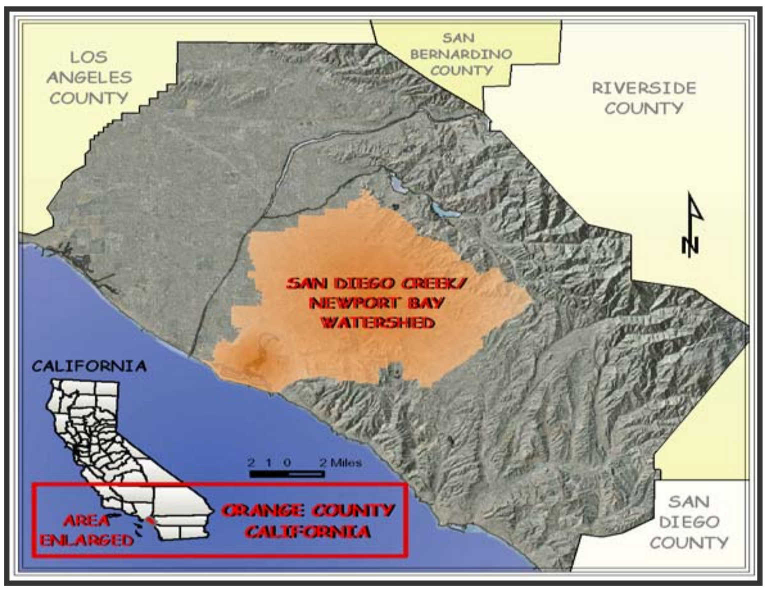
REGIONAL MONITORING PROGRAM REPORT
FOR THE NEWPORT BAY/SAN DIEGO CREEK WATERSHED
NUTRIENT TMDL

(Resolution No. 98-9, as amended by Resolution No. 98-100)

November 2005



Prepared and submitted on behalf of:

The County of Orange
and
The Cities of Irvine, Tustin, Newport Beach,
Lake Forest, Santa Ana, Orange and Costa Mesa
and
The Irvine Company and Irvine Ranch Water District

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1.0 INTRODUCTION

In 1996, the State of California placed the Newport Bay and San Diego Creek Watershed on the Clean Water Act Section 303(d) list of water quality limited segments. This listing was in response to qualitative and quantitative measurements indicating the inability to meet the nutrient-related Water Quality Objectives (WQOs) for Newport Bay (Bay) as stated in the Water Quality Control Plan for the Santa Ana Region (Basin Plan).

The WQOs for Newport Bay are narrative and state:

- "Waste discharges shall not contribute to excessive algal growth in receiving waters"
- "The dissolved oxygen content of enclosed bays and estuaries shall not be depressed to levels that adversely affect beneficial uses as result of controllable water quality factors"

The WQOs for San Diego Creek are narrative and numeric and state:

- "Waste discharges shall not contribute to excessive algal growth in inland surface receiving waters"
- Reach 1 (Jeffrey Road to Newport Bay) –13 mg/L total inorganic nitrogen (TIN)[1]
- Reach 2 (Jeffrey to headwaters) – 5 mg/L TIN

In 1998, the Santa Ana Regional Water Quality Control Board (Regional Board) adopted an amendment to the Basin Plan to establish a Total Maximum Daily Load (TMDL) for nutrients in the Newport Bay/San Diego Creek Watershed (Resolution No. 98-9, as amended by Resolution No. 98-100). The Nutrient TMDL establishes targets for reducing the annual loading of nitrogen and phosphorus to Newport Bay by 50%[2] and meeting the narrative and numeric quality objectives by 2012. For total nitrogen, the overall annual target of 298,225 lbs per year is divided into a summer season allocation (153,861 lbs) and a winter season allocation (144,364 lbs). Compliance is to be achieved in two stages: a 30% and 50% reduction in summer loads by 2002 and 2007, respectively, and a 50% reduction in winter loads by 2012 (SARWQCB, 2004). For total phosphorus, the compliance targets require a 30% and 50% reduction by 2002 and 2007, or total annual loads of 86,912 and 62,080 pounds per year respectively **(Table 1).**

The 50% reduction in total nitrogen and total phosphorus is based upon the historical data from 1973-1974 that indicates nitrate nitrogen loading to Newport Bay was approximately 383,000 lbs (accounting for total nitrogen, the load would be approximately 428,000 lbs). This time frame was selected by the Regional Board because qualitative information indicates that there were limited macrophytes present at that time, and therefore, presumably limited impact due to nutrient enrichment (EPA, 1998).

[1] The numeric targets were established by the Santa Ana Regional Board through the 1983 Basin Plan. A 5 mg/L TIN objective was proposed for both Reach 1 and Reach 2. However, the 5 mg/L objective was not established for Reach 1 due to economic reasons. The Regional Board staff averaged low-flow concentrations from San Diego Creek at Campus Drive to derive the 13 mg/L TIN objective for Reach 1.

[2] The 50% reduction was established relative to the average loads from an eight-year baseline period (1990 – 1997)

Table 1. Nutrient TMDL Loading Targets and Compliance Time Schedules. (compliance to be achieved no later than the listed dates.)

TMDL	December 31, 2002	December 31, 2007	December 31, 2012
Newport Bay Watershed Total Nitrogen – Summer Load[3]	200,097 lbs	153,861 lbs	
Newport Bay Watershed Total Nitrogen – Winter Load[4]			144,364 lbs
Newport Bay Watershed Total Phosphorus Annual Load[5]	86,912 lbs	62,080 lbs	
San Diego Creek, Reach 2 Total Nitrogen – Daily Load[6]			14 lbs

After the adoption of the Nutrient TMDL into the Basin Plan, a Regional Monitoring Program (RMP) was developed in order to monitor and evaluate the goals of the Nutrient TMDL. In February 2000, the County of Orange, on behalf of the watershed cities (Costa Mesa, Irvine, Laguna Hills, Laguna Woods, Lake Forest, Newport Beach, Orange, Santa Ana, and Tustin), initiated the RMP for Newport Bay and its watershed pursuant to the requirements established by the Santa Ana Regional Board (Resolution 99-77 to establish an RMP pursuant to the TMDL). The objectives of the RMP are to quantify the three endpoints of the TMDL: (1) the seasonal nutrient loading from the watershed, (2) the nutrient concentrations in San Diego Creek, Reaches 1 and 2, and (3) the extent, magnitude, and duration of algal blooms in San Diego Creek and Newport Bay. This RMP was designed by watershed stakeholders and was approved by the Santa Ana Regional Board.

This report provides a summary of the data and results from the RMP for the July 2004 through June 2005 reporting period and analysis of the cumulative RMP data from 2000. The three objectives of the RMP are addressed through three program elements: 1)Watershed Monitoring; 2) Bay Monitoring; and 3) Algal Biomass Monitoring. Sections 2-4 discuss each program element, sampling methodology, and results. Section 5 provides analysis of the data with respect to WQO compliance. Raw data from each program element can be found in Appendices A-D and has been submitted in electronic format to the Regional Board.

