Sustainable Yield
of the
Fresh Groundwater Resources in Lanai

Summary Statement

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Lanai is not located to benefit from favorable annual average rainfall over a large area and cosequently its water resources are limited. On only about ten percent of the island is there enough rainfall to contribute sufficient recharge to sustain exploitable fresh water aquifers. Elsewhere groundwater is brackish. The fresh water aquifers are restricted to an approximately 14 square mile area in the highest part of the island starting about two miles windward and ending about two miles leeward of the topographic divide. The maximum length of the fresh water envelope along the northwest-southeast axis is approximately five miles.

The fresh water aquifers are composed of permeable lavas intersected by impermeable dikes and other structures associated with the caldera of the original volcano and its rift zones. These aquifers are referred to as "high level aquifers"; they contain fresh groundwater that is not endangered by sea water intrusion. Individual aquifers are small, but they are hydraulically connected to the extent that the area of high level water can be treated as a single unit in determining sustainable yield of the resource. The transmissivity and storativity of the aquifers are modest to poor.

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Total natural recharge to the aquifers from rainfall and fog drip is estimated as 9.3 mgd, of which 5.0 mgd originates leeward of the crest and 4.3 mgd windward of the crest. Not all of the 9.3 mgd can be developed as sustainable yield; recharge is not equivalent to sustainable yield. Maximum sustainable yield of the groundwater system under optimal development is about 6.0 mgd (see J.F. Mink, 1983, Lanai Water Supply: Consultant Report). This value can't be achieved, however, except at costs associated with reconstructing the pumping sources.

The realistically developable sustainable yield for the current configuration of existing wells and for a configuration that could be accomplished without re-drilling is appreciably less than 6.0 mgd. Sustainable yield may be withdrawn by a few wells or by many; the number of wells has no bearing on the magnitude of sustainable yield. Wells are drilled only to optimize production within the limits of sustainable yield.

Total sustainable yield of the aquifers can be estimated by employing the results of water balance calculations and a groundwater flow model. Every investigation has calculated recharge by the balance method to be substantially less than 10 mgd; estimates range from a low of 4.85 mgd to a high of 9.3 mgd. The disparity is caused by the choice of area which receives recharge; the lower estimate is based on an intake area of about 7000 acres, while the higher estimate assumes an area of nearly 9000 acres. In either case total recharge is quite small in comparison with high level aquifers in other islands.

Computations for scenarios of groundwater development which are achievable at low cost are summarized below. The first scenario allows the wells and pump settings to remain as they now exist and permits the equilibrium water table elevation to descend to 20 feet above each pump intake. No additional development cost will be incurred. The second scenario assumes that the pumps will be lowered to 20 feet above the bottom of each well and the equilibrium head will stabilize at 20 feet above the pump intake. A substantial cost would accompany this re-configuration. Sustainable yields for the leeward and windward sectors to fit these scenarios, along with current production, are as follows (all values in mgd).

Pump Setting	Leeward SY	Windward SY	Total SY	Leeward Draft	Windward Draft	Total Draft
Existing	2.0	0.8	2.8	2.1	0.6	2.7
20 Feet Above Well Bottom	3.0	2.0	5.0			

The above estimates state that current production has already reached allowable sustainable yield for the existing well configurations. This means that the water table will continue to decline to the pump intakes. The additions of Wells 6 and 7 will provide flexibiliy in operation but will not increase sustainable yield.

Lowering the pump intakes to within 20 feet of the bottom of each well increases sustainable yield to 3.0 mgd leeward and 2.0 mgd windward. The leeward increase is achievable simply by lowering the pumps; to take advantage of the windward increase another well may have to be drilled.

A further increase in sustainable yield is possible but only if the existing wells are deepened and the pump intakes lowered into the newly drilled bores. If all wells were deepened to sea level and the pumps set about 20 feet above sea level, total sustainable yield would exceed 7 mgd.

Comparison of projected demand (memorandum of J. Kumagai, M&E Pacific) against sustainable yield for the current configuration of wells and pumps (Case 1) and the improved configuration by lowering the pumps (Case 2) is given below. Demand is restricted to potable useage. The 'difference' column indicates production in excess of sustainable yield by -, and sustainable yield in excess of production by +.

	Demand (mgd)			Case 1		Case 2	
Year	Plant.	Other	Total	SY	Diff.	SY	Diff.
1987	2.7	0.4	3.1	2.7	-0.4	5.0	+2.3
1989	2.7	1.1	3.8	2.7	-1.1	5.0	+1.2
1990/95	2.7	1.8	4.5	2.7	-1.8	5.0	+0.5
2000	2.7	2.2	4.9	2.7	-2.2	5.0	+0.1

The above suggests that present total draft exceeds sustainable yield of the system as it is now configured by 0.4 mgd. In this case, eventually the water table will be lowered to intake levels in some wells, forfieting their utility. It may take years to reach the new equilibrium, but the trend of water table elevation will continue downward. This can be avoided by lowering the pumps to conform to Case 2. In the long term, reconfiguration will have to be resorted to if the projected demands are to be met.