TO: WA Sensible Shorelines Association Board **Dec. 27, 2010**

FROM: Martin Nizlek, Board Member

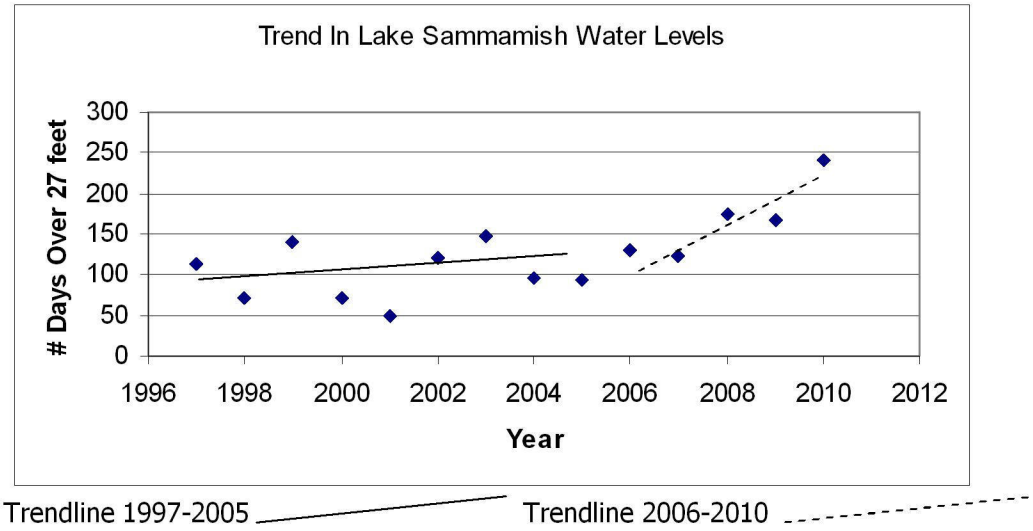
RE: Summary of Lake Water Level Analyses and Implications to SMP

As you're aware from my reports this fall, a number of residents on Lake Sammamish and Phantom Lake have been monitoring water level conditions[1]. Our awareness was raised at that time, as it continues to be, that these levels are related to poor maintenance of the weirs which control lake out-flow. My purpose in this report is to convey an analysis of Lake Sammamish's situation. Also, I have asked Brian Parks if he would update the Board on Phantom's status.

A primary concern is, if lake water levels are being allowed to remain at higher and higher levels, the base situation when a storm occurs will be markedly different than witnessed historically. Stated simply – our lakes (Sammamish and Phantom) will take less time to fill if rain starts with their water levels unusually high. The result will be unnecessary impacts to our properties and the environment.

<u>Analysis of Historic Water Levels</u> - (Basic question - **Have lake water levels changed in recent years?** Quick Answer – **Yes**.)

The following graph depicts the number of days each year that water levels on Lake Sammamish have been above 27 ft.[2] Two periods were selected – 1997 through 2005 and 2006 to date.



[1] Appendix 1 contains figures from the original evaluation prepared by several lake residents showing the decline in flow capacity at the weir on the Sammamish River. This information was provided King County last summer.

[2] The US Army Corps of Engineers established in 1972, and still quotes, a water surface elevation of 27 ft. NGVD'29 as the Ordinary Higher Water Mark (OHWM) for Lake Sammamish. State administrative code notes that this standard can only change by natural processes or as permitted by government agencies. NOTE: the 1929 NGVD elevations can be adjusted to the more recent 1988 NAVD elevations by addition of 3.56 feet.

While a persistent upward trend is readily apparent in the graph, to lend credence to the analysis, I've conducted two statistical tests[3], essentially testing whether the number of days[4] over 27 ft. has increased recently when compared to the earlier period's levels.

The conclusion of these tests, at surprisingly high statistical significance, is clear– the level of Lake Sammamish has been allowed to remain above historic levels -- the average number of days above 27 ft. has risen from 100 days per year by more than two months to 167 days[5]. This year (through 12/23) has had more than 240 days over 27 ft! This will have "influenced" the OHWM higher.

As important, there are other impacts. In addition to the damages to our property, there will be an increased pollutant load drawn into the lake. The following picture was taken this spring, and shows how shorelines erode; in this instance, chunks of land actually breaking off and floating into the lake. Ironically, sediment is listed as a reason why the Marymoor weir channel cannot be cleared of debris – returning endangered salmon would be impacted by any silt!

