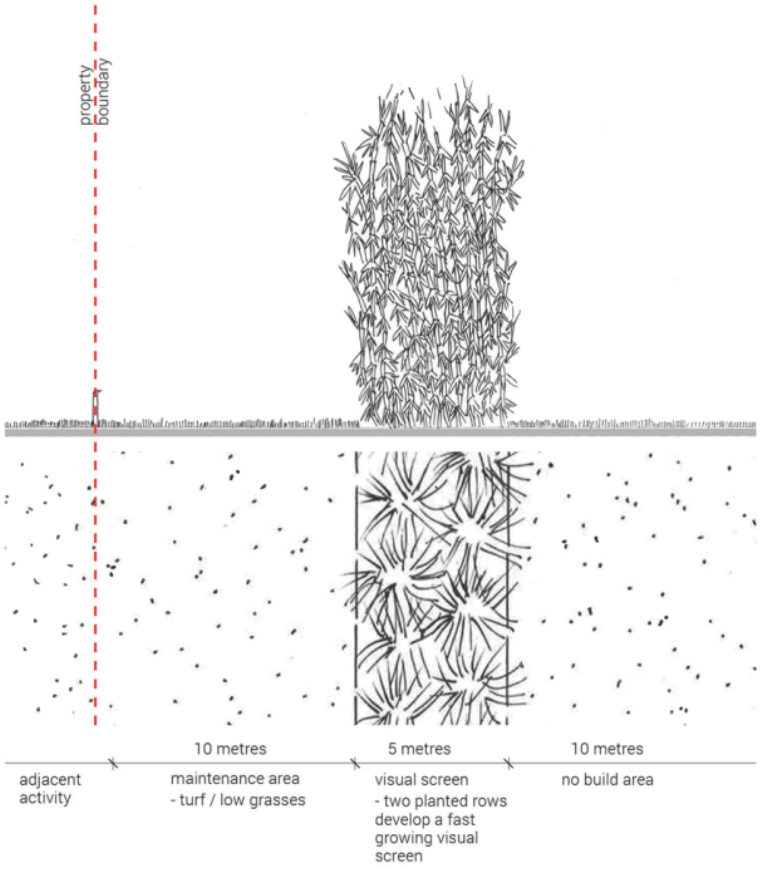


place design group.
Place Design Group Pty Ltd
131 Robertson Street
Fortitude Valley, Brisbane, QLD
4006 Australia
T + 61 7 3852 3922
F + 61 7 3852 4766

Bundaberg Agricultural Buffers
Landscape Technical Information

DATE	PROJECT NO.	REVISION	DWG NO.
05/06/2020	1119105	C	SK05

buffer type c



place design group.
Place Design Group Pty Ltd
131 Robertson Street
Fortitude Valley, Brisbane, QLD
4006 Australia
T + 61 7 3852 3922
F + 61 7 3852 4766

Bundaberg Agricultural Buffers
Landscape Technical Information

DATE	PROJECT NO.	REVISION	DWG NO.
05/06/2020	1119105	C	**SK06**

appendix a - buffer planting

bamboo species 1per 2.5m

Bambusa oldhamii - Sweet Shoot Bamboo

Bambusa textilis gracilis
- Slender Weaver's Bamboo

Bambusa malingensis - Sea Breeze Bamboo

tree planting - pioneer species 1per 3m

Acacia disparrima - Hickory Wattle

Acacia maidenii - Maiden's Wattle

Macaranga tanarius - Macaranga

place design group.

Place Design Group Pty Ltd
131 Robertson Street
Fortitude Valley, Brisbane, QLD
4006 Australia
T + 61 7 3852 3922
F + 61 7 3852 4766

Bundaberg Agricultural Buffers
Landscape Technical Information

DATE	PROJECT NO.	REVISION	DWG NO.
05/06/2020	1119105	C	**SK07**

appendix a - buffer planting

groundcover planting - 1 plant per metre along buffer edges


Lomandra longifolia


Lomandra hystrix


Dianella caerullea

shrub species 1per 5m to infill gaps between tree planting


Callistemon pallidus - Lemon Bottlebrush


Buckinghamia celcissima


Callistemon viminalis


Callistemon pollandi


Corymbia ptychocarpa


Leptospermum polygalifolium

place design group.
Place Design Group Pty Ltd
131 Robertson Street
Fortitude Valley, Brisbane, QLD
4006 Australia
T + 61 7 3852 3922
F + 61 7 3852 4766

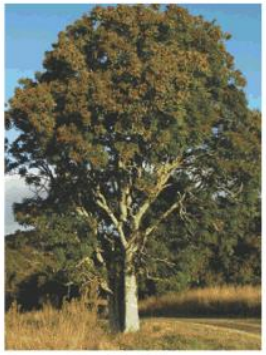
Bundaberg Agricultural Buffers
Landscape Technical Information

DATE	PROJECT NO.	REVISION	DWG NO.
05/06/2020	1119105	C	**SK08**

appendix a - buffer planting

low density buffer tree planting


Glochidion ferdinandi - Cheese Tree


Jagera pseudorhus - Foam Bark


Callistemon viminalis - Weeping bottlebrush

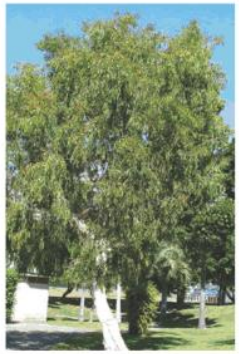
note: high density planting species can also be used in the low density planting area

high density buffer tree planting


Casuarina equisetifolia Coastal She-Oak


Casuarina glauca - Swamp She-Oak


Melaleuca dealbata - Blue Paperbark


Melaleuca leucodendra - Weeping Paperbark


Melaleuca viridifolia - Broad-leafed Paperbark


Syzygium leumannii - Riberry

place design group.
Place Design Group Pty Ltd
131 Robertson Street
Fortitude Valley, Brisbane, QLD
4006 Australia
T + 61 7 3852 3922
F + 61 7 3852 4766

Bundaberg Agricultural Buffers
Landscape Technical Information

DATE	PROJECT NO.	REVISION	DWG NO.
05/06/2020	1119105	C	SK09

appendix b - supporting information

place design group.
Place Design Group Pty Ltd
131 Robertson Street
Fortitude Valley, Brisbane, QLD
4006 Australia
T + 61 7 3852 3922
F + 61 7 3852 4766

Bundaberg Agricultural Buffers
Landscape Technical Information

DATE	PROJECT NO.	REVISION	DWG NO.
05/06/2020	1119105	C	**SK10**

Citrus Fact Sheet

CITTgroups AUSTRALIA

Windbreaks for Citrus

Citrus trees require a protected environment in order to produce high yields of top quality fruit. Wind protection may be provided in various ways – a row or rows of trees around the planting, single rows within the orchard, plantings of tall grasses between rows of newly planted trees, or construction of an artificial windbreak.

Types of Damage

The following are examples of the damage caused by wind:

- markedly reduced growth rates
- reduced yields
- root damage in young trees
- bark damage at ground level
- bent or fallen trees
- few or no fruit on the windward side
- lesions on the leaves and stems and fruit scarring
- limb breakage
- fallen fruit.

Some of these losses are readily measurable, while others do not become apparent until harvest. There are other invisible effects from wind, including increased evaporation and transpiration resulting from reduced relative humidity and temperatures, from excessive wind movement over the trees. The many surveys and quality control reports that have been produced over the years from packing sheds indicate that rind blemish accounts for most downgrading. Results from a case study following this report indicate that 75% of major blemishes and 87% of minor blemishes of navel oranges in Waikerie, South Australia in 2005 were due to wind damage.

The geographical location of the citrus planting will partly determine the type of windbreak required. Each citrus growing area and each planting will have specific windbreak requirements. For example, a planting close to the coast with constant multidirectional winds may require a substantial windbreak around and throughout the planting. However in drier

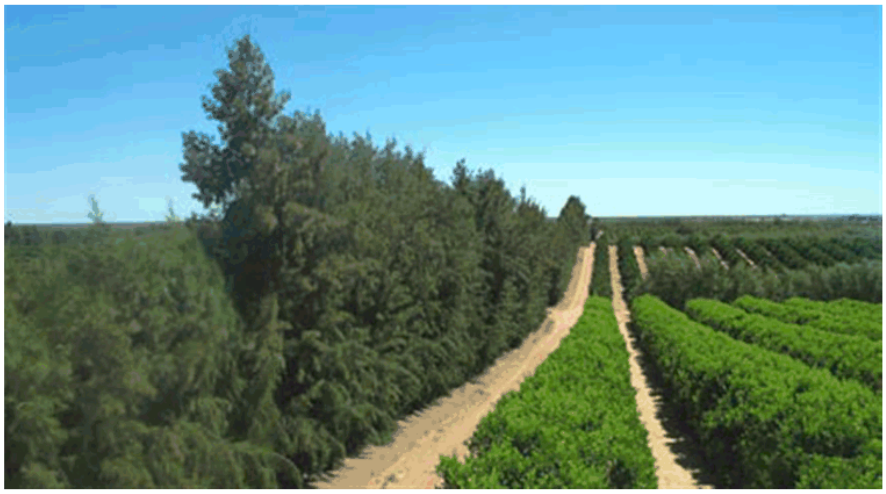


Photo 1:Windbreaks provide protection for trees and fruit resulting in reduced rind blemish.

inland areas windbreaks may only be required against the prevailing wind. Hot dry summer winds will measurably reduce the growth rate of young trees and tall grass windbreaks between each or every second row would benefit newly planted trees. Some varieties may also be adversely affected by living windbreaks. For example, in some subtropical areas it may be necessary to consider using artificial windbreaks because tall living windbreaks can cause shading and keep citrus foliage wet for too long. This applies when growing varieties that are susceptible to *Alternaria alternata* or Brown Spot. Mandarin varieties such as Murcott and Nova require good air movement for rapid drying (skirting, good air drainage, and no shade). In this instance if rind blemish is to be reduced then artificial white windbreak material should be considered.

Losses to blemish

Each year wind blemish causes a large percentage of otherwise perfect fruit to be downgraded to either second grade or rejected. In many years the large volume of seconds allows the price received for first grade fruit to be discounted.

The percentage of crops downgraded throughout Australia's citrus growing areas ranges from as low as 10% up to a massive 50% in some years (see case study). The real positive outcomes which can result from established windbreaks are fewer grade 2 fruit with a corresponding increase in Grade 1 and therefore increased returns. The less volume of Grade 2 on the market, the less likelihood there is of discounting Grade 1 prices.

When does wind blemish occur?

A high percentage of rind blemish on fruit is directly attributed to adverse wind events in the first six weeks after petal fall. However significant damage (95%) occurs within 12 weeks of petal fall. (Freeman, 1973). As soon as the petals fall and the small immature fruit is exposed, wind blemish to the rind can occur with any movement of leaves, branches, twigs, dead wood, thorns and even other fruit.

Leaf margins, particularly from hard old leaves are the main cause of this blemish. (Freeman, 1973). The surface of young fruitlets have irregularly raised ridges and bumps on which adjacent leaves tend to rub. The abrasion results in damage to the fruit skin, followed by the release of small quanties of oil on the fruit surface and then the production of repair tissue which becomes corky. Initially this corky material is raised and coarse in texture but eventually wears down to a finer texture usually creamy yellow in appearance. With fruit colour development the scar becomes buff coloured, but the final colour varies depending on the spray program used particularly the amount of copper used.

Other factors

While wind is responsible for the initial fruit blemish, two other factors can aggravate the

Photos 2 and 3: Wind scarring on fruit is a major cause of fruit downgrading.

problem. Poor pruning methods can increase blemish and copper sprays can darken blemish.

Dead wood and long spindly fruit bearing wood resulting from poor pruning practices will increase the amount of blemish. Regular pruning is necessary to remove dead wood, reduce the length of bearing wood and let light into the tree to make inside buds fruitful. The removal of a central limb often achieves this purpose. Fruit protected inside the canopy usually has less wind blemish. In some areas the essential copper sprays used to control disease can darken the appearance of any blemish.

Benefits of windbreaks

From the published literature some of the quantifiable benefits of wind protection have included:

- Improved Grade 1 packouts. Grade 1 fruit was 67% in protected blocks with 40% in unprotected blocks (Revelant, 1987) and 53% in protected blocks with only 30% in unprotected blocks (Freeman, 1976).
- Improved yields due to increased fruit set and size. Yield increases of between 13% and 16% (Freeman, 1976).
- Increased tree canopy growth of between 8% and 12% (Freeman, 1976).

Some additional advantages of well designed windbreaks include:

- Reduced wind speed
- Reduced spray drift and improved spray coverage
- Reduced wind scarring of fruit
- Increased and earlier yields
- Reduced water loss from evaporation by up to 30%
- Reduced soil erosion
- Slightly higher temperatures in winter
- Reduced dust on plants, thereby increasing photosynthesis and reducing the damage caused by scale insects and mites
- Provides a habitat for insects and pollinators
- Provides protection from sun for harvested bins of fruit and for workers

Some disadvantages of living windbreaks include:

- Competition for moisture and nutrients if not managed properly
- Shading
- Material and labour costs
- Occupies valuable land
- Competes with crops for light
- Increased humidity which can slow drying times of foliage and fruit and may favour some fungal pathogens
- Requires valuable water
- Interferes with the movement of machinery
- Not able to be moved
- May act as a heat trap in summer
- In frost prone areas may dam cold or frosty air if not designed properly
- Trees blown over may cause damage
- Possible pest and disease buildup in a crop due to microclimate changes
- Tree seeds/flowers may attract unwanted bird species
- Trees may harbour pests
- Take five to 10 years to be fully effective.

When are windbreaks necessary?

Where wind blemish is responsible for more than 10% of fruit downgrading, and prevailing winds during the first 12 weeks after petal fall exceed 15 kilometres per hour, then serious thought should be given to providing wind protection. Winds stronger than 24kph will cause wind scarring. The minimum threshold for damage is 24kph for one hour (Andy Krajweski).

Whilst there are many good examples both in Australia and overseas of how windbreaks have markedly reduced rind blemish, the decision to install windbreaks needs to be practicable and economic. An analysis of the possible benefits

and full cost of the required windbreak protection is recommended. You need to determine the amount of wind blemish that is acceptable in your operation in order to determine the need for primary and secondary windbreaks.

The loss of productive land and projected yield that is forgone for windbreaks should be added to the establishment and annual maintenance costs and equally the increased yield of better quality fruit attributable to the windbreak also needs to be included.

If windbreaks are required then the design, direction, length, depth, permeability, height and type of material (living or synthetic) needs to be thoroughly investigated. A deficiency in any of these areas would cause the structure to fail because the protection provided would be ineffective.

There is no 'one solution fits all' since all orchards are different. However there are some basic rules to follow, which may be varied to suit the particular orchard location and the type of wind events most likely to cause blemish.

Windbreaks, where possible should be designed into any new planting. Windbreaks must be fully costed to include deep ripping, weed control, irrigation, nutrition, canopy management or pruning and the area of productive land lost. Fencing to exclude stock also may be necessary. Failure to undertake these things will result in slow growth, and subsequent 'robbing' of the nutrition and water applied to adjacent rows of citrus trees.

Windbreak Design

Design the position of your windbreaks on paper first. Correcting mistakes on paper is much easier than waiting until after planting is complete. For a windbreak to be effective the following factors need to be addressed:

- Orientation
- Height
- Permeability
- Secondary breaks
- Length
- Traffic/access points
- Shape and width
- Suitable species
- Maintenance.

Orientation

In areas where the damaging wind direction is predictable during the critical 12 week period after petal fall, then the windbreak should be placed at right angles (perpendicular) to that direction. Placed in this position, protection is provided even when the wind shifts up to 30° from the perpendicular. The more the angle exceeds 30°, the less protection provided downwind of the 'break'. Length of the windbreak past the last tree is also a factor.

Where it is possible and practicable, main breaks should be north-south in direction to minimize shading. Property boundaries, topographical features and existing plantings will often prevent the ideal layout.

For those growing areas where there is a lot of variability in damaging winds, windbreaks need to be established along lines which provide the most protection. In countries such as New Zealand and South Africa, where there must be a packout of at least 70% export quality fruit, many growing areas require protection around the whole orchard, with additional internal windbreaks. Indeed, in windier areas, windbreak protected citrus blocks do not exceed two hectares. In South America internal windbreaks divide production units into 3-4 hectare blocks.

Height

The higher the windbreak, the greater the area protected. However **the effective height** of the windbreak is only the **height above the citrus trees**. For example, if citrus trees are 4.5 metres high and the windbreak is 16m high the effective height is 11.5m. Figure 1, *(not to scale)* gives a basic idea of distance and amount of protection from the break.

Most literature seems to indicate that the greatest wind speed reduction is in the 'quiet zone' or 'zone of protection' which extends for a distance

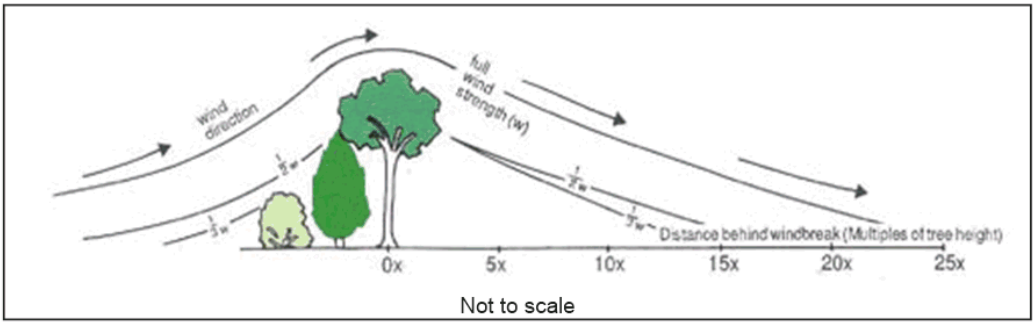


Figure 1: Conceptual presentation of the reduction in wind velocity provided by a windbreak.
(Source: Designing Windbreaks for Farms. 1989. Line drawing by Shirley Turner)

of six times the effective height of the windbreak. However, some protection is provided for a distance of 10 times the effective height of the windbreak. The distance of protection will vary with topography. For example, it will be less if the land rises on the downward side and more if the ground slopes away.

The Zone of Protection = (Actual windbreak height – Crop height) x 6 – 10. For example, if the windbreak is 14m high and the citrus trees are 4m high then the best protection will extend for 60 – 100m *on the ground.*

In areas past this 'quiet zone' wind speed will increase until all the benefit from the windbreak ceases. Some literature suggests that some protection is provided for a distance of 30 times the effective windbreak height. Just how much wind blemish is sustained on fruit in trees beyond the 'quiet zone' has not been determined for citrus.

The question is *"how much wind blemish is sustainable for your orchard and how many windbreak rows do I need to achieve my goal?"* The answer to windbreak height and number of windbreaks required is answered in the following quote from the publication 'Trees for Shelter'.

