

Effects of voluntary year round phosphorus removal on reported Lake Mead water quality



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History of P removal



- 1931 first WWTP built
 - Population of 5,165
 - Treats 1 MGD
- 1955 WWTP flows increase
 - CLV WPCF moves to current location near Las Vegas Wash
 - Las Vegas Wash flows no longer seasonal
 - Wetlands start to establish

History of P removal

- 1967-1970 – WQ problems begin
 - Dept. of Interior “LV Bay has objectionable aesthetic conditions”
 - EPA substantial nuisance algal growth in LV Bay. Suggested flows to wash not exceed 0.010 mg TP/L.
- 1972-1981 – P load between 1200 and 1500 lbs P/day



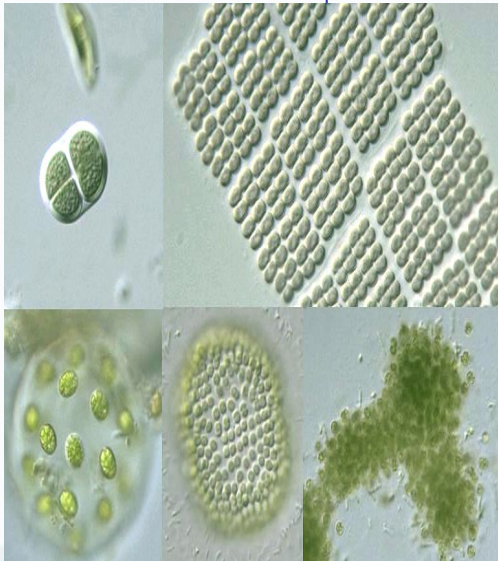
History of P removal

- 1970-1981 – controversy over P limits
 - Panel decides 0.5 mg TP/L best available with current technology
 - 1978 lawsuit ends in limit of 1 mg TP/L
- 1981 – P standard set at 1 mg TP/L
 - CLV and CCWRD begin P treatment using chemicals
 - Loads decreased to 400 lbs P/ day



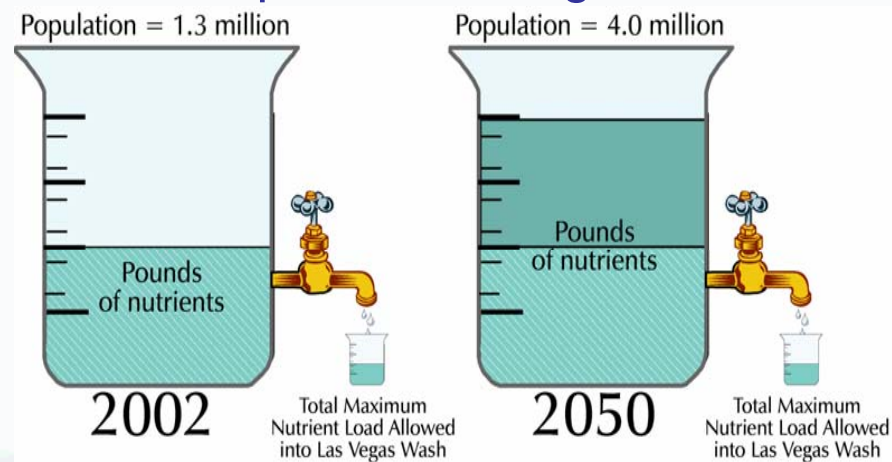
History of P removal

- 1986 – loads gradually increased to 620 lbs P/day
 - *Microcystis* bloom
 - Chl-a levels peaked at 378 mg/m³
- 1987 – NDEP Proposed changes to beneficial use standard
 - eliminated the 1 mg/L P std
 - Chl-a std of 30 mg/m³ at LM3
 - 1986 and 1987 values exceed std



History of P removal

- 1987- 1989 TMDL Study
 - Conducted by by Richard French.
 - Target concentration of 0.051 mg TP/L at LM3
 - Used a dilution model to determine Wash concentration of 0.64 mg TP/L
 - Using flows from same time came up with 434 lbs P/day TMDL
 - Non-point source given 100 lbs P/day



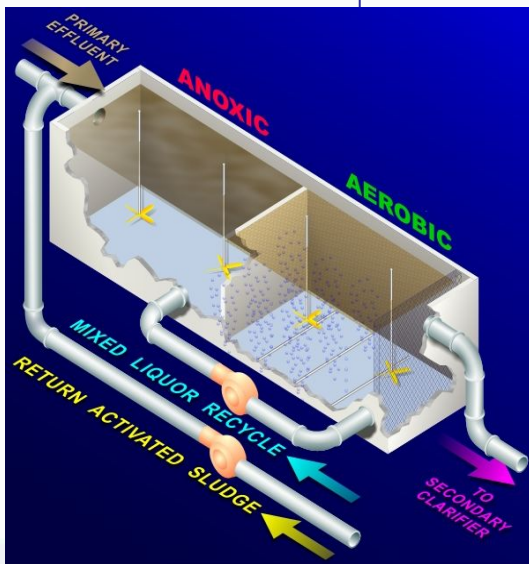
History of P removal

- 1994 TMDL and WLA's begin
 - 1994 Activated sludge and filtration added to treatment processes
 - 1994 – present no exceedances of WLA's
- 2001 large green algae bloom in Lake Mead
 - Chl-a values peaked at 221 mg/ m³
 - Algae Task Force created

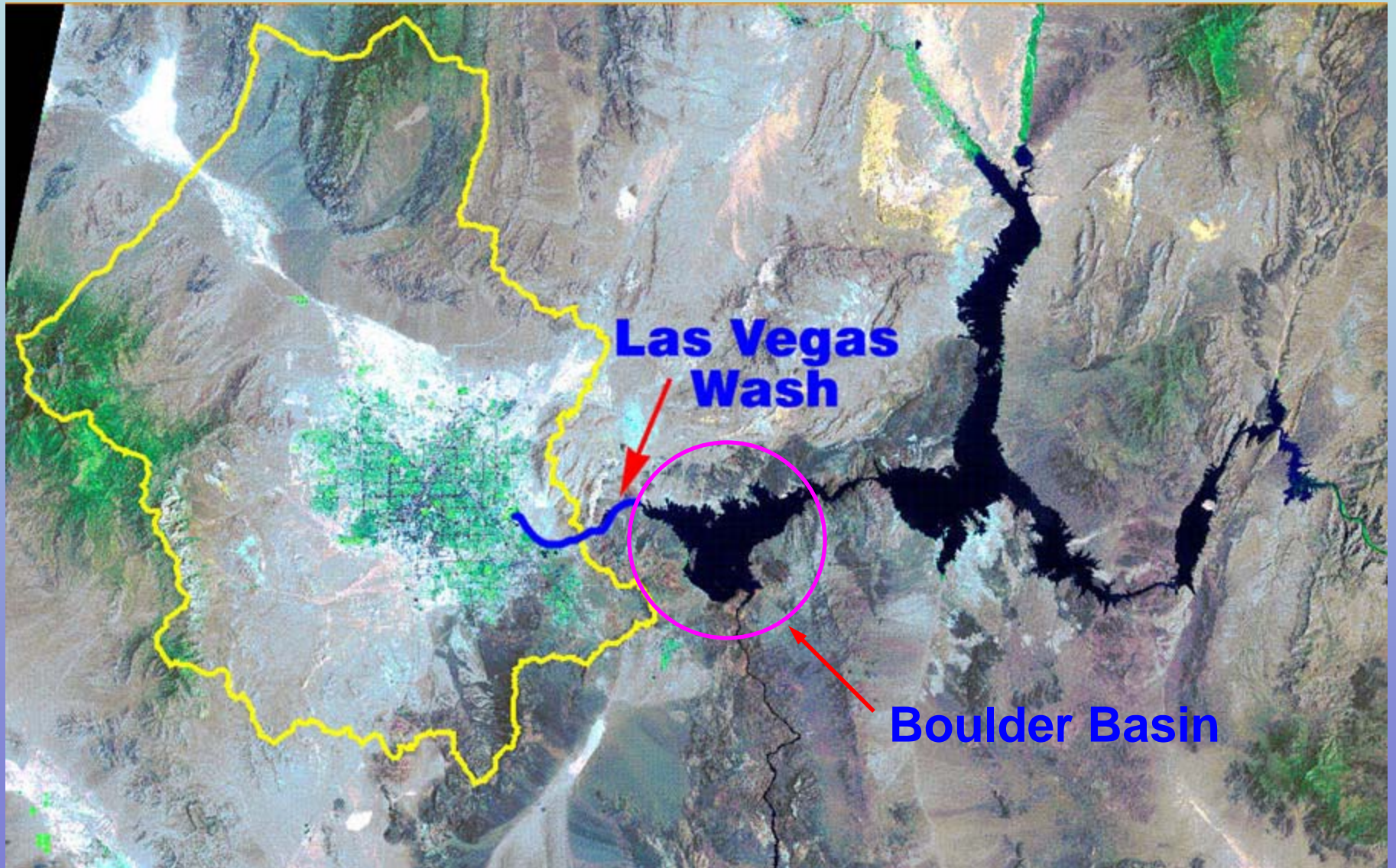


History of P removal

- 2001- WWTP's agree to voluntarily remove P year round
 - 90 – 95% removal Nov. - Feb.
 - Allow down time for maintenance/ construction
- 2003 CLV starts BNR process
 - TP around 0.15 mg P/L
- Late 2004 CCWRD refines BNR process
 - TP around 0.08 mg P/L
- Combined loading currently ~130 lbs P/day