Since proposed shoreline regulations would measure setbacks from the OHWM, coercion of it higher on our properties will result in the regulations being administered further onto our properties. Such action should be challenged as a "property taking without just compensation."

Analysis of Lake "Reaction" to Rainfall Patterns - (Basic question(s) - **Is the contention that flows into the lake have increased true? ... and does the lake "handle" these flows differently?** Quick Answer – **In-flow remains the same, but the lake reacts differently**.)

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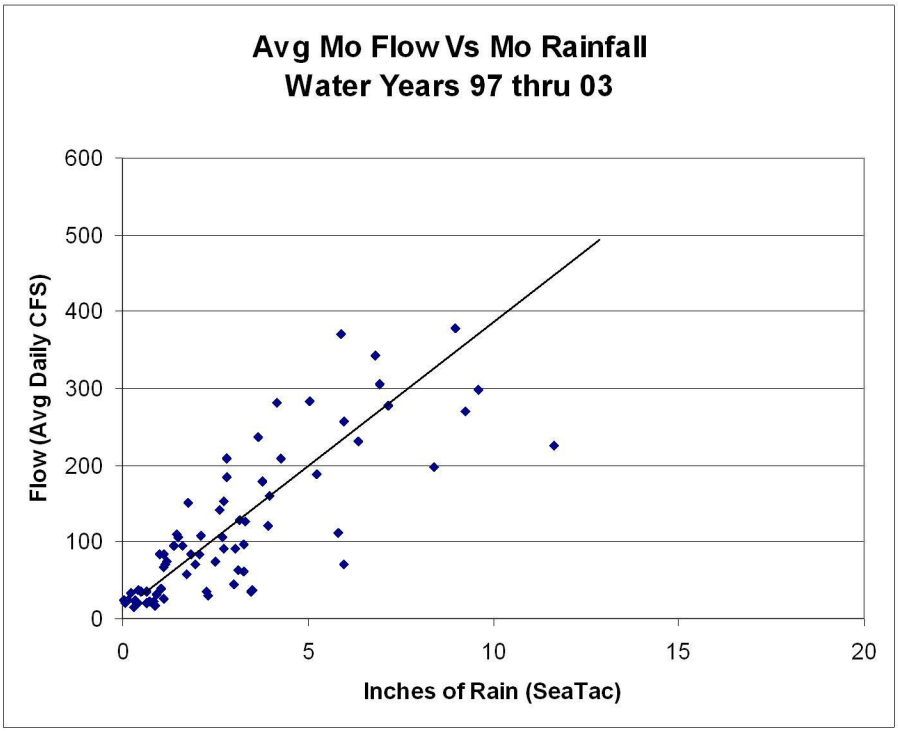
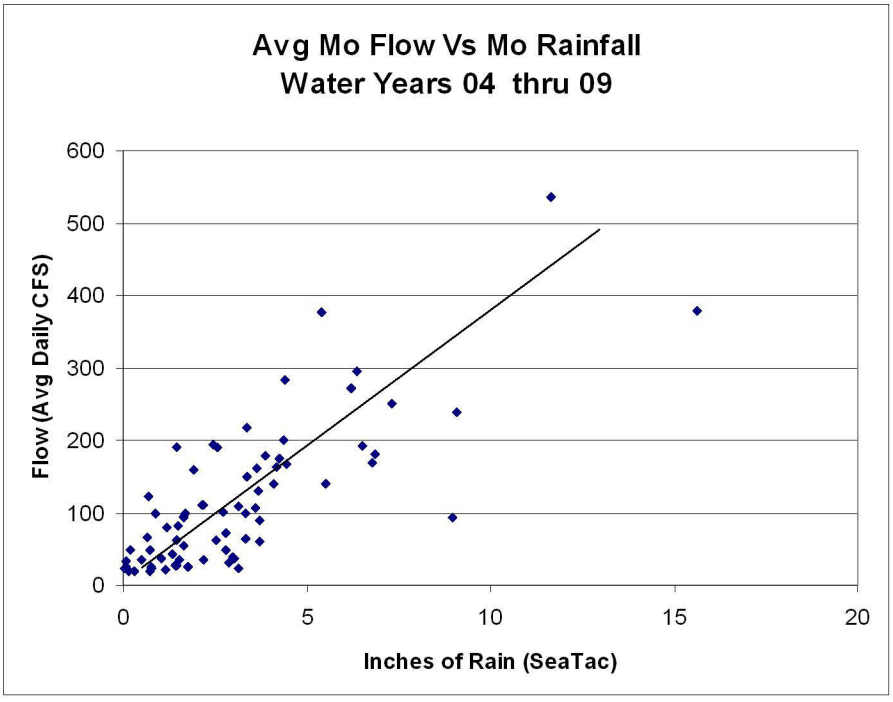
[3] I will be happy to review these tests (found in an appendix) in more detail with anyone upon request. I recommend that we have an independent analysis done to thoroughly vet my approach and the analysis.