"The National Windbreaks Program also investigated the effects of 'multiple windbreaks' i.e. several windbreaks planted parallel to one another and spaced either 6H or 12H apart (H represents the height of the windbreak). This mimics the plantings used in alley farming and kiwifruit vineyards. Multiple windbreaks were found to provide a high degree of 'regional' shelter, with each progressively reducing the wind speed such that the shelter behind a multiple array of windbreaks was greater than that for an individual windbreak."

Permeability

Another critical factor is permeability, or how much wind is let through. It appears that the ideal permeability is between 45% to 55%. A solid break that allows no wind through causes damaging turbulence on the side it is meant to protect (better to have no windbreak at all). In frost prone areas permeability is important as windbreaks can be responsible for damming cold or frosty air.

Note: The only way to maintain your windbreak at the correct permeability is to have a regular pruning or hedging program in place (at least

Photo 4: A row of Casuarinas that have been hedged to allow more air permeability and to promote more vertical growth as well as to stop encroachment onto public roads.

annually depending on species, age, distance planted and location). It is also important to prune on a slight angle, for example, the base of the trees should be wider than the top. This guarantees that the foliage at the bottom of the trees will receive adequate light in order to keep growing and therefore not lose lower branches creating open areas under the tree which will cause turbulence.

Figure 1 illustrates many of the suggestions contained in the literature. Severe wind events will reduce the protected area. The area of protection will vary on sloping land. Slopes facing the wind will need to have closer spaced breaks and on the opposite slope, breaks will need to be further apart.

Secondary breaks

Orchards may require secondary breaks for large blocks. The spacing of these secondary breaks will depend on the height of the primary break, the strength of the most damaging winds and the slope of the land. In addition, allowance in the cost needs to be made for modified protection at access points. Decisions need to be based on how much wind blemish is acceptable in your operation. A guide to the spacing of secondary breaks may be calculated from Figure 1 and also from the amount of blemish being sustained in trees further from the break. In South Africa, and some areas in Australia, three poplar trees have been used at the end of a row to decrease wind velocities when there is no room to put in a full windbreak and turning lane.

Length

Where only a single windbreak is required, the length of the break past the citrus block governs the amount of downwind protection. Wind will curl around the end of a break causing turbulence.

The recommendation is that the maximum length of a break should be12 times the mature height of the break. Connecting breaks to existing forest or shelter belts improves protection. If possible, work with neighbours if appropriate to plan mutually beneficial windbreaks.

Machinery access

The continuous nature of cultural activities in citrus orchards demands practicable access. It is critical that access through a windbreak does not allow the

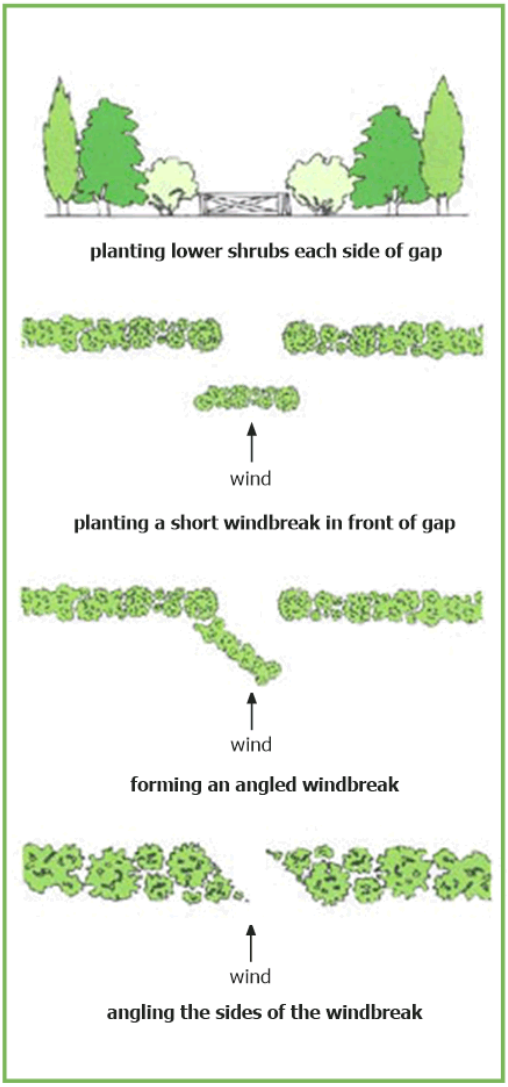


Figure 2: Possibilities for protecting machinery access points. (Source: Designing Windbreaks for Farms. 1989. Line drawing by Shirley Turner)

wind to funnel through and cause severe damage to adjacent trees. Access to all blocks within a protected orchard needs to be well planned. Several suggested ways to protect access areas are shown in Figure 2.

In frost prone areas planning is important as windbreaks can be responsible for damming cold

or frosty air. This can result in frost damage to trees and fruit. The windbreak design needs to include an air drainage break in the lowest part of the protected block so cold dense air drains away from the crop.

Photo 5: Three Poplar trees are used at the end of tree rows in South Africa and some parts of Australia when there is not enough space for a full windbreak row.

Shape and width

Figure 1 indicates one type of windbreak, showing different sized trees, and indicating that the tallest tree does shed its lower branches when mature. This shedding of lower branches would leave a gaping hole if there were no lower storey tree protection. There are also many successful windbreaks using a single staggered row of trees that do not shed their lower branches if pruned correctly. Single rows of specific type bamboo

Photo 6: A windbreak of mature Eucalypts inter-planted with bamboo to compensate for the loss of the Eucalypt's lower branches.

breaks can also be used but these can grow into a dense stand and need thinning to allow for the required permeability. Which ever type is chosen, correct permeability is a major consideration.

Suitable tree species

Throughout the citrus industry, many native and exotic species have been used as windbreaks. Some have been successful and others have not. There is no one species which fits all the needs of a windbreak tree, including: not losing lower branches, fast growing, non- invasive root system, cheap to buy, upright growth habit, tolerance to drought, salinity and water logging, tolerance to herbicides, immunity to pest and diseases, ability to be side trimmed, and many more.

In addition, the wide variations in the citrus growing environment in Australia does not allow for a situation where one group of species fits all orchards. Each State has lists of suitable species for different regions. There are a range of Eucalypts, Casuarinas, Pines, Cypress, Alders and Poplars that allow for a choice of several species to suit most situations.

The following comments regard the most commonly used species.

Native species

One of the main advantages of using native species is that they are adapted to the local soils and climate.

- ***Eucalypts***

Many Eucalypts lose their lower branches as they mature and so become less effective as single row windbreaks. When selecting Eucalypts species choose locally adapted species. On the central and north coast of New South Wales, a number of eucalypt species are used successfully as boundary windbreaks, including: tallow wood (Eucalyptus microcorys) and turpentine (Syncarpia glomerulifera). In central NSW, several species have shown promise including: Paddy's river box (E. macarthurii), narrow-leafed peppermint (E. radiata) and wattle-leaved peppermint (E. acaciiform). In the Riverina, one species has shown outstanding potential, E. platypus var platypus

which is medium sized, retains its lower branches, is good on heavy soils, salt tolerant and can be hedged.

Photo 7 : A row of mature turpentines on the Central Coast of NSW (Syncarpia glomerulifera).

- ***Casuarinas (she-oaks)***

Casuarina and *Allocasuarina* species are both commonly known as she-oaks. They respond well to side pruning, maintaining an even permeability when regularly trimmed. These species are relatively fast growing after establishment in the first season. *Casuarinas* have been widely used in Australia, New Zealand and South Africa for horticultural windbreaks and are regarded as having most of the desirable qualities for windbreaks. *Casuarinas* are dioecious – that is, male and female flowers are produced on separate trees. In late spring the male trees sometimes appear to be dying because of the rusty coloured flowers produced on the ends of the needles. The female trees can sometimes produce large numbers of cones at the expense of foliage growth.

Photo 8: A young Casuarina windbreak

There are many species of casuarina with a wide range of growth habits and climatic adaptation. *Casuarina cunninghamiana*, or river she-oak, has proved to be the most adaptable to varying environments and the most suitable in tree form and development. Establishment and initial tree growth is dependent on the presence of an actinomycete organism *Frankia* in the soil, which stimulates the development of nitrogen producing nodules on the roots. *C. cunninghamiana* responds well to irrigation but is tolerant of some water stress. Trees will respond to fertilisers when the existing soil nutrition is poor, but moderate natural fertility is usually enough.

Late winter frosts can cause damage to the tips of the previous season's growth. Severe frosts, with temperatures less than -8°C may cause yellowing of foliage. Seedlings from a locally adapted seed source in the colder areas may reduce this problem. Pruning or trimming in late spring encourages a greater amount of young growth. This can be repeated every second year to maintain the best control over growth and windbreak porosity. In New South Wales coastal districts, both *C. glauca* (swamp oak) and *Allocasuarina littoralis* (forest oak) have been used successfully.

Despite the success of *Casuarinas*, some growers have experienced problems with poor growth and yellowing of the needles. Problems have included:

- poor growth in shallow soils with poor drainage (*C. glauca*, 'swamp oak' tolerates wet sites)
- *Phytophthora cinniamomi* root rot (often associated with poor drainage)
- herbicide damage – usually glyphosate on immature bark
- lack of the actinomycete organism (unusual)
- frost damage.

- ***Other native species***

The potential of other species is largely unknown for many districts. Melaleucas are ideal for small intensive enterprises and as understorey species, but in districts with a high risk of frost, Melaleucas can suffer from both winter and late spring frost

damage on the new season's growth. Wattles are fast growing and produce a good hedge but they are generally short-lived. They are also a host for various tree borers. Hakeas (*Hakea saligna*) have been used in South Africa and respond well to hedging but can become too dense.

Exotic – evergreen

In the past various pines and cypresses have been used as windbreaks, including Pinus radiata (Radiata or Monterey pine) and P. elliottii (Slash pine). Although pines will grow fairly quickly and can tolerate drier and poorer growing conditions they have a number of drawbacks. As the trees age they become bare at the bottom and dead limbs can cause 'holes' in the breaks, they do not respond to hedging and are highly flammable. Cypresses are slow growing and tend to form a hedge which is usually too dense for efficient wind protection. Today these species are not normally recommended for windbreaks.

Exotic – deciduous

The three main deciduous groups used include Populus (poplars), Salix (willows) and Alnus (alders). All are moderate to fast growing, and respond well to intensive management and side trimming. The willows are especially fire tolerant. The main disadvantage with deciduous species is the loss of wind protection in winter when the trees are bare. All three species are susceptible to silver leaf fungus and should not be used in areas growing stone and pome fruit.

Hybrid Willows

Rapid growing hybrid willows were introduced into Australia in 1980. They were easy to propagate, grew rapidly and were free of rust and many plantings were established. There are many clones of willow and they differ in their tolerance to pests, disease and water stress. The potential 'weed' status of willows is currently under investigation and hybrid willows are not being generally recommended. Plantings of willows should be limited to male clones (NZ1002 and NZ1184) and no trees should be planted near watercourses. Ensure the reliability of nursery stock and do not buy 'hybrid willows' but specify the clone by name and number.

- ***Alders***

Alders (*Alnus species*) are slower growing, deep rooted and can utilise lower water tables in heavier soils. They perform best in their native conditions of cool, moist temperate regions and are limited to good soils in the cooler districts. There are a number of species some of which are still being evaluated.

Grasses

Various grasses have been used as short-term windbreaks for protection of young trees whilst the main windbreak is established and they are also used between tree rows. One of the most notable of these is barner grass (Pennisetum sp. a tall growing strain of elephant grass) which has been used on the central and north coast of New South Wales, Queensland and some of the warmer inland districts. This grass is a vigorous perennial that can grow up to 3m tall. It is robust and has provided

Photo 9: Sudax used as a temporary windbreak for young trees.

Photo 10: Barner grass used as a temporary windbreak.

a rapid-growing thick shelter, however it is very flammable. Some bamboos such as Bambuso oldhami can create a similar or larger windbreak but these have not been accepted commercially.

Barner grass and bamboos are equally competitive and difficult to eradicate once established, creating a potential weed problem especially in tropical and subtropical areas. Various annual cereal grass species such as hybrid sorghums and Sudax can provide good protection to young trees. The hybrid sorghum 'Jumbo graze' can reach up to 3 m and will not reseed.

Tree spacing

Traditional spacings of three to four metres between windbreak trees are too wide for wind protection early in the life of the planting, particularly when single row plantings are used. A one to two metre spacing has proved satisfactory in Australia, New Zealand and Europe for many of the recommended windbreak trees, such as the deciduous and Casuarina species, but not for eucalypts. For boundary windbreaks, wider spacings can be used particularly with multiple row plantings, with each row offset to cover the gaps in the adjacent row. Farm Trees Booklet No. 5, *Designing Windbreaks for Farms*, has more details.

Problems

Windbreaks are designed to overcome problems, but in some cases they can create them.

- ***Will windbreak trees block pipes and drains?*** Willows in particular have a reputation for blocking and breaking drains. Various species can also cause problems with pipes. Avoid planting species such as willows within 40 to 50m of pipes. Ripping to a depth of 0.75 to 1.0m at about 1.5m on either side of the windbreak will reduce roots moving into the crop. Only rip one side each season to prevent creating unstable trees with poor anchorage. Ripping should not be carried out on species that sucker as disturbing the roots increases suckering.
- ***Do windbreaks compete with the crop?*** Windbreaks can compete with the crop for light, space, water and fertiliser. Shading can specifically reduce fruit quality, flower bud formation and crop yield. A north-south orientation for the windbreak rows will help overcome this problem by giving the adjacent crop rows direct sunlight for at least part of the day. Where the north-south orientation is not possible, the effects of shading must be accepted or the distance between the crop and the windbreak increased. The level of competition will depend on species planted, soil type, amount of water and nutrients applied, distance planted from the crop, final windbreak height, and frequency of pruning. Regular maintenance is critical.

Photo 11: Windbreak trees provide protection but they cause shading. Orientate your windbreak trees in a north-south direction when possible to reduce shading.

Establishment and Management

Establishment

Perimeter windbreaks with suitable access points should be established at least 12 months prior to planting the citrus trees. They require as much care and attention as the young citrus trees. Irrigation, fertilizing and weed control are essential activities. Good soil preparation and weed control prior to planting will favour early and rapid establishment. Care should be exercised in the type of herbicides used as many native species are sensitive to damage. Establishing internal windbreaks requires an equivalent level of management. Consider and cost the use of plastic mulch or weed matting and trickle irrigation underneath the windbreak for initial establishment.

Management

Proper management is essential for getting the best efficiency out of the windbreak. Management includes: weed control, nutrition, irrigation, pruning and pest and disease control.

- **Weed control**

Remove weeds before planting as excessive weed growth will compete with the newly planted trees. Both synthetic and natural mulches can be used to reduce weed problems. Contact herbicides can be used however care is needed to avoid spraying the immature green bark of young trees. Hand held applicators with a shield should be used.

- **Nutrition**

Adequate nutrition needs to be provided, particularly for the exotic deciduous species. Willows are the most demanding and alders the least. Native species will respond to fertiliser application, but care must be taken to select a fertiliser formulated for native plants.

- **Irrigation**

Most horticultural windbreaks require supplementary irrigation during summer months. Permanent irrigation is recommended for young trees in drier areas. Native species may not develop a good deep root system if irrigated. In high rainfall areas some tree species will grow well with little irrigation, but requirements vary between species.

- **Deep ripping**

Deep ripping may be required annually and is best done when the ground is damp. Depending on circumstances deep rip to a depth of one metre. Try and vary the rip site from year to year to stop roots growing below the rip line and up into the root zone of the crop. Where you have citrus planted on both sides of a windbreak deep rip alternate sides.

- **Pruning**

Pruning and trimming are needed to maintain the correct shape and permeability of the windbreak. Encouraging a single leader is essential in young trees. Depending on vigour and species, older trees can be hedged every second or third year. The ideal timing for pruning varies with species. Casuarinas should be pruned in late October, just prior to the growth flush. This ensures good development of new lateral growth.

- **Pest and disease control**

The use of pesticides to control insects and diseases should be kept to a minimum and have minimal impact on the local environment. Scale, borers leaf eating and sap sucking insects are the most common and need to be monitored.

Artificial Windbreaks

A variety of polythene mesh products are available with known porosities which makes it easy to select the right permeability. The initial expense may be a little higher than a living windbreak but mesh will satisfy all the requirements of the 'perfect' windbreak. Advantages include: they are instant, are very low maintenance and are more easily installed into an existing planting. The life of the mesh can vary but most probably last for up to 10 years. However, as artificial windbreaks are normally not as high as living trees, they need to be closer together in order to achieve the same result.

There are examples of using poly mesh over the whole planting. A thorough economic analysis of this would be wise, perhaps targeting particular niche markets. The August 2003 edition of *Australian Citrus News* contained an article on a 5.5ha fully enclosed windbreak structure. The story reported that this 17% shade hail netting was producing a 98% packout of one of the summer navels.

Photo 12: An artificial windbreak

Pests and Biological Control

Integrated pest management (IPM) is becoming essential for sustainable pest management. This work would not be complete without comments from Dan Papacek, a pests expert with both national and international recognition.

"We have always considered windbreaks to be an advantage with regard to biological control. Windbreak trees can provide refuge for some beneficials such as predatory mites, ladybird beetles and lacewings. Additionally some windbreaks are also pollen producers. The pollen can provide supplementary food for predatory mites. Generally biological diversity is a good thing in an orchard and the presence of windbreak trees can contribute to this. I have heard of suggestions that windbreaks can harbour pest species but this has not been our experience. Generally if they do have pests present then the natural enemies will also coexist (unless some disruption has occurred).

In South Africa there have been reports that Casuarina species as windbreaks were likely to increase the presence of Scirtothrips in citrus orchards. In coastal orchards, where higher humidity and higher rainfall incidences occur, closely planted windbreaks may restrict airflow and sunlight and hence can cause an increase in the occurrence of diseases such as Alternaria alternata (Brown spot) and Guignardia citricarpa (Black spot.)"

Common mistakes with windbreaks:

- not planning correctly
- pruning off bottom branches
- rows too short
- not protecting access ways
- not immediately replacing trees that die
- not pruning regularly
- not irrigating
- only planting one when two rows are needed
- planting too close to the crop
- not deep ripping regularly or deep enough
- not varying the position of the rip line.

Case Studies

John Cox, Waikerie, South Australia

Fruit quality audits for navel oranges have been kept for four years on 31 different sites at properties owned by John Cox at Waikerie, South Australia. Between 100 and 150 fruit are examined at each site for various types of rind damage. Table 1 shows the average and maximum percentage of fruit with major and minor wind blemish across all sites. Other blemishes were also recorded including insect damage and albedo breakdown. However, in 2005 wind damage accounted for 75% of all major blemishes and 87% of all minor blemishes.

Blemish definitions are taken from the Riversun manual. A 'major wind blemish' is defined as light coloured marks greater than or equal to 20mm surface area, deep (>1mm) or darkened marks greater than or equal to 12mm surface area. There is a zero tolerance for this type of blemish in grade 1 fruit. A 'minor wind blemish' is defined as light coloured marks covering an area less than 20mm, deep (>1mm) or darkened marks, but covering an area less than 12mm. There is a 10% tolerance for this blemish in grade 1 fruit.