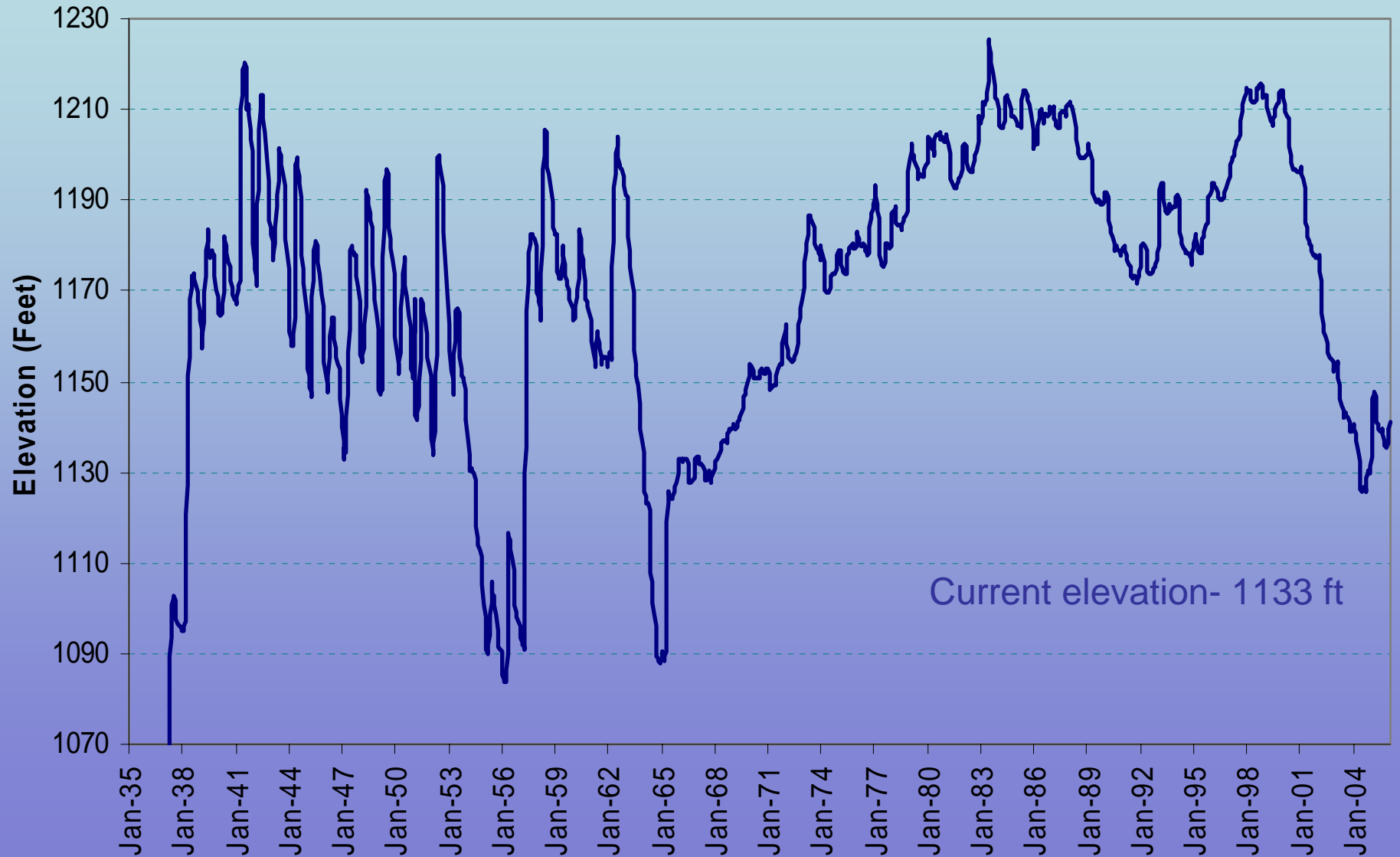
Las Vegas Hydrographic Basin



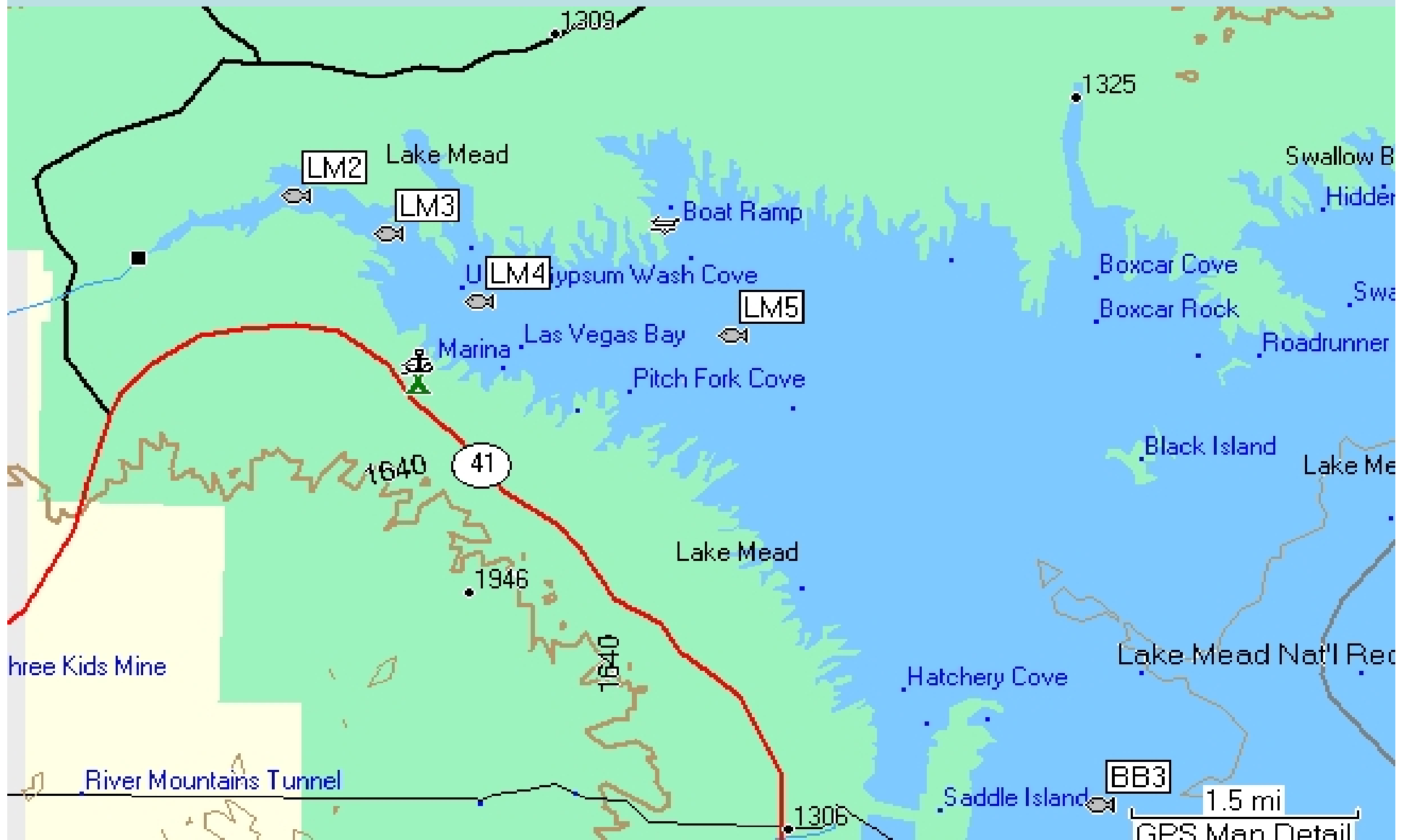
Sampling Sites



Lake Mead Historical Elevation



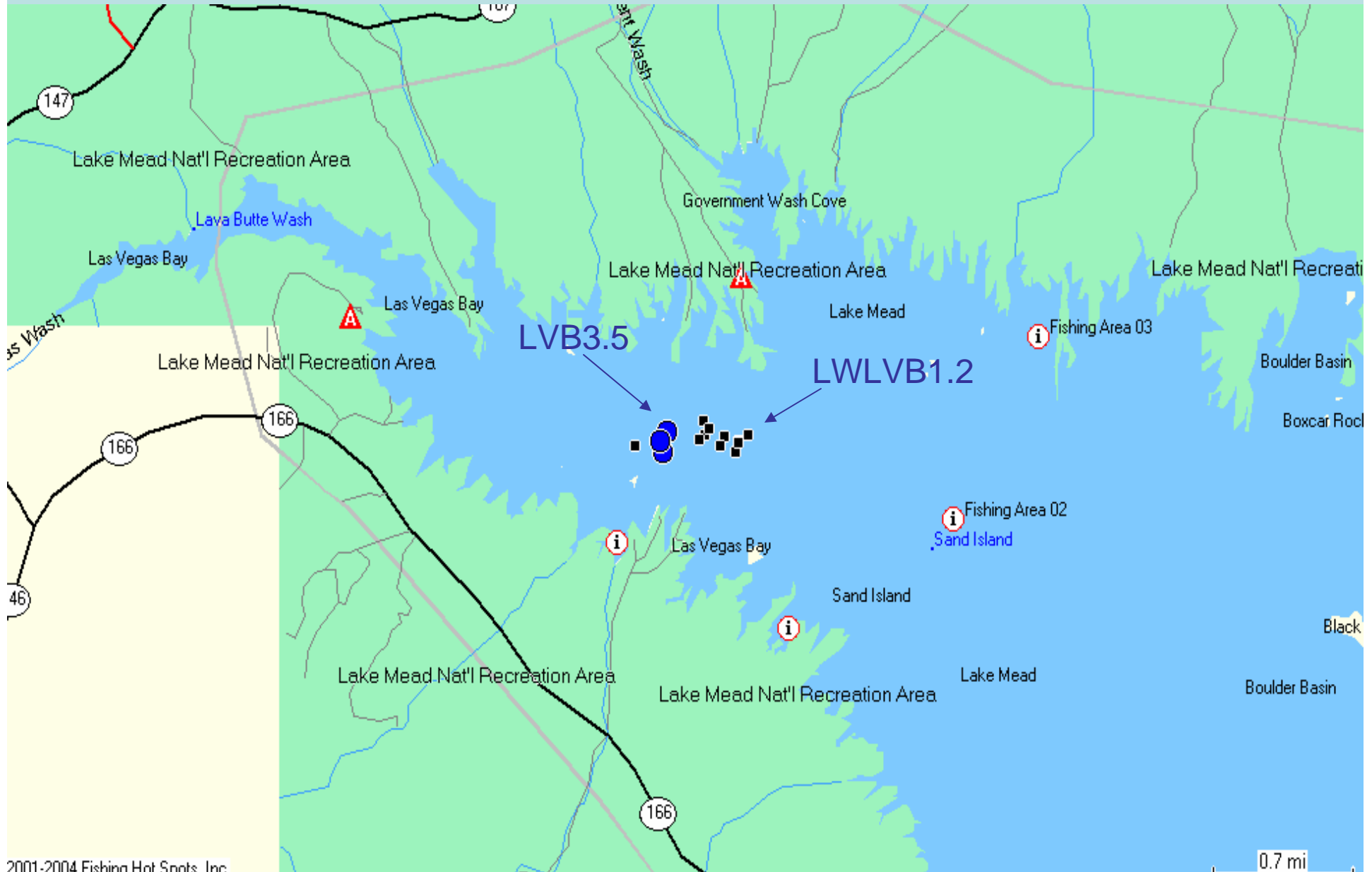
Las Vegas Bay Stations- Original Locations