[4] These water levels are reported at USGS gage number 12122000. The mean level of the lake for each day was used as published for this gage at the online reporting site - **http://waterdata.usgs.gov/wa/nwis/uv/?site_no=12122000**

[5] Since this report is being written before the end of 2010, data for the year is incomplete. However, as of 12/23/2010 there have been 240 days to date with mean daily water levels above 27 ft.

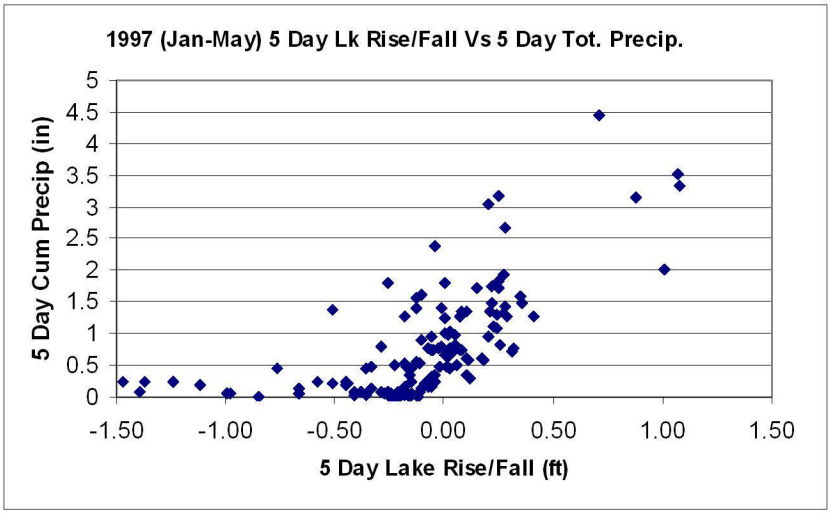
I have not done as rigorous an analysis of this situation because of a lack of data on precipitation and in-flows[6]. However, using Spring (Jan. thru May) rain data from SeaTac Airport shows that Issaquah Creek flows appear to remain the same under similar rain situations as occurred historically, when the most recent 6 years are compared to the 6 years just prior. You'll note the similarity in the graphs, below.

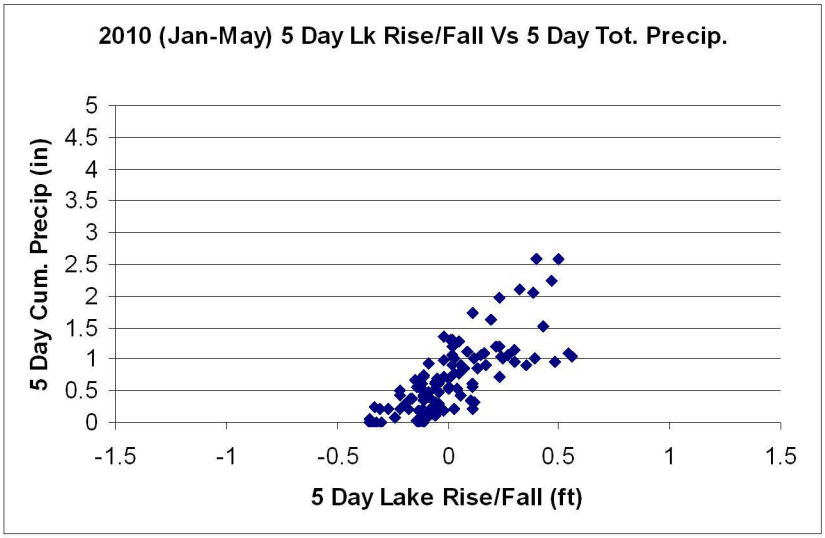




[6] I am seeking data from King County on flows into Lake Sammamish. A significant number of stream monitoring gages appear to have been taken out of service in the late 1980's or '90's. One of our recommendations should insist upon monitoring of both the quantity and the quality of what's being dumped into each of our lakes.

Second, I carried out what's called a "runs" analysis. Here, periods of 5 or more days of rain were plotted against lake water levels during two similar rainfall seasons.