On one of John Cox's properties there are two Washington Navel blocks separated by a road where a wind break was established five years ago on the southern side of the property. Most of the prevailing winds come from the south east although there are also some strong north winds at various times after petal fall. This wind break is comprised of *Casuarina cunninghamiana* at a 1.5m spacing. They have been hedged and were 10m to

Photo 13: A windbreak of Casuarina trees on John Cox's property at Waikerie.

Year	Average % Wind Blemish		Maxium % Wind Blemish	
	Major	Minor	Major	Minor
2002	17	5	40	19
2003	20	11	32	19
2004	14	5	26	8
2005	24	8	41	17
Average all years	***19***	***7***	***35***	***16***

Table 1: Blemish results from fruit quality survey, John Cox, Waikerie, South Australia.

Year	% Wind blemish in block without Wind Break		% Wind blemish in block with Wind Break		Percent Reduction	
	Major	Minor	Major	Minor	Major	Minor
2003	26	8	18	2	30.8	75.0
2004	16	5	10	4	37.5	20.0
2005	21	14	12	9	42.9	35.7
Average	**21.0**	**9.0**	**13.3**	**5.0**	**36.5**	**44.4**

Table 2: Results of fruit quality audit between blocks with and without windbreaks.

12m in height in early 2006. Their height was less during the time of the navel fruit quality audits in 2002- 2004.

Table 2 shows that there has been a 30% to 40% reduction in wind damage in the block with protection from the windbreak, which has reduced the amount of blemished fruit (both major and minor) from 30% to 18%. Whilst this is only a small study it is an actual situation. The average of three years indicates a reduction of 12% in the amount of wind blemish sustained behind the windbreak. For every tonne of fruit over the three years 2003-2005, there were an additional six boxes of fruit available for the grade 1 market. This equates to an extra 240 boxes of better quality fruit based on production of about 40 tonnes per hectare. In terms of dollar value, using average returns for United States (US) grade 1 export fruit, of $800/ tonne in 2001 and $250/t in 2002 a 12% reduction in down grading due to wind damage represents increased returns of between 0.12 X $250 X 40 t/ha = $1,200/ha and 0.12 X $800 X 40 t/ha = $3840/ ha. This example illustrates the dollar value in reducing wind damage to trees.

Rod Hand, Colignan, Victoria

Rod has established sorghum as a temporary windbreak for protecting young trees. Currently

Photo 14: Sorghum windbreaks planted to protect newly established citrus trees under sprinkler irrigation. Trees established Spring 2003.

he plants a row of sorghum every third row of trees. The sorghum is irrigated with a drip line and receives the same water and nutrients as the young citrus trees. When the citrus trees grow bigger the drip line in the sorghum will be moved into the row

of citrus trees. Trees directly beside the sorghum windbreak show better growth than rows further from the break. For future plantings, Mr Hand will plant a sorghum windbreak every second row of citrus trees. Tree spacings are 7m x 3m for the sprinkler irrigated block and 6m x 2m for the drip block. Mr Hand will plant the sorghum seed at less than the recommended sowing rate so as to achieve good windbreak height sooner and allow more porosity.

Photo 15: Improved tree growth in rows directly beside the sorghum wind break, using drip irrigation. Trees planted December 2004.

References

Baker, J. D. Windbreaks from barner grass. *NSW Agricultural Gazette,* Vol 88, No. 3, June 1977.

Campbell, M. Windbreaks for Citrus. *Australian Citrus News*. 10, 15. Oct. 1967.

Cleugh, H. Trees for Shelter. A guide to using windbreaks on Australian Farms. ISBN 0642 58458 3. www.rirdc.gov.au

Coey, R.G. Windbreaks Save Crops. *Nambour Chronicle* 6. 1975.

Cooper, M. Playing Games with the Wind. *Small Farmers* (QLD) 5. 1986.

Feutrill, C. Windbreaks. *Australian Citrus News*. 1, 1996, 11.

Freemen, B. How Artificial Windbreaks Help Citrus Growers in Australia. *The Citrus and Sub-tropical Fruit Journal.* March 1974, pp. 4-8.

Freeman, B. Rind Blemish of Citrus 1: Initiation and Development. *Scientia Hort*., 4:317-327.

Freeman, B. Rind Blemish of Citrus 11: Structure and Ultrastructure. *Scientia Hort.*, 4:329-336.

Freeman, B. Artificial Windbreaks and the Reduction of Wind scar of Citrus. *Proc.Fla.State Hort.Soc*.89:52-54, 1976.

Freeman, B. 1973. *Controlling Rind Blemish in Citrus Fruit.* NSW Department of Agriculture. Bulletin H 238.

Goebel, R. Bana Grass Temporary Windbreak for Orchards. *Rare Fruits Council of Australia* 7.1988. 51.21, 22.

Hardy, S. *Results of a fruit quality survey 1992-93* in Pest and Disease Management Guide for Coastal Citrus in NSW. NSW Agriculture, 1995.

Hathaway, R. L. Back to Basics on Shelters. National Plant Materials Centre. Aukautere. NZ. *Growing Today*. 1983, Vol 1 No 1 p14.

Hathaway, R. L. Tree Species for Horticulture Shelter. *Growing Today* 9. 1983:16-19.

Hathaway, R. L. Management of Shelterbelts for Horticultural Crops. *Growing Today*. 9.1983 Vol 1 No 2.

Hathaway, R. L. *et al*. Aggressive Shelter a Liability. *Growing Today.*

Hort. Branch Officers. (QDPI). Windbreaks for Horticulture. *Small Farms* (QLD) 1. 1968, pp. 2- 3.

Jamieson, G I. (QDPI) Windbreaks in Horticulture. *Q F&VNews.* June 1988, pp.15-18.

Krajweski, A. Windbreaks in Citrus Orchards. CGSA Newsletter.

Lantzke, N. Windbreaks for Horticulture on the Swan Coastal Plain. AgWA Farmnote 43/99. www.agric.wa.gov.au

Lewis, T. Windbreaks, Shelter and Insect Distribution. *Rothamsted Exp. Stn. Span.* 11.3. 1968 pp. 187.

Lewis, J.R. (QDPI) Protect Macadamia Plantations. *Q F & V News*. 9. 1985, pp. 20-22.

Madge, D. Windbreaks in Horticulture. Dept. of Ag & Rural Affairs. (Booklet Sunraysia).

McMullen, B. Give yourself a break with a horticultural windbreak. *Good Fruit and Vegetables*. October 1997, pp 71-74.

Menzies, R. Horticultural Windbreaks. NSW Primefact currently in preparation.

QDPI Hort Branch. Windbreaks to Protect your Crops. Leaflet 523. May 1959.

Revelant, L. and Doumit, F. Windbreaks for Citrus. 1990. NSW Agriculture and Fisheries Agnote 5/90/2.

The Citrus Industry. 1973 Vol.III. p53.

Wakefield, S. 1989. Designing Windbreaks for Farms. No.5 in the Farm Trees Series of leaflets. NSW Agriculture and Fisheries, Forestry Commission of NSW and Soil Conservation Service of NSW.

Authors: John Owen-Turner *(Consultant) and* ***Sandra Hardy****, NSW Department of Primary Industries, with contributions from Kym Thiel, Citrus Growers of South Australia; Tony Filippi, Murray Valley Citrus Board and George Morris, WA Department of Agriculture. This fact sheet has been compiled by CITTgroups Australia from information previously published on windbreaks.*
June 2006

Windbreaks for horticulture on the Swan Coastal Plain

Page last updated: Friday, 10 November 2017 - 11:26am

Well-designed windbreaks will help achieve high yields and quality for most horticultural crops. They have a number of benefits and drawbacks and need to be managed to reduce adverse impacts on crops.

Strong winds reduce horticultural yield and quality

High wind speeds cause problems on most horticultural properties on the Swan Coastal Plain. The dominant wind direction is from the east in the morning and from the south-west in the afternoon. In winter, strong winds can also come from the north-west with the approach of cold fronts.

Well-designed windbreaks will help achieve high yields and quality for most horticultural crops.

Windbreaks benefits to horticulture

Windbreaks can:

Reduce plant damage
Windbreaks decrease the incidence of broken stems, leaf loss and lodging of plants. The percentage of fallen and blemished fruit is reduced. Vegetable crops are protected from sandblasting.

Increase plant performance
Trials of various crops have shown that windbreaks can increase yield. Strong, hot winds increase evapo-transpiration, causing moisture stress so that more frequent irrigation is required. In winter cold, dry winds cool the soil and plants, slowing growth and delaying crop maturity. Wind reduces the activity of insect pollinators.

Increase sprinkler uniformity
Windy conditions can greatly reduce the uniformity of sprinkler irrigation. Investigations have shown that yield variation due to poor irrigation uniformity is common on many properties. Reducing wind speeds allows irrigation systems to function more efficiently.

Decrease wind erosion
Bare, cultivated areas — such as those during fallow periods on vegetable properties — are prone to wind erosion. Windbreaks can help alleviate this problem.

Increase spray efficiency
Windbreaks reduce spray drift, increasing the efficiency of pesticide applications. Reducing wind speeds also increases the number of days in the year when spraying is possible.

Windbreaks disadvantages to horticulture

The disadvantages need to be balanced against the advantages for any given horticultural area and business. Disadvantages include:

money and time are needed to plant the trees

the area in which the windbreak is planted is lost to production

windbreaks require maintenance if they are to function properly

roots and branches may need to be pruned to prevent competition with the crop

the windbreak needs to be irrigated and possibly fertilised.

In most situations on the coastal plain, the advantages of a well-designed and maintained windbreak outweigh the disadvantages. However, on more protected areas or where land is limited, windbreaks may not be needed.

Back to top

Windbreak design

Before planting trees, considerable thought must go into planning the design of the windbreak. Poorly designed and sited windbreaks interfere with farm operations and may need to be removed later.

Orientation

To provide maximum protection, windbreaks should be at right angles to the dominant or most damaging wind direction. On the Swan Coastal Plain, windbreaks should ideally run north-north-west to south-south-east.

Windbreaks can be placed around all sides of the production area to cover all wind directions. Windbreaks running east-west may cause shading of crops to the south of the windbreak in winter, reducing production.

Other factors may affect the orientation of windbreaks. A windbreak should be compatible with the overall property plan. You may have to realign roadways and other structures to gain maximum benefit.

Windbreaks on ridges increase turbulence on the down-wind side. If possible, locate the windbreak downslope from the top of the ridge so that the top of the trees is about level with the ridge top.

Permeability

An effective windbreak should filter wind rather than present a solid barrier to it. A solid barrier diverts wind over the top, creating turbulence on the leeward side.

Ideally, windbreaks should have a permeability of about 50%. This means that thick, bushy windbreaks need to be trimmed. Foliage should extend to the ground otherwise the wind will blow under it, creating turbulence.

Access and gaps

Gaps in a windbreak will cause the wind to tunnel and can increase plant damage. Access roads through windbreaks can be protected by planting an additional short windbreak at least twice the length of the gap to the windward side of the access road. If a tree dies, plant another or turbulence will occur downwind from this area.

Height

The higher a windbreak the larger the area it will protect. However, windbreaks over 6–10 metres tall often become difficult to manage and cause excessive shading of crops.

Windbreaks offer good wind protection at ground level to a distance of 4 to 6 times their height and adequate protection to a distance of about 10 times their height. For example, a 10m high windbreak will give adequate protection at ground level for about 100m downwind. The protection offered to orchard, grapevine and other taller crops will be less because of their height above ground.

Setback from crop

To reduce shading and competition from tree roots, plant windbreaks at least 10m from the cropping area. Tall windbreak species need a greater buffer area. Leave sufficient room to allow ripping of the tree roots and vehicle access and turning space. A greater distance between crop and windbreak is required when trees are planted to the north of the cropping area to minimise shading in winter.

Frost

Cold air flowing downhill can be trapped or dammed up behind a dense windbreak causing frost damage in susceptible crops. On sloping areas, a windbreak above the crop can reduce this problem by preventing cold air from flowing into the cropped area.

Windbreaks in the crop should be sited on hillsides with sufficient gradient to allow the cold air to flow downhill out of the crop. The lower end of the windbreak must not be blocked, so that cold air can move away freely.

Alternatively, use deciduous trees in frost-susceptible locations.

Back to top

Establishment and management

Ground preparation

Deep rip the soil along the line where the trees will be planted. Some trees, such as casuarinas, may suffer from iron chlorosis if planted on soils with shallow limestone.

Transplanting

You can propagate trees from seed or cuttings or buy them from a nursery. If buying transplants, check that the seedlings are not root-bound. This can cause strangulation which restricts the growth of new roots into the soil and may cause the trees to blow over in strong winds.

Seedlings must not be allowed to dry out or they will suffer from transplanting shock and subsequent growth will be reduced. The best time of year for planting is following the first autumn rains but, with irrigation, trees can be planted at any time of the year.

Tree spacing

Most trees should be planted in a line about 1.5–2m apart. Eucalypts however should be planted at 3–4m. If sufficient ground is available, plant multiple-row windbreaks; a second parallel, but offset, row of trees can be planted about 2.5m from the first row. Alternatively, a small tree or shrub can be planted on the outside and a tall tree on the inside of the windbreak.

Weed control

Before planting the trees, kill weeds in the 1 or 2m wide planting area by cultivation and/or with herbicides. Use non-residual herbicides, such as paraquat, diquat or glyphosate. For the most effective weed control, use a residual herbicide as well as a knockdown herbicide. If using a residual herbicide wait at least 2

weeks before planting the trees. Black plastic or organic mulches can be laid before planting to control weeds.

Weeds in established windbreaks should be controlled as necessary by herbicides or cultivation. Grass weeds can be controlled with selective herbicides. Other weeds need to be controlled by a directed spray of a knockdown herbicide. Take care as spray drift can damage or kill trees in the windbreak.

The registration and availability of chemicals for disease, pest and weed control change regularly. Consult a trained and experienced horticultural agronomist or the **Australian Pesticides and Veterinary Medicines Authority** for chemicals which are currently registered or have a permit for use in your situation. The information on the label or permit for a chemical must be followed, including the directions for use, critical use comments, withholding period and maximum residue limit. Quality assurance schemes for horticultural crop production require producers to have current information on chemical registrations and permits at their fingertips. The information to be found at this website allows this requirement to be met.

Pruning and trimming branches

Almost all tree species require pruning and trimming to maintain a suitable windbreak shape. In some trees, corrective pruning in the first year or two may be necessary to maintain a single dominant leader. After the first 2–3 years, side trimming of branches may be needed every second year.

Side trimming is necessary to maintain about 50% porosity and prevent the tree from becoming too wide. This can be done either by hand or with a pruning machine. Trees should not be lopped until they reach the final desired height.

Managing roots

A major problem with some species is invasion of tree roots into the production area. At Medina Research Centre, roots from a casuarina windbreak were detected in the crop about 20m from the windbreak. For species with extensive, shallow root systems, root pruning should be done at an early stage to encourage deeper rooting. Roots should be ripped to a depth of at least 1m at a distance of about half the tree's height.

On deep sandy soils, it is likely that the tree roots will eventually grow below the rip line and resurface. On these soils, the roots of established trees should be ripped at 3, 6 and 10m from the windbreak to help prevent them invading the crop area. Irrigation of the windbreak will reduce the extent of root invasion into the cropped area.

Irrigation

Irrigation is essential for establishment. Once established, irrigation ensures sustained tree growth and reduces root invasion into the production area. Drip or sprinkler irrigation can be used. Water at about 50% of pan evaporation.

Fertiliser

Trees respond to fertiliser when soil nutrient levels are low. On newly developed, sandy soils, a light basal dressing of macro and trace elements can be applied before transplanting. About 100g per tree of a fertiliser containing nitrogen, phosphorus, potassium (NPK) plus micronutrients is sufficient.

Alternatively, use a slow release fertiliser with a 3–4 month release period. To increase growth, apply a light dressing of nitrogen annually. Apply fertiliser over the whole plant root zone rather than just at the base of the tree.

Pest and disease control

Some windbreak species may be damaged by specific insects and diseases. Spraying pesticides on a mature windbreak may be costly. Choose species with low risk of being attacked and, if pest or disease problems occur, spray the trees as soon as possible. Stock should not have access to windbreaks at any time because they will graze the lower foliage.

Back to top

Suitable windbreaks

Many species have been evaluated for their potential as windbreaks. No single species has all of the following beneficial criteria:

- cheap
- fast growing
- upright habit
- retention of lower branches
- immunity to pests and diseases
- 50% porosity to wind
- non-competitive or non-intrusive root system
- branches which don't break in strong winds
- minimal suckering
- easily trimmed or hedged.

The following species are most suitable for use as horticultural windbreaks on the Swan Coastal Plain.

Casuarinas

Demonstrations have shown casuarinas to be one of the best species for windbreaks on horticultural properties on the Swan Coastal Plain. The best performing casuarina species in most cases is *Casuarina cunninghamiana* (river sheoak).

This tree is native to eastern and northern Australia and grows to about 15m. River sheoaks are fast growing and have a good shape and form to reduce wind speed.

On heavier soil types, *Casuarina glauca* (swamp oak) and *Casuarina obesa* (also called swamp oak) have also performed well, though they are more prone to splitting in high winds.

On white and pale grey sands, *Casuarina equisetifolia* (coastal sheoak) performs well, though tree shape is fairly open, possibly allowing too much wind to pass through.

All casuarina species are resistant to almost all pests and diseases (including weevils). Rabbits like to eat young casuarina seedlings and should be controlled before transplanting.

Like all natural windbreaks, casuarina windbreaks need to be maintained. Lack of pruning, ripping, irrigation and weed control will usually result in a poor windbreak.

Take particular care when using casuarina windbreaks for drip irrigated perennial crops. If the tree's roots are not adequately pruned they will grow into the production area, seriously competing with the crop and even entering into the drippers.

The problem is less severe with annual crops as shallow tree roots in the cropped area are destroyed by cultivation before each crop. Increase the setback distance from the windbreak when growing drip irrigated, perennial crops.

Eucalypts

A number of eucalyptus species have been used for windbreaks on horticultural properties. Limb breakage on mature trees during high winds can be a problem and, with many taller species, an additional, lower growing species is needed to fill in holes in the base. Eucalypts are prone to attack by a range of insects. Spacing between trees should be 3–4m. Species that may be suitable are listed in Table 1.

Large trees are generally only suitable for external windbreaks and need to be placed further from the crop area to prevent competition. Smaller trees can be used for both internal and external windbreaks.

Table 1 Trees that may be suitable for windbreaks on horticultural properties on the Swan Coastal Plain

Small trees	Large trees
Melaleuca nesophila	*Eucalyptus botryoides* (southern mahogany)
Melaleuca lanceolata	*Eucalyptus gomphocephala* (tuart)
Eucalyptus decipiens	*Eucalyptus grandis* (rose gum)
Eucalyptus platypus (coastal moort)	*Corymbia maculata* (spotted gum)
Eucalyptus lehmannii (bushy yate)	
Eucalyptus cladocalyx (dwarf sugar gum)	
Acacia iteaphylla	
Acacia celastrifolia	
Callitris priessii	

Exotic deciduous trees

The three main deciduous groups suitable for boundary and internal orchard windbreaks are *Populus* (poplars), *Salix* (willows) and *Alnus* (alders). All are moderate to fast growing and respond well to intensive management and side trimming.