Moving Stations



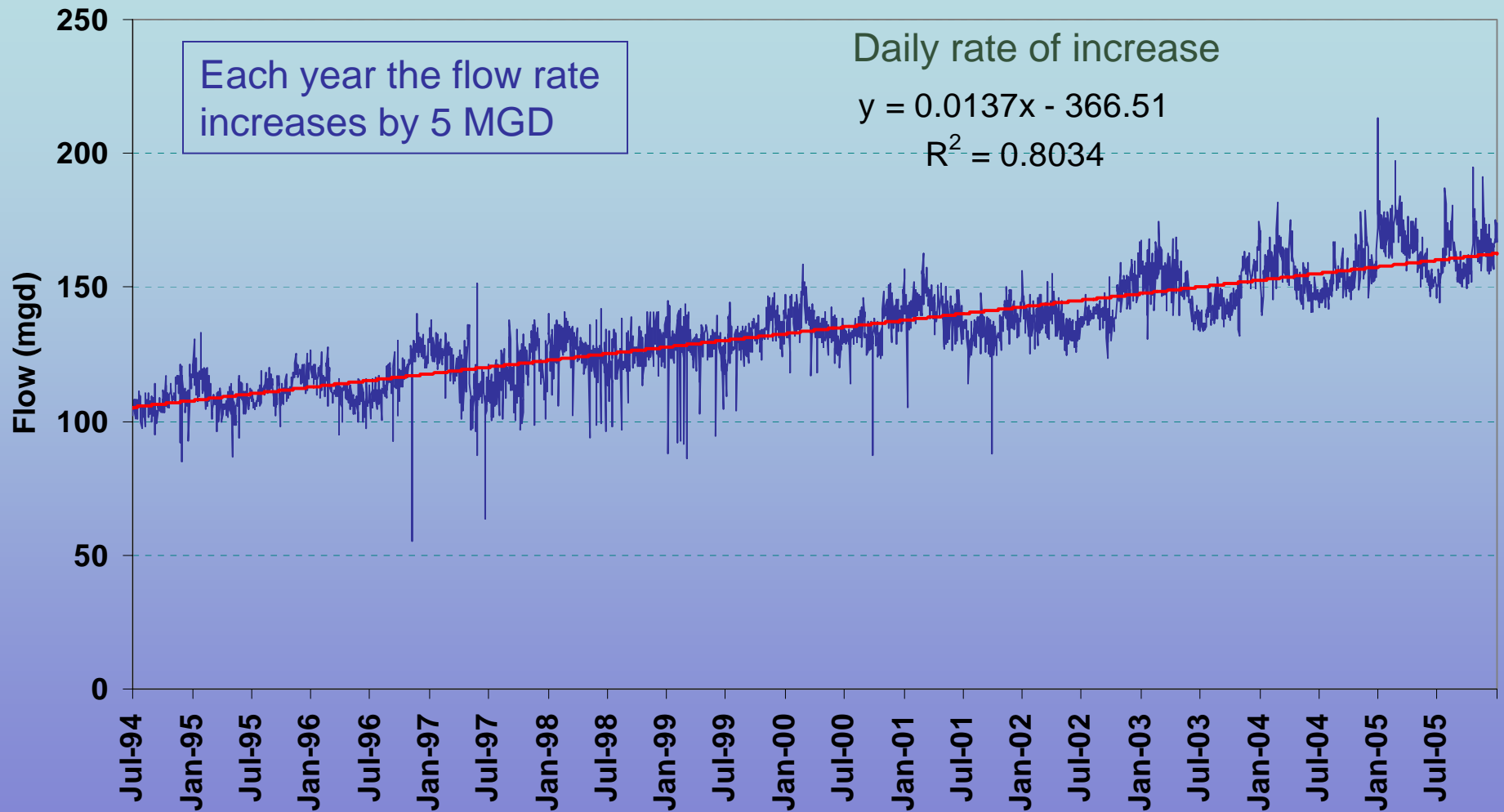
Stations used for comparison



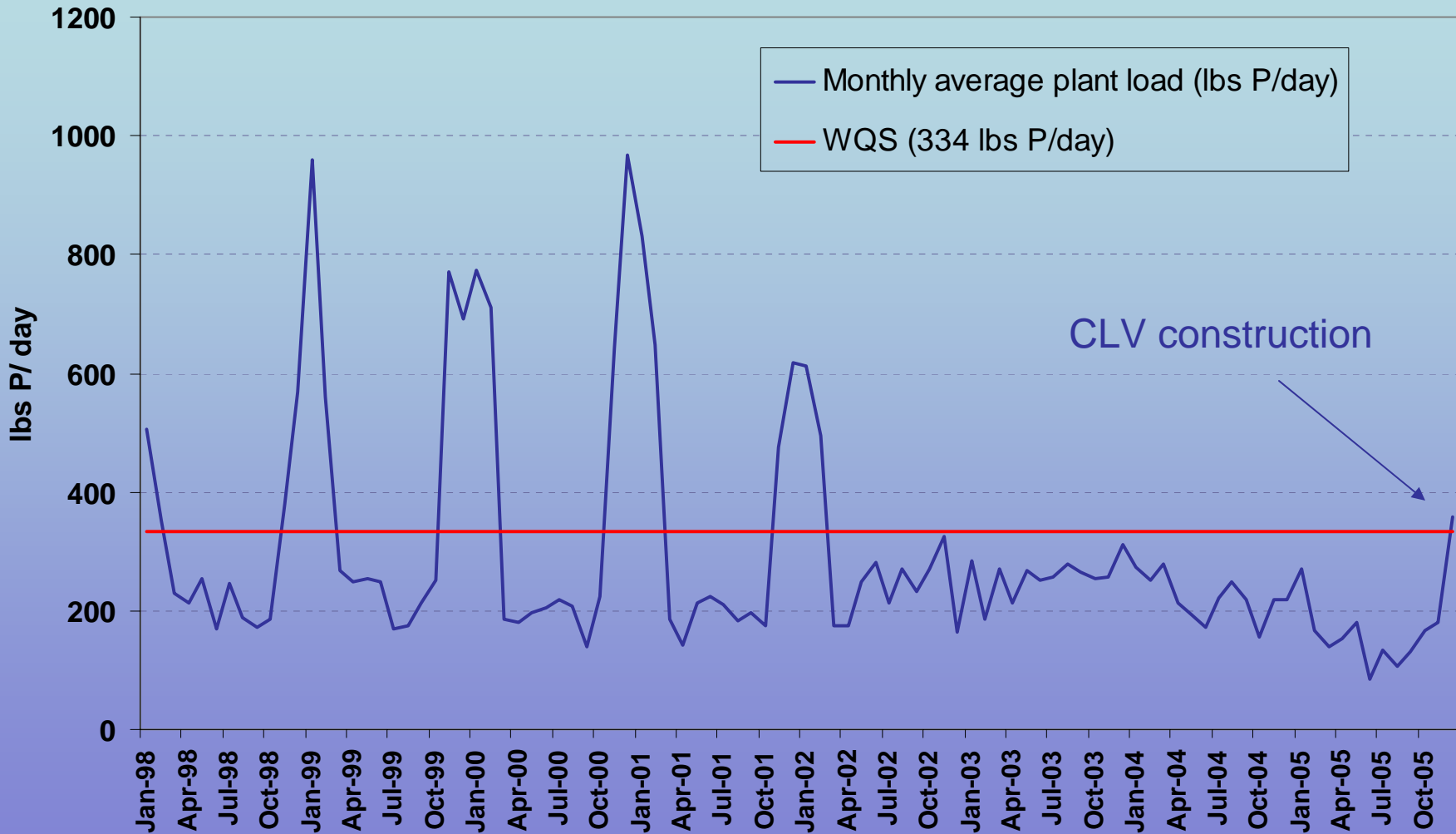
Data analysis methods

- Time scale for analysis
 - Mostly 1998-2005
 - Complete CWC data set ranges from 1994-2005
- Plant loads – daily data
- Wash loads
 - Biweekly monitoring
 - Annual totals - interpolated from biweekly data
- LVB monthly average data
 - Uses LVB 3.5 and LWLVB 1.2 stations
- Correlations
 - Use log-transformed monthly averages

