BEFORE THE HEARINGS' COMMITTEE

IN THE MATTER of hearings on submissions concerning the proposed One Plan notified by the Manawatu-Wanganui Regional Council

***SUPPLEMENTARY* STATEMENT OF EVIDENCE OF**

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ON BEHALF OF:

PALMERSTON NORTH CITY COUNCIL

1.0 INTRODUCTION

1.1 As outlined in my primary evidence, the flow regime of the Turitea Stream has been modified by PNCC's water abstraction for over 100 years. Although a range of measurements are made in relation to the reservoir levels and abstraction, it is not possible to derive an accurate naturalised flow record using local data.

1.2 A synthetic naturalised flow regime for the Turitea was therefore generated by correlation, translation, and then adjustment of the flow records from the Tokomaru River and Kahuterawa Stream.

1.3 This synthetic flow series for the Turitea is, however, biased by the higher rainfall to the south. This is a result of the higher elevations of the headwaters of the Tokomaru and Kahuterawa catchments, and the orographic enhancement of rainfall i.e., these catchments get more rain and therefore experience higher flows. The flow series may also be biased by different rainfall-runoff processes in the various catchments.

1.4 This supplementary evidence therefore describes a method for adjusting the synthetic flow record so that it more accurately reflects a possible naturalised flow regime of the Turitea i.e., the flow regime without any influences from PNCC's water supply activities.

2.0 SYNTHETIC FLOW RECORD FOR TURITEA STREAM

2.1 As outlined in my primary evidence, a correlation between the daily average concurrent flow data from the Tokomaru River and Kahuterawa Stream was used to generate a

longer term synthetic flow record for the Kahuterawa (Figure 1). This synthetic data spans from 14 December 1979 to 11 January 2006, the length of the Tokomaru River flow record.

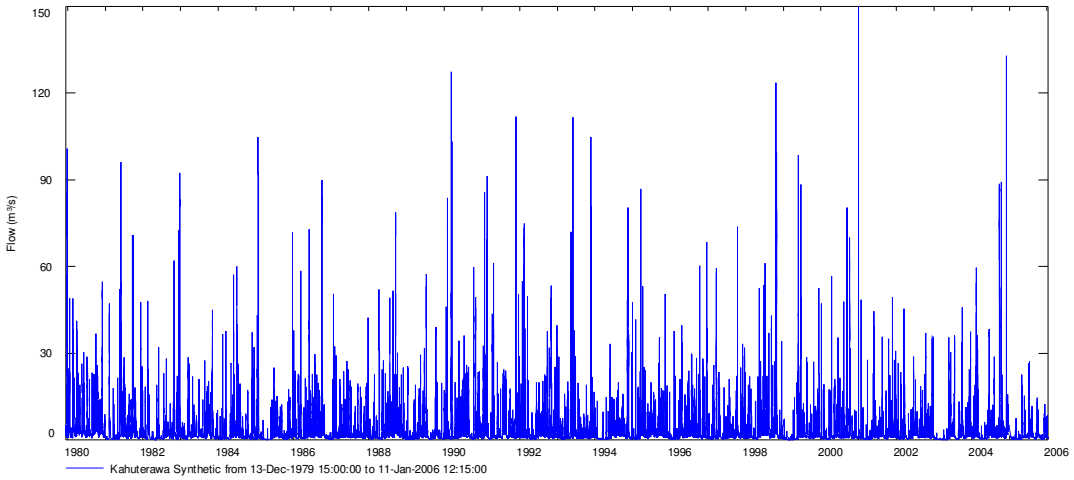

Figure 1: Longer term synthetic flow record for Kahuterawa Stream.

2.2 It is argued that this record provides a good indication of the long term flow regime of the Kahuterawa Stream. However, it tends to be biased by the higher rainfall experienced in the Tokomaru River. This is despite the fact that the upper reaches of the Tokomaru River above the dam, that area with the highest rainfall, have been excluded from consideration. The flow from this area is diverted away from the recorder site.

2.3 Despite the fact that the synthetic record is a good analogue for the actual flow regime it is biased towards higher estimated flows as highlighted in Table 1. The differences between the synthetic and actual flow records are illustrated and explained further in my principal evidence.

Table 1: Comparison of summary statistics for the actual and synthetic Kahuterawa Stream flow records over the common period. **Note: Synthetic 2 is a linear function through the origin which was shown in my previous evidence to produce a more accurate flow regime.**

Summary statistics for overlapping period							
	Min	**Max**	**Mean**	**Std Dev**	**L.Q.**	**Median**	**U.Q.**
Kahuterawa at Johnstons (l/s)	227	9773	1428	1273	598	1074	1819
Kahuterawa Synthetic 2 (l/s)	281	9663	1451	1209	709	1125	1731
Actual/Synthetic (%)	81	101	98	105	84	95	105

2.4 The synthetic record provides a good approximation of the higher flows (i.e., mean, maximum, upper quartile) but it over-estimates the lower flows. This is likely to be caused by differences in the storage and controls on 'baseflow' between the two catchments.

