APPENDIX C

DEFINITION OF 'RECEIVING WATER', 'REASONABLE MIXING' AND 'ADEQUATE DILUTION', WITH RESPECT TO STANDARD 6.3.1.8

Contents

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1.0 RECEIVING WATER

The ARC has decided to use the presence or absence of water during the low flow period, as determined by a visual check, as the criterion for deciding where receiving waters from a given discharge begin. This approach has the merits of simplicity and cost advantage and, moreover, operators' experience of the waterways on their properties during low flows can also be utilised. The ARC will be able to calibrate the reasonableness of the approach adopted in each case by backing up the decision with scientific assessments based on catchment baseflow information, or measured flows where these are available.

The result of this approach is to define the '**Receiving Water**' to include part of the definition of '**River**' in Section 2 of the Resource Management Act as follows:

"Receiving Water"

Means a continually flowing body of fresh water; and includes a stream and modified water course but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation and farm drainage canal).

2.0 REASONABLE MIXING

It is important to clarify some of the common misunderstandings about reasonable mixing. Reasonable mixing is not total mixing and therefore must not be considered the sole use of the receiving environment, and thus should not create a toxic barrier to the migration of fish or other aquatic life into the catchment above the point of discharge. Therefore the mixing zone is an area which may be toxic to an organism resident within it for an extended period but an organism's travel through the area is not obstructed by the present contaminants. The term does not envisage that filling a waterway from bank to bank with acutely toxic material would be permitted. Therefore, many Auckland streams will only support mixing zones of short physical extent or plumes of high quality wastewater, particularly during the summer low-flow period.

Several publications, both from New Zealand and overseas, were considered before defining this term.

The definition chosen is considered to be the best available, in that the width of the particular waterway is the determining factor. This value is easily obtained by the operator and the formula could be applied without specialist knowledge. Therefore there is a significant cost benefit from adopting this proposed rule of thumb.

The ARC's proposed definition of reasonable mixing (that is, the point of compliance for consideration of the ammonia standard for treated dairy washwater discharges) is:

'30 times the width of the receiving water downstream and 1/3 the width across'

3.0 ADEQUATE DILUTION

3.1 Development of the Ammonia Standard

The ARC has promulgated a receiving water standard of 0.7g/m^3 of total ammonia after reasonable mixing.

This value was set after considering the potential environmental effects of the toxic components of dairy oxidation pond wastewater discharges. Other regulatory authorities have historically based their consideration of dairy wastewater effects on waterways upon suspended solids and biochemical oxygen demand. However work by Hickey et al (1989) showed that of the contaminants discharged from these systems, ammonia had the greatest potential for adverse environmental effects.

Investigations by the ARC, other regional councils and research organisations have generally produced similar results in terms of average ammonia concentrations in pond discharges. Auckland studies found on average total ammonia levels of 77g/m^3. Various studies have shown that pond systems discharge for prolonged periods and a large number of days each year.

The appropriate standard for comparison is therefore considered to be the chronic (long term) aquatic protection criteria promulgated by the USEPA. The ARC was concerned that it might be inappropriate to adopt a standard from criteria specified for another country in that New Zealand species may be of greater or lesser sensitivity. Consequently the ARC contracted the National Institute of Water and Atmospheric Research (NIWA) to conduct toxicity tests on native fauna typical of Auckland streams (fish and invertebrate species) to ensure that the levels recommended were appropriate. The results of this study indicated that the USEPA criteria would provide an adequate level of protection for New Zealand species, although it was noted that local species seemed to be more sensitive than those tested by the USEPA.

3.2 Summer Flow Regimes

The ARC undertakes monitoring of stream flows at a large number of locations throughout the Region. One of the objectives for these studies is to provide a baseline of supporting information for allocation of scarce resources under pressure from conflicting resource uses, especially abstraction of water and the assimilation of wastewater discharges. The issue becomes more acute during summer low flow periods each year when the need for water supply is greatest and stream flows available for waste assimilation are at their minimum.

The ARC allocates up to 70% of the one 1 in 5 year low flow for abstraction purposes. The residual 30% is intended to maintain aquatic ecosystems and assimilate wastewater discharges. Discharges from dairy wastewater treatment systems have historically not required a discharge consent and the lack of records has made it difficult to estimate the flows needed to dilute them.

Summer low flows are mainly dictated by soil lithology in the catchment concerned. The predominant soil type throughout much of the Region is relatively low permeability weathered Waitemata Series materials (sandstone and mudstone) and greywacke. Other lithologies include high permeability sands of Awhitu and South Kaipara Peninsulas and weathered volcanic materials particularly in the Southern Manukau.

ARC stream flow data predicts that for catchments with low permeability soils, 0.5 l/sec/km^2 can be used as a rule-of-thumb 1:5 year summer low flow specific discharge. This return period is considered appropriate as it is used to predict available run of stream flow for water allocation. Clearly it is not a worst case low flow, however the ARC considers that it represents a reasonable frequency for evaluation of environmental protection.

With some other lithologies basic rules-of-thumb cannot be applied as flow predictions are complicated by discrete spring flows which have unique characteristics. In these catchments flow characteristics will need to be evaluated on a case-by-case basis.