WWTP's Combined Effluent Flow

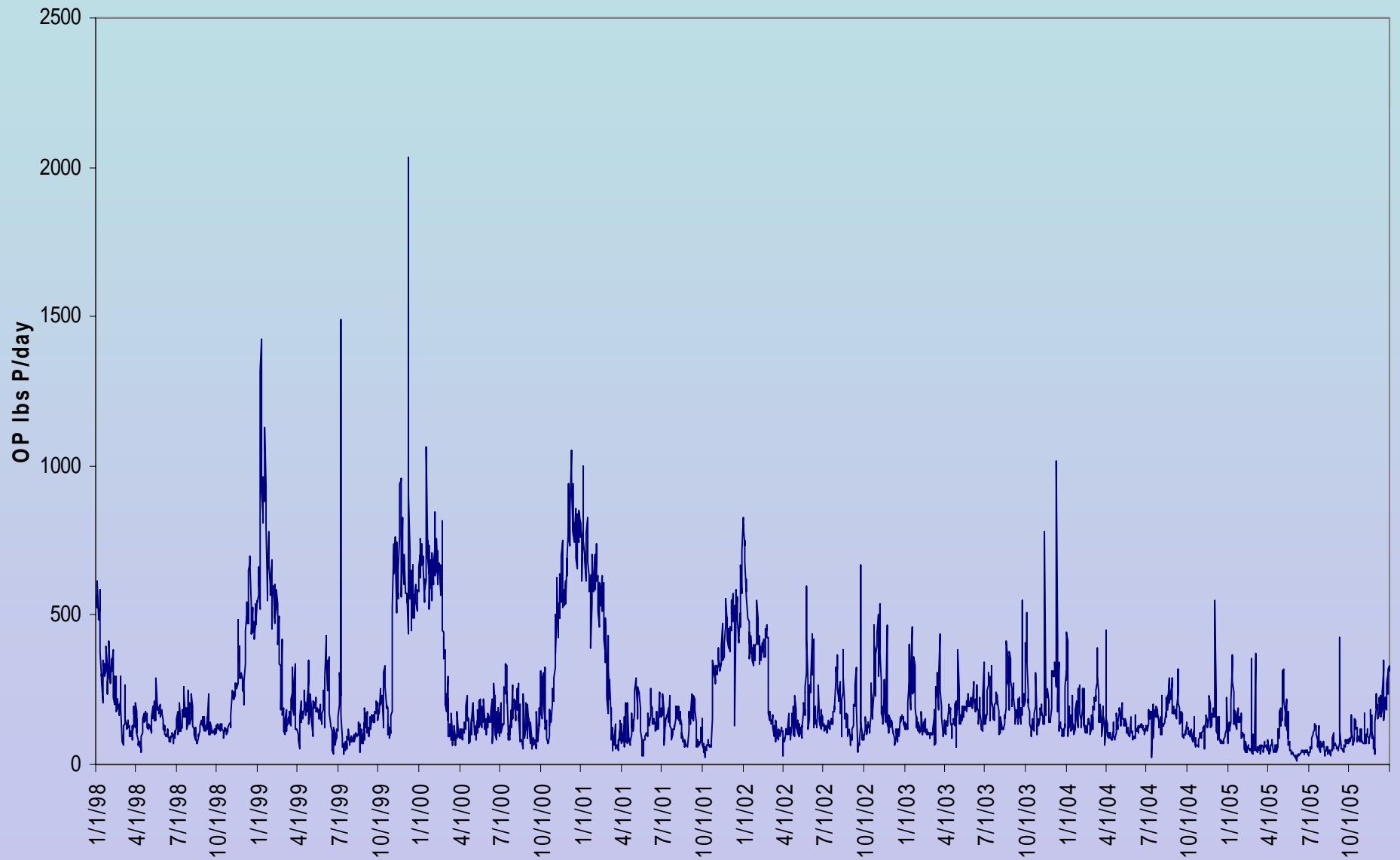


Monthly Average WWTP Total Phosphorus Loads

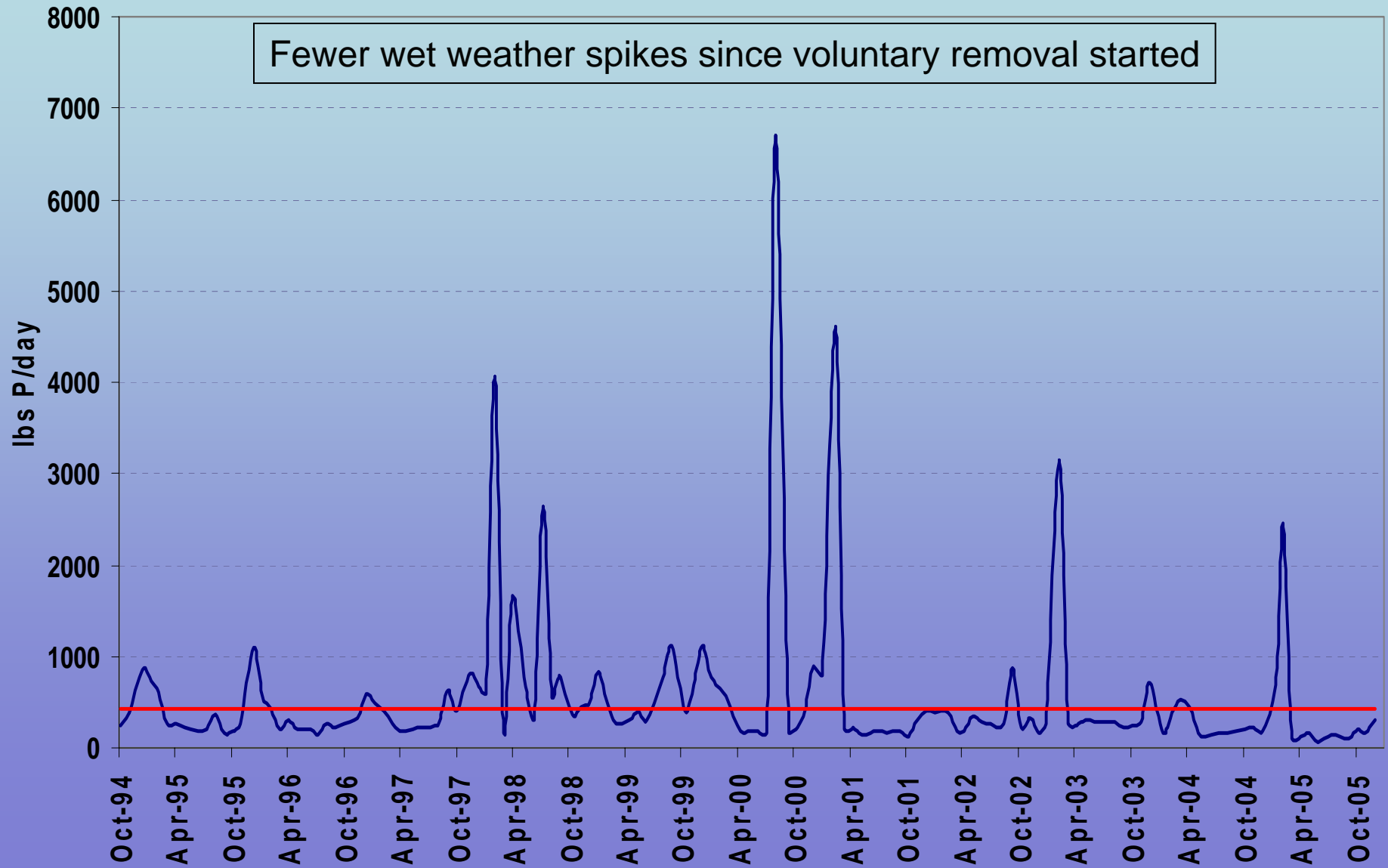


Voluntary winter reductions: 2001-present, reduce winter peaks

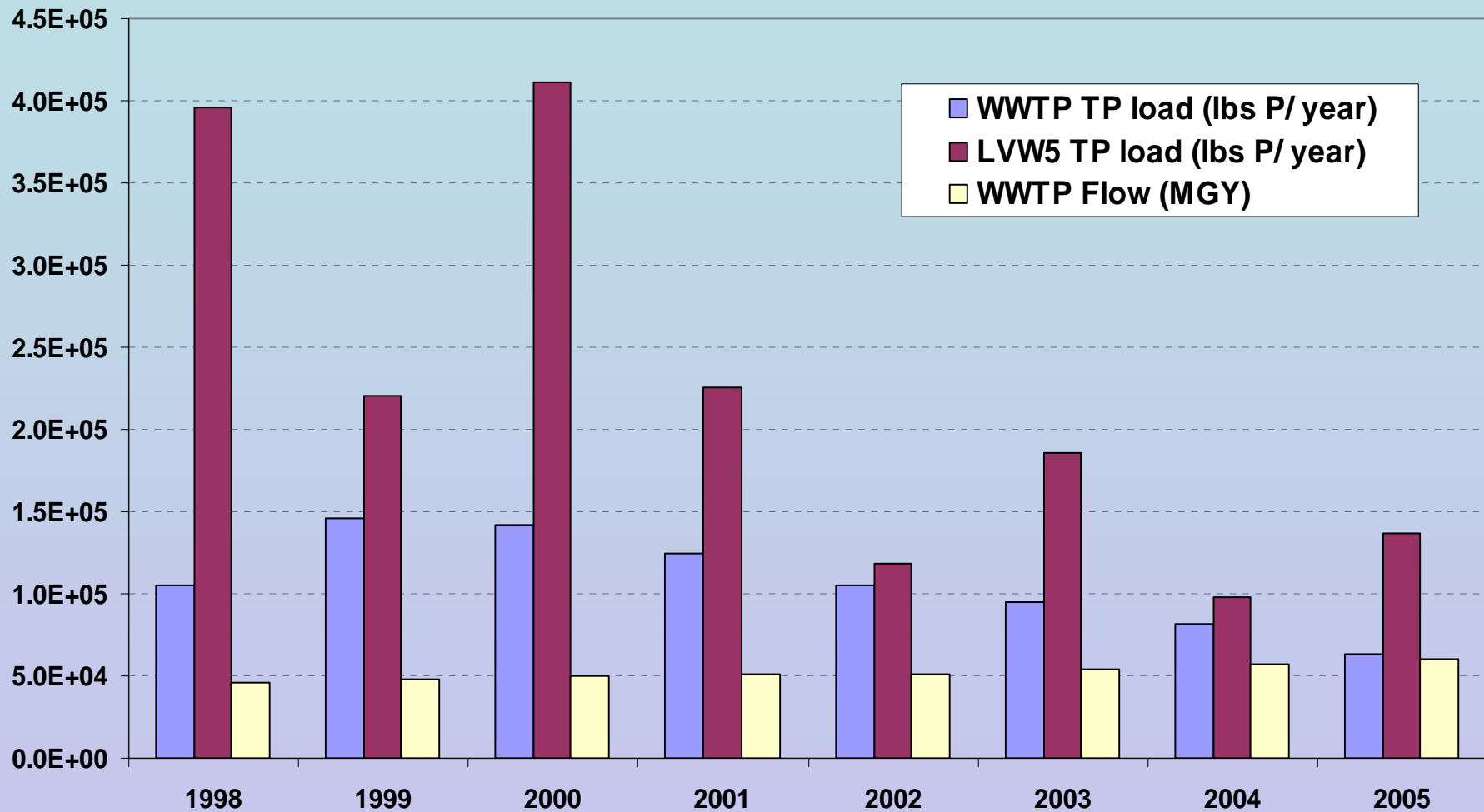
WWTP Ortho- Phosphorus Loads



LVW5 Monthly Average Total Phosphorus Loads (plant + nonpoint)