Deciduous trees provide less wind protection during the winter. This is a disadvantage for annual vegetable cropping and evergreen perennial crops.

Poplar rust affects poplars, though some species are resistant. The Tasman poplar (*Populus x euramericana* hybrid) and *Alnus cordata* (Italian alder) have performed well in windbreak trials at Manjimup Horticultural Research Institute. Willows are a host for the carrot aphid, which is a pest of carrots, parsnips and celery.

Radiata pine

Advantages of *Pinus radiata* pines:

They are fast growing and reach a height of 15–20m.

They are cheap and relatively easy to establish.

Disadvantages of *Pinus radiata* pines:

The canopy can be too dense when young (leads to turbulence near the windbreak).

Older trees:

become too open at the base and often require an underplanting of a shade tolerant, lower growing species; the lower growing species should be planted at the same time as the pines

become too wide unless regularly pruned, and do not form good hedges; limited side pruning just before the spring flush is useful in younger trees.

Heavy pollen loads may discolour adjacent crops (causes a blue-green appearance on citrus).

Pinus pinaster (Monterey pine) is more suited for planting on white sands. It is slower growing when young and has much better resistance to sun-scorching of the trunk.

Cypress

Cupressocyparis leylandii (clone Naylor's Blue) has been trialled in the south-west of Western Australia with encouraging results. It is a hardy, fast-growing species that has a narrow, columnar shape. It will grow at about 1.5m a year and reach a maximum height of about 15m. Leighton's Green may perform well, but it is slower growing than Naylor's Blue.

Cypress species can be killed by the fungal disease *Seiridium*. Take care that the disease is not brought in on the trees from the nursery. *Seiridium* is spread by rain splash from infected plants. If present, it should be immediately controlled by fungicide.

Bana grass

Bana grass grows rapidly to about 3m within 6 months and will reach a mature height of 4–5m. It is usually planted from cuttings in spring at a spacing of 60cm. The plant is erect growing and there is little lodging or lateral spreading.

Negative characteristics include lateral root growth, shedding of leaves, fire hazard and poor wind porosity creating turbulence. As bana grass is very fast growing, it is useful as a temporary windbreak. It can be removed by slashing and spraying regrowth with glyphosate, although some people have reported difficulties in killing the plant.

Back to top

Artificial windbreaks

Artificial windbreaks have advantages and disadvantages:

they take very little space

they do not have any competition for moisture or nutrients (but may shade adjacent crops)

they work immediately after erection

they can be part of a fully-netted protection program

they are relatively costly to establish, especially if very tall or fully enclosed.

Nursery crops

Nursery crops of cereal rye or other cereals can be planted between the rows of direct-seeded vegetables, such as carrots and onions, to reduce sandblasting of emerging seedlings. Cereal rye is tough and withstands sandblasting much better than other cereals. It is sown at a rate of about 50kg/ha. The cereal rye is killed with a selective grass herbicide once the crop is established and before it seriously competes with the vegetable crop. Nursery crops only protect the emerging seedling and do not offer many of the other advantages of windbreaks that are listed above.

Topics

Crops Horticulture

Contact information

Pest and Disease Information Service (PaDIS)

+61 (0)8 9368 3080

Email Pest and Disease Information Service (PaDIS)

Windbreaks for horticulture on the Swan Coastal Plain

View on one page

See Also

Establishing effective windbreaks on the Swan Coastal Plain

Regions

Peel
Perth regions
South West
Wheatbelt

Share

Short URL https://agric.wa.gov.au/n/3345

About

Department of Primary Industries and Regional Development's Agriculture and Food division is committed to growing and protecting WA's agriculture and food sector.

Head office

3 Baron-Hay Court
South Perth WA 6151

Postal

Locked Bag 4 Bentley Delivery Centre
WA 6983

ABN

18 951 343 745

Contact us

Telephone: +61 (0)8 9368 3333
Fax: +61 (0)8 9474 2405
Email: **enquiries@dpird.wa.gov.au**

Emergency Animal Diseases: 1800 675 888
Exotic Plant Pest Hotline: 1800 084 881
Pest and Disease Information Service (PaDIS):
Telephone: +61 (0)8 9368 3080
Email: **padis@dpird.wa.gov.au**

Haddaway *et al. Environ Evid (2016) 5:18*
DOI 10.1186/s13750-016-0067-6

Environmental Evidence

SYSTEMATIC MAP PROTOCOL Open Access

The multifunctional roles of vegetated strips around and within agricultural fields. A systematic map protocol

Neal Robert Haddaway[1*], Colin Brown[2], Sönke Eggers[3], Jonas Josefsson[3], Brian Kronvang[4], Nicola Randall[5] and Jaana Uusi-Kämppä[6]

Abstract

Background: Agriculture and agricultural intensification can have significant negative impacts on the environment, including nutrient and pesticide leaching, spreading of pathogens, soil erosion and reduction of ecosystem services provided by terrestrial and aquatic biodiversity. The establishment and management of vegetated strips adjacent to farmed fields (including various field margins, buffer strips and hedgerows) are key mitigation measures for these negative environmental impacts and environmental managers and other stakeholders must often make decisions about how best to design and implement vegetated strips for a variety of different outcomes. However, it may be difficult to obtain relevant, accurate and summarised information on the effects of implementation and management of vegetated strips, even though a vast body of evidence exists on multipurpose vegetated strip interventions within and around fields. To improve the situation, we describe a method for assembling a database of relevant research relating to vegetated strips undertaken in boreo-temperate farming systems (arable, pasture, horticulture, orchards and viticulture), according to the primary question: What evidence exists regarding the effects of field margins on nutrients, pollutants, socioeconomics, biodiversity, and soil retention?

Methods: We will search 13 bibliographic databases, one search engine and 37 websites for stakeholder organisations using a predefined and tested search string that focuses on a comprehensive list of vegetated strip synonyms. Non-English language searches in Danish, Finnish, German, Spanish, and Swedish will also be undertaken using a web-based search engine. We will screen search results at title, abstract and full text levels, recording the number of studies deemed non-relevant (with reasons at full text). A systematic map database that displays the meta-data (i.e. descriptive summary information about settings and methods) of relevant studies will be produced following full text assessment. The systematic map database will be displayed as a web-based geographical information system (GIS). The nature and extent of the evidence base will be discussed.

Keywords: Vegetative strip, Buffer strip, Filter strip, Buffer, Agri-environment, Agricultural policy, Mitigation, Agricultural pollution, Agricultural management

Background

The ecological impacts of agricultural intensification and change in Europe since the Second World War are well documented and affect both agricultural areas and their surrounding systems [1]. Biodiversity, air and water quality, soil structure and ecology have all been affected [2]. Well-documented impacts of agricultural development include: widespread negative effects of the application of nutrients in fertilisers (mineral and organic) and agrochemicals on soil, and surface and ground water quality [3], emission of N_2O as a potent greenhouse gas [4], and negative effects of pesticides on non-target invertebrate species [5], birds [6] and biological control potential [7]

*Correspondence: neal.haddaway@eviem.se; neal_haddaway@hotmail.com
[1] Mistra Council for Evidence-Based Environmental Management (EviEM), Stockholm Environment Institute, Box 24218, 10451 Stockholm, Sweden
Full list of author information is available at the end of the article

together with the loss of ecological heterogeneity at multiple spatial and temporal scales [8]. The establishment and management of vegetated strips (including field margins, buffer strips and hedgerows) are key mitigation measures for these negative environmental impacts [9].

Definition of vegetated strips

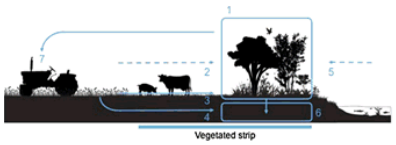
Here, we define vegetative strips as any vegetated area set-aside from the main cropping regime within or around a field, and installed for the purposes of benefiting native biota, water and air quality, socio-economics, and yield. Examples of such interventions include: hedgerows, field margins, buffer strips, beetlebanks and shelterbelts (Fig. 1). For the purposes of this review, we focus on those interventions that are permanent or semi-permanent fixtures in agricultural landscapes, and the interventions must therefore be in place for longer than 12 months (see Inclusion Criteria for further details).

Vegetated strips have a multi-functionality that covers a range of processes, including protection of water quality in surface waters, habitat improvement, biodiversity, shading, carbon sequestration, flow capture, biomass production, landscape diversity, and societal services [10]. These processes are recognised to occur through a suite of pathways that impact socio-economic and environmental outcomes (Fig. 2).

Vegetated strips and water flow

Many of the ecosystem services provided by vegetated strips exist because of a reduction in water flow that occurs due to the presence of aboveground vegetation, roots and soil complexity.

As surface runoff passes across field margins, the velocity of flow tends to decrease in response to the type and density of strip vegetation as well as to any changes in slope. This reduction of flow allows suspended sediment to be deposited, which decreases the transport of sediment and sorbed nutrients and other contaminants beyond the strip. The reduction also provides potential for infiltration of water into the strip, decreasing the total volume of runoff water and the associated load of dissolved contaminants. The effectiveness of vegetated strips in reducing sediment transport off-site is known to vary with the ratio of runoff area to the area of the strip [11] as well as with other factors including soil type, topography, soil–water management (such as drainage pipes), land use, rainfall intensity and antecedent moisture conditions [12]. For instance, nutrients and pollutants may readily flow through vegetated strips from the soil surface and into drainage pipes, particularly in clay soils, through macropores, cracks and root channels. This effect may be prevalent on any soil type where heavy rain follows dry periods. Similarly, the beneficial flow reduction properties of vegetated strips can be negated either where the strips occur on steep ditch banks, or where steep channels allow flow to be diverted around the strips.



Pathways to impact:
1. Presence of habitat
2. Interception of chemical drift
3. Overland flow/surface unoff
4. Subterranean flow (sublateral flow, artificial drainflow, shallow groundwater flow)
5. Interception of wind
6. Interaction with the soil
7. Agronomic

Fig. 2 Conceptual model of pathways to impact for vegetated strips within or around fields. Illustration: Neal Haddaway

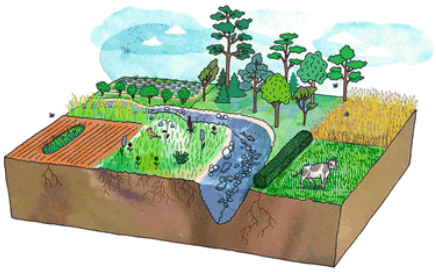


Fig. 1 Illustration of the variety of vegetated strips used within and around fields. Interventions include: in-field strips such as beetlebanks, hedgerows, forested shelterbelts, shrubs, grassy strips, and wildflower margins. Illustration: Gunilla Hagström/Form Nation

Effects on nutrients and other contaminants

Nutrients and pesticides are amongst the most important pressures on aquatic ecosystems, where excess inputs may deteriorate ecosystem integrity and/or threaten drinking water resources [13, 14]. Even strongly-sorbed compounds, including faecal pathogens from livestock or slurry fertiliser applications, can harm surface water quality through long-distance erosive runoff. Management of these pollutant losses takes place both through baseline regulations, and by introducing cross compliance or general binding rules for protection of receiving water bodies [15]: both for control at source and locally targeted regulations using incentives at high risk contaminant pathways. Buffer strips are one of the most commonly applied management measures, and are mainly

designed and implemented to control sediment, phosphorus, nitrogen and pesticide losses to off-site surface waters [16, 17]. They have been shown to be highly efficient for reducing nutrient runoff from farmed fields in a wide range of climate regions across the world [18, 19]. Similarly, vegetated strips in riparian zones are also effective at removing nitrogen in proximity to watercourses, particularly subsurface nitrogen, although their efficacy appears to be variable [20]. Generally, the effectiveness of vegetated strips in controlling transport of more soluble contaminants is less than for strongly-sorbed chemicals. There is also potential that dissolved contaminants infiltrating into the margin may subsequently reach surface water via subsurface drains and/or shallow groundwater.

Where contaminants may be emitted to the air, as for pesticide spraying, vegetated strips have a dual functionality in increasing the distance between the emission source and vulnerable habitats such as surface waters or non-crop habitats, but also through the potential for interception of spray drift. Finally, it is known that pharmaceuticals used in animal husbandry may also be important contaminants of terrestrial environments adjacent to agricultural fields [e.g. 21]. In such cases, vegetated strips can provide a physical barrier where operations such as spreading of manure and biosolids are not allowed.

Effects on biodiversity

The widespread loss of spatial landscape heterogeneity, associated with the use of a few high yielding crop types across large uniform fields [8], is often viewed as a key driver of biodiversity loss on arable land across Europe [22–24]. Hence, the creation and management of various field margin habitats has the potential to restore habitat diversity for the benefit of associated farmland biodiversity [25]. Hedgerows and other field margin vegetation types have been shown to affect the richness and abundance of flora, invertebrates and birds [26–28]. For instance, grassy field margins have been shown to provide important refuge and food for invertebrates, mammals and birds [29, 30]. Yet, these effects may depend on landscape structure and regional levels of agricultural intensification [31]. As a result measures are sometimes implemented in landscapes where their effects are small or even negative [32].

As field margins comprise a variety of different vegetation types that are managed for different purposes, their effects on biodiversity and associated ecosystem services may vary. For instance, pollinator habitat enhancement in the form of hedgerows and flower-rich buffer strips may contribute to yield on adjacent fields [33] but also overall biodiversity and biological control potential in the surrounding landscape [34]. Buffer strips established using densely planted perennial grasses may primarily benefit invertebrates for pest suppression [35] but also increase the availability of suitable nesting sites for ground-foraging farmland birds on adjacent crop fields [36]. However, the access to foraging opportunities for insectivorous birds in these strips may be substantially lower compared to margins planted with wildflower mixes [37] or naturally regenerating margins on poor soils with a diverse seed bank (19). At the regional scale these benefits may be particularly valuable in resource-poor landscapes [38]. In addition, both at local and regional scales, vegetated strips provide valuable linear habitats that may promote connectivity between areas of non-agricultural land or semi-natural landscapes [39]. Finally, it is important to mention that vegetated strips around and within fields may also negatively impact on crop production and biodiversity. This is because field margins harbour weeds, pests and diseases (e.g. viruses), which could potentially create a conflict between crop production and biodiversity conservation [9, 40]. Increased habitat heterogeneity may also have negative impacts on some species that require or prefer large, homogeneous environments, such as farmland and migratory birds [41, 42]. Some of these homogeneous environments, commonly considered to be the result of agricultural development and intensification, may represent natural systems, particularly those in central and eastern Europe [43].

Other effects

Depending on the nature of their management, vegetated strips can provide various other services. For example, strips with perennial grasses or trees and/or shrubs, can counter soil erosion via filtration of larger sediment particles [44, 45], and by increasing soil stability through increased root density [46]. Some resources from vegetated strips can be harvested periodically, such as wood and fodder [16], and strips are also used to provide nesting and foraging habitat for game bird populations [e.g. 47] although elevated mortality and nest predation can occur in these habitats [48, 49]. A less well-studied aspect of vegetated strips is their potential to enhance aesthetic values and perceived "naturalness" of agricultural landscapes, especially when vegetated with trees and/or shrubs and employed in areas where such features are absent [16]. Similarly, other values may be investigated, including provision of game habitat, refugia for crop pest predators, and amenity use of agricultural land, for example by horse riders.

Multipurpose vegetated strips and conflicting objectives

One key question relating to vegetated strips as an environmental intervention on farmland is how to evaluate multifunctional effects; that is, impacts of single strips on

multiple outcomes. True evaluation for areas larger than the plot-scale is difficult to undertake due to difficulties in having representative controls. One possibility to overcome large-scale evaluation problems is therefore upscaling of plot results and/or modelling, and in both cases collection of data from experimental studies conducted around the world will be invaluable as a baseline. In their review of the multifunctional role of vegetated strips on arable farms, Hackett and Lawrence [50] concluded that although different strip types can produce multiple benefits, none can wholly provide for all environmental outcomes. One way to optimise multiple benefits from field margins at the field and landscapes scale could therefore be to adjust management practices locally according to purpose.

In reality, however, many vegetated strips vary in their purpose, method of establishment and ongoing management. Common forms of field margins include those that are naturally regenerated from unused farmland, those sown with grass or wildflower mixes, those sown specifically for target organisms such as pollinators (nectar and pollen mixes) or for wild birds (seed mixes), those that are annually cultivated and those that are unmanaged [50]. The specific design and management of a vegetated strip may depend on the main reason for the intervention, and the resultant efficacy for the different outcomes described above may vary accordingly. Wildflower strips, for example, are designed to benefit pollinators such as bees [29], whereas densely vegetated strips typically established by sowing a mixture of perennial grass species adjacent to water courses, are primarily used to mitigate soil erosion [51] and reduce leaching of nutrients and agro-chemicals [52]. The access to foraging opportunities for insectivorous birds in strips designed for water protection may be substantially lower compared to strips planted with wildflower mixes [37] or naturally regenerating strips on poor soils with a diverse seed bank [30]. Accordingly, managing vegetated strips for biodiversity or for diffuse pollution purposes may entail very different management practices, since retained dissolved or particulate matter eventually accumulates within the strip, which in turn may reduce the potential for biodiversity benefits. However, removal of plant material from vegetated strips could help maintain long-term retaining capacity, avoiding their transformation into nutrient sources, and with simultaneous benefits of lower nutrient levels and/or sparser vegetation for wild flora and visual foragers such as birds [53]. An additional consideration in this context relates to pollution swapping [54], where mitigation measures for one pollutant cause an increase in another pollutant. In this way, vegetated strips for controlling nitrogen leaching could lead to simultaneous transformation of sediment-bound phosphorus into soluble reactive phosphorus.

Identification of the topic

The topic was suggested at a general stakeholder meeting arranged by MISTRA EviEM on September 24th, 2012. Suggestions for the topic were made by the Swedish Board of Agriculture, the Swedish Environmental Protection Agency, the Swedish Ministry of the Environment, Svensk Sigill, Hushållningssällskapet, WWF, and researchers from the Centre for Biodiversity and the Department of Ecology at the Swedish University of Agricultural Sciences. The focus and scope of the review was narrowed and better defined during a specific stakeholder event on September 1st, 2015.

Objective of the review

The aims of this review are to identify, collate, and describe relevant published research relating to the effectiveness of vegetated strips in and around farmland for a wide variety of purposes, including but not limited to: the enhancement of biodiversity; the reduction of pesticide and nutrient drift/runoff/leaching; the mitigation of soil loss; the reduction of pathogens and toxins; and, socioeconomic values, such as provision of game habitat and reduction of crop pests. The map will be restricted in geographical scope to boreal and temperate systems (see Inclusion Criteria below) and will consist of a report describing the review process, a searchable database describing the identified relevant studies, and an interactive, web-based geographical information system (GIS) displaying the contents of the database.