[3] Summer Load = April 1 – September 30

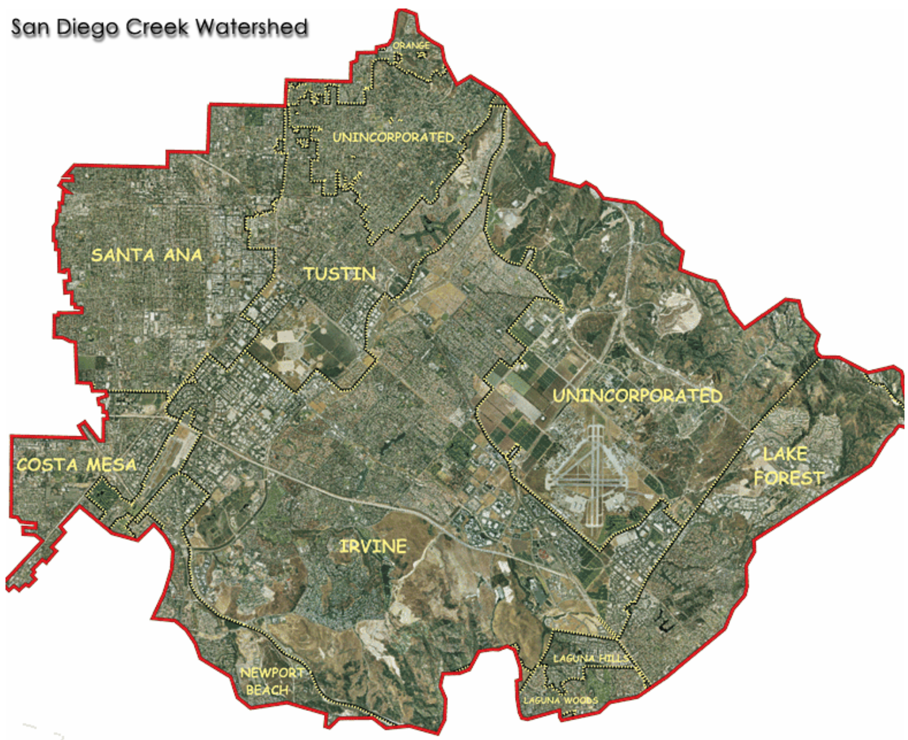
[4] Winter Load = October 1 – March 31 and when the mean daily flow rate at San Diego Creek at Campus Drive is below 50 cfs and when mean daily flow rate is above 50 cfs, but not as a result of precipitation

[5] Sum of summer and winter loading during all flow rates

[6] Loading limit applies when mean daily flow rate at San Diego Creek at Culver Drive is below 25 cfs and when the mean daily flow rate is above 25 cfs, but not as a result of precipitation

SECTION 2.0

REGIONAL MONITORING PROGRAM
FOR THE
SAN DIEGO CREEK WATERSHED



2.0 SAN DIEGO CREEK WATERSHED

2.1 DESCRIPTION

Monitoring in the Newport Bay/San Diego Creek watershed is used as the basis for evaluating both the load and concentration endpoints of the Nutrient TMDL as well as evaluating the urban runoff wasteload allocation. 24-hour composite surface water samples are collected either weekly, bi-weekly, or monthly, and during approximately three storms per year depending upon RMP requirements **(Table 2)** from nine locations throughout the watershed **(Figure 1)**. These monitoring locations (and station codes) are:

- San Diego Creek at Campus Drive (SDMF05)
- Santa Ana-Delhi at Irvine Avenue (SADF01)
- Peters Canyon Wash at Barranca Parkway (BARSED)
- San Diego Creek at Harvard (WYLSED)
- El Modena-Irvine Channel at Michelle (MIRF07)
- Costa Mesa Channel at Westcliffe (CMCG02)
- Lane Channel at Jamboree (LANF08)
- Bonita Canyon Creek at MacArthur Boulevard (BCF04)
- Agua Chinon Channel at Irvine Boulevard (ACWF18)
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Figure 1. Newport Bay Watershed Monitoring Locations.

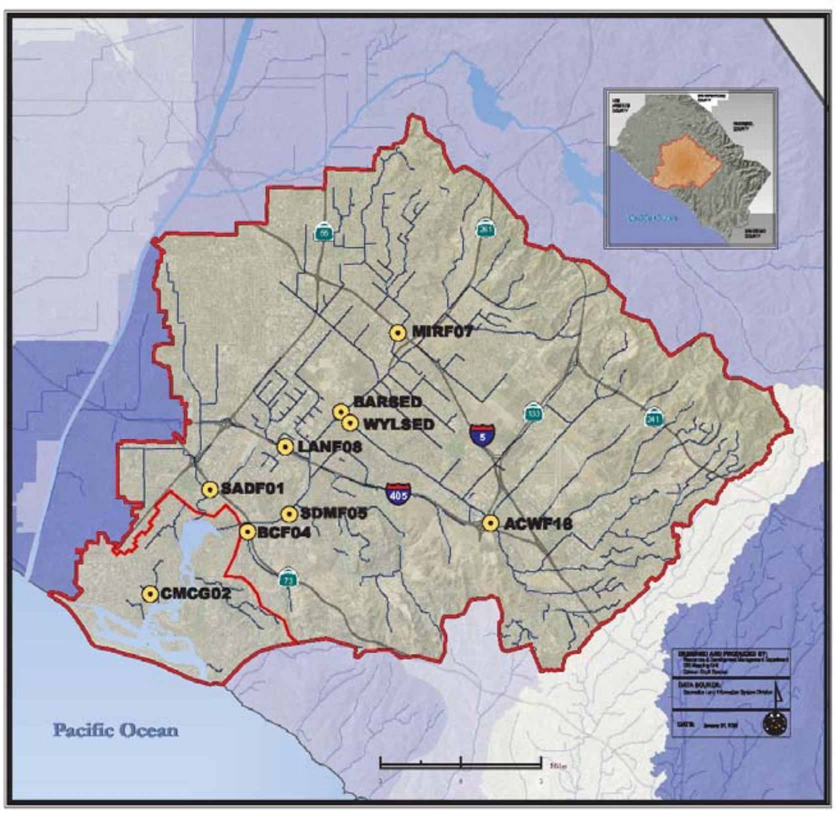


Table 2. San Diego Creek Watershed Sampling Frequencies per Year (as required by RMP).

Station Code	Location	Weather	Temperature	Dissolved O2	pH	Conductivity	Nutrients	Ortho-phosphate	Flow Rate	Hardness
SADF01	Santa Ana Delhi at Irvine Avenue	Dry	24	24	24	24	24	24	C	24
		Storm	3	3	3	3	3	3	C	3
SDMF05	San Diego Creek @ Campus	Dry	52	52	52	52	52	52	C	52
		Storm	3	3	3	3	3	3	C	3
CMCG02	Costa Mesa Ch @ Westcliff*	Dry	12	12	12	12	12	12	C	12
		Storm	3	3	3	3	3	3	C	3
MIRF07	El Modena Irvine Ch @ Michelle	Dry	12	12	12	12	12	12	C	12
		Storm	3	3	3	3	3	3	C	3
LANF08	Lane Channel @ Jamboree	Dry	12	12	12	12	12	12	C	12
		Storm	3	3	3	3	3	3	C	3
ACWF18	Agua Chinon Channel @ Irvine Boulevard	Dry	12	12	12	12	12	12	C	12
		Storm	3	3	3	3	3	3	C	3
BARSED	Peters Canyon Wash @ Barranca	Dry	24	24	24	24	24	24	C	24
		Storm	3	3	3	3	3	3	C	3
WYLSED	San Diego Creek @ Harvard	Dry	24	24	24	24	24	24	C	24
		Storm	3	3	3	3	3	3	C	3

TS- Total volume of storm runoff and amount sampled; C - Continuous Discharge Measurement
Nutrient: Nitrate + Nitrite, Ammonia, TKN, Total Phosphate, TSS, VSS, turbidity
*RMP only requires monthly monitoring but sampled weekly as model urban runoff station

The watershed monitoring stations provide the primary data for evaluation of compliance with TMDL targets. Of the nine watershed monitoring locations, four locations are used to evaluate the loading endpoint (overall TMDL compliance), two locations are used to evaluate the concentration endpoint (Basin Plan Numeric WQOs), and five locations are used to evaluate the urban runoff wasteload allocation **(Table 3)**. Additionally, water quality data collected at Peters Canyon Wash at Barranca (BARSED) and Central Irvine Channel (CICF25) are also included for informational purposes. While these two locations are not officially used to determine TMDL compliance, they are important monitoring locations as they provide useful data from an area known to have groundwater inputs with high nitrate concentration as well as containing discharges from nurseries which have previously been a major nutrient source. Refer to **Appendix A** for all watershed sampling results.