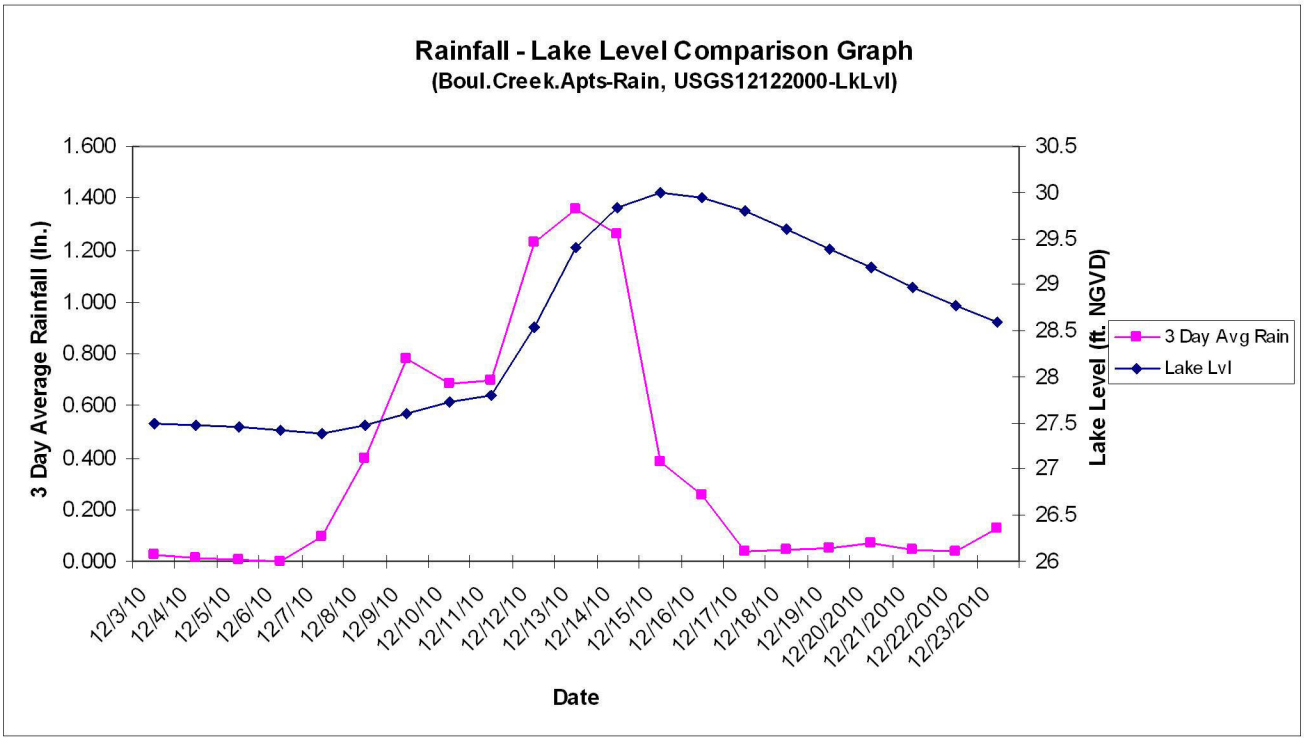
Interestingly, in comparing spring 1997 data to spring 2010, the following observations can be made:

A) Both years had about the same amount of rain during the spring (20 inches).

B) 2010 had fewer 5 day rainy periods (January through May), none going over about 2.6 inches total in 5 days. 1997 had 7 periods over this level.

C) In 1997 the lake would continue to fall during the start of rainy periods, in some instances with more than 2 inches in 5 days. In 2010, through May, this phenomenon did not occur. Now the lake steadily rises with 1 inch or more in 5 days!

This latter situation and our "end of year" weather prompted monitoring of recent rainfall and the lake's response. The following graph depicts December's experience.



As shown, when rainfall reached about 1 inch per day, the lake rapidly rose. Since the very heavy rains at mid-month, the water levels have only gradually subsided. I believe this leaves us vulnerable should major storms occur one after another. The most likely cause is restricted out-flow at the weir.

As you are aware, at the urging of a number of residents around the lake, in September the County was prompted to clear one of the two primary channels beyond the weir in the river. Rapidly flowing water can be seen in the cleared channel in the picture on the left below (versus the lack of flow in its sister channel, on the right, which was not cleared.)