Primary question	What evidence exists regarding the effects of field margins on nutrients, pollutants, socio-economics, biodiversity, and soil retention?
Secondary question	To what extent has this research focused on multi-use vegetated strips?
Population	Boreo-temperate regions as defined by the following Köppen-Geiger climate classification zones [55]: Cfa, Cfb, Cfc, Csb, Csc, Dfa, Dfb, Dfc.
Intervention	Vegetated strip interventions around and within fields used for arable, grazing and horticulture, orchards and vineyards, where presence of a vegetated strip or management of the strip is investigated.
Comparator	Before vegetated strip establishment, before a change in vegetated strip management

	(temporal comparisons); no vegetated strip, different vegetated strip management, including strip width (spatial comparisons); outside a vegetated strip.
Outcome	Outcomes will be included iteratively as they are identified within the relevant literature and will be coded accordingly

Methods

Searches

Bibliographic databases

The following academic citation databases will be searched for studies using English search terms (non-English articles, where present, are typically catalogued with English titles, abstracts and/or keywords):

1. Academic Search Premier (http://www.ebscohost.com/academic/academic-search-premier)
2. Agricola (http://www.agricola.nal.usda.gov/)
3. AGRIS: agricultural database (FAO) (http://www.agris.fao.org/agris-search/index.do)
4. Biosis Citations Index (http://www.wok.mimas.ac.uk/)
5. Directory of Open Access Journals (http://www.doaj.org/)
6. PubMed/MEDLINE (http://www.ncbi.nlm.nih.gov/pubmed)
7. Scopus (http://www.scopus.com/)
8. Web of Science Core Collections (http://www.wok.mimas.ac.uk/)
9. Zoological Record (http://www.thomsonreuters.com/products_services/science/science_products/a-z/zoological_record)
10. JSTOR (http://www.jstor.org/)
11. DART-Europe E thesis (http://www.dart-europe.eu/basic-search.php)
12. EThOS (British Library) (http://www.ethos.bl.uk/Home.do)
13. Index to Theses Online (http://www.theses.com/)

Search string

The following search string will be used as a basis for searches within each of the above databases:

("agroforestry buffer" OR "barrier strip*" OR "beetle bank*" OR beetlebank* OR "bird cover barrier*" OR "bird cover border*" OR "bird cover boundar*" OR "bird cover buffer*" OR "bird cover filter*" OR "bird cover margin*" OR "bird cover strip*" OR "bird cover zone*" OR "border strip*" OR "boundary buffer*" OR "boundary management*" OR "boundary margin*" OR "boundary strip*" OR "buffer management*" OR "buffer strip*" OR bufferstrip* OR "buffer zone*" OR bufferzone* OR "conservation buffer*" OR "conservation head land*" OR "conservation headland*" OR "countour strip*" OR "cropland buffer*" OR "cultivated barrier*" OR "cultivated border*" OR "cultivated boundar*" OR "cultivated buffer*" OR "cultivated filter*" OR "cultivated margin*" OR "cultivated strip*" OR "cultivated zone*" OR "ditch bank*" OR "farm buffer*" OR "farm edge*" OR "farm interface*" OR "farmland buffer*" OR "farmland margin*" OR "field bank*" OR "field border*" OR "field boundary*" OR "field buffer*" OR "field edge*" OR "field interface*" OR "field margin*" OR "filter margin*" OR "filter strip*" OR "filter strip*" OR filterstrip* OR "filter zone*" OR "filter zone*" OR filterzone* OR "*flower barrier*" OR "*flower border*" OR "*flower boundar*" OR "*flower buffer*" OR "*flower filter*" OR "*flower margin*" OR "*flower strip*" OR "*flower zone*" OR "forest barrier*" OR "forest border*" OR "forest boundar*" OR "forest buffer*" OR "forest filter*" OR "forest margin*" OR "forest strip*" OR "forest zone*" OR "forested barrier*" OR "forested border*" OR "forested boundar*" OR "forested buffer*" OR "forested filter*" OR "forested margin*" OR "forested strip*" OR "forested zone*" OR "grass water way*" OR "grass waterway*" OR "*grass barrier*" OR "*grass border*" OR "*grass boundar*" OR "*grass buffer*" OR "*grass filter*" OR "*grass margin*" OR "*grass strip*" OR "*grass zone*" OR "grassed barrier*" OR "grassed border*" OR "grassed boundar*" OR "grassed buffer*" OR "grassed filter*" OR "grassed margin*" OR "grassed strip*" OR "grassed water way*" OR "grassed waterway*" OR "grassed zone*" OR "grassy barrier*" OR "grassy border*" OR "grassy boundar*" OR "grassy buffer*" OR "grassy filter*" OR "grassy margin*" OR "grassy strip*" OR "grassy water way*" OR "grassy waterway*" OR "grassy zone*" OR "grazed barrier*" OR "grazed border*" OR "grazed boundar*" OR "grazed buffer*" OR "grazed filter*" OR "grazed margin*" OR "grazed strip*" OR "grazed zone*" OR "hedge row*" OR hedgerow* OR "herbacious barrier*" OR "herbacious border*" OR "herbacious boundar*" OR "herbacious buffer*" OR "herbacious filter*" OR "herbacious margin*" OR "herbacious strip*" OR "herbacious zone*" OR "managed barrier*" OR "managed border*" OR "managed boundar*" OR "managed buffer*" OR "managed edge*" OR "managed filter*" OR "managed margin*" OR "managed strip*" OR "managed zone*" OR "margin strip*" OR "nectar barrier*" OR "nectar border*" OR "nectar boundar*" OR "nectar buffer*" OR "nectar filter*"*

OR "nectar margin" OR "nectar strip*" OR "nectar strip*" OR "nectar zone*" OR "noncropped barrier*" OR "non-cropped barrier*" OR "noncropped border*" OR "non-cropped border*" OR "noncropped boundar*" OR "non-cropped boundar*" OR "non-cropped buffer*" OR "non-cropped buffer*" OR "non-cropped filter*" OR "non-cropped filter*" OR "non-cropped margin*" OR "non-cropped margin*" OR "noncropped strip*" OR "non-cropped strip*" OR "noncropped zone*" OR "non-cropped zone*" OR "perennial barrier*" OR "perennial border*" OR "perennial boundar*" OR "perennial buffer*" OR "perennial filter*" OR "perennial margin*" OR "perennial strip*" OR "perennial zone*" OR "permanent border*" OR "permanent buffer*" OR "permanent margin*" OR "permanent strip*" OR "plant barrier*" OR "plant border*" OR "plant boundar*" OR "plant buffer*" OR "plant filter*" OR "plant margin*" OR "plant strip*" OR "plant zone*" OR "planted barrier*" OR "planted border*" OR "planted boundar*" OR "planted buffer*" OR "planted filter*" OR "planted margin*" OR "planted strip*" OR "planted zone*" OR "pollen barrier*" OR "pollen border*" OR "pollen boundar*" OR "pollen buffer*" OR "pollen filter*" OR "pollen margin*" OR "pollen strip*" OR "pollen zone*" OR "riparian barrier*" OR "riparian border*" OR "riparian boundar*" OR "riparian buffer*" OR "riparian filter*" OR "riparian margin*" OR "riparian strip*" OR "riparian zone*" OR "river barrier*" OR "river border*" OR "river buffer*" OR "river margin*" OR "setaside border*" OR "set-aside border*" OR "setaside buffer*" OR "set-aside buffer*" OR "setaside margin*" OR "set-aside margin*" OR "shelter belt*" OR shelterbelt* OR "sown barrier*" OR "sown border*" OR "sown boundar*" OR "sown buffer*" OR "sown filter*" OR "sown margin*" OR "sown strip*" OR "sown zone*" OR "sterile strip*" OR "stream barrier*" OR "stream border*" OR "stream buffer*" OR "stream margin*" OR "strip management" OR "strip vegetation" OR "strip-management" OR "uncropped barrier*" OR "un-cropped barrier*" OR "uncropped border*" OR "un-cropped border*" OR "uncropped boundar*" OR "un-cropped boundar*" OR "uncropped buffer*" OR "un-cropped buffer*" OR "uncropped filter*" OR "un-cropped filter*" OR "uncropped margin*" OR "un-cropped margin*" OR "uncropped strip*" OR "un-cropped strip*" OR "uncropped zone*" OR "un-cropped zone*" OR "uncultivated barrier*" OR "uncultivated border*" OR "uncultivated boundar*" OR "uncultivated buffer*" OR "uncultivated filter*" OR "uncultivated margin*" OR "uncultivated strip*" OR "uncultivated zone*" OR "unmanaged barrier*" OR "unmanaged border*" OR "unmanaged boundar*" OR "unmanaged buffer*" OR "unmanaged filter*" OR "unmanaged margin*" OR "unmanaged strip*" OR "unmanaged zone*" OR "unploughed barrier*" OR "un-ploughed barrier*" OR "unploughed border*" OR "un-ploughed border*" OR "unploughed boundar*" OR "un-ploughed boundar*" OR "unploughed buffer*" OR "un-ploughed buffer*" OR "unploughed filter*" OR "un-ploughed filter*" OR "unploughed margin*" OR "un-ploughed margin*" OR "unploughed strip*" OR "un-ploughed strip*" OR "unploughed zone*" OR "un-ploughed zone*" OR "vegetated barrier*" OR "vegetated border*" OR "vegetated boundar*" OR "vegetated buffer*" OR "vegetated filter*" OR "vegetated margin*" OR "vegetated strip*" OR "vegetated water way*" OR "vegetated waterway*" OR "vegetated zone*" OR "vegetation barrier*" OR "vegetation border*" OR "vegetation boundar*" OR "vegetation buffer*" OR "vegetation filter*" OR "vegetation margin*" OR "vegetation strip*" OR "vegetation zone*" OR "vegetative barrier*" OR "vegetative border*" OR "vegetative boundar*" OR "vegetative buffer*" OR "vegetative filter*" OR "vegetative margin*" OR "vegetative strip*" OR "vegetative water way*" OR "vegetative waterway*" OR "vegetative zone*" OR "water way border*" OR "water way buffer*" OR "water way maring*" OR "waterway border*" OR "waterway buffer*" OR "waterway margin*" OR "weed strip" OR "weeded barrier*" OR "weeded border*" OR "weeded boundar*" OR "weeded buffer*" OR "weeded filter*" OR "weeded margin*" OR "weeded strip*" OR "weeded zone*" OR "weedy barrier*" OR "weedy border*" OR "weedy boundar*" OR "weedy buffer*" OR "weedy filter*" OR "weedy margin*" OR "weedy strip*" OR "weedy zone*" OR "widlife strip*" OR "wildlife corridor*" OR "wind buffer*" OR "wood barrier*" OR "wood border*" OR "wood boundar*" OR "wood buffer*" OR "wood filter*" OR "wood margin*" OR "wood strip*" OR "wood zone*" OR "wooded barrier*" OR "wooded border*" OR "wooded boundar*" OR "wooded buffer*" OR "wooded filter*" OR "wooded margin*" OR "wooded strip*" OR "wooded zone*" OR "woody barrier*" OR "woody border*" OR "woody boundar*" OR "woody buffer*" OR "woody filter*" OR "woody margin*" OR "woody strip*" OR "woody zone*") AND ("agro-ecosystem*" OR agroecosystem* OR agricult* OR agronom* OR arable* OR crop* OR cultivat* OR farm* OR field* OR grassland* OR "grass land*" OR hotricult* OR meadow* OR orchard* OR plantation* OR ranch* OR vineyard* OR pasture* OR cattle* OR graz*) OR "riparian buffer"*

Search terms were identified through a scoping process. Firstly, we generated a list of 120 articles known by the review authors to be relevant to the topic. The titles, keywords and abstracts were then subjected to textual analysis to identify the most frequently occurring words. Key terms were then selected from this list and added to a pre-existing list generated by the review authors. Key terms were then used to probe the titles and keywords of articles in the above list to identify common *co-locators* (i.e. words located next to key terms in the text). *Common pairs* (i.e. any pair of words that frequently occur together in the corpus) were also identified. All key terms were then assembled and tested both individually and in combination. Terms that resulted in very large numbers of results but that were also subjectively assessed as having low relevance (i.e. the terms 'vfs', 'bz', 'bzs', 'fbz') were excluded from the final search string. See Additional file 1 for details of search string development.

The search yielded a total of 10,263 results in Web of Science Core Collection using a 'topic word' search on 22/12/2015. Abstract and title level screening demonstrated that a subsample of the search results had a proportional relevance of 31 % (n = 100).

Specialist searches

Searches for grey literature will be performed in two key ways (in addition to the searches as part of the citation database searches above; i.e. thesis databases and Scopus). Firstly, searches will be performed using an extensive (i.e. downloading and assessing the first 1000 results) title-only search of Google Scholar (http://www.scholar.google.ca/intl/en/scholar/about.html) (see Web-based Search Engine Searches, below), which has been proven to return a high percentage of grey literature (c. 37 %; [56]).

Secondly, the websites of the following organisations will be queried and downloaded using web crawling software [56]:

1. Aarhus University, Department of Agroecology (http://www.au.dk/en/, http://www.agro.au.dk/en/).
2. Columbia Basin Agricultural Research Center (http://www.cbarc.aes.oregonstate.edu/long_term_pubs).
3. European Environment Agency (http://www.eea.europa.eu/).
4. European Soil Portal (http://www.eusoils.jrc.ec.europa.eu).
5. GRACEnet, USDA Agricultural Research Service (http://www.ars.usda.gov/research/programs/programs.htm?np_code=212&docid=21223).
6. Rothamsted Research (http://www.rothamsted.ac.uk/).
7. Soilservice (http://www4.lu.se/o.o.i.s/26761).
8. Swedish Board of Agriculture (http://www.jordbruksverket.se).
9. Swedish Environmental Protection Agency (http://www.naturvardsverket.se).
10. Swedish University of Agricultural Sciences (http://www.slu.se).
11. UC Davis, Agricultural Sustainability Institute (http://www.ltras.ucdavis.edu/).
12. University of Copenhagen (http://www.ku.dk/english).
13. University of Illinois, Department of Crop Sciences (http://www.cropsci.illinois.edu/research/morrow).
14. USDA Agricultural Research Service (http://www.ars.usda.gov/research/programs/programs.htm?np_code=211&docid=22480).
15. World Bank (http://www.worldbank.org/reference/).
16. Adas (http://www.adas.uk/).
17. INIA (http://www.inia.es/IniaPortal/verPresentacion.action).
18. INRA (http://www.inra.fr/).
19. Arvalis (http://www.arvalisinstitutduvegetal.fr/index.html).
20. IRSTEA (http://www.irstea.fr/accueil).
21. OPERA (http://www.operaresearch.eu/).
22. SERA-17 (http://sera17.org/).
23. Hydrotekniska Sällskapet (http://www.hydrotekniskasallskapet.se/).
24. Wageningen University (http://www.wageningenur.nl/en/wageningen-university.htm).
25. Alterra (Wageningen University) (http://www.wageningenur.nl/en/Expertise-Services/Research-Institutes/alterra.htm).
26. Greppa Näringen (http://www.greppa.nu).
27. National Farmers Union (http://www.nfuonline.com/home/).
28. RSPB (http://www.rspb.org.uk/).
29. NABU (https://www.nabu.de/).
30. European Crop Protection Association (http://www.ecpa.eu/).
31. LUKE (http://www.jukuri.luke.fi/).
32. SYKE (http://www.syke.fi/fi-FI/Julkaisut).
33. Aalto University (http://www.otalib.fi/tkk/julkaisee/).
34. Theseus (https://www.theseus.fi/).
35. ARTO (https://www.arto.linneanet.fi/vwebv/searchBasic?sk=fi_FI).
36. VIIKKI (http://www.eviikki.hulib.helsinki.fi/).
37. Hankehaavi (http://www.hankehaavi.fi/).

Internet searches

Title-only searches in Google Scholar will be performed for a range of key intervention search terms that

individually returned more than 100 search results in Web of Science during scoping. Details of these searches are provided in Additional file 1. Searches will be performed in English, French, Spanish, Swedish, German, Finnish and Danish. Only the first 1000 results are viewable within Google Scholar, but these records will be downloaded into a database for later screening using the method outlined in Haddaway et al. [56].

Supplementary searches

The results of the above searches will be tested for comprehensiveness by comparing a predefined test list of 114 studies against the combined results to ensure all of these relevant studies are found. This checking will be performed iteratively at the start of the searching process and the strategy will be adapted should additional terms be identified for inclusion in the search string. In addition, the bibliographies of all relevant reviews identified through searching will be screened to retrieve any potentially relevant studies missed by the search strategy.

Screening

All articles identified through searching will be screened at title, abstract and then full text levels for relevance using predefined inclusion criteria (detailed below). Consistency in the application of the inclusion criteria will be tested by comparing agreement between two reviewers at abstract level screening, using a subset of 200 abstracts. Disagreements will be discussed and the inclusion criteria refined where necessary. Agreement will be tested formally using a kappa test [57], and if agreement score falls below 0.6, indicating moderate agreement, a third reviewer will be consulted and a further 200 abstracts screened following discussion of disagreements. Following abstract screening, potentially relevant studies will be retrieved in full text. Unobtainable articles will be listed in the final report. All screened full texts that are excluded from the review will be listed along with exclusion reasons in the final report.

Inclusion criteria

Relevant subjects	Boreo-temperate regions as defined by the following Köppen-Geiger climate classification zones [55]: Cfa [warm temperate]; Cfb and Cfc [maritime temperate or oceanic]; Csb [dry summer or Mediterranean]; Csc [dry summer maritime subalpine]; Dfa [hot summer continental]; Dfb [warm summer continental or hemiboreal]; and, Dfc [continental subarctic or boreal (taiga)].
Relevant interventions	Vegetated strip interventions in or around fields used for arable, grazing and horticulture, orchards and vineyards, where presence of a vegetated strip or management of the strip is investigated.
Relevant comparators	Before vegetated strip establishment, before a change in vegetated strip management (temporal comparisons); no vegetated strip, different vegetated strip management, including strip width (spatial comparisons); outside a vegetated strip.
Relevant outcomes	Outcomes will be included iteratively as they are identified within the relevant literature and will be coded accordingly. Outcomes will include but are not restricted to: terrestrial and aquatic biodiversity (including connectivity); nutrient runoff or leaching; pesticide runoff, leaching or drift; soil retention; socioeconomics.
Relevant types of study design	Primary research studies involving field-based experimental manipulations and observations. Interventions must have been in place for 12 months or more. Management interventions within fields that are effected upon existing crops (such as cover crops, intercropping, etc.)

will not be considered. Furthermore, only direct evidence of the impacts of vegetated strips will be included in the map: i.e. not indirect evidence, such as the ability of a border species grown elsewhere to alter an outcome. Modelling studies will be included where they provide primary data. Laboratory studies will not be included. Relevant reviews and meta-analyses will be recorded in a separate database.

Relevant languages

All languages included where possible. Studies in languages not able to be translated will be included in a separate supplementary database.