Table 3. Watershed Monitoring Stations and TMDL Compliance

Station	Loading Endpoint	Concentration Endpoint	Urban Runoff Allocation	Informational Purposes Only
Santa Ana-Delhi Channel at Irvine Boulevard	X		X	
San Diego Creek at Campus Drive	X	X		
Bonita Canyon Creek at MacArthur Boulevard	X			
Costa Mesa Channel at Westcliff	X		X	
El Modena-Irvine Channel at Michelle			X	
Lane Channel at Jamboree			X	
Agua Chinon Wash at Irvine Center Drive			X	
San Diego Creek at Culver		X		
Peters Canyon Wash at Barranca				X
Central Irvine Channel				X

2.2 METHODOLOGY

Dry Weather

Samples are collected at one hour intervals using automatic samplers (ISCO 3700 or 6700 models) with tygon or telfon-lined tubing. The samples are composited, acidified with sulphuric acid (H_2SO_4) as a preservative if necessary, placed on ice in a cooler, and then transported to a contract laboratory for analysis. Samples are analyzed for nitrate/nitrite as nitrate, total ammonia as nitrogen, total Kjeldahl nitrogen, total phosphate as phosphate, and ortho-phosphate (Standard Nutrient Suite). Physical measurements of dissolved oxygen, temperature, pH, and conductivity are recorded using a multi-parameter probe each time the automatic samplers are serviced (i.e. when the samples are collected for processing by County staff).

Wet Weather

Samples are collected at 2 hour intervals for a 96-hour period using automatic samplers (ISCO 3700 or 6700 models) with actuators, tygon or telfon-lined tubing. An actuator is attached to the sampler that triggers the first sample collection when the water level rises to storm flow. The samples are composited, acidified with sulphuric acid (H_2SO_4) as a preservative if necessary, placed on ice in a cooler, and then transported to a contract laboratory for analysis. Samples are analyzed for the Standard Nutrient Suite. Physical measurements of dissolved oxygen, temperature, pH, and conductivity are recorded using a multi-parameter probe each time the automatic samplers are serviced (i.e. when the samples are collected for processing by County staff).

Flow

The flow data used to calculate loadings for certain monitoring locations are continuously collected year-round from stream gauging stations in the San Diego Creek/Newport Bay watershed. The stream gauging stations are operated by the County of Orange (OC) and United States Geological Survey (USGS) at the following locations:

- San Diego Creek at Campus Drive (OC)
- Santa Ana-Delhi at Irvine Avenue (OC)
- Peters Canyon Wash at Barranca Parkway (OC)
- San Diego Creek at Culver Drive (OC)
- El Modena-Irvine at Michelle Drive (OC)
- Bonita Canyon Creek at MacArthur Boulevard (USGS)
- Agua Chinon Channel at Irvine Boulevard (USGS)

Each of the County stations are equipped with a continuous water-stage recorder and Automated Local Evaluation in Real-Time (ALERT) transmitter/data logger which provides the ability to monitor rainfall and channel water level in real-time. The USGS stations are equipped with continuous water-stage recorders and a satellite telemetry system. Rating curves have been fully developed for the County stations. The rating curves for the USGS stations are under development and all flow data from these stations are therefore considered preliminary. In addition, the County of Orange is attempting to develop rating curves for Lane Channel and Costa Mesa Channel. Dry weather flow rates from Costa Mesa Channel, for the purposes of this report, were based on continuous flume measurements in October and November 1999. The average dry weather flow rate from Lane Channel was based on sixteen instantaneous discharge measurements made between September 2003 and December 2004. Again, any flow data from these stations is considered preliminary and provides an estimation only.

2.3 RESULTS

Nutrient Concentrations

Figure 2 is a graphical summary of the mean dry- and wet-weather nitrate nitrogen concentrations measured at the RMP watershed sites during the 2004-05 reporting year. **Figure 3** is a summary of the mean dry- and wet-weather total nitrogen concentrations for the same locations and time period. Compared to the 2003-04 monitoring year, the dry weather mean nitrate nitrogen and mean total nitrogen concentrations have increased except for small decreases at the BARSED and WYLSED stations. Concentrations at CICF25 continued the decreasing trend seen in the last reporting period with 46% and 28% decreases in dry-weather mean nitrate nitrogen and mean total nitrogen respectively.

The Total Inorganic Nitrogen concentrations for San Diego at Campus (Reach1) in **Figure 4** are consistent with last year's concentration cyclical pattern (lowest concentrations in the summer months and highest concentrations in the winter months) and are consistently in compliance with the 13 mg/L Basin Plan WQO. However, during the 2004-05 reporting year, the watershed received a record rainfall amount (28.44"). After the winter rains, the dry weather concentrations are elevated compared to the months prior to the record rains and compared to previous monitoring years.

The TIN concentrations for San Diego at Harvard (Reach 2) shown in **Figure 5** consistently above the 5 mg/L objective during the 2004-05 reporting year. These concentrations are consistent with previous results.

Figure 2. Mean Nitrate Nitrogen Concentrations at RMP Stations (2004-2005).

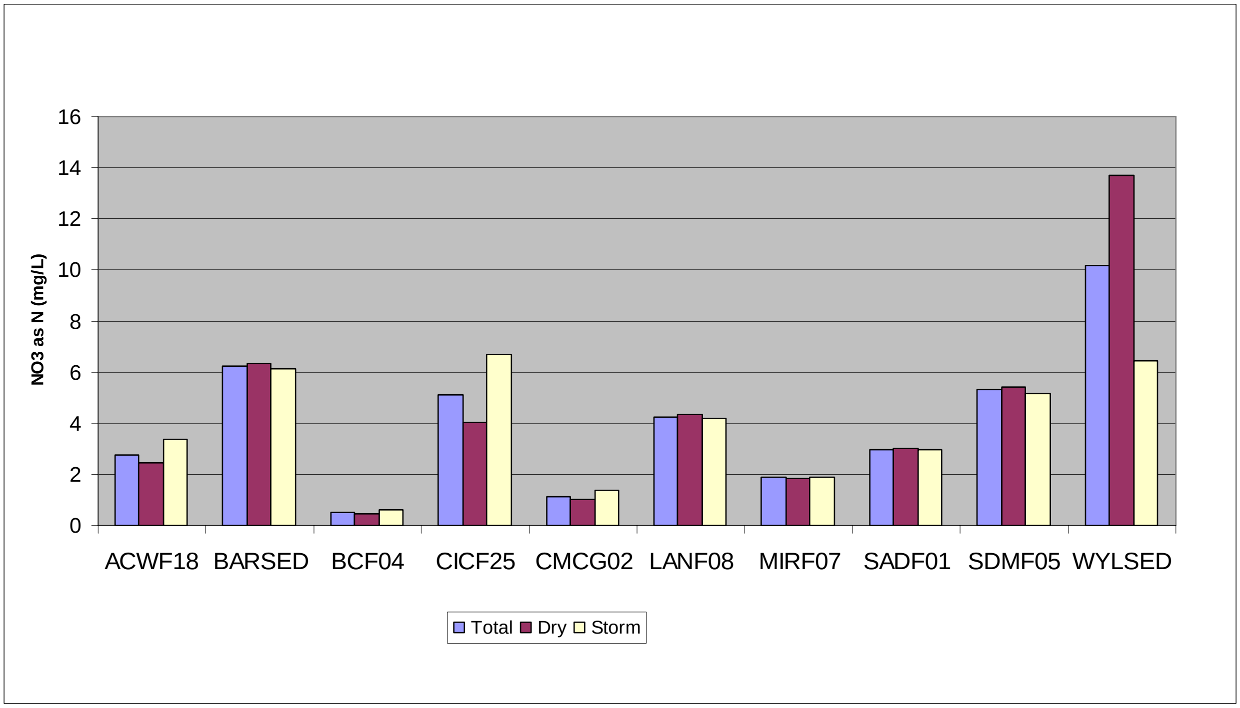


Figure 3. Mean Dry and Wet Weather Total Nitrogen Concentrations from RMP Stations (2004-2005).