2.5 The actual flows in the Kahuterawa Stream under low flow conditions (i.e., defined by flows less than the lower quartile – the lowest 25% of flows) are only 81-84% of those in

the synthetic record.

2.6 The annual 1-day minimum flows from the synthetic record ranges from 99l/s (2003) to 640l/s (1980). The mean annual low flow (MALF) for the complete years of record is 234l/s. Given that the actual flows are only 81% of those in the synthetic record, the adjusted MALF is likely to be approximately 190l/s (i.e., 0.81x234).

2.7 Assuming that the only control on the MALF is catchment area, the corresponding MALF for the Turitea @ Ngahere Park would be 169l/s (i.e., 32/36x190). The catchment areas of the Turitea and Kahuterawa catchments are 32 and 36km^2 respectively.

2.8 However, as discussed in my primary evidence, catchment rainfall also has a significant control on runoff and streamflow generation. An analysis of the mean and median catchment rainfalls for the Kahuterawa and Turitea catchments, above the flow monitoring sites, was therefore undertaken. This showed that the rainfall in the Turitea catchment is, on average, only about 88% of that in the Kahuterawa. Assuming that there is a 1:1 relationship between rainfall and low flows in a catchment then the estimated MALF for the naturalised flow in the Turitea would be 149l/s (i.e., 0.88x169).

2.9 Within the Officer's Reports to support the draft One Plan a relationship is presented that defines the 'minimum flow' as a function of the MALF (Fig A, Box 11, p. 48; Roygard). For a catchment of the size of the Turitea this scale factor is 0.909. This gives a suggested minimum flow at Ngahere Park, based on the synthetic naturalised record MALF, of 135l/s. The minimum annual flow from the synthetic record for the Kahuterawa would give a minimum flow of at Ngahere Park of 57l/s.

2.10 These estimates of the naturalised MALF and minimum flow are likely to be conservative (i.e., high) because the period of record used in the analysis coincided with higher than average rainfall. The effect of this is discussed in detail in my primary evidence.

3.0 ACTUAL FLOWS AT NGAHERE PARK

3.1 The natural flow regime of the Turitea catchment has been modified, with water being abstracted to meet Palmerston North's potable supply needs, for over 100 years. Since the granting of the last consent, Palmerston North City Council (PNCC) has maintained a residual flow of approximately 25l/s past the lower dam. The reservoirs behind the dams allow this residual flow to be maintained largely irrespective of the water balance and runoff processes in the upstream catchment; particularly during the summer low-flow period. This residual flow has the effect of stabilising hydraulic and environmental conditions in the lower catchment during periods of low flow.

3.2 Flow data for the Turitea Stream has a number of limitations. Flows have been recorded at Ngahere Park for only the past 9 years (Figure 2). It is possible that these data do not accurately reflect the longer-term flow variability of the catchment, especially since this

period coincides with higher than average annual rainfall. Flows are augmented during periods of low flow by the residual flow past the lower dam of 25l/s. A proportion of each flood flow is also stored behind the dams; depending on their levels at the start of the flood, and the total flow involved. A relatively small proportion of the flow from the catchment is also diverted to meet the potable water needs of Palmerston North City. Finally, flow from 34% of the catchment is essentially natural and unaffected by any operations or controls related to the provision of potable water. These flows are not monitored separately. Despite the limitations discussed above, the flow record at Ngahere Park is of considerable value.