Critical appraisal

Critical appraisal will not be undertaken within this map, since the measurement methods will vary substantially across different outcomes. A very basic quality assessment will be undertaken in the form of a 'free text' meta-data variable where a brief description of the study quality will be made, flagging up clearly unreliable research that should be excluded, or serious deficiencies that should be pointed out in those studies that remain in the map.

Data coding strategy

Meta-data (i.e. descriptive data regarding the methods and setting of each study) will be extracted from included, relevant studies and entered into a searchable database. In addition, the database will be populated with a number of variables, each given a category according to a predetermined strategy (also known as coding). This database will form one of the main outputs of the review and will be supplied as a supplementary file along with a help file. Consistency of data extraction across team members will be conducted using a subset of 100 studies to ensure complex data are extracted reliably.

The following information will be entered into the systematic map database for all included studies that are available and deemed as relevant at full text. The following types of information will be recorded (see Additional file 2 for further details): author email address, study location, soil management practices, soil description, farm management practices, vegetated strip description, vegetated strip management, study design, experimental design, sampling design, measured outcome, data location, and critical appraisal comments.

Study mapping and presentation

The database will be accompanied by a report that describes the review process and the evidence base, identifying possible knowledge gaps (i.e. subtopics requiring further primary research), knowledge gluts (i.e. subtopics with enough evidence and interest to warrant a systematic review), and best practices in research methodology. Particular attention will be paid to studies that describe vegetated strips established for multiple purposes (e.g. biodiversity and nutrient retention). In addition, the database will be displayed visually in the form of a geographical information system (GIS) that maps studies by their location across a cartographical map. This GIS will be made available via the EviEM website (http://www.eviem.se).

Additional files

Additional file 1. Search strategy development.

Additional file 2. Coding tool.

Abbreviation

N_2O: nitrous oxide.

Authors' contributions

This review protocol is based on a draft written by NRH. All authors assisted in editing and revising the draft. All authors read and approved the final manuscript.

Author details

[1] Mistra Council for Evidence-Based Environmental Management (EviEM), Stockholm Environment Institute, Box 24218, 10451 Stockholm, Sweden. [2] Environment Department, University of York, York YO10 5DD, UK. [3] Department of Ecology, Swedish University of Agricultural Sciences, 75007 Uppsala, Sweden. [4] Department of Bioscience, Aarhus University, 8600 Silkeborg, Denmark. [5] Harper Adams University, Newport TF10 8NB, UK. [6] Natural Resources Institute Finland (Luke), 31600 Jokioinen, Finland.

Acknowledgements

The authors thank two anonymous reviewers whose advice improved this protocol.

Competing interests

The authors declare that they have no competing interests. Authors of research studies included in this review will not be involved in any decisions regarding their own work.

Availability of data and materials

A list of excluded studies at full text, a list of unobtainable and un-translated articles, a list of relevant reviews and meta-analyses, the systematic map database, and the GIS will be included as supplementary files with the final review report.

Funding
This protocol and the forthcoming review are financed by the Mistra Council for Evidence-Based Environmental Management (EviEM).

Received: 15 April 2016 Accepted: 30 June 2016
Published online: 22 August 2016

References

1. Stoate C, Boatman N, Borralho R, Carvalho CR, De Snoo G, Eden P. Ecological impacts of arable intensification in Europe. J Environ Manage. 2001;63(4):337–65.
2. Stoate C, Báldi A, Beja P, Boatman N, Herzon I, Van Doorn A, et al. Ecological impacts of early 21st century agricultural change in Europe–a review. J Environ Manage. 2009;91(1):22–46.
3. Lal R. Soils and sustainable agriculture. A review. Agron Sustain Dev. 2008;28(1):57–64.
4. Sutton MA, Howard CM, Erisman JW, Billen G, Bleeker A, Grennfelt P, et al. The European nitrogen assessment: sources, effects and policy perspectives. Cambridge: Cambridge University Press; 2011.
5. Gill RJ, Ramos-Rodriguez O, Raine NE. Combined pesticide exposure severely affects individual-and colony-level traits in bees. Nature. 2012;491(7422):105–8.
6. Hallmann CA, Foppen RP, van Turnhout CA, de Kroon H, Jongejans E. Declines in insectivorous birds are associated with high neonicotinoid concentrations. Nature. 2014;511:641–3.
7. Geiger F, Bengtsson J, Berendse F, Weisser WW, Emmerson M, Morales MB, et al. Persistent negative effects of pesticides on biodiversity and biological control potential on European farmland. Basic Appl Ecol. 2010;11(2):97–105.
8. Benton TG, Vickery JA, Wilson JD. Farmland biodiversity: is habitat heterogeneity the key? Trends Ecol Evol. 2003;18(4):182–8.
9. Marshall E, Moonen A. Field margins in northern Europe: their functions and interactions with agriculture. Agric Ecosyst Environ. 2002;89(1):5–21.
10. Stutter MI, Chardon WJ, Kronvang B. Riparian buffer strips as a multifunctional management tool in agricultural landscapes: introduction. J Environ Qual. 2012;41(2):297–303.
11. Arora K, Mickelson SK, Baker JL. Effectiveness of vegetated buffer strips in reducing pesticide transport in simulated runoff. Trans ASAB. 2003;46(3):635.
12. Boyd PM, Baker JL, Mickelson SK, Ahmed SI. Pesticide transport with surface runoff and subsurface drainage through a vegetative filter strip. Trans ASAE. 2003;46(3):675–84.
13. EEA. The European environment: state and outlook: synthesis. Copenhagen: European Environment Agency; 2015. p. 2015.
14. Kronvang B, Jeppesen E, Conley D, Søndergaard M, Larsen S, Ovesen N, et al. An analysis of pressure, state and ecological impacts of nutrients in Danish streams, lakes and coastal waters and ecosystem responses to nutrient pollution reductions. J Hydrol. 2005;304:274–88.
15. Schoumans O, Chardon W, Bechmann M, Gascuel-Odoux C, Hofman G, Kronvang B, et al. Mitigation options to reduce phosphorus losses from the agricultural sector and improve surface water quality: a review. Sci Total Environ. 2014;468:1255–66.
16. Borin M, Passoni M, Thiene M, Tempesta T. Multiple functions of buffer strips in farming areas. Eur J Agron. 2010;32(1):103–11.
17. Dorioz J-M, Wang D, Poulenard J, Trevisan D. The effect of grass buffer strips on phosphorus dynamics—a critical review and synthesis as a basis for application in agricultural landscapes in France. Agric Ecosyst Environ. 2006;117(1):4–21.
18. Daniels R, Gilliam J. Sediment and chemical load reduction by grass and riparian filters. Soil Sci Soc Am J. 1996;60(1):246–51.
19. Dillaha TA. Vegetative filter strips for agricultural non-point source pollution control. Trans Am Soc Agric Eng. 1989;32:513–9.
20. Mayer PM, Reynolds SK, McCutchen MD, Canfield TJ. Meta-analysis of nitrogen removal in riparian buffers. J Environ Qual. 2007;36(4):1172–80.
21. Pisa L, Amaral-Rogers V, Belzunces L, Bonmatin J-M, Downs C, Goulson D, et al. Effects of neonicotinoids and fipronil on non-target invertebrates. Environ Sci Pollut Res. 2014;22(1):68–102.
22. Andreasen C, Stryhn H, Streibig J. Decline of the flora in Danish arable fields. J Appl Ecol. 1996;33(3):619–26.
23. Butler S, Vickery J, Norris K. Farmland biodiversity and the footprint of agriculture. Science. 2007;315(5810):381–4.
24. Eggers S, Unell M, Pärt T. Autumn-sowing of cereals reduces breeding bird numbers in a heterogeneous agricultural landscape. Biol Conserv. 2011;144(3):1137–44.
25. Hiron M, Berg Å, Eggers S, Josefsson J, Pärt T. Bird diversity relates to agri-environment schemes at local and landscape level in intensive farmland. Agric Ecosyst Environ. 2013;176:9–16.
26. Boatman N. Field margins: integrating agriculture and conservation. UK: BCPC Farnham; 1994.
27. De Snoo G. Unsprayed field margins: effects on environment, biodiversity and agricultural practice. Landsc Urb Plan. 1999;46(1):151–60.
28. Hinsley SA, Bellamy PE. The influence of hedge structure, management and landscape context on the value of hedgerows to birds: a review. J Environ Manage. 2000;60(1):33–49.
29. Marshall E, West T, Kleijn D. Impacts of an agri-environment field margin prescription on the flora and fauna of arable farmland in different landscapes. Agric Ecosyst Environ. 2006;113(1):36–44.
30. Vickery JA, Feber RE, Fuller RJ. Arable field margins managed for biodiversity conservation: a review of food resource provision for farmland birds. Agric Ecosyst Environ. 2009;133(1):1–13.
31. Batáry P, Báldi A, Kleijn D, Tscharntke T. Landscape-moderated biodiversity effects of agri-environmental management: a meta-analysis. Proc Biol Sci. 2011;278(1713):1894–902.
32. Wretenberg J, Pärt T, Berg Å. Changes in local species richness of farmland birds in relation to land-use changes and landscape structure. Biol Conserv. 2010;143(2):375–81.
33. Hoehn P, Tscharntke T, Tylianakis JM, Steffan-Dewenter I. Functional group diversity of bee pollinators increases crop yield. Proc Biol Sci. 2008;275(1648):2283–91.
34. Wratten SD, Gillespie M, Decourtye A, Mader E, Desneux N. Pollinator habitat enhancement: benefits to other ecosystem services. Agric Ecosyst Environ. 2012;159:112–22.
35. Bianchi F, Booij C, Tscharntke T. Sustainable pest regulation in agricultural landscapes: a review on landscape composition, biodiversity and natural pest control. Proc Biol Sci. 2006;273(1595):1715–27.
36. Josefsson J, Berg Å, Hiron M, Pärt T, Eggers S. Grass buffer strips benefit invertebrate and breeding skylark numbers in a heterogeneous agricultural landscape. Agric Ecosyst Environ. 2013;181:101–7.
37. Douglas DJ, Vickery JA, Benton TG. Improving the value of field margins as foraging habitat for farmland birds. J Appl Ecol. 2009;46(2):353–62.
38. Scheper J, Holzschuh A, Kuussaari M, Potts SG, Rundlöf M, Smith HG, et al. Environmental factors driving the effectiveness of European agri-environmental measures in mitigating pollinator loss–a meta-analysis. Ecol Lett. 2013;16(7):912–20.
39. Forman RT, Baudry J. Hedgerows and hedgerow networks in landscape ecology. Environ Manage. 1984;8(6):495–510.
40. Capinera JL. Relationships between insect pests and weeds: an evolutionary perspective. Weed Sci. 2005;53(6):892–901.
41. Silva JP, Palmeirim JM, Moreira F. Higher breeding densities of the threatened little bustard Tetrax tetrax occur in larger grassland fields: implications for conservation. Biol Conserv. 2010;143(11):2553–8.
42. Dänhardt J, Green M, Lindström Å, Rundlöf M, Smith HG. Farmland as stopover habitat for migrating birds–effects of organic farming and landscape structure. Oikos. 2010;119(7):1114–25.
43. Baldi A, Batary P. Spatial heterogeneity and farmland birds: different perspectives in Western and Eastern Europe. Ibis. 2011;153(4):875–6.
44. Van Dijk P, Kwaad F, Klapwijk M. Retention of water and sediment by grass strips. Hydrol Process. 1996;10(8):1069–80.
45. Wilson L. Sediment removal from flood water by grass filtration. Trans ASAE. 1967;10:35–7.
46. Schultz RC, Collettil J, Isenhart T, Simpkins W, Mize C, Thompson M. Design and placement of a multi-species riparian buffer strip system. Agrofor Syst. 1995;29(3):201–26.
47. Potts G. The partridge: pesticides, predation and conservation. London: Collins; 1986.
48. Morris AJ, Gilroy JJ. Close to the edge: predation risks for two declining farmland passerines. Ibis. 2008;150(s1):168–77.

49. Oakley M, Bounds D, Mollett T, Soutiere E. Survival and home range estimates of pen-raised northern bobwhites in buffer strip and non-buffer strip habitats. In: Quail V, editor. Proceedings of the fifth national quail symposium. Austin: Texas Parks and Wildlife Department; 2002. p. 74–80.
50. Hackett M, Lawrence A. Multifunctional role of field margins in arable farming. Report for European Crop Protection Association by Cambridge Environmental Assessments – ADAS UK Ltd., Report no. CEA.1118. 2014.
51. Vought LBM, Pinay G, Fuglsang A, Ruffinoni C. Structure and function of buffer strips from a water quality perspective in agricultural landscapes. Landsc Urb Plan. 1995;31(1):323–31.
52. Uusi-Kämppä J, Jauhiainen L. Long-term monitoring of buffer zone efficiency under different cultivation techniques in boreal conditions. Agric Ecosyst Environ. 2010;137(1):75–85.
53. Bedard-Haughn A, Tate K, Van Kessel C. Using nitrogen-15 to quantify vegetative buffer effectiveness for sequestering nitrogen in runoff. J Environ Qual. 2004;33(6):2252–62.
54. Stevens CJ, Quinton JN. Diffuse pollution swapping in arable agricultural systems. Crit Rev Environ Sci Technol. 2009;39(6):478–520.
55. Kottek M, Grieser J, Beck C, Rudolf B, Rubel F. World map of the Köppen-Geiger climate classification updated. Meteorologische Zeitschrift. 2006;15(3):259–63.
56. Haddaway NR, Collins AM, Coughlin D, Kirk S. The role of google scholar in evidence reviews and its applicability to grey literature searching. PLoS One. 2015;10(9):e0138237.
57. Cohen J. A coefficient of agreement for nominal scales. Educ Psychol Meas. 1960;20(1):37–46.

WetlandInfo — Department of Environment and Science

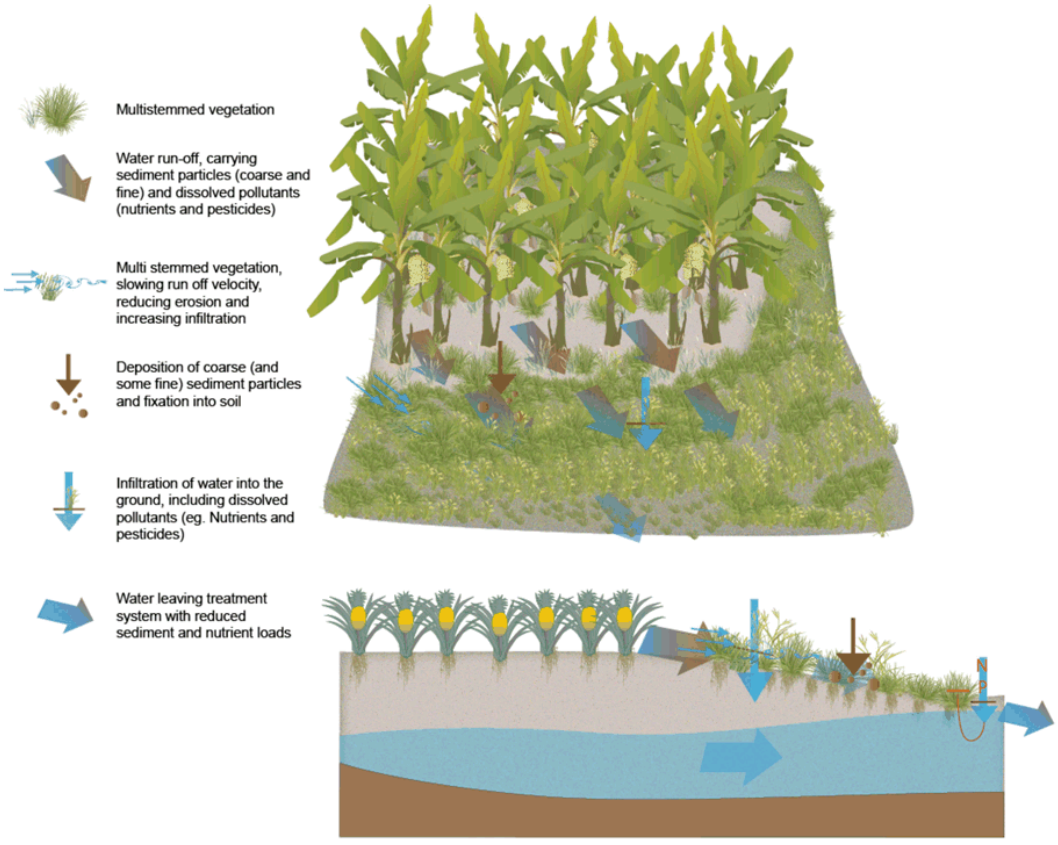
Queensland Government

Home > Management > Treatment systems > For agriculture > Treatment system options > Vegetated buffers and swales

Vegetated buffers and swales

« expand content to fit window »

Buffers | Swales



Select from the tabs below

Overview | Key Considerations | Planning and design | Construction and operation | Links and references

Other name/s

Vegetated buffers and swales, filter strips, riparian buffers

Description

Vegetated buffers and swales for agricultural water quality improvement are vegetated areas that separate an agricultural production area from a waterway or wetland. Buffers are usually located perpendicular to water flows whereas swales are located parallel to the flow and convey water in a drainage line (as shown in the diagrams). Vegetated buffers and swales are primarily used as a best management practice in agricultural production systems to prevent erosion, but they can have a secondary benefit as a treatment system, although their effectiveness in treating agricultural run-off varies depending on site conditions[3][4]. Vegetated buffers and swales help protect wetlands and waterways from the impact of adjacent land

uses and can also protect agricultural land from flooding and bank erosion. They can be vegetated with grass, trees or both and the type of vegetation influences the services that buffers can provide.

A grass buffer located immediately adjacent to the crop has been shown to be more effective than trees for treating run-off while deep rooted trees in the riparian area are more effective for bank stabilisation[4][1]. A buffer with grass closest to the agricultural production area and trees adjoining the receiving environment could therefore help achieve multiple water quality, bank stabilisation and habitat benefits (Figure 1).

Figure 1 Buffer with a combination of grass adjacent to the banana production area and riparian/forested buffer adjoining the river.
Photo by Peter Breen

When used as part of a treatment system, vegetated buffers and swales work by increasing the roughness of the ground surface and therefore increasing friction, which slows the water velocity and causes settling of coarse to medium sediments and some particulate nutrients and pesticides. By slowing the flow velocity, water is given more opportunity to infiltrate into the soil, rather than run off. Infiltration of water into the soil is the most efficient way for vegetation structures to assist in removal of finer sediments (e.g. less than 40µm (microns) in diameter), nutrients and pesticides[2]. In some cases, pollutants can also be removed through adsorption to the plant or soil material[4] or uptake by vegetation[5].

Vegetated buffers and swales are best positioned as one of the first systems in a treatment train to prevent erosion and enable trapping of coarse to medium sediments prior to run-off entering other treatment systems. They provide an important pre-treatment function for other elements in a treatment train.

Illustration of possible locations for buffers and swales in a treatment train.

For more information on the different buffer designs and principles refer to the Queensland Wetland Buffer Planning Guideline (PDF, 4.4 MB) on Wetland*Info*.