Annual Total P Loadings and Flow

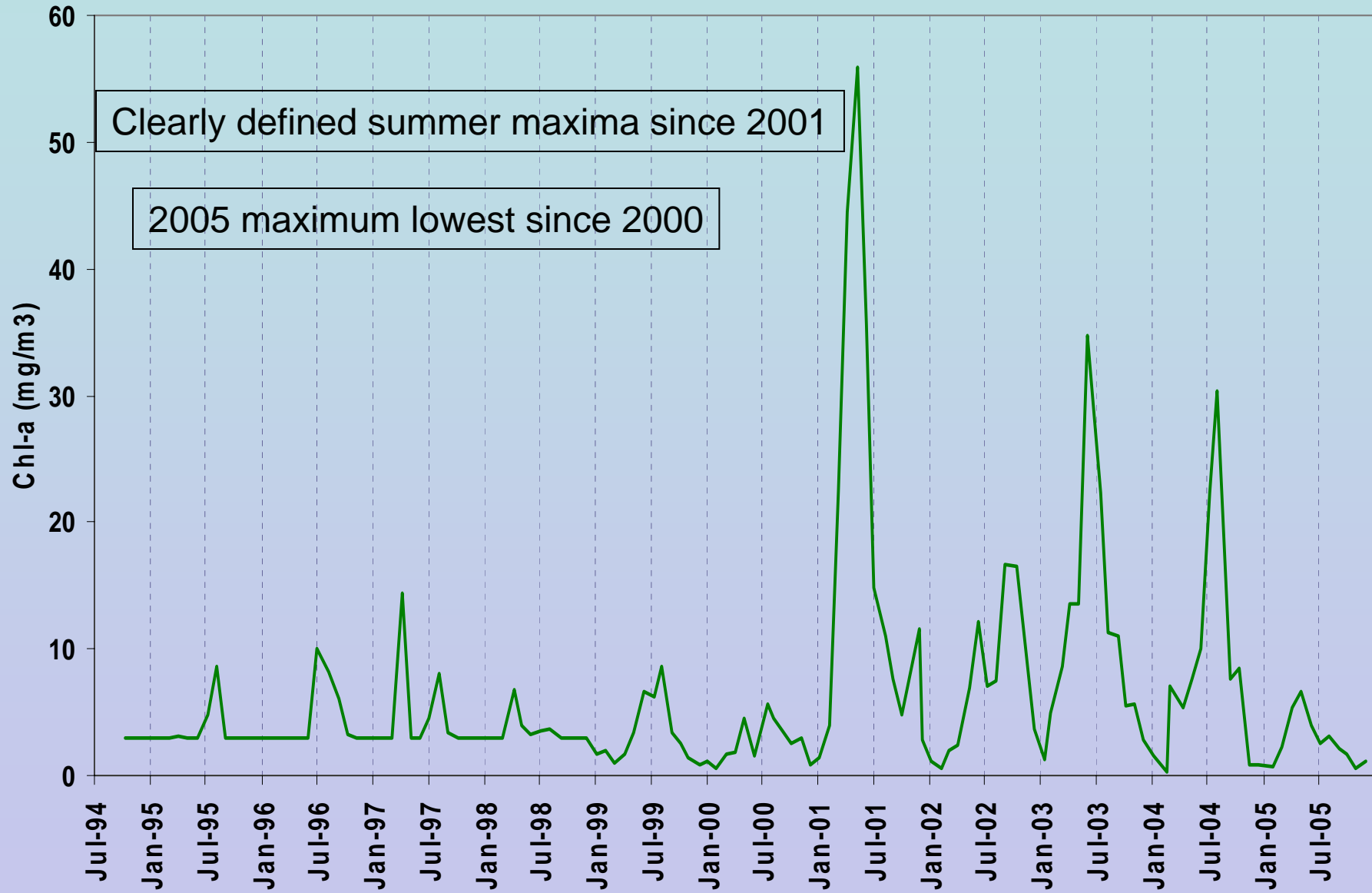


WWTP loads trending steadily down; LVW5 loads erratically down

Summary – Wash flow & P loading

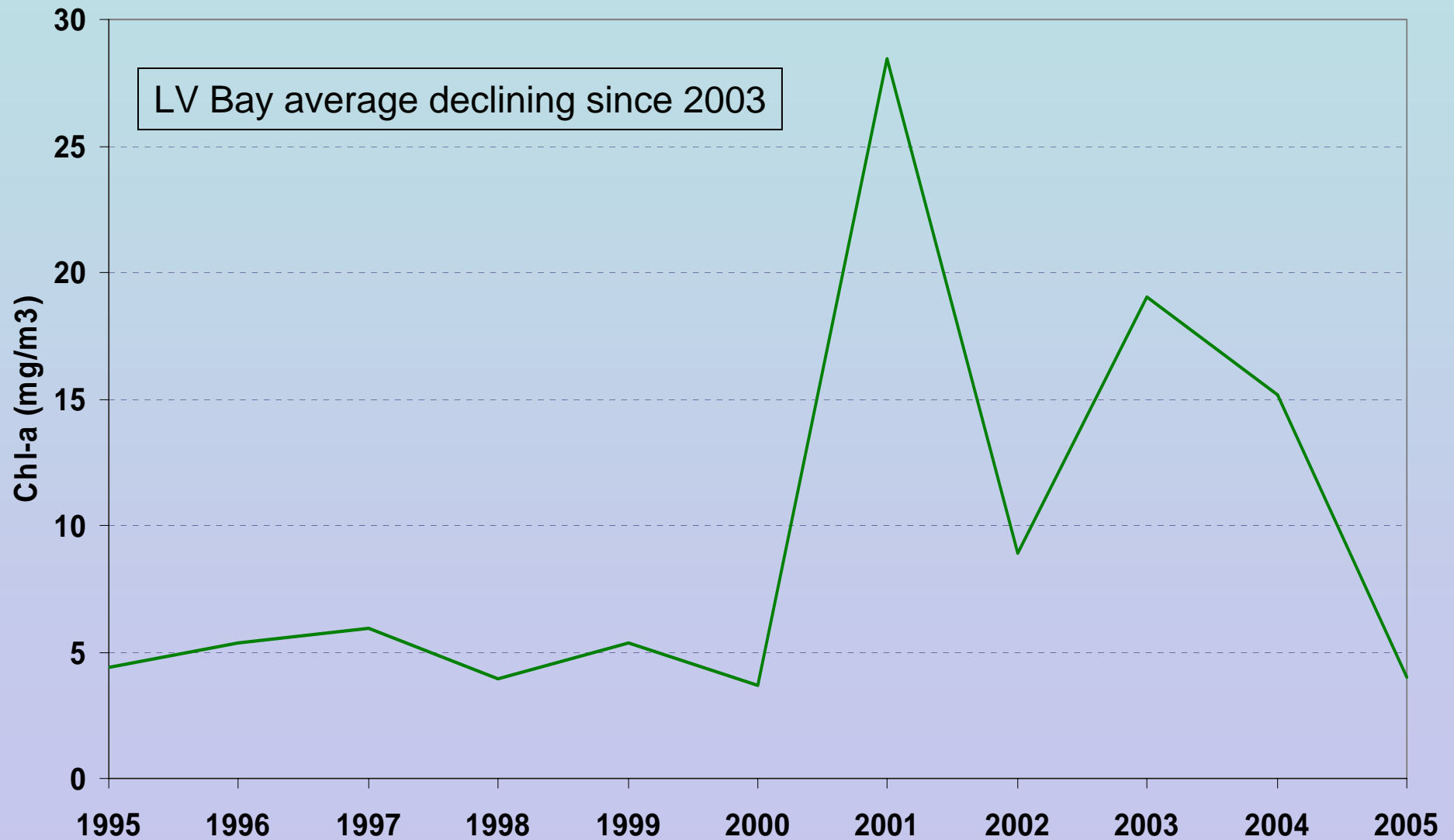
- Wash flow steadily increasing
- Winter seasonal WWTP P loads decreased after 2001
- Winter seasonal Wash (nonpoint + WWTP) loads decreased after 2001
- Annual WWTP P loads show steadily decreasing trend
- So, what's the impact on chlorophyll-a?

Las Vegas Bay Monthly Average Chl-a

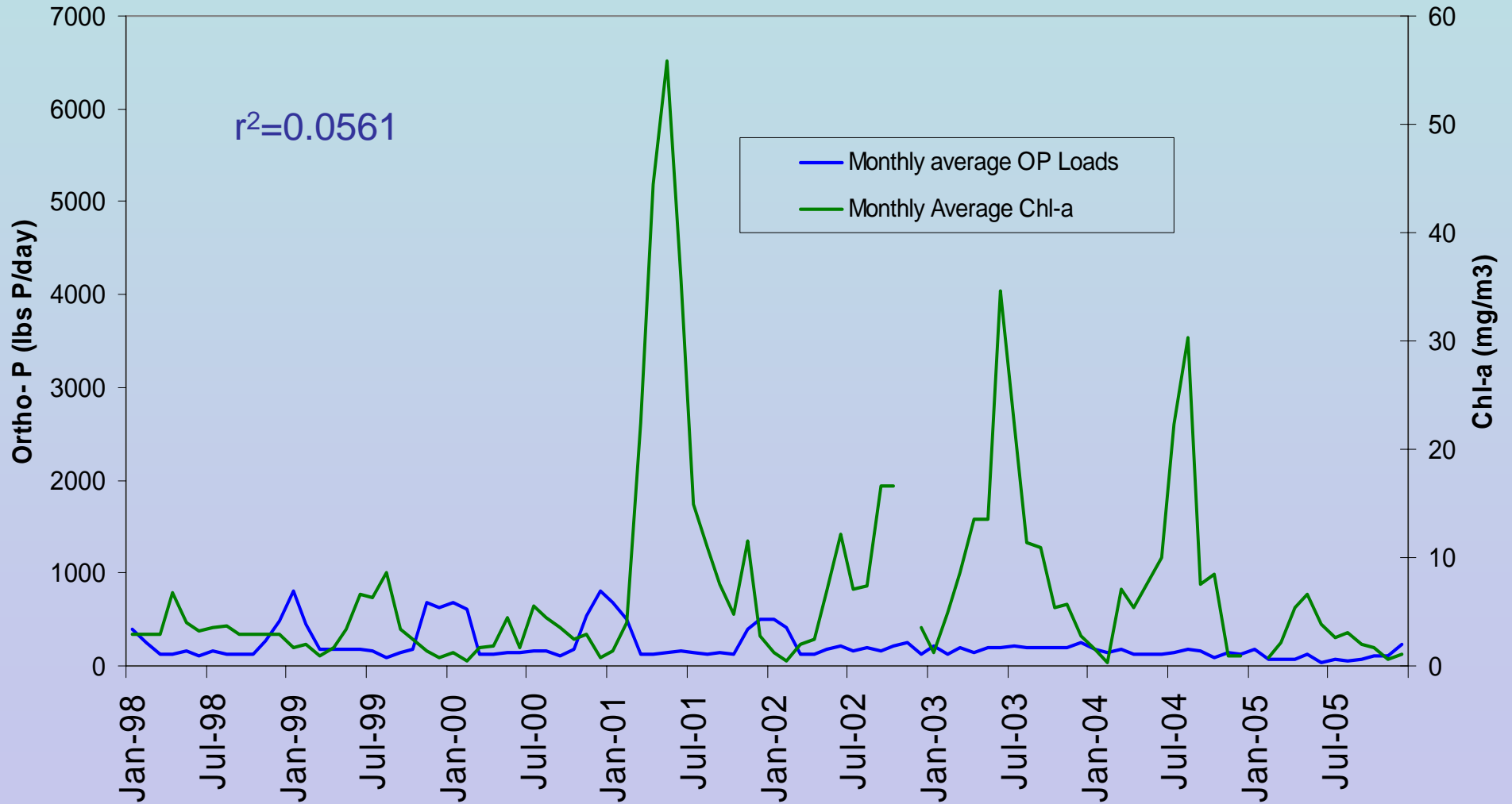


note detection limit change since 1999

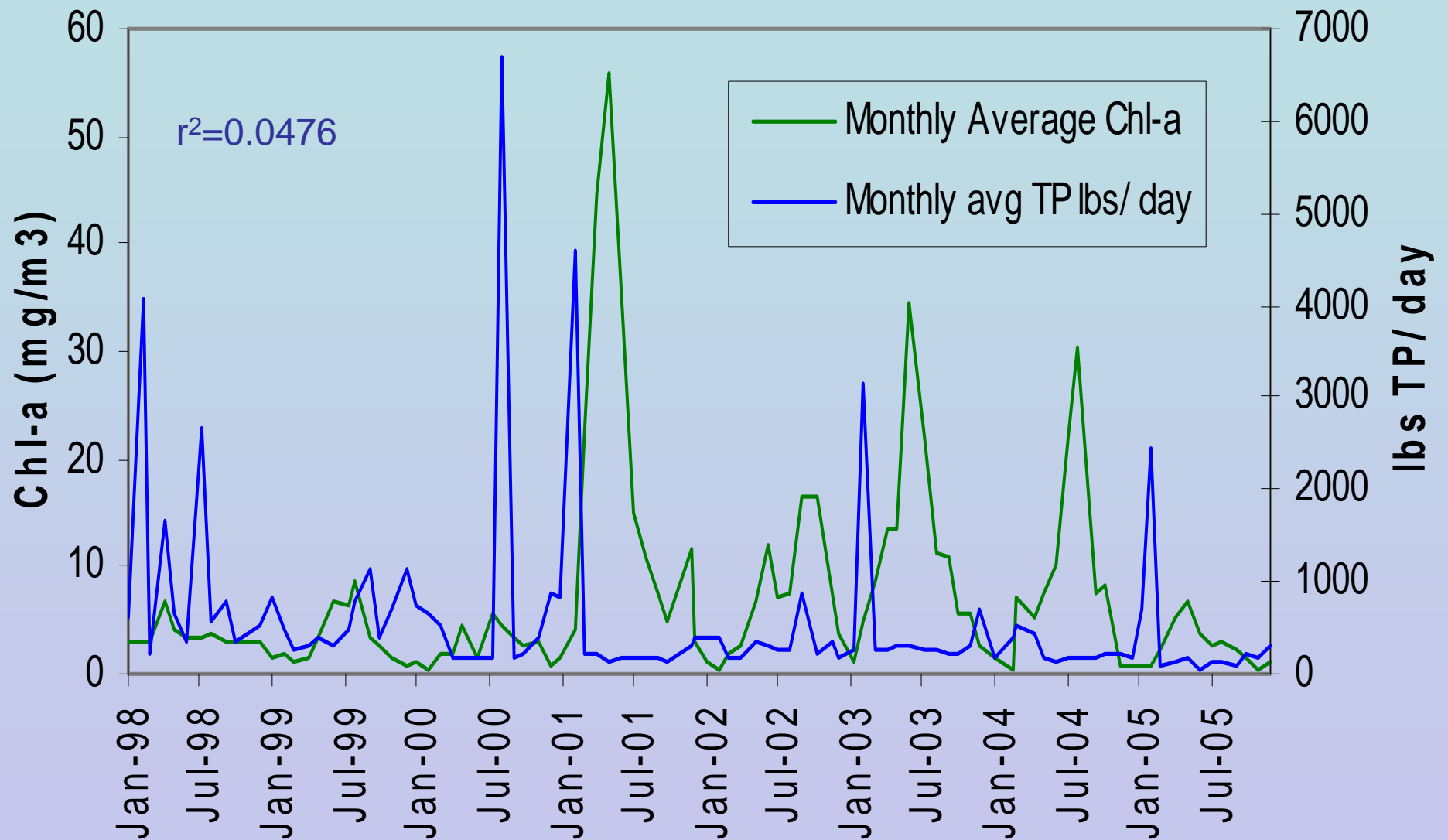
Las Vegas Bay Growing Season (Apr-Sept) Average Chl-a