The practicability of oxidation pond wastewater discharge assimilation during summer low flow periods can be estimated by considering a number of worked examples, as follows:

3.2.1 Scenario 1

Assumptions
(a) Two discrete pulses of effluent (12 hrs daily in total)
(b) 50 l washwater/cow/day
(c) 1:5 year low flow specific discharge = 0.5 l/sec/km^2
(d) No water abstractions

	200 Cow Herd	150 Cow Herd	100 Cow Herd
Daily volume (m^3)	10	7.5	5
Effluent discharge (l/sec)	0.23	0.174	0.116
100 times dilution (l/sec)	23	17.4	11.6
Required catchment area (km^2)	46	34.8	23
Catchment area (ha)	4,600	3,480	2,300

3.2.2 Scenario 2

Assumptions
(a) Effluent spread evenly over 24 hour period
(b) 50 l washwater/cow/day
(c) 1:5 year low flow specific discharge = 0.5 l/sec/km^2
(d) No water abstractions

	200 Cow Herd	150 Cow Herd	100 Cow Herd
Daily volume (M^3)	10	7.5	5
Effluent discharge (l/sec)	0.116	0.09	0.06
100 times dilution (l/sec)	11.6	9.0	6.0
Required catchment area (km^2)	23.2	18	12
Catchment area (ha)	2,320	1,800	1,200

The above scenarios clearly highlight substantial impediments to achieving the required dilution of treated dairy wastewater discharges to streams throughout the Region. Especially when the run of stream flows used for existing authorised abstractions are considered.

ARC records indicate that all catchments in the southern Manukau are heavily utilised for abstraction for irrigation and are therefore also unlikely to support wastewater discharges during the low flow period.

This problem is made even more acute by the cumulative effects of multiple discharges. For this reason the ARC contracted NIWA to develop a catchment based ammonia assimilation model. This model, which is a complex series of mathematical formulae, will be used to support decisions on whether sufficient dilution is available for individual discharges considering other catchment inputs.

3.3 Winter Flow Regimes

As stated in Section 3.2, the ARC monitors the stream flows at a large number of locations throughout the Region. These studies provide rating information for a wide variety of flow scenarios, enabling the ARC to provide supporting information on winter flow patterns for catchments of differing lithologies throughout the Region.

The ARC has considered a number of winter flow measures for evaluating the practicability of treated dairy wastewater discharges. The ARC needs to be confident that the measure chosen will afford environmental protection in the majority of discharge scenarios without being unnecessarily restrictive, yet be scientifically robust and defensible

Measures considered were:
- winter 1:5 year low flow,
- mean flow and
- median flow.

Stream flows in the Auckland Region fluctuate a great deal during both winter and summer. The ARC's stream flow monitoring measures:
- summer low flow gauging for the purposes of water allocation,
- high flow gauging summer or winter to assess flood events, and
- representative gaugings throughout the normal range of flow regimes.

All of this information is then combined to produce a rating for the waterway measured.

The 1:5 year winter low flow was considered an unsuitable measure primarily because of the lack of gauging information for this return period.

Mean flows were considered inappropriate as they are derived from all the combined flow information and therefore can be unduly influenced by extreme flow events, either high or low, depending on the balance of high and low flow assessments and the severity of high flows.

Median flows are also influenced by the balance of high and low flows, but provided sufficient flow gaugings are included, should provide a reliable flow estimate for general use. By using the median flow the ARC can be confident that 50% of the time stream flows will be greater than or equal to the stated value. The ARC can also be confident that during the winter flow period, generally accepted to lie between the 1st May and 31st October, flows will exceed this value most of the time.

ARC flow gauging for a large number of catchments throughout the region indicates that median flows for rural catchments range between 6.6 - 11.6 l/sec/km^2.

The practicability of oxidation pond wastewater discharge assimilation during winter flow periods can be gauged by consideration of a number of worked examples, as follows:

3.3.1 Scenario 1

Assumptions
(a) Two discrete pulses of effluent (12 hours daily)
(b) 50 litres washwater/cow/day
(c) Median flow specific discharge = 6.6 l/sec/km^2

	200 Cow Herd	150 Cow Herd	100 Cow Herd
Daily volume (m^3)	10	7.5	5
Effluent discharge (l/sec)	0.23	0.174	0.116
100 times dilution (l/sec)	23	17.4	11.6
Required catchment area (km^2)	3.5	2.6	1.8
Catchment area (ha)	350	260	180

3.3.2 Scenario 2

Assumptions
(a) Effluent spread evenly over 24 hr period
(b) 50 l washwater/cow/day
(c) Median flow specific discharge = 6.6 l/sec/km^2

	200 Cow Herd	150 Cow Herd	100 Cow Herd
Daily volume (m^3)	10	7.5	5
Effluent discharge (l/sec)	0.116	0.09	0.06
100 times dilution (l/sec)	11.6	9.0	6.0
Required catchment area (km^2)	1.75	1.36	0.91
Catchment area (ha)	175	136	91

The above indicates that assimilation of oxidation pond discharges will be practicable for most catchments during the winter flow period. Where multiple discharges are proposed in a catchment, the Council will utilise the NIWA model described above to assess cumulative impacts.