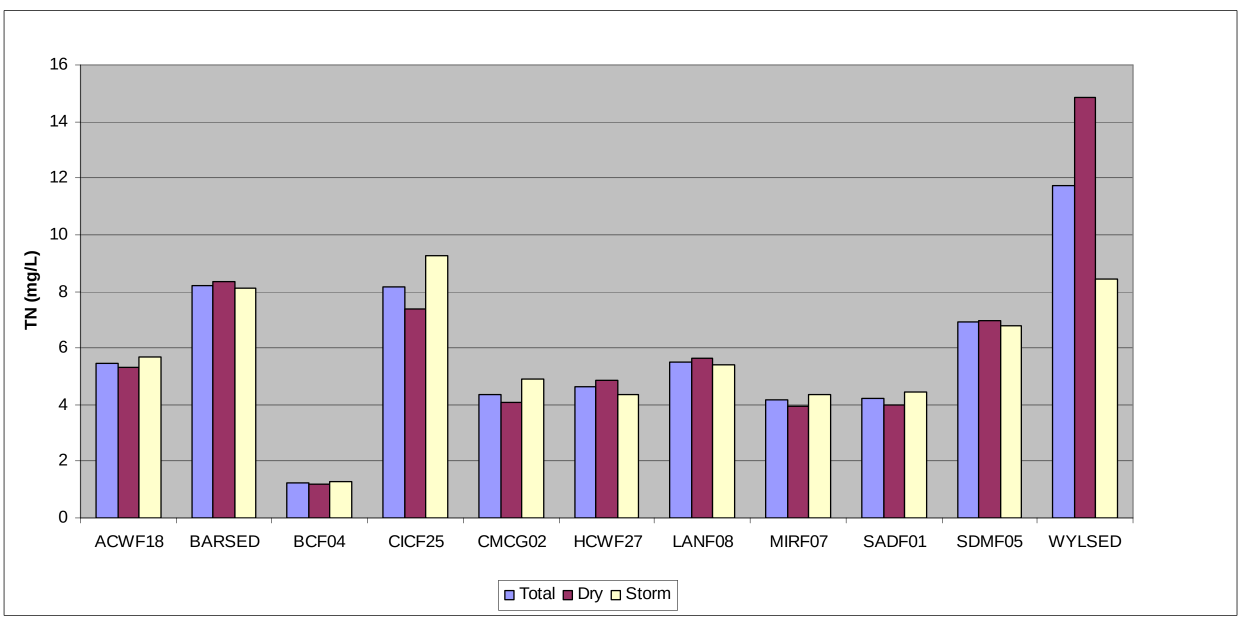


Figure 4. TIN Concentrations for San Diego Creek Reach 1 (measured at SDMF05). 2004-2005.,

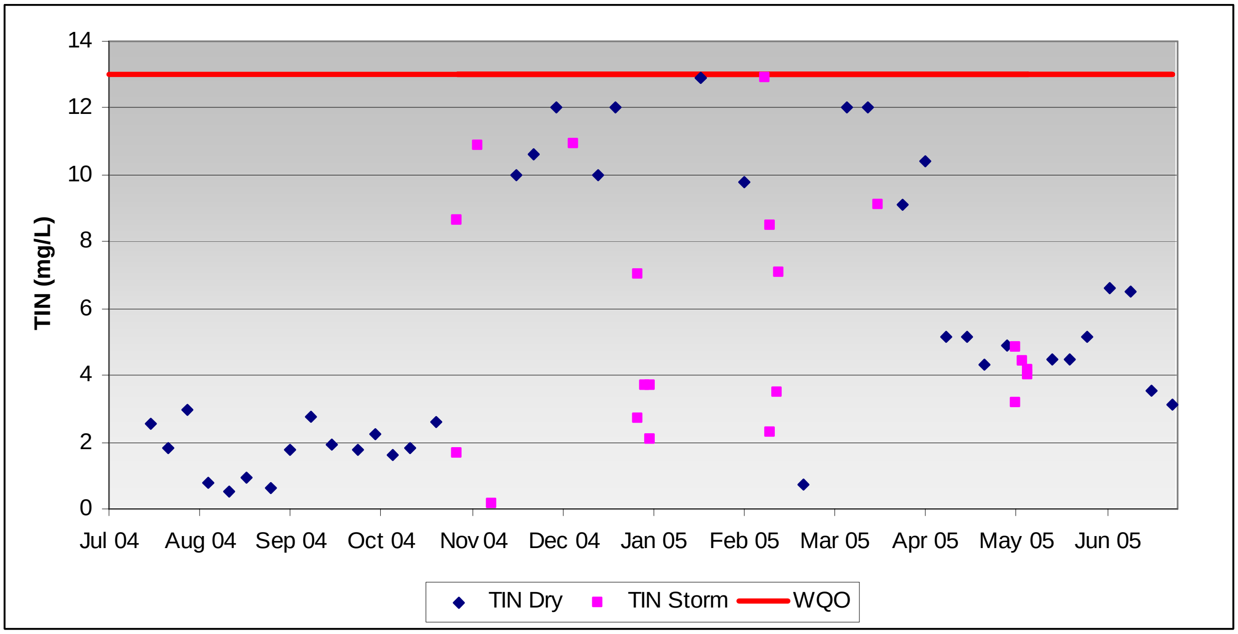
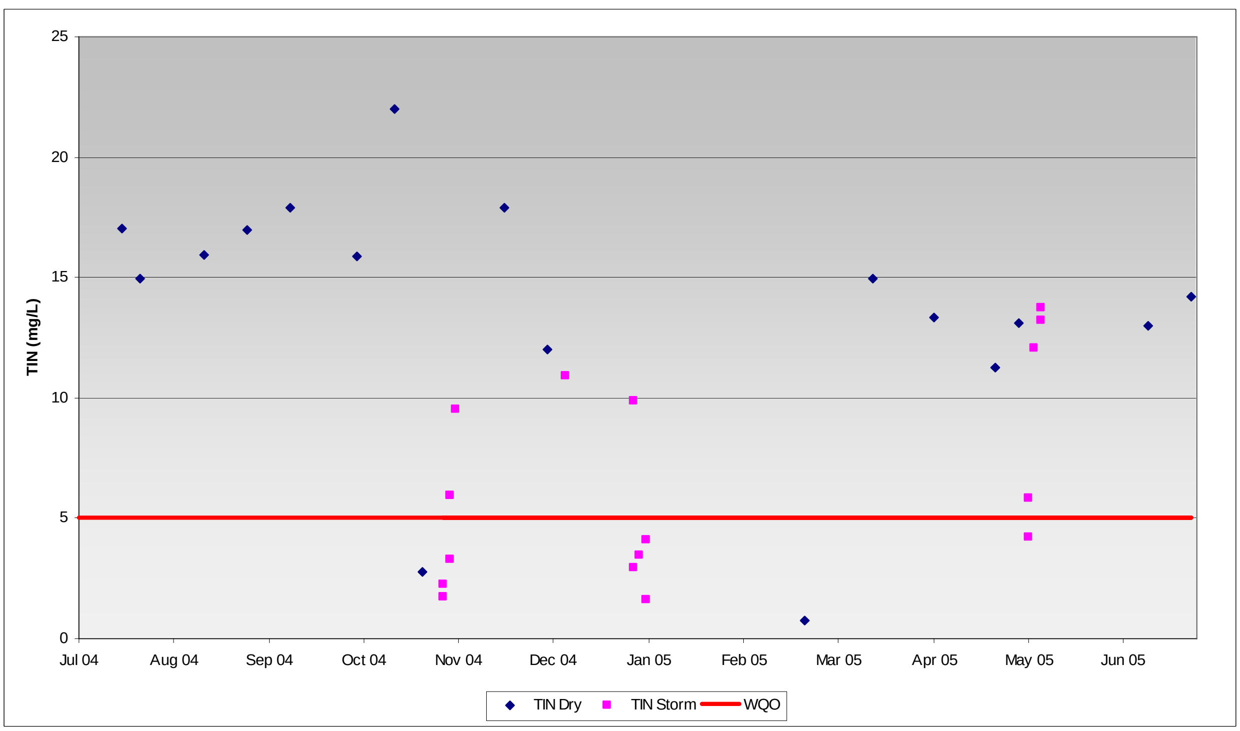


Figure 5. TIN Concentrations for San Diego Creek Reach 2 (measured at WYLSED). 2004-2205.



Flow Measurements

During the 2004-05 wet season, a near record 28.44'' of precipitation was recorded at the Santa Ana Cooperative Observer Rain Gauge. In comparison, 8.41" of precipitation was recorded during 2003-04 wet season. The resultant flows measured at the watershed gauging stations indicate a two-fold increase in annual average flow and a two- to three-fold increase in wet yearly average flows across all stations.