Las Vegas Bay Monthly Average Chl-a and Eff OP loading

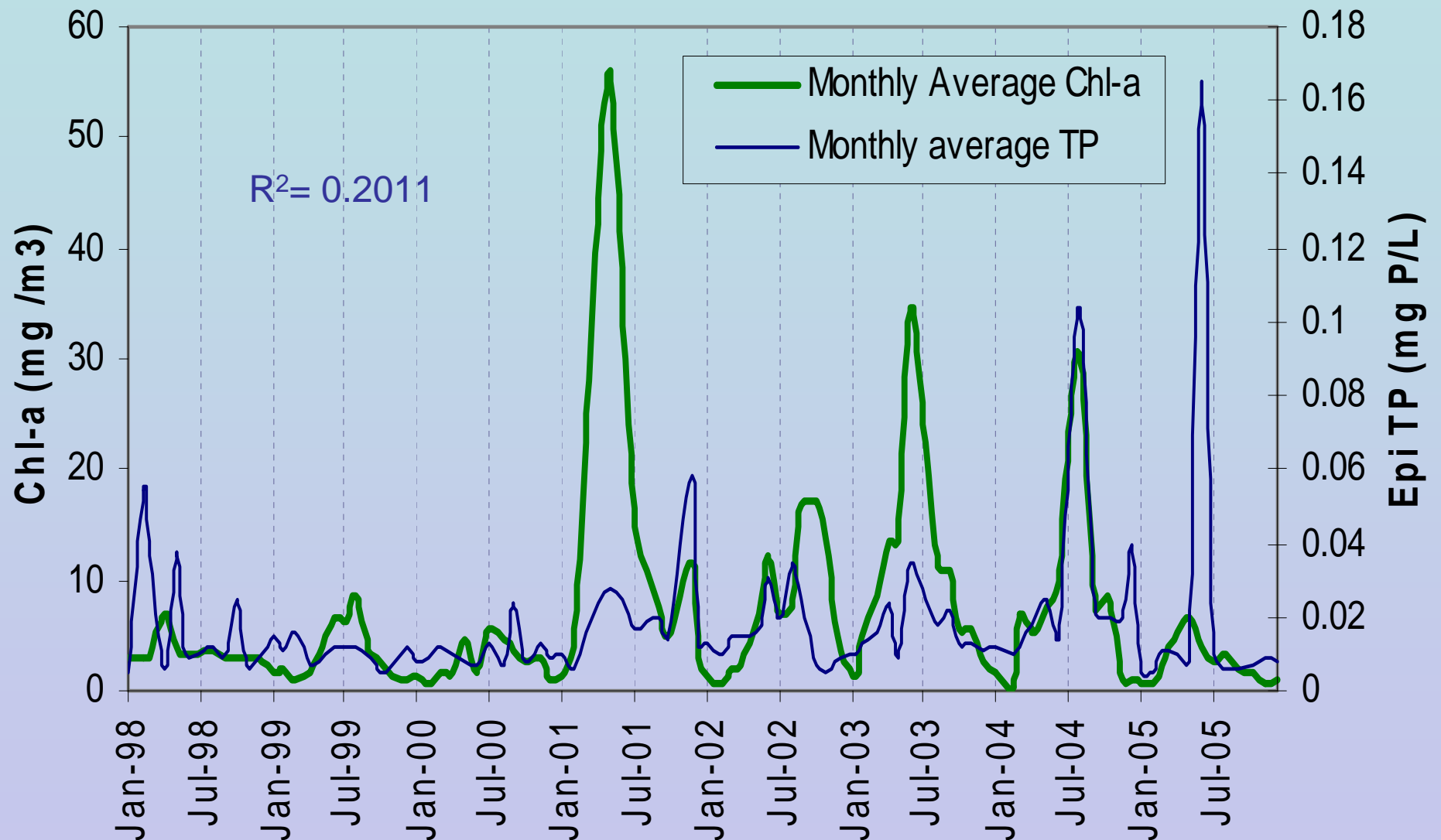


Las Vegas Bay Monthly Average Chl-a and LVW P loading



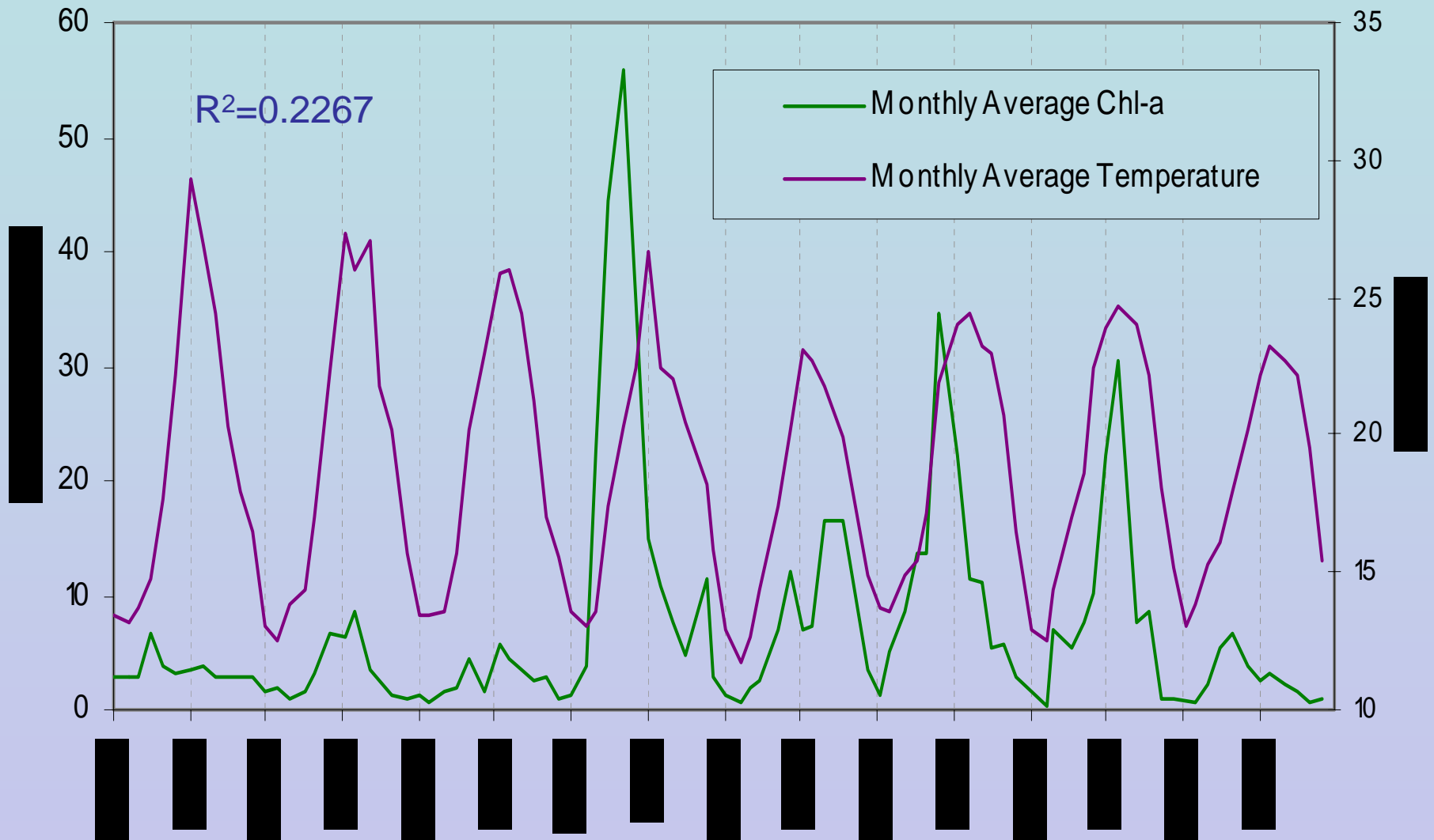
Chl-a peaks trail P load peaks in 2001, 2003 & 2005

Las Vegas Bay Monthly Average Chl-a and Epilimnion Total P



Chl-a peaks coincide with epilimnion total P peaks but response is inconsistent

Las Vegas Bay Monthly Average Chl-a and Epilimnion Temperature



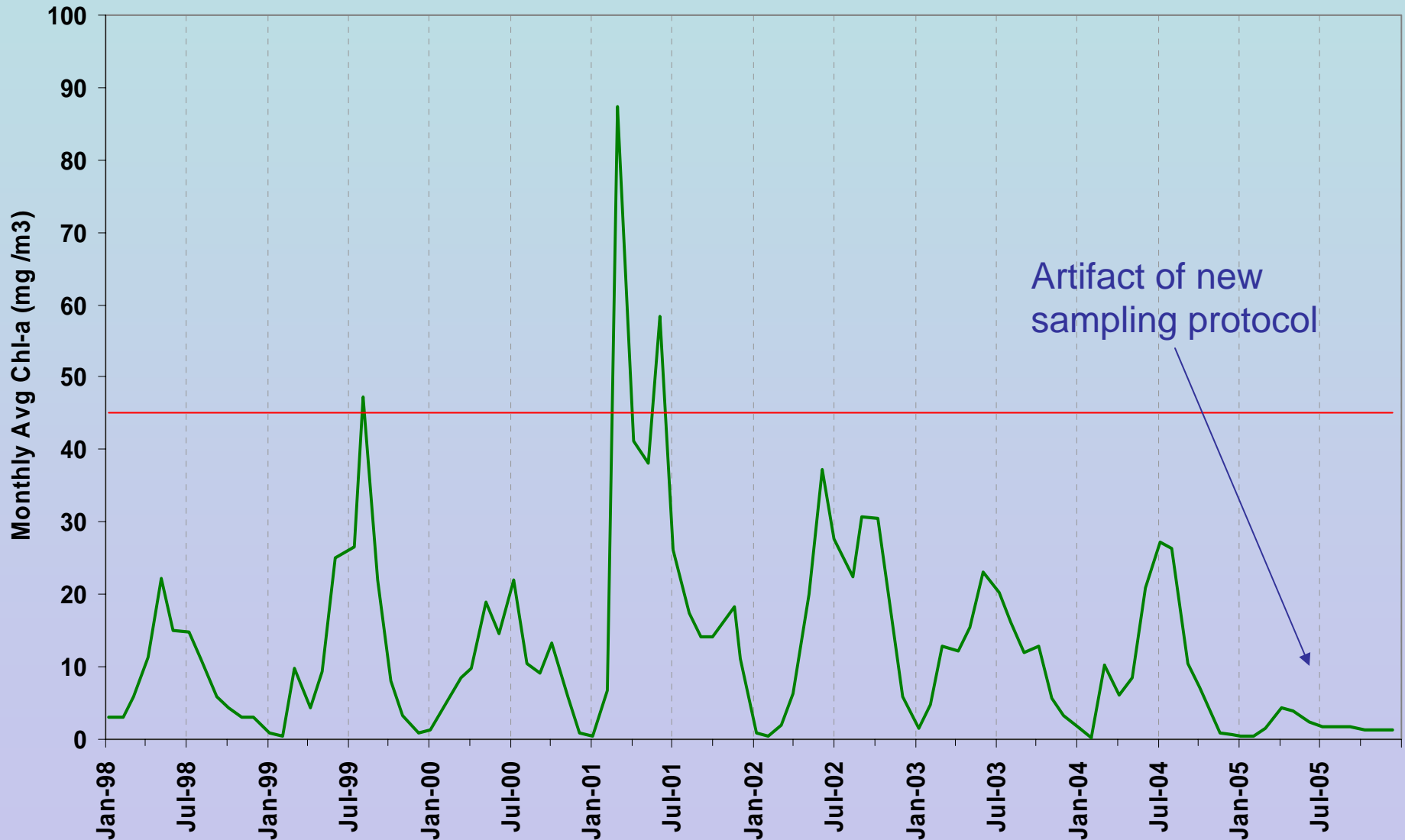
Best correlation is with light level/temperature