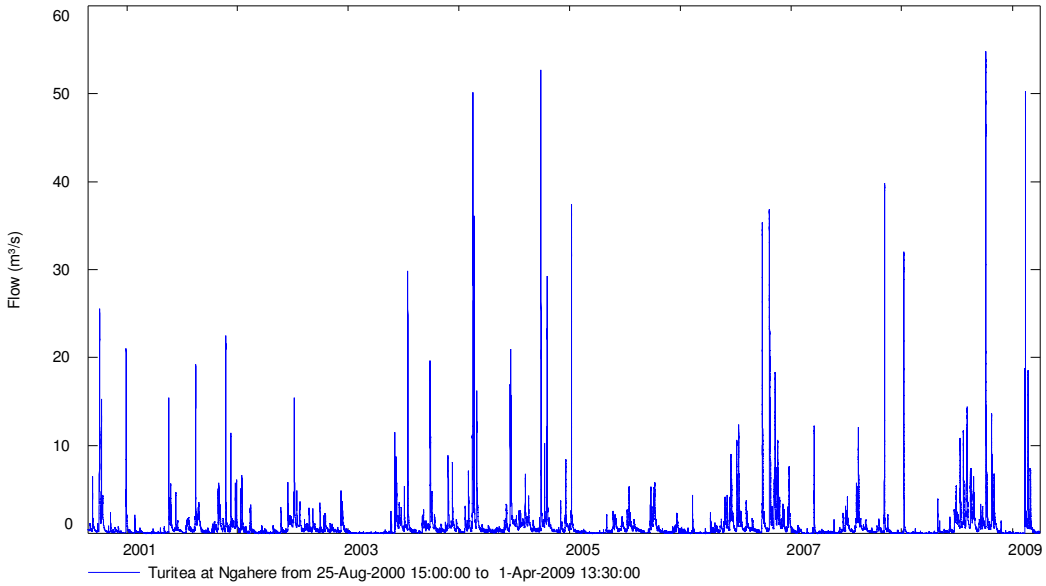

Figure 2: Flow record for Turitea Stream at Ngahere Park.

3.3 The flow record from the Turitea Stream is characterised by a high degree of variability (Figure 2). This is typical of relatively small hill country catchments. The minimum recorded flow is approximately 7l/s, despite PNCC attempting to maintain a residual flow of 25l/s past the lower dam. The peak flow has been 55m^3/s or 55,000l/s (Table 2). While flows are generally higher and floods more frequent during winter, large flood events can occur at any time of the year. It should be noted that the flow recorded at this site includes all the effects of modifications in the upper catchment for water supply purposes.

Table 2: Summary of the flow regime for the Turitea Stream @ Ngahere Park (l/s).

Minimum	Mean	Maximum	Standard deviation	Lower quartile	Median	Upper quartile
7	774	54,783	1,795	90	312	802

3.4 The flow regime at Ngahere Park (Figure 2; Table 2) therefore reflects a stream that retains the majority of its natural characteristics. The stream would appear to be 'healthy' and in equilibrium with current conditions. There is no documented evidence that I am aware of that the Turitea Stream has suffered significantly as a result of water abstraction

from the upper catchment. In fact, the dams provide some flood mitigation and have the potential to maintain higher than natural baseflow during periods of low flow, particularly towards the end of summer.

3.5 The only detailed study that I am aware of into the ecology of the Turitea has shown that while there are three notable effects of the dams and abstracting water from the stream *"the lower Turitea Stream generally continues to support a viable and healthy assemblage of macroinvertebrate communities that are present at comparable densities to reaches of the stream upstream of the water supply reservoirs."* (Coffey, B.T. September 2007)

3.6 The annual 1-day minimum flows recorded at Turitea @ Ngahere range from 10l/s (2003) to 102l/s (2004). The MALF for the complete years of record is 33l/s. Including all years of record, raises the MALF to 41l/s.

4.0 CONCLUSIONS

4.1 A synthetic naturalised flow regime for the Turitea catchment has been generated using the records from adjacent catchments. While this synthetic record is considered to reasonably reflect the flow regime under natural conditions there is still a degree of inherent uncertainty. This uncertainty is likely to be greatest at low flows where catchment parameters that affect the rainfall-runoff relationship are likely to have more significance than rainfall. Information derived from the synthetic record is therefore likely to be conservative i.e., reflect higher than actual flows.

4.2 The minimum naturalised flow of the Turitea, derived from the synthetic record, is likely to be approximately 135l/s. However, minimum flows as low as 57l/s would have been experienced.

4.3 These estimates are likely to be higher than the longer term values because of higher than average rainfall during the period of flow record used in the analysis.

4.4 The flow regime of the Turitea is highly modified but it still retains the majority of its natural characteristics. The catchment continues to support a viable and healthy aquatic ecosystem that is comparable to reaches above the dams.

4.5 Assuming the conservative MALF derived from the actual flow record from Ngahere Park, and that this continues to be adequate to maintain the in-stream values etc., the minimum flow at this site would be about 37l/s (i.e., 41l/sx0.909). Scaling this back, as a simple function of area, to provide a residual flow past the lower dam yields a value of 24.6l/s (i.e., 37x0.66). This is the current minimum residual flow of 25l/s.

4.6 The maintenance of a residual flow of 25l/s therefore has had the effect of generating a MALF of about 41l/s. This is likely to be less than the MALF under a natural flow regime. The stream and its ecology, however, have adapted over the past 100 years to this

reduced flow without any apparent adverse environmental effects.

4.7 The maintenance of a MALF at Ngahere Park of 41l/s would therefore appear reasonable and sustainable given the long history of modified flows, and the importance of the Turitea to meeting Palmerston North City's potable water supply.

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