Continuous water level recording gauges are maintained at San Diego Creek at Campus Drive, Santa Ana-Delhi at Irvine Avenue, Peters Canyon Wash at Barranca Parkway, San Diego Creek at Culver Drive, El Modena-Irvine at Michelle Drive, Bonita Canyon Creek at MacArthur Boulevard (USGS) and Agua Chinon Channel at Irvine Boulevard (USGS). Storm hydrographs (water level vs. time) from each monitored storm at these stations are presented in **Appendix D**. Note that no hydrographs are available for Lane Channel (LANF08) during this monitoring period due to an equipment failure during the major storm event in late February 2004.

Rating curves, based on numerous field measurements, have been developed for MIRF07, BARSED, WYLSED, SDMF05, and SADF01. The mean daily discharge rates for the stream gauges with established channel ratings are presented **Appendix D**.

Nutrient Loads

Figure 6 shows the mean daily total nitrogen load from the five stations for which rating curves have been developed (SDMF05, SADF01, MIRF07, WYLSED, and BARSED).

Results from the 2004-05 monitoring year show an increased total nitrogen load compared to prior reporting years **(Figures 7, 8, 9)**. The most likely cause for the increased loads is the record rainfall, resulting in more flow in the watershed as well as increased inputs of groundwater known to have high nitrate concentrations. **Figure 10** shows the impact of this year's wet season on the nitrogen loading as measured at Campus Drive (SDMF05). Prior to the winter rains, daily dry weather nitrogen loading is relatively stable and comparable to previous years. However, once the rains began in October, daily dry weather loading increases substantially and remains elevated (compared to standard conditions) for the remainder of the monitoring year. As the record rainfall saturated the groundwater table, it is most likely that increased groundwater seepage occurred well into the spring months.

Figure 6. Mean Daily TN Loads from RMP Stations – SDMF05, SADF01, MIRF07, WYLSED, BARSED

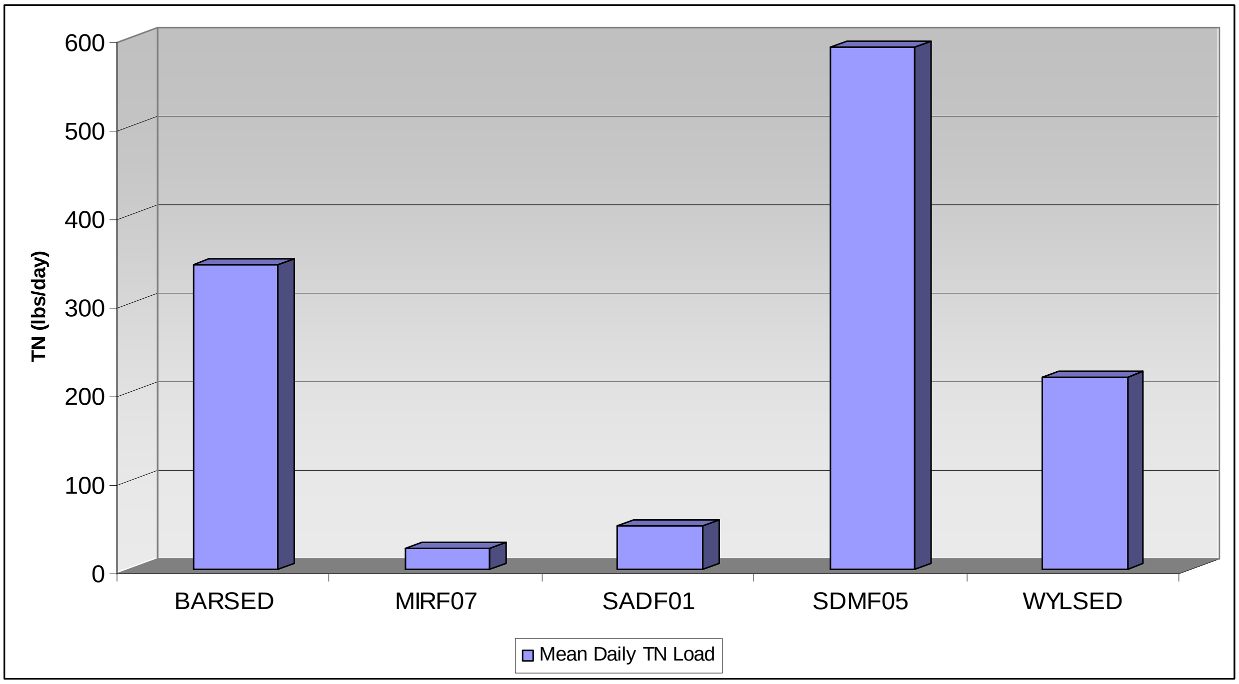


Figure 7. TN Load by Month as measured at SDMF05 (2000-2005).

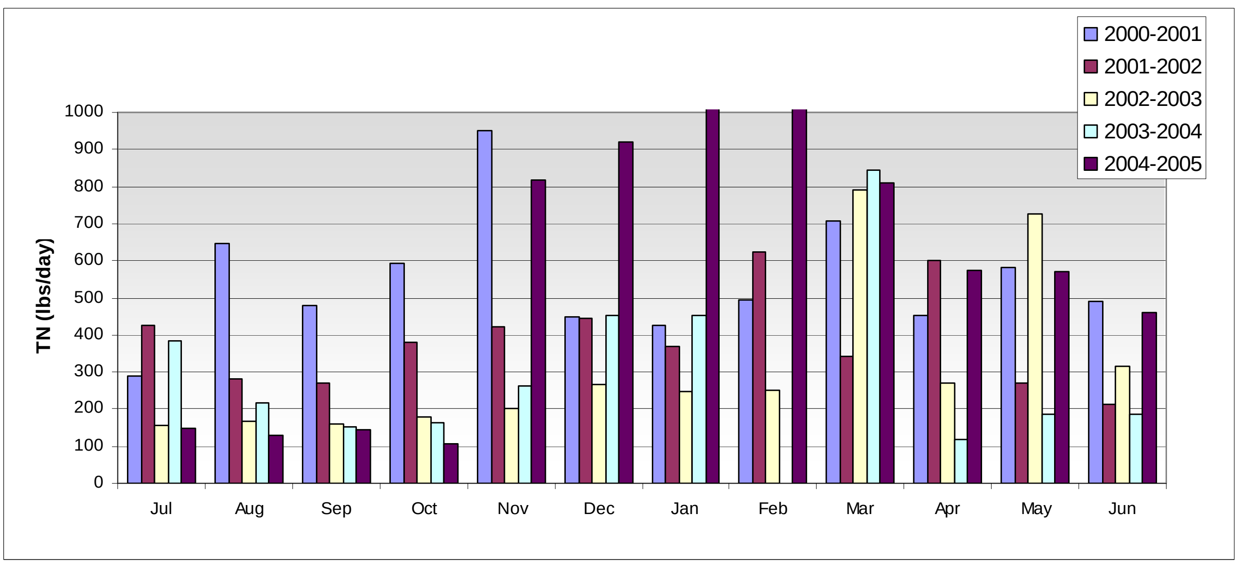


Figure 8. TN Load by Month as measured at BARSED (2000-2005).