Conclusions - LVB total P and chl-a

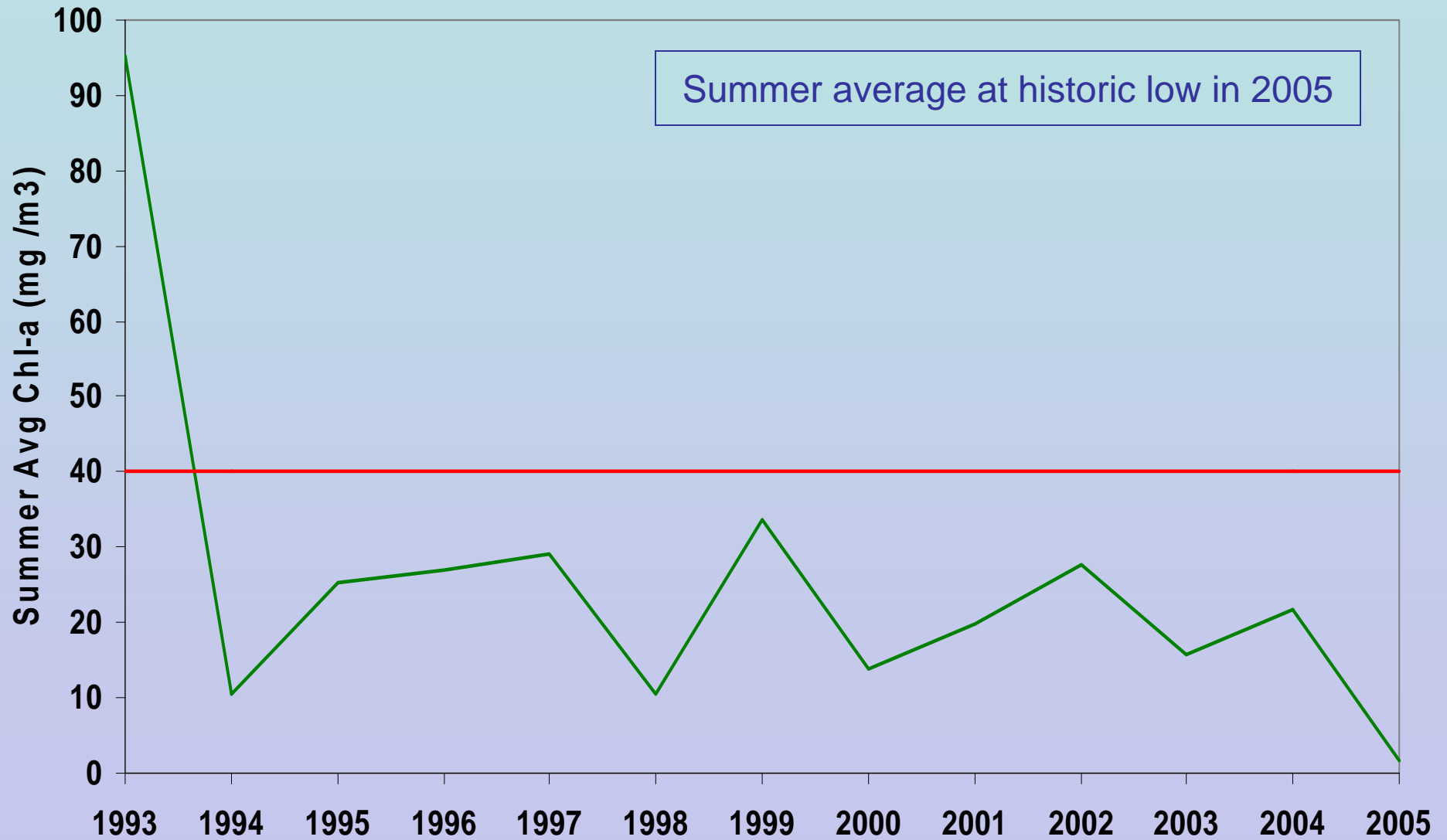
- LVB total P - no significant trend with time
- LVB chl-a growing season average declining since 2003
- LVB chl-a 2001-2004 summer maxima better defined than 1997-2000 maxima
- Chl-a correlation summary
 - Chl-a - Total P – very weak
 - Chl-a - Epi total P – better, but still low
 - Chl-a - Temperature – best, but still low

LVB1.85M Monthly Average Chl-a

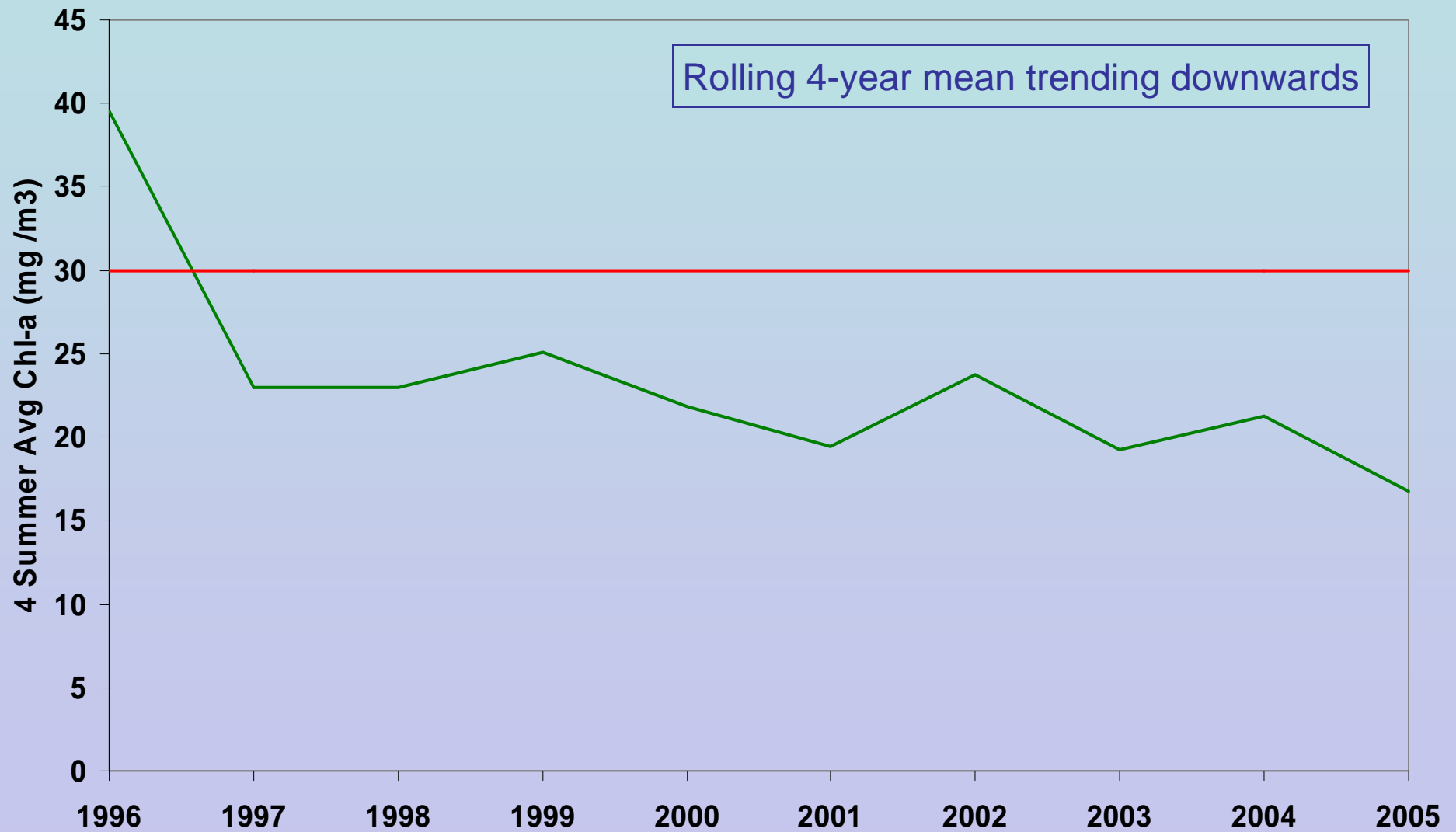
No exceedances since 2001 – 2005 is lowest since 1998



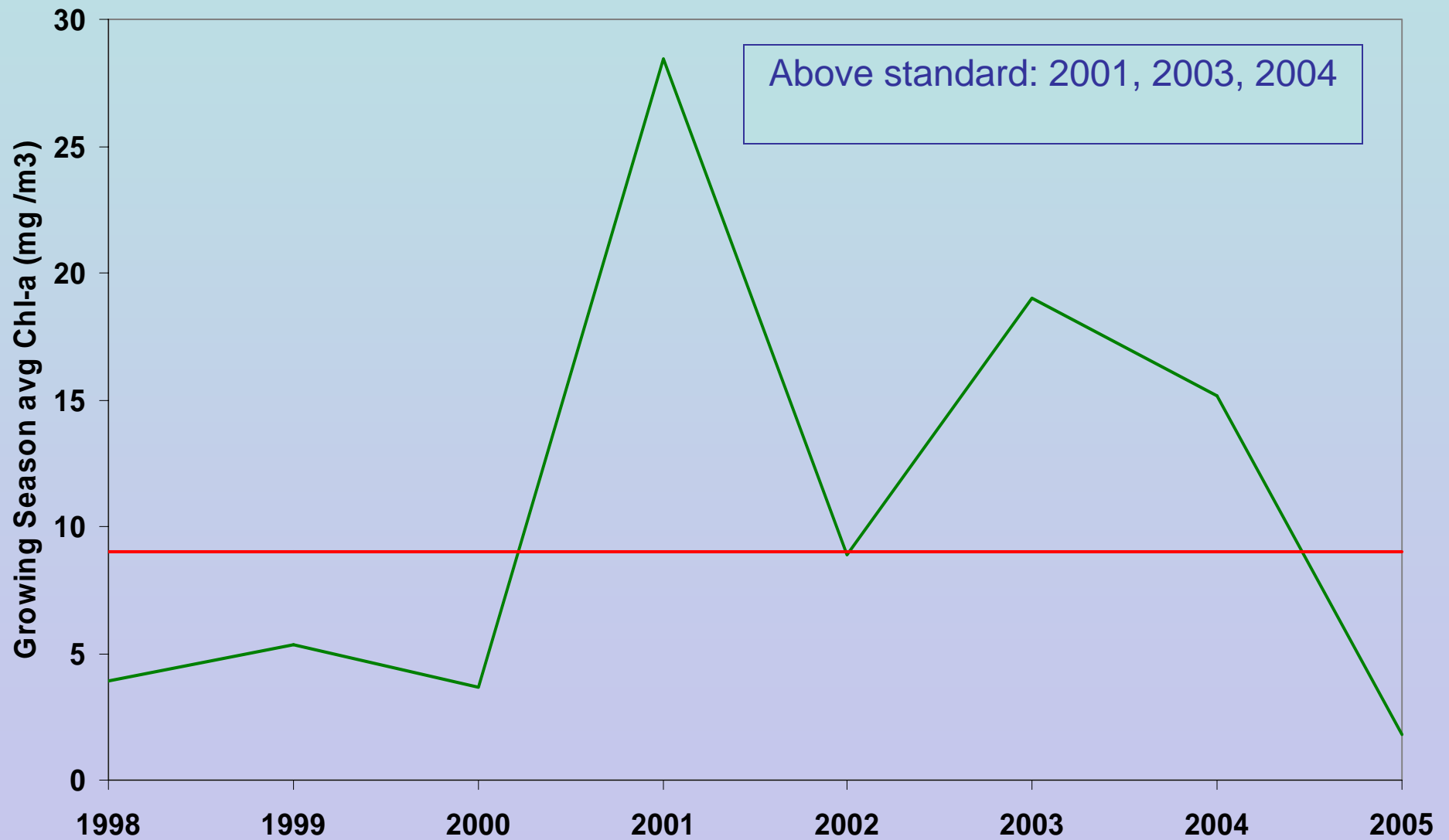
LVB1.85M Summer (July-Sept) average Chl-a