Trimming of overgrowth and brush helped achieve some improvement to flow. However, clearing both channels down to the base-level of rock which lines them, would remove the damming effect caused by ten or more year's accumulation of clogging deposits and trimmings that were left to rot. Field measurement in September showed this layer to be 18 inches deep and this is corroborated by the tendency of the lake to stabilize at 27.5 feet which is 18 inches above the weir. (See early part of December lake levels in graph, above.)

Conclusions and Recommendations

Lake Sammamish and Phantom Lake have had their shorelines inundated by high water levels. This has unnecessarily impacted the environment and private properties. If objection is not made, shoreline regulations, which are administered from the OHWM, will be adopted and result in further losses and may be construed as property takings.

More severe losses may be stimulated if a major, sustained storm hits with lake levels already at unusually high levels. If bulkhead repairs/rebuilds are forced to consist of soft stabilization designs, it is foreseeable that unpredictable water levels, combined with characteristic lake wave action, will destroy them.

Finally, FEMA base flood elevations (BFE) for the 100 year design storm will be mapped higher, resulting in unnecessary flood insurance restrictions – restrictions which might not be needed at all if diligent management of lake water levels was occurring.

WSSA should undertake the following actions –

1) Have an independent review carried out of my statistical analysis and its conclusions.

2) Insist that the SMP include a monitoring program that tracks and reports the quantity and quality of waters flowing into our lakes.

3) Support efforts encouraging King County to maintain the Sammamish River weir (technically called the transition zone) to standards prescribed by the US ACOE in the agreements dating to the 1960's when the weir and channels were constructed. A similar recommendation with respect to Phantom should occur based on Brian Park's report.

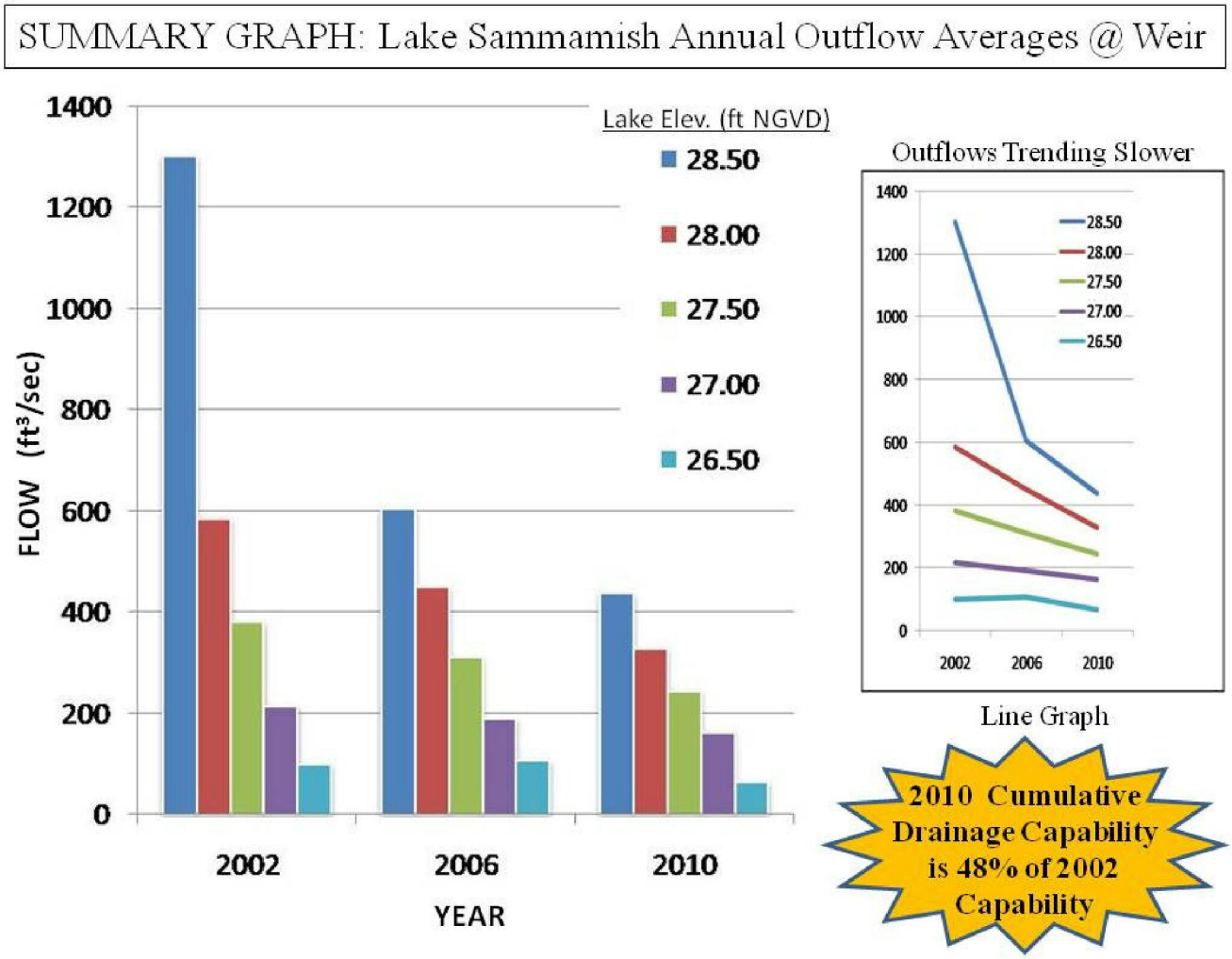
4) Insist that the SMP NOT mandate soft shoreline stabilization at least until lake water levels are managed similar to those on Lake WA.

5) Begin briefing Planning Commission, City Council members, and lake residents, alerting them of the threats posed by mismanaged water levels, including impacts to the environment and possible "takings" issues.

Marty Nizlek, Ph.D C.E., M.S.I.E.

(Appendices follow)

Appendix 1
Graph of Flow Reduction at Sammamish Weir (Source: R.Crispin & M.Nizlek)



Note: US Army Corps of Engineers specified to King County, when the County took over maintenance, that when the lake reaches **29 ft. NGVD, flow over the weir should be 1500 cubic feet per second.** The above graph indicates such capacity no longer exists. A meeting in August 2010 prompted trimming of one channel. Field inspection with County staff and elected officials present in September 2010 prompted removal of trimmings left in the channel, but no commitment was made to remove channel blockage of some 18 inches depth.

Appendix 2
Results of Statistical Analysis of Lake Water Levels

STATISTICAL ANALYSIS OF HISTORIC Vs RECENT LAKE SAMMAMISH WATER LEVELS

NULL HYPOTHESIS - Number of days per year lake over 27 ft '97-'05 is same as most recent 5 years

ALTERNATE HYPOTHESIS - Most recent 5 years have higher number of days over 27 ft

Yr	NoDaysOvr	ThisLevel
1997	114	27
1998	72	27
1999	139	27
2000	71	27
2001	48	27
2002	120	27
2003	148	27
2004	95	27
2005	94	27
2006	130	27
2007	124	27
2008	175	27
2009	166	27
2010	240	27

Average value 1997 thru 2005

Mean1 = 100

Average value 2006 thru 2010

Mean2 = 167

N (sample size) = 5

St'nd Deviation = 46.4 (estimate of population variance)

(Mean2-Mean1) = 67

"t" Test Statistic = (Mean2-Mean1)/(StndDev/SqRt(N))

67/(46.4/(SQRT(5)) = 3.229

"t" Statistic, 4 degrees of freedom = 2.132 (at 5% level of significance)

Since the test statistic falls above the standard value, reject the null hypothesis and conclude the most recent 5 years have a higher than expected number of days over 27 ft

CONTINGENCY TABLE (CHI - SQUARE) ANALYSIS OF LAKE LEVELS

(NULL HYPOTHESIS - Frequency of Days Over 27 ft. last 6 years, same as preceding 6 years)

Yr	NoDaysOvr	ThisLevel
1997	114	27
1998	72	27
1999	139	27
2000	71	27
2001	48	27
2002	120	27
2003	148	27
2004	95	27
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2006	130	27
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Analysis through 12/23/2010

Observed Days Over 27 vs 27 or Lower By Period

	1997 - 2003	2004 - 2010	*Total*
Days Above 27	**712**	**1024**	*1736*
Days 27 or Lower	**1843**	**1490**	*3333*
TOTAL	*2555*	*2514*	*5069*

Expected Frequencies

	1997 - 2003	2004 - 2010
Days Above 27	**875**	**861**
Days 27 or Lower	**1680**	**1653**

Chi Square Test Statistic = Sum (Observed - Expected)^2 / Expected

= ((712 - 875)^2/875) + ((1024 - 861)^2/861) + ((1843 - 1680)^2/1680) etc.

Chi Squared Test Value = 93.1

N = # of periods being compared minus 1 = 2 -1

Chi Square Statistic = 6.6 (p = .01) N = 1

Conclude - There is a significant difference between the periods