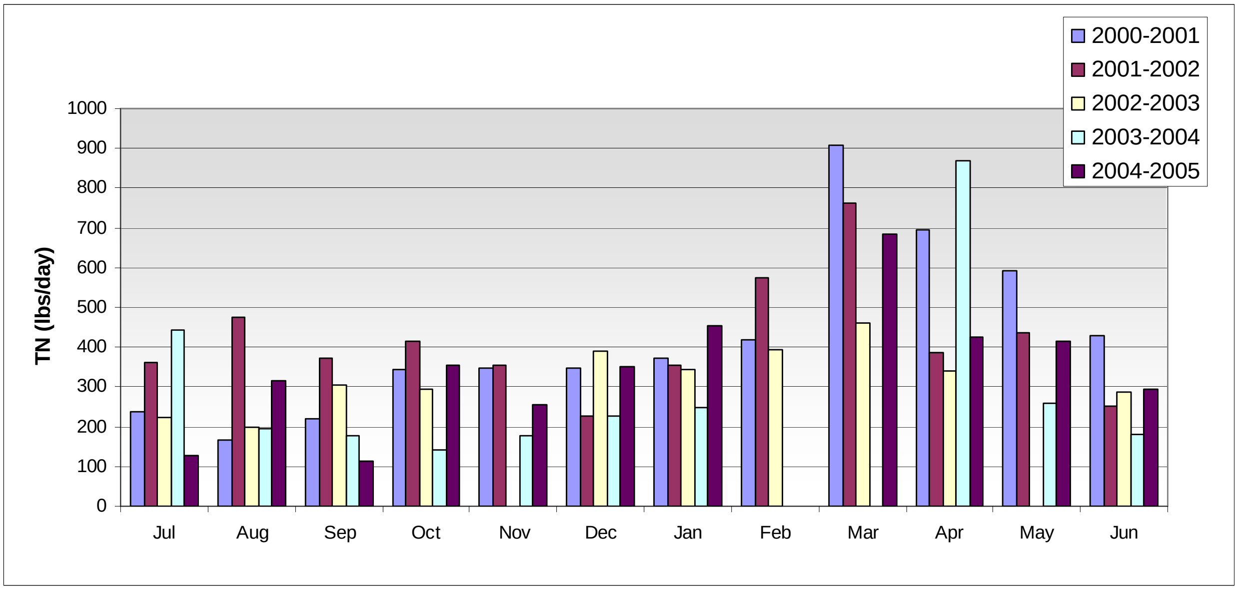


Figure 9. TN Load by Month as measured at WYLSED (2000-2005).

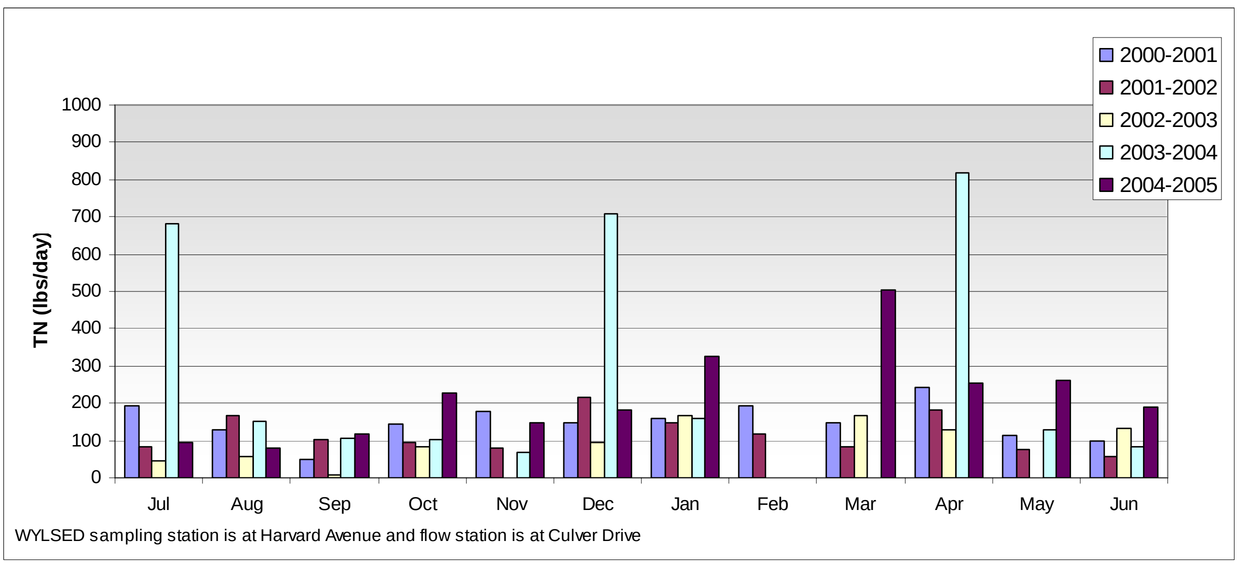
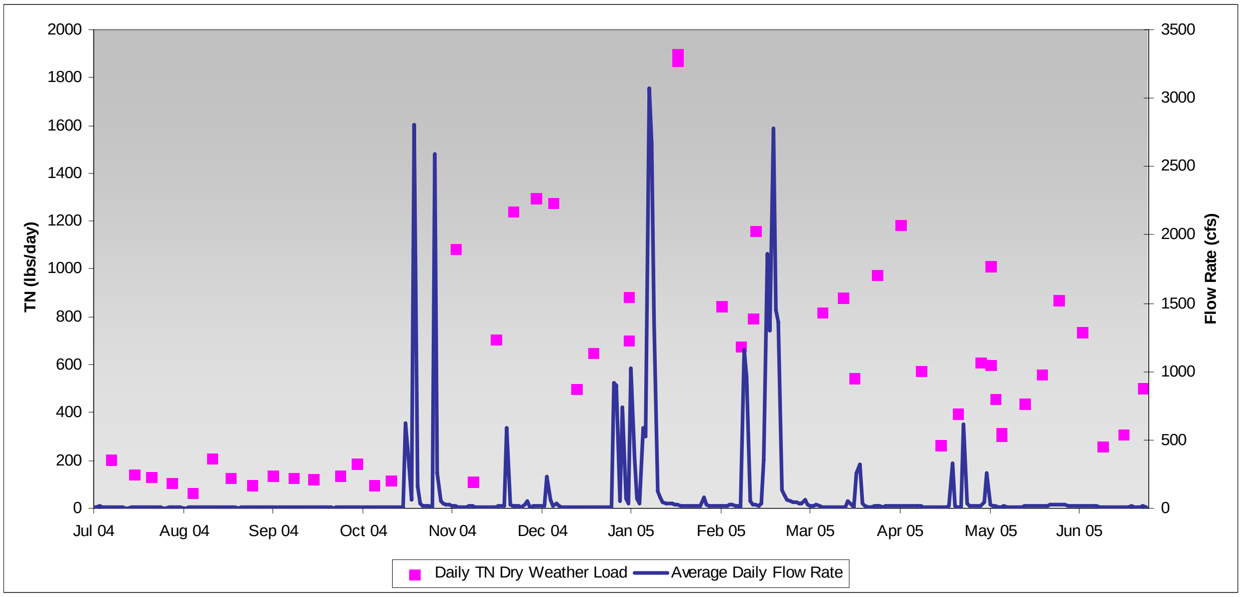


Figure 10. Mean Daily TN Load and Mean Daily Flow Rate. SDMF05 (2004-2005).



SECTION 3.0

REGIONAL MONITORING PROGRAM
FOR
NEWPORT BAY

3.0 NEWPORT BAY

3.1 DESCRIPTION

Monitoring in Newport Bay provides information regarding the actual levels of nutrients in various parts of the Bay. It should be noted that as part of the TMDL, there are no allocations or numeric targets that apply within Newport Bay. Compliance is achieved and regulated by the watershed monitoring element. Water column samples are collected monthly from five locations during dry weather (Table 3). Four sites are located in Upper Newport Bay and one site is located in Lower Newport Bay **(Figure 11)**. The monitoring locations (and station codes) are:

- Unit 1 Basin (UNBJAM)
- Unit 2 Basin (UNBSDC)
- North Star Beach (UNBNSB)
- Coast Highway Bridge (UNBCHB)
- Harbor Island Reach (LNBHIR)

Figure 11. Newport Bay Monitoring Stations.

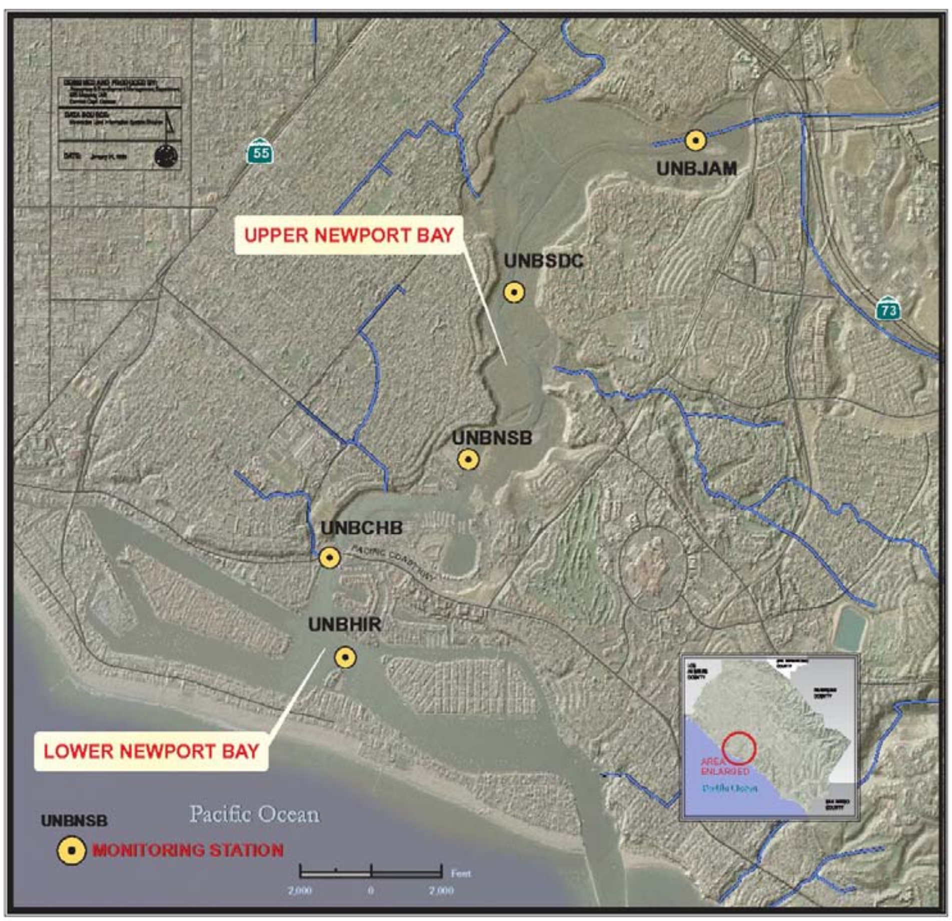


Table 4. Newport Bay Sampling Frequencies per Year (as required by RMP).

Station Code	Location	Weather	Special Requirements	Temperature	Dissolved O2	pH	Conductivity	Nutrients	Ortho-phosphate
UNJAM	Upper Newport Bay in Unit I Basin	DRY	Surface, mid, bottom depth	12	12	12	12	12	12
UNBSDC	Upper Newport Bar in Unit II Basin	DRY	Surface, mid, bottom depth	12	12	12	12	12	12
UNBNSB	Upper Newport Bay at North Star Beach	DRY	Surface, mid, bottom depth	12	12	12	12	12	12
UNBCHB	Upper Newport Bay at Coast Highway Brid	DRY	Surface, mid, bottom depth	12	12	12	12	12	12
LNBHIR	Lower Newport Bar at Harbor Island Reach	DRY	Surface, mid, bottom depth	12	12	12	12	12	12

3.2 METHODOLOGY

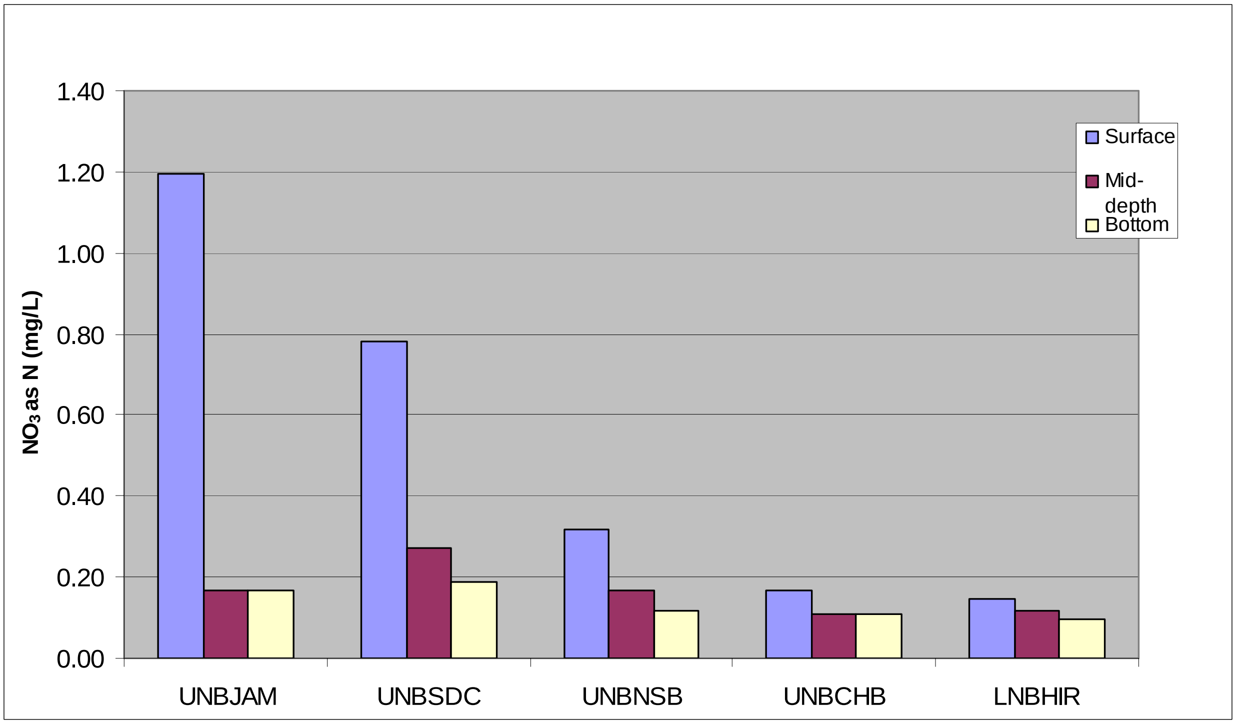
Grab samples are collected from three depths (surface, mid-depth, and bottom) using peristaltic pumps with tygon tubing and weighted strainers. Samples are acidified with sulphuric acid (H_2SO_4) as a preservative if necessary, placed in a cooler, and then transported to a contract laboratory for analysis of the Standard Nutrient Suite. Physical measurements of dissolved oxygen, temperature, pH, and conductivity are recorded using a multi-parameter probe at the time of sampling.

3.3 RESULTS

The 2004-05 dry-weather samplings of the Newport Bay were conducted eleven times during the reporting period. One sampling event was canceled due to equipment and weather related issues. Refer to **Appendix B** for all Bay sampling results.