Services provided

- Bank stabilisation
- Soil conservation
- Water treatment (sediment, some nutrients and pesticides)
- Spray-drift management
- Wildlife habitat
- While buffers can provide many services the focus of this guidance is on water quality improvement

Disclaimer

In addition to the standard disclaimer located at the bottom of the page, please note the content presented is based on published knowledge of treatment systems. Many of the treatment systems described have not been trialled in different regions or land uses in Queensland. The information will be updated as new trials are conducted and monitored. If you have any additional information on treatment systems or suggestions for additional technologies please contact us using the feedback link at the bottom of this page.

References

1. ^ Department of Employment, EconomicDevelopmentandInnovation 2011, *Wetland Management Handbook: Farm Management Systems (FMS) guidelines for managing wetlands in intensive agriculture.*, Queensland Wetlands Program, Brisbane, <https://wetlandinfo.des.qld.gov.au/resources/static/pdf/resources/reports/fms/fms_025_handbook_web.pdf (PDF)>.
2. ^ Liu, X, Zhang, Z & Zhang, M 2008, 'Major factors influencing the efficacy of vegetated buffers on sediment trapping: A review and analysis', *Journal of Environmental Quality*, vol. 37, pp. 1667-1674.
3. ^ McKergow, LA, Prosser, IP, Grayson, RB & Heiner, D 2004, 'Performance of grass and rainforest riparian buffers in the wet tropics, Far North Queensland. 2. Water quality.', *Australian Journal of Soil Research*, vol. 42, no. 4, pp. 485-498.
4. ^ a b c Reichenberger, S, Bach, M, Skitschak, A & Frede, H 2007, 'Mitigation strategies to reduce pesticide inputs into ground- and surface water and their effectiveness; a review.', *Science of the Total Environment*, vol. 384, pp. 1-35.
5. ^ USDA 2000, *Conservation buffers to reduce pesticide losses.*, USDA Natural Resources Conservation Service, <https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_023819.pdf (PDF)>.

Last updated: 5 October 2018

This page should be cited as:

Vegetated buffers and swales, WetlandInfo 2018, Department of Environment and Science, Queensland, viewed 19 April 2020, <https://wetlandinfo.des.qld.gov.au/wetlands/management/treatment-systems/for-agriculture/treatment-sys-nav-page/vegetated-buffers/>.

Shelterbelt Design

Note Number: LC0136
Published: May 2006
Updated: October 2009

The benefits of shelter to the farm enterprise have long been recognised and include protection of crops, livestock, and the home, reduction of soil erosion, salinity control and biodiversity improvements.

There are many reasons to establish shelterbelts and what you want your shelterbelts to do, determines the type of shelterbelt you should plant.

This note outlines the many aspects of design and location, which you should consider when planning your shelterbelt to ensure a successful and efficient result.

How shelterbelts work

Shelterbelts are vegetative barriers that are designed to reduce wind speed and provide sheltered areas on the leeward side away from the wind) and windward (the side toward the wind) sides of the shelterbelt.

As wind approaches the belt, some goes around the end of the belt, some goes through the belt and most goes over the top of the belt.

Air pressure builds up on the windward side and decreases on the leeward side. It is this difference in pressure that drives the shelter effect and determines how much reduction in wind speed occurs and how much turbulence is created.

The amount of air pressure difference is determined by the structure of the shelterbelt. The more dense the shelter, the greater the difference in air pressure.

The structure of a belt can be altered by modifying the:

- height
- density
- number of rows
- species composition
- spacing between the trees or shrubs.

Paying attention to the length, orientation and continuity of your shelterbelt will also improve its efficiency.

Design of a shelterbelt

The first step in designing a shelterbelt is to determine what you want that belt to do. What you want the shelterbelt to do determines the type of shelterbelt to plant. Shelterbelts can actually have a detrimental impact on farm productivity if they are not appropriately designed.

There are several key elements to effective shelterbelt design. The elements that need to be considered when designing a windbreak are height, length, density, location, number of rows and the species to be used.

It is important to maximise the height of a windbreak, as its height will determine the area over which the windbreak has a positive impact.

Using the tallest suitable shelter species in at least one row of the belt will increase the eventual area over which a windbrea is effective. The use of good quality plant species from a local provenance will help to achieve this. The species used for the taller row can be fast growing, to achieve maximum height quickly.

Longer windbreaks are more effective than short ones. Wind has a tendency to flow around the ends of a shelterbelt and increase turbulence at that point. Therefore to reduce overall turbulence it is wise to create a shelterbelt that is as long as possible. The length of a windbreak combined with its height determines the extent of the protected area. For maximum efficiency the uninterrupted length of the windbreak should be at least 10 times it's height.

Gaps within a windbreak reduce its effectiveness. Gaps can result in an increase in wind speed due to the wind accelerating as it funnels through the gap within the shelterbelt. This effect is often called wind tunneling.

Where gaps in a break are necessary, for example for gateways, a small strip of shelter in front of the gap or creating an angled gap can over come this problem.

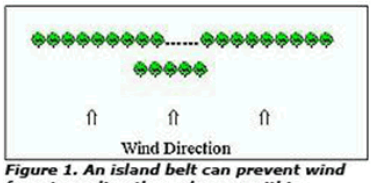


Figure 1. An island belt can prevent wind from tunneling through gaps within a shelterbelt

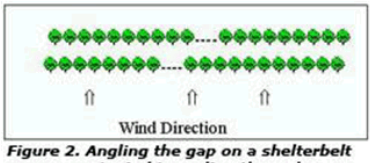


Figure 2. Angling the gap on a shelterbelt can prevent wind tunneling through gateways etc.

Density

The desired density of a shelterbelt depends upon the purpose of the belt. Density is the proportion of solid material, such as foliage, branches etc. within a windbreak. Density can effect the extent and level of shelter provided. Wind turbulence is generally reduced with lower degrees of density.

A high-density shelterbelt will provide a higher level of shelter over a shorter distance than a medium or low-density belt. Therefore very dense windbreaks may be used where a high level of shelter is required over a short distance.

A very dense windbreak forces wind to be pulled down on the leeward side creating turbulence. As the density of a shelterbelt is reduced, more air passes through the shelterbelt and reduces the amount of turbulence created by the dense windbreak. As a result the extent of the down-wind protected area increases.

The design should aim for a medium density belt with a density of around 40-60%. It should also aim to have an even densit from the ground level to the top of the shelterbelt.

If shelter is not provided to ground level wind will tunnel through the gaps at the bottom of the belt creating a zone of higher wind speed immediately to the lee of the belt. To achieve even density, shelter should be established using shrubs and ground cover species as well as taller species. Advice on suitable species can be obtained from our offices.

Using species with dense foliage, having more rows or spacing plants closer together can increase windbreak density.

Row design

Multiple windbreak rows are less susceptible to the impacts of gaps and non-uniform growth and are more likely to achieve a greater overall height.

Single row species can be effective if they are established using a species that has a uniform foliage density from ground level to the top of the belt. One or two row belts can be effective and economical if they are well designed and use appropriate species. The effectiveness of these belts depends on high survival rates of plants.

An effective windbreak design often consists of 2- 4 rows using taller species that provide the benefits of a tall belt combined with shrub species that provide shelter lower down and therefore overall a more uniform density.

Shelterbelts of 2-4 rows can provide significant benefits while not requiring large areas of land to be removed from direct productivity purposes. It is important to select appropriate species for belts of one or two rows because they may be significantly less effective if the form of the species varies significantly.

Increasing the number of rows can provide different benefits but not more protection of land. Biodiversity aspects of a belt ar increased through increasing the width of a belt. Tailoring the number of rows to the objective is the key to a successful belt.

Including a row of fast growing species can provide quicker benefits and also protect species that are slower to establi This row can later be removed if desired.

A stock haven can be created if belts are wide enough. Stock can be moved into the vegetated area itself during spells extreme weather conditions but they will damage the haven and should generally be excluded.

Timber production can be incorporated into a multi-rowed shelterbelt. Timberbelts consist of a row or rows of timber species combined with lower growing shrub species.

See Agriculture Notes AG0756 - Introducing Timberbelts and AG0757 - Timberbelt Design.

Plant location and spacing within shelterbelts

Rows should be spaced between 2 to 4 metres apart to allow the plants to grow relatively unrestricted. There should be at least 2 metres between the first row of plants and the fence to prevent stock from grazing on the plants.

Smaller trees and shrubs should be placed on the outer rows of a belt to prevent them from being shaded out by the taller species.

One aspect of design to keep in mind is the common misconception that a sloping cross-section profile enhances windbreak effectiveness. Steep sided belts shelter a larger area because they provide a greater height barrier to wind flow and a lower density on the windward side. Sloping profiles on the windward side can actually reduce the distance over which protection i provided.

Taller species should be placed in the centre of a belt. Lower growing species can be placed on each side. The cross sectional profile of a break that consists of shrub species on both sides, it is a more valuable design for wildlife habitat and is more practical. Large tree branches are less likely to fall on and damage fences if the trees are located in the centre of the belt.

Considerations when deciding spacings between plants should include the time taken for the plants to reach the desired density level and the size of the species selected. Medium to tall trees are usually spaced 3 to 4 metres apart. Large shrubs can be spaced between 2.5 to 4 metres while smaller growing shrubs are generally placed 1.5-2.5 metres apart.

Plants should be placed closer together in belts with fewer rows to obtain the desired level of density. This will also provide protection more quickly. Staggering trees in alternate rows can obtain more uniform density and a reduction in gaps so that they are not directly opposite each other.

Species selection

The species selected for your shelterbelt should provide the height, growth rate and density characteristics suitable for the objectives of the belt.

Points for consideration when selecting plant species include:

- Locally native species generally have higher survival and establishment rates.
- Locally native species provide valuable habitat for local wildlife species.
- Species that will grow tall on the site should be used for one or more rows. Noting the height and health of particular tree species in the area can identify these species.
- Species with an appropriate foliage density that complements the height and density of other selected species to obtain even and suitable density should also be used.
- The growth rate of species should be taken into consideration. Where the effects of shelterbelts are required qu fast growing species can be used.
- The use of species that regenerate naturally on the site may be useful where this is desirable.
- Having too many different species can reduce the uniformity of the shelterbelt. Generally people use one specie row or species with similar or compatible growth forms.

The use of species that provide timber for firewood fence posts or commercial uses may be desired. Using a shelterbelt for timber production may require more specific management practices. Information on appropriate species and management can be obtained from Forestry Officers by contacting us.

Fodder species can be used in a shelterbelt to provide a food source. These plants can be grazed directly by stock or cut an provided to stock. Removing fodder from the belt can compromise its ability to provide shelter.

References such as Trees and Shrubs for South West Victoria (Bird et. al) are excellent sources of information on plant species and their suitability for particular purposes.

Windbreak location

The location of shelterbelts will determine their level of effectiveness. Thought should be given to the location of a shelterbelt that will provide the maximum benefit for stock, crops, pasture and wildlife.

The direction of prevailing and other winds and the location of stock and crops that require protection are major deciding factors on the orientation of shelterbelts. Shelterbelts should be placed perpendicular to problem winds. No single orientatior of a shelterbelt will provide protection from all winds. Therefore several belt orientations will provide greater shelter.

A consideration for the siting of shelterbelts is the ability to move livestock into sheltered areas during adverse conditions. It can be difficult to move stock in a direction that opposes the wind direction. This needs to be weighed up against potential reduction in protection if the belt is not perpendicular to the problem winds.

During summer shelterbelts can protect pasture and crops from moisture losses by reducing the impact of hot drying winds. Shelterbelts can also reduce erosion by wind during summer months when soils can be bare. Ideally belts should form a gric using north-south and east-west orientations. This will provide shade for stock at different times of the day and protection from winds coming from all directions.

Alternatively, cornered windbreaks provide protection from winds that come from a range of directions. Therefore a windbrea established in a right angled corner protects a larger area from a range of wind directions.

North-south orientated windbreaks will prevent permanent shading of pastures and crops as they will receive sunlight at different times of the day.

The incorporation of remnant vegetation will provide a cost-effective belt and one that enhances biodiversity values.

Hillside plantings

Shelterbelts can generally be established at the mid-slopes on the contour of a hill or on the crest of a hill. Gullies on a hill ar generally protected. Steeper and higher areas of the hill are generally more exposed to wind. Planting on the ridge of a hill provides extra height which in turn increases the area sheltered. Hill top plantings can protect areas that are prone to erosior and strong winds.

Plantings on the contour of a hill can trap air and create a localised frost zone unless precautions are taken. Establishi gaps within the belt or allowing the air to drain out at one end can reduce this effect. Alternatively reducing the density belt on a contour can reduce the effect also.

Establishment

It is very important to plan and prepare the site for a shelterbelt in advance. Thorough site preparation will ensure a shelterbelt gets off to a good start, reaches an ideal height and maximises it's potential to achieve the your objectives. In the longer term less work is involved in the establishment of a belt on a site that has been well prepared.

Thorough weed control and ripping of a site into which tubestock is to be planted is vital. It is frequently said that the three most important factors involved in site preparation are weed control, weed control and weed control.

Weed removal should be undertaken well in advance of planting or direct seeding. This will allow moisture to be held within the soil rather than be used by weeds.

On some sites deep ripping of the site will also improve the water availability for tubestock plantings and should also be undertaken in advance. Ripping also promotes deep, strong root growth.

Mounding the site may be an important preparation technique for sites prone to water logging or cracking.

An integrated pest animal control program should be implemented prior to planting if required. Young trees are susceptible t grazing by rabbits and hares. Rabbit proof netting may be placed around the site to protect it from re-invasion following control works. Native species such as kangaroos and cockatoos may also damage young plants.

Stock proof fencing should be constructed around the site prior to planting. Stock can cause high levels of damage in a very short amount of time.

Advice on vegetation establishment and site preparation can be obtained from our offices. See Landcare Note LC0104 - Tre planting and Aftercare.

Conclusion

There has been a large amount of research into the benefits, design and economics associated with shelterbelts. These studies have shown that correctly designed belts can provide a range of significant benefits to landholders.

Shelterbelts can contribute towards the creation of a more productive, sustainable and visually attractive farm. They also provide intrinsic values for wildlife and contribute to the overall landscape appearance of an area.

Further reading

See Landcare Notes:

LC0137: Shelterbelts for Livestock Protection

LC0138: Shelterbelt Management

LC0139: Shelterbelts and Wildlife

LC0104: Tree planting and aftercare

LC0133: The benefits of using indigenous plants

Australian Journal of Experimental Agriculture (2002) Special edition, Vol. 42, Number 6.

Bird, P.R. (2000) Farm Forestry in Southern Australia. Pastoral and Veterinary Institute Hamilton, Centre State Printing.

Bird, P.R., Kearney, G.A. and Jowett, D.W. (1994) Trees and Shrubs for South West Victoria. Pastoral and Veterinary Institut Hamilton. Osborn Mannett Pty. Ltd.

Design Principles for Farm Forestry - a guide to assist farmers to decide where to place trees and farm plantations on farms (RIRDC1997)Burke, S. (1998) Windbreaks. Inkata Press, Sydney

Acknowledgements

This Landcare note was developed by Hayley Johnson and Dr James Brandle (USA), May 2009.

It was reviewed Hayley Malloy, Farm Services Victoria. October 2009.>

ISSN 1329-8062

Published and Authorised by:
Department of Environment and Primary Industries
1 Spring Street
Melbourne, Victoria

Buffer strips

This fact sheet is one of a series which provides advice to extension officers and land managers on the use of buffer strips to improve farm run-off water quality, specific to coastal agriculture in the wet/dry tropics region between central and Far North Queensland.

Buffer strips

Buffers have many different purposes depending on the area to be buffered, the values of that area and the threats which the buffer is designed to manage. This factsheet deals specifically with buffer strips which have the primary purpose of intercepting water flow on its way to a watercourse or drain (may also be known as grassed filter strips).

Buffer strips work by allowing shallow dispersed flow to move through the vegetation, which then traps the sediments and particulate matter.

The flow into buffer strips needs to be dispersed and needs to remain that way as the water moves through the strip. Vegetation cover in the buffer strip needs to be similar in structure and must be maintained. The formation of concentrated flow channels should be avoided.

Where buffer strips are immediately adjacent to crop areas, the buffer can be slashed to manage pests.

Treatment processes

Vegetation within buffer strips slows the speed of run-off, allowing sediments to be deposited into the buffer strip area.

Infiltration of water into the buffer strip also assists with the removal of other pollutants; however, buffer strips are less effective at removing dissolved nutrients and pesticides (Table 1). Buffer strips perform best when there is dense vegetation growth at the ground level, e.g. vegetation with multiple stems and groundcover, and shallow flow depths (below the vegetation height).

Example of a buffer strip. Photo: Peter Breen

Table 1 - Summary of buffer treatment processes

Pollutant Size / Type	Treatment Performance	Description of Buffer Treatment Process
Coarse to medium sized pollutants (e.g. coarse sediments and organic matter)		Vegetation facilitates enhanced sedimentation of particles, particularly coarse to medium sediments, through filtration and deposition.
Fine particulates (e.g. fine sediments and particulate nutrients)		Vegetation may also trap some fine particles which may retain or adsorb pollutants.
Dissolved pollutants (e.g. nutrients, chemicals and pesticides)		Direct uptake of nutrients by vegetation is achieved after infiltration. After infiltration, saturated sediments in buffer strips can provide suitable conditions for denitrification which transforms nitrate into nitrogen gas.

1 The Queensland Wetland Buffer Planning Guidelines has been developed to assist with the design of a wetland buffer that will maintain wetland environmental values and protect wetlands from current and future threats from adjacent land uses. Available at www.wetlandinfo.ehp.qld.gov.au

Australian Government

Queensland Wetlands Program

Queensland Government

Use of buffer strips on farms to manage run-off

Vegetated buffer strips can be used as part of an overall farm drainage strategy to improve run-off water quality provided best practice farm management is implemented and a number of key design considerations are addressed. Planning treatment elements should also consider their position in the catchment and whether the location is suitable.

Sizing and site constraints

To improve performance, water flows need to be dispersed and shallow when entering buffer strips e.g. as sheet flows. These flows should enter the system laterally, ensuring all flows move throughout the full width of the buffer strip rather than through discrete channels.

Buffer strips are therefore less well suited to sites with:

- Steep topography (>4%)—flow velocities are likely to move quickly through the area, reducing treatment performance.
- Large catchment (>2ha)—flow volume and velocities will be too large to achieve optimal treatment performance.
- Channelised flows—buffer strips require dispersed surface flow and are unable to provide optimal treatment for channelled flows.

These site characteristics don't preclude the use of buffer strips, but they may require additional design considerations with cost implications to achieve desired treatment performance.

Even if the site constrains the use of buffer strips to treat run-off, they can still be an effective way to prevent erosion and provide some other buffer functions between the production area and adjoining drainage lines or waterways and should be considered as part of the farm layout.

Position and role in a run-off treatment train

Buffer strips provide good treatment (i.e. coarse sediment removal) prior to flows being conveyed along other treatment devices, such as swales, and are therefore best positioned as one of the first treatment systems in a treatment train (Figure 2).