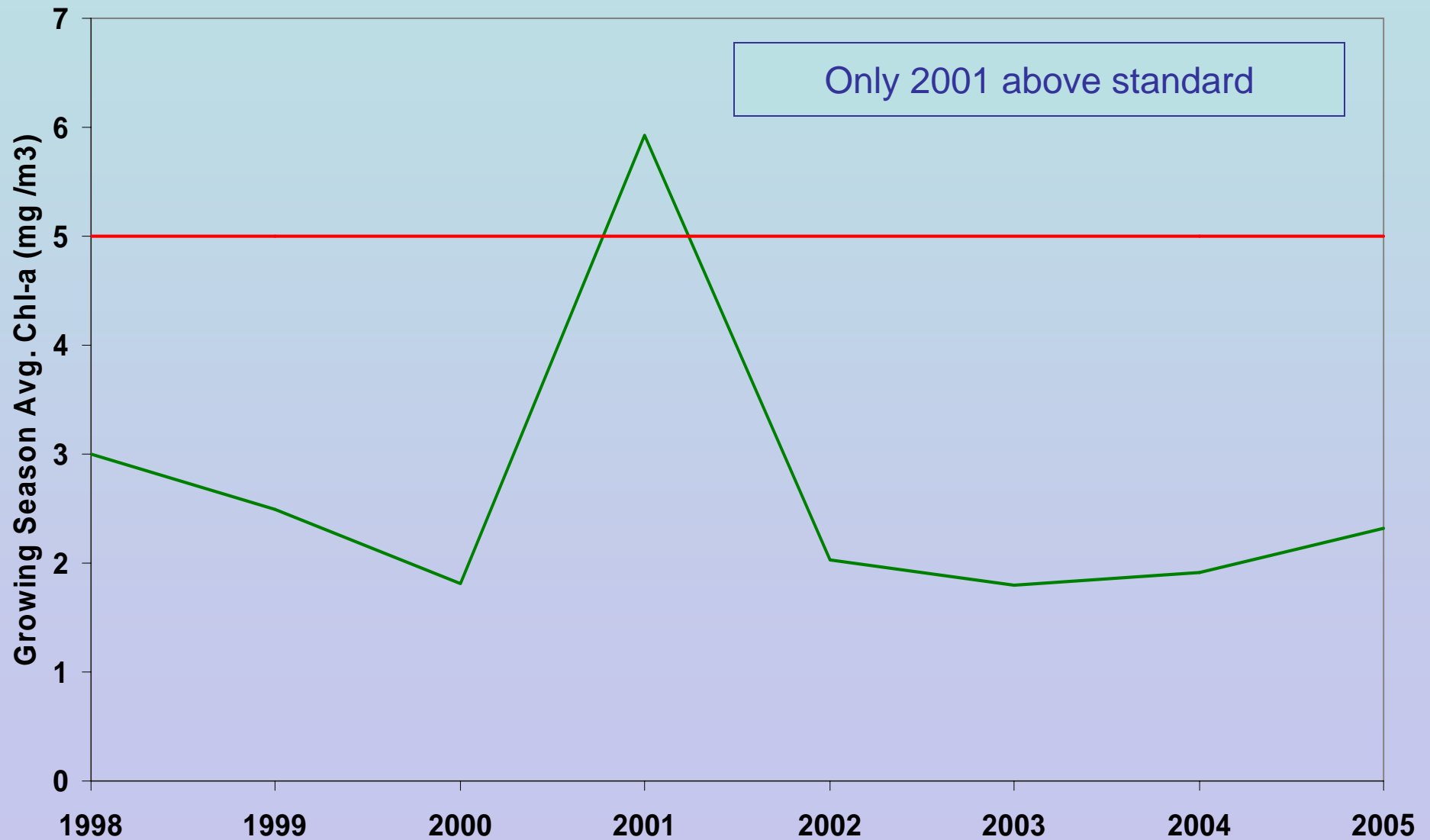
LVB1.85M 4-year rolling mean of summer (July-Sept) average Chl-a



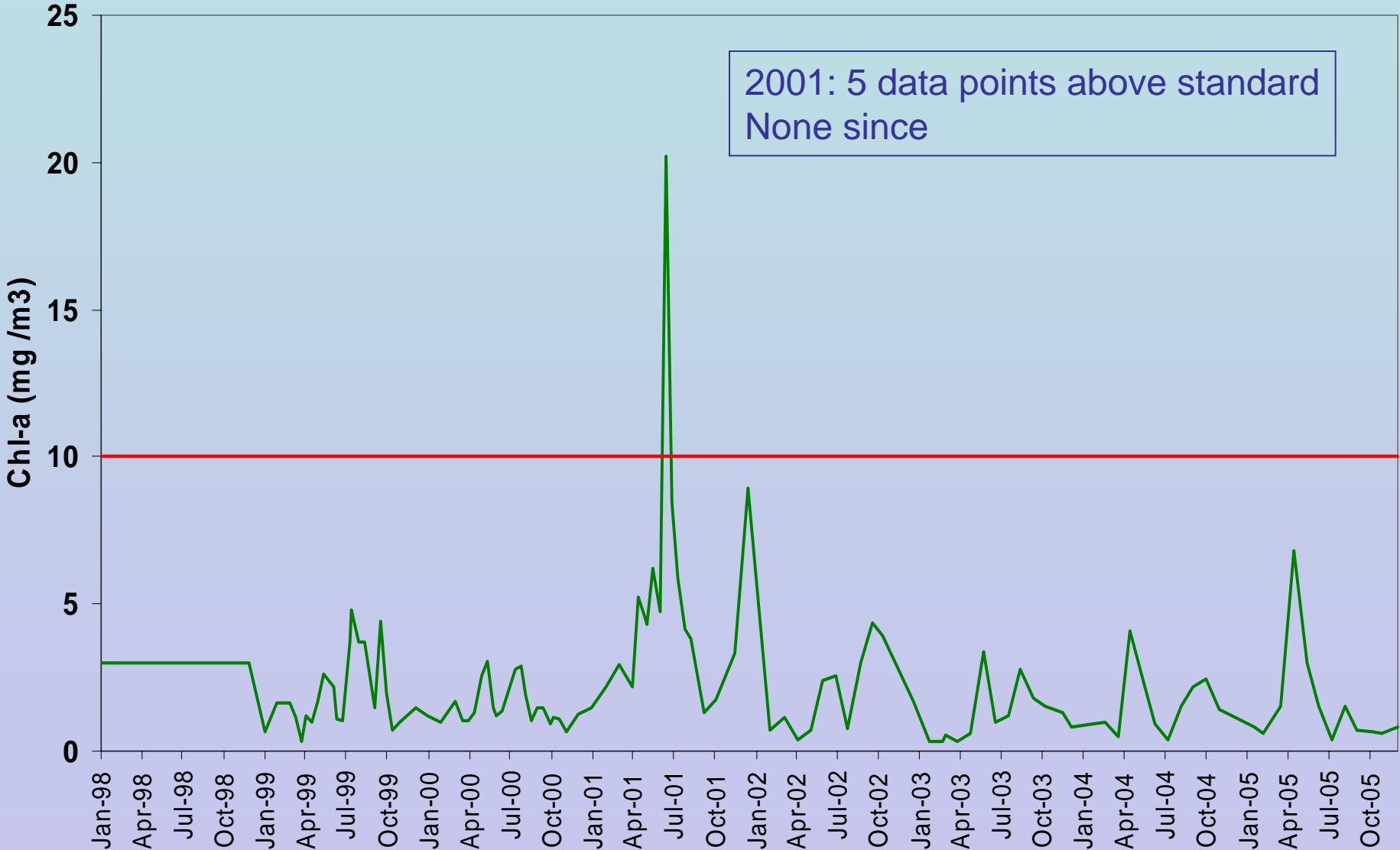
LVB3.5 Growing Season (Apr -Sept) average Chl-a



CR346.4 Growing Season (Apr-Sept) average Chl-a



CR346.4 Single Value Chl-a



Summary - Lake chl-a vs water quality standards

Location – standard	Value (mg/m ³)	Observation
LVB1.85M – monthly avg	45	No exceedances since 2001; <u>2005 lowest since 1998</u>
LVB1.85M – summer average	40	No exceedances since 1993; <u>2005 is lowest on record</u>
LVB1.85M – 4-year rolling summer average	30	No exceedances since 1996; <u>2005 is lowest on record</u>
LVB3.5 growing season	9	2001,2003 & 2004 exceed standard <u>2005 is lowest on record</u>
CR346.4 growing season	5	Only 2001 exceeds standard
CR346.4 single value	10	5 exceedances in 2001, none since

Conclusions – Effects of WWTP winter P removal on LVB water quality

- WWTP flow has increased
- WWTP total P loading to the lake has decreased
- Monthly average summer chl-a maxima in 2001-2004 are 4 highest in the 1994 – 2005 record
- Growing season LVB average chl-a low in 2005, but 2001-2004 values are 4 highest in 1995-2005 record

Bottom Line

- Has winter voluntary P removal brought growing season chl-a values to pre-bloom levels?
- No (through 2004)
- Why not? – possibilities:
 - other P loads & stored P in sediment?
 - Selection for more efficient P uptake?
 - Declining lake levels
- However,
 - Values would be higher without P reduction

Acknowledgements

- Dischargers – Water quality data
 - Clark County Water Reclamation District
 - City of Henderson
- US Geological Survey
 - Wash flow
- US Bureau Reclamation
 - Lake levels
- NDEP
 - Water Quality Rationales
- Larry Bazel
 - History of P removal