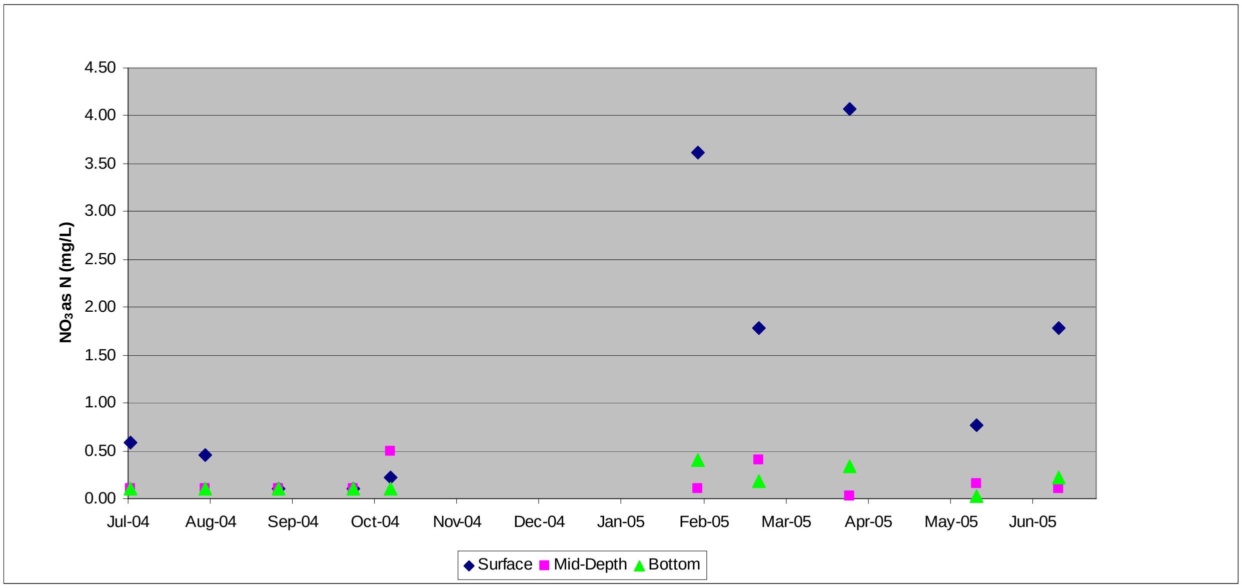
Impacts from the near record rainfall received during the 2004-05 reporting period can be seen in a variety of measurements collected in the Bay. Elevated average dry weather concentrations of nitrate nitrogen in surface level samples from upper bay sites (UNBJAM, UNBSDC and UNBNSB) may be in response to increased inputs of nutrient-rich groundwater from the surrounding watershed. The average nitrate nitrogen concentrations decrease both with depth and with station location from upper to lower Bay, suggesting the impact decreases with distance from freshwater influences. Additionally, results from the stations in the lower reach of Upper Newport Bay (UNBNSB,UNBCHB, and UNBSDC) and one station in the lower bay (LNBHIR) consistently showed low nitrate nitrogen concentrations, often approaching laboratory detection limits of 0.10 g/L NO_3 as N (see **Figure 12**).

Figure 12. Dry Weather Nitrate-Nitrogen Concentrations in Newport Bay (2004-2005).



This trend is again seen in **Figure 13** as nearly 70% of the bottom and mid-depth samples from UNBJAM had concentrations at nearly detection limits of 0.10 mg/L NO_3 as N, while surface samples ranged from .099 to 4.065 mg/L.

Figure 13. Dry Weather Nitrate Nitrogen Concentrations at UNBJAM (2004-2005).



Figures 14-16 show the yearly mean nitrate concentrations for all Bay sites from surface to bottom depth respectively. Prior to 2004-2005, a general decreasing trend was seen across all sites and at all depths. In the 2004-2005 values, the impact of increased levels of nutrient-rich groundwater/freshwater can be seen primarily in the upper bay station surface concentrations. 2004-05 mid- and bottom-depth concentrations show a minor increase at certain stations, but in general concentrations are similar to previous monitoring years.

Figure 14. Surface Nitrate Nitrogen Concentrations in Newport Bay (2000-2005).

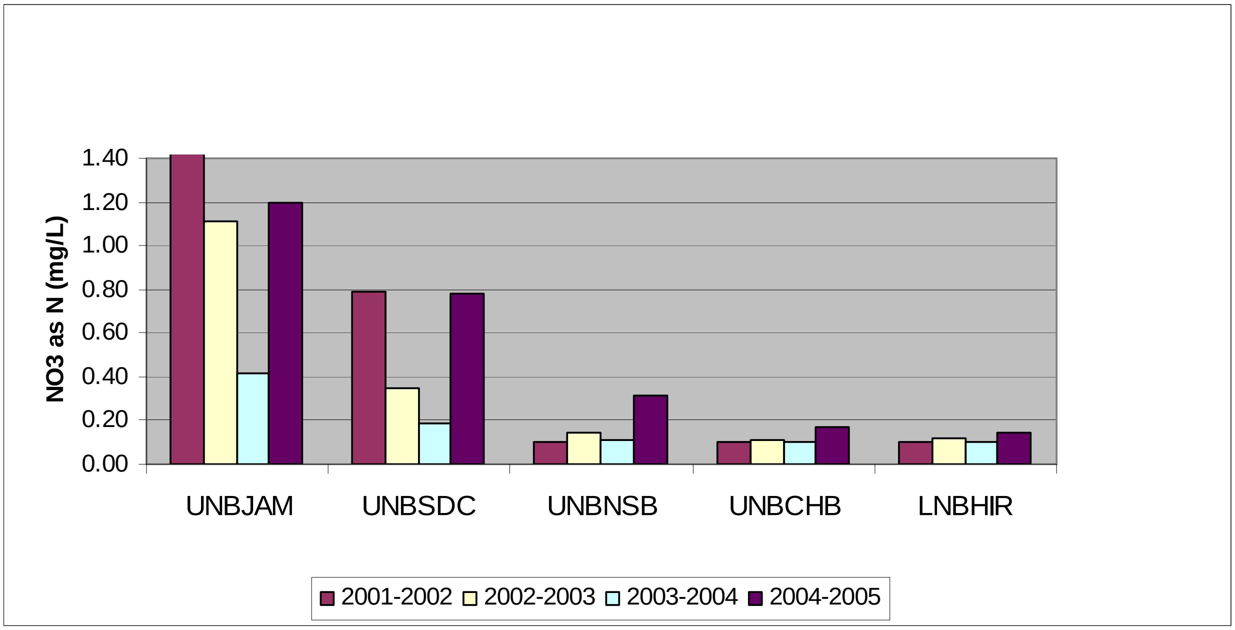


Figure 15. Mid-Depth Nitrate-Nitrogen Concentrations in Newport Bay (2000-2005).

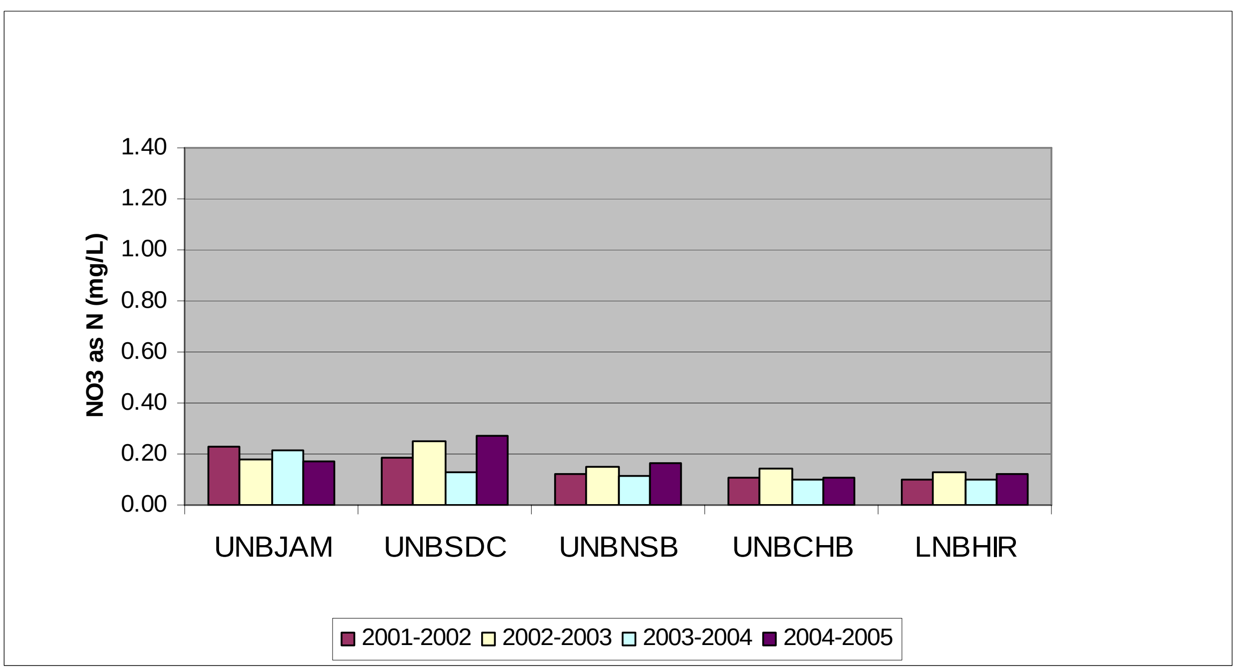