The adoption of in-paddock best management practices and appropriate location within the drainage regime of the farm will protect the buffer strip from scour and high levels of sedimentation and will improve the overall water quality leaving the farm.

Buffer strips can also be located along receiving environments to protect existing vegetation, in-stream habitats and improve water quality entering these larger drains or waterways.

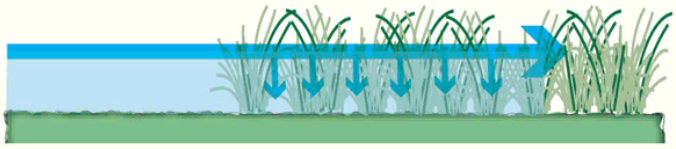


Figure 1 - Buffer strips trap sediments through deposition as surface flows move through the vegetation as sheet flow.

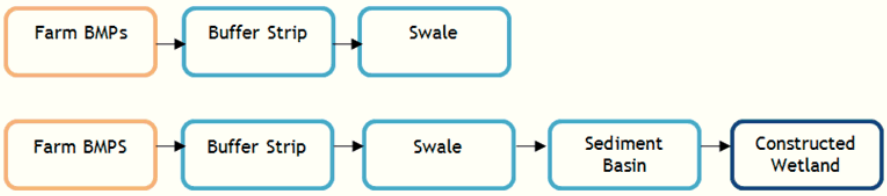


Figure 2 - Possible locations of buffer strips in farm run-off treatment trains.

Design, construction and maintenance

Design requirements

When designing vegetated buffer strips consider the following design features to enhance their treatment performance:

Width

Width will be driven largely by the available space, but the wider the buffer, the greater the treatment capacity.

Slope

Steep slopes through the buffer area will result in poor treatment performance as flow velocities will be high. Slow, uniform flows through the area will result in the optimal treatment performance.

Vegetation type

Buffer vegetation can be a mix of native grasses, sedges and rushes. The most cost effective approach is to seed the system with a mix of native species or if suitable vegetation exists nearby on farm, allow the vegetation to recruit or colonise naturally. Natural recruitment runs the risk of erosion, increased weediness and increased maintenance. Rhizomatous species should also be included in the mix to help resist traffic impacts.

Soils

Soils need to be suitable to support growth of buffer strip vegetation and may need to be watered during drought periods.

Flow velocities

Velocities through the buffer strips should be kept low, preferably less than 0.1m/s for frequent flows and less than 2m/sec in major storm events, to prevent damaging the vegetation.

Additional design considerations

Weed management

Dense stands of trees in buffer strips designed for run-off treatment should be avoided as while they can shade out weeds, they may also shade out the groundcovers. Densely vegetated groundcovers are preferable in these systems as they can make it difficult for weeds to establish by occupying the habitat. For more information on the different buffer designs and values refer to the Wetland Buffer Planning Guideline on www.wetlandinfo.ehp.qld.gov.au.

Sediment removal

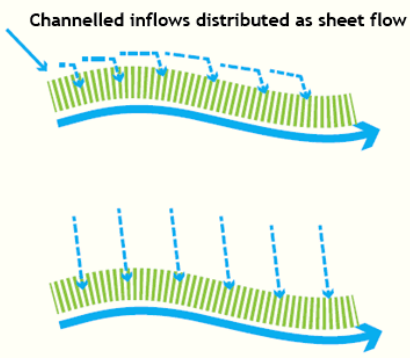
As the buffer strip will accumulate sediment over time it is important to design the area to allow for periodic removal of the sediment from the buffer strip and placement back onto the farm.

Traffic damage

Buffer strips need to be protected from traffic damage. As part of farm BMP, wet season routes need to be identified.

Key Design Questions

1. Is the farm run-off delivered to a buffer strip as sheet flow?
   - If not, can an inflow be dispersed via a contour drain to attain sheet flow?
2. Can run-off be directed to an area with the following characteristics?
   - be capable of retaining good vegetation cover
   - have a moderate slope or be flat
   - be capable of supporting sheet flow with no preferential flow paths.



Find all your wetlands management resources on Wetland*Info*
www.wetlandinfo.ehp.qld.gov.au

Typical construction issues

Existing vegetation and approvals

A buffer strip can make use of existing vegetation, and should not involve removing any native vegetation. This avoids the requirement for any clearance approvals.

However, as the hydrology of the area may be altered (e.g. introduction of more flow through the vegetation), the sensitivity of the existing vegetation to periodic or extended wetting should be considered as should the potential impacts on any downstream wetlands and waterways.

Earthworks

Buffer strips should require only minimal earthworks, especially if flows already enter the area as sheet flow. If this is not the case, some earthworks may be required to create a contour drain along the upper edge of the buffer to disperse flows into the buffer. This could be done with small breaches in the swale at regular intervals. The amount of earthworks should be kept to a minimum to avoid disturbing acid sulfate soils and shallow bedrock. Exposing bare soils should be minimised during construction to reduce the risk of sediment moving off site. Also, earthworks within the vicinity of an area mapped as a wetland protection area may trigger an approval process.

Planting and establishment

Buffer strips need to be well vegetated. The most suitable species are grasses, sedges and rushes. Grass seeds can be used or naturally occurring grasses and groundcovers can be encouraged to germinate in the buffer area.

Use local guidelines if they are available to assist with plant selection or contact your local Landcare or NRM group. Naturally vegetated systems such as waterways, wetlands and riparian zones are a good reference from which to create a species template.

The dry season is the best time to establish a buffer strip to reduce the risk of run-off induced erosion. It allows for adequate establishment and root growth before heavy summer rainfall. Planting early in the dry season would take advantage of the existing moisture in the soil. Irrigation and weed management may be needed until the vegetation is fully established.

Cost implications/risk

The risk of not achieving the desired design planting densities is poor treatment performance and the colonisation of weeds in the buffer. Therefore, it is important that the vegetation in the buffer is established successfully.

Cost savings can be gained by using existing vegetated areas as buffers. Where this is not an option grass seed can be a cheaper alternative to seedlings.

Maintenance

Buffer strips rely on good, dense, similarly structured vegetation for optimal treatment. Adequate vegetation growth is the key maintenance objective for buffer strips while minimising channelisation.

The most intensive period of maintenance is during the plant establishment period when watering and replanting/reseeding may be required to ensure design densities of plants are achieved.

Typical maintenance will involve:

- Buffer vegetation being slashed to 300mm to maintain good cover and growth. Where buffers are immediately adjacent to crop areas the buffer can be slashed to 100mm to manage pests. The slashed material should be removed from the area and used on the farm.
- Weed management to prevent propagation of weeds downstream or in riparian zones.
- Replanting/reseeding of desired species to achieve design densities.
- Irrigating vegetation, as required.
- Removing sediment if its build-up is concentrated and impedes even flows through the buffer area. This should be done during the dry season to allow re-establishment of vegetation before the next wet season. Removed sediment should be disposed of in the farm blocks, away from the buffer and any other drainage lines.
- Filling any areas in the buffer that have been caused by erosion which are channelling flows.

The buffer strips should be inspected every six months or after every major rain event.

Slashed buffer between cane block and water reuse pit. Photo: E2DesignLab

Further information

This fact sheet is part of a series on run-off treatment systems, as listed below. The Wetland Management Handbook provides more detail on treatment structures and general farm management to improve water quality leaving farms.

These resources and other wetland management tools and guides are available at http://wetlandinfo.ehp.qld.gov.au/wetlands/management/wetland-management/

Number	Publication Title
Fact sheet 1	Farm run-off treatment systems—toolkit
Fact sheet 2	Buffer strips
Fact sheet 3	Vegetated swales and drains
Fact sheet 4	Sediment basins
Fact sheet 5	Constructed (treatment) wetlands

These factsheets were developed by the Queensland Department of Agriculture, Fisheries and Forestry (QDAFF), Healthy Waterways and E2DesignLab with funding from the Queensland Wetlands Program.

The Queensland Wetlands Program supports projects and activities that result in long-term benefits to the sustainable management, wise use and protection of wetlands in Queensland. The tools developed by the Program help wetlands landholders, managers and decision makers in government and industry. The Program is a joint initiative of the Australian and Queensland governments.

Contact wetlands@ehp.qld.gov.au
or visit www.wetlandinfo.ehp.qld.gov.au

QWP/2013/19

E2DESIGNLAB

HEALTHY WATERWAYS

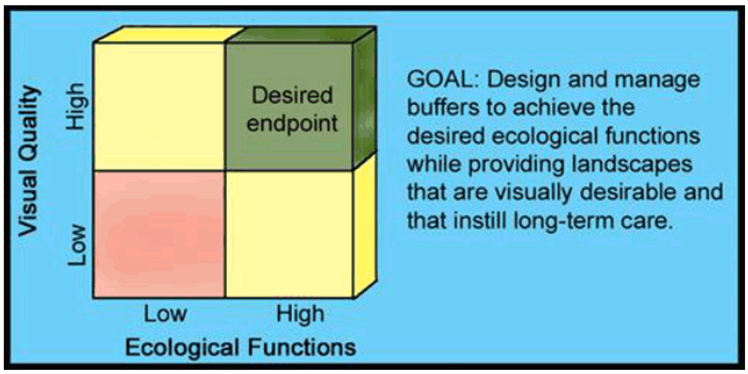
Find all your wetlands management resources on Wetland*Info*
www.wetlandinfo.ehp.qld.gov.au

Conservation Buffers

USDA National Agroforestry Center

GUIDELINES / 6.0 Aesthetics & Visual Quality

6.5 Developing an Ecological Aesthetic



Many people, regardless of background, prefer similar visual elements in the landscape. Some of these include:

Commonly Preferred Visual Elements

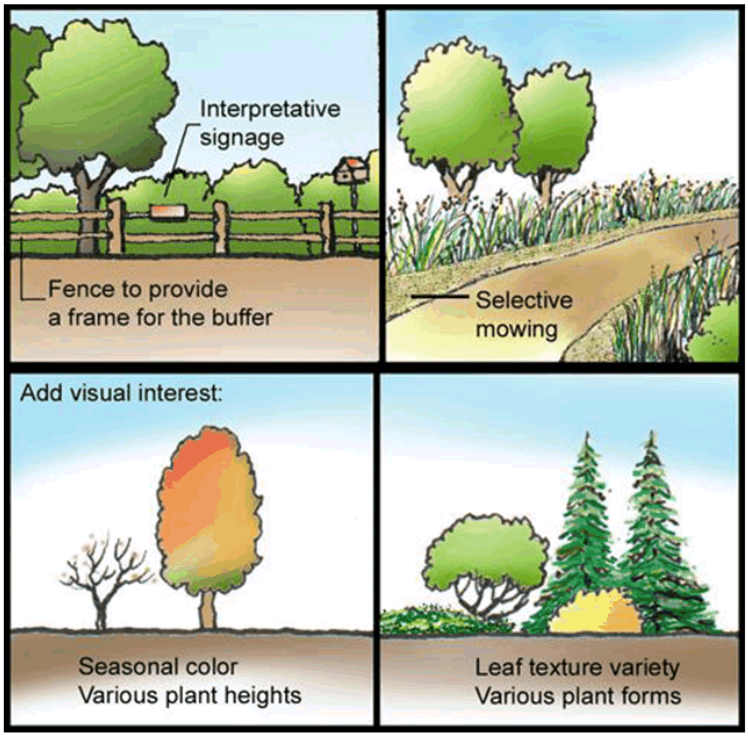
- Waterscapes (e.g., lakes, meandering streams)
- Manicured landscapes
- Savanna or park-like landscapes
- Trees in scale with surrounding features
- Absence of dead and downed wood
- Clean waterways with no or limited woody debris
- Large mature trees and trees with broad canopies
- Spaces defined by edges (e.g., pasture bordered by woods)

Some of these visual elements are not desirable for achieving goals such as water quality and wildlife habitat. Naturalistic landscapes providing valuable ecological functions are often viewed as untidy and undesirable, while manicured landscapes with limited ecological functions are perceived as demonstrating stewardship and are visually desirable.

The challenge is to design buffers that achieve the desired ecological functions while providing landscapes that are visually desirable and that instill long-term commitment. The next page provides strategies for addressing this challenge.

Strategies for Enhancing Visual Preference of Buffers

- Design the part of the buffer viewable by public to be visually pleasing while the interior can be designed to achieve the desired ecological functions.
- Use selective mowing to indicate stewardship without greatly reducing the ecological functions.
- Provide visual frames to contain and provide order around the buffer (e.g., wooden fence).
- Use interpretative signage and education programs to increase awareness and preference.
- Enhance visual interest and diversity by increasing seasonal color and by varying plant heights, textures, and forms.
- Provide simple habitat improvements such as nesting boxes and feeders. Wildlife usually increases visual preference.
- Use bold planting patterns to indicate a designed landscape.



DOWNLOAD: 6.5 Guidelines and References (PDF)

Back to top

Policies & Links | Plain Writing | USA.gov | USDA.gov

place
design
group.

Australia
China
South East Asia

Follow us on

placedesigngroup.com

Item

25 August 2020

Item Number:	File Number:	Part:
S1	.	TOURISM & REGIONAL GROWTH

Portfolio:

Community & Environment

Subject:

Request for Sponsorship for Variety Bash Adventure - Bundaberg November 2020

Report Author:

Gavin Steele, General Manager Community & Environment

Authorised by:

Gavin Steele, General Manager Community & Environment

Link to Corporate Plan:

Our Community - 1.2 Safe, active, vibrant and inclusive community - 1.2.3 Support and facilitate community programs, networks, projects and events that promote social connectedness; and active and healthy community life.

Background:

Variety – the Children's Charity, Queensland conduct an annual Variety Bash which is a car rally which raises funds to support children and their families. The Variety Bash has been conducted annually since 1984 and takes a different route each year.

The 2020 Variety Bash was planned to commence in Winton in August but due to the current COVID restrictions the event had to be cancelled earlier this year, however, Variety have remodelled the event and are now going to hold a Variety Bash Adventure starting in Bundaberg on 9 November 2020 and concluding in Noosa on 14 November 2020.

Variety Qld have invited Bundaberg Regional Council to sponsor the event as the host town for the 2020 Bash Adventure and have asked for Council's consideration for sponsorship of $20,000 plus GST, which is the same level of sponsorship that Winton were providing for their cancelled event.

The Variety Club had also sought use of the Multiplex from 6 to 9 November 2020, however, the venue is presently already booked for another event. The Variety Club will be raising money to support local causes whilst they are here and they are hoping to raise enough money for Bundaberg State High School to purchase a 50 seater bus that will assist with their IGNITE (transition to work program) which assists at-risk youth to attend an offsite learning location.

The Variety Bash will attract significant local and State media interest and the opportunity to host the 2020 event will place a focus on the Bundaberg Region which

should translate into an increase in drive tourism, particularly given the indefinite border closures at the moment restricting interstate travel.

Associated Person/Organization:

Nil

Consultation:

Councillors

Chief Legal Officer's Comments:

Council may resolve to provide the funding and should enter into a Partnership/ Sponsorship Agreement to determine the terms and conditions of the funding.

Policy Implications:

There appears to be no policy implications.

Financial and Resource Implications:

Given the uncertainty with other events that Council had budgeted in the current financial year due to COVID-19, there is sufficient funding presently available in the Events sponsorship and partnership budget to provide the financial support requested for Variety Bash Adventure.

Risk Management Implications:

There appears to be no risk management implications.

Human Rights:

There appears to be no human rights implications.

Attachments:

⇩1 Variety letter Bundaberg

Recommendation:

That Council authorise the CEO to enter into a Partnership/Sponsorship Agreement with Variety Queensland for the 2020 Variety Bash Adventure to be held in Bundaberg in November 2020 with Council providing $20,000 plus GST, in sponsorship for the event.

2 July 2020

Dear Steve,

I am writing to you after a recent discussion with Heidi to request Bundaberg Regional Council's support for the Variety Bash Adventure that will be starting in Bundaberg this November.

Organised by Variety – the Children's Charity of Queensland, the Variety Bash Adventure is a 6-day combined Bash and 4WD event, where all vehicle types are welcome, travelling through some of the most amazing outback and coastal scenery Australia has to offer, all in the name of helping Aussie kids in need.

The Variety Bash Adventure will be starting in Bundaberg on 9 November before making its way to Nindigully and finishing in Noosa. The Variety team along with about 100 cars and 300 participants will start arriving in Bundaberg on 6 November for registration, scrutineering and our opening function which will take place on the evening of 8 November.

Three hundred people spending a few days in Bundaberg means a huge amount of spending on accommodation, fuel, food, entertainment and car parts/repairs. In fact, a study conducted by the University of Queensland showed that the Bash can bring an economic boost of $120,000 to $180,000 to the start location.

We've chosen Bundaberg as it's not only a picturesque start for our event, but it's also a community that is very generous toward Variety with many wonderful supporters and members of the Variety family in the region.

With the devastating impact of the COVID-19 pandemic on families and businesses in Bundaberg, we wanted to give back to your beautiful region by bringing the colourful Bash to town, supporting local kids and providing an economic boost to the area.

During the Variety Bash Adventure, using the funds raised through the event, we will present grants to local children and organisations who have requested our assistance. Families in Bundaberg who have been hit hard by the effects of COVID-19 will receive support for their kids who are sick, disadvantaged or have a disability.

Steve, given the benefits to your city, we would like to invite Bundaberg Regional Council to be the official start line sponsor of the 2020 Variety Bash Adventure with a cash investment of $20,000 plus GST.

Variety – the Children's Charity of Queensland

ABN 35 940 541 014
Unit 1, 5 Ashtan Place, Banyo QLD 4014
P. 07 3907 9300 | E. info@varietyqld.org.au | variety.org.au

With an estimated return on investment to your region of at least 6:1, this is in line with the generous support we have received from other QLD councils such as Gladstone, Winton, Townsville and Mackay for other Variety events.

In return for your investment, we are able to offer the following benefits:

- Invitation for the mayor and a guest to attend the opening night function on 8 November and speak
- Opportunity to show a promotional video to the 300 attendees at the opening night function to encourage business and tourism in your region
- Bundaberg Regional Council logo featured on all event promotional collateral including website, e-newsletters and event guide
- Bundaberg Regional Council logo decal to be placed on all participating cars (approximately 100)
- Opportunity to provide promotional collateral about your region in participant event packs
- Social media mentions before, during and post-event
- Media release to promote Bundaberg Regional Council's support of the event and encourage coverage of the start line
- Custom benefits subject to further discussion

If you have a couple of minutes, please watch our promotional video to give you an idea of the event, its impact and its reach:
https://www.facebook.com/VarietyBashQLD/videos/335892684062658

I look forward to discussing this partnership opportunity with you in further detail. In the meantime, please contact me with any questions at 0458 628 133.

Many thanks for your consideration,

Christine Anderson
Head of Fundraising and Marketing

Variety – the Children's Charity of Queensland

ABN 35 940 541 014
Unit 1, 5 Ashtan Place, Banyo QLD 4014
P. 07 3907 9300 | E. info@varietyqld.org.au | variety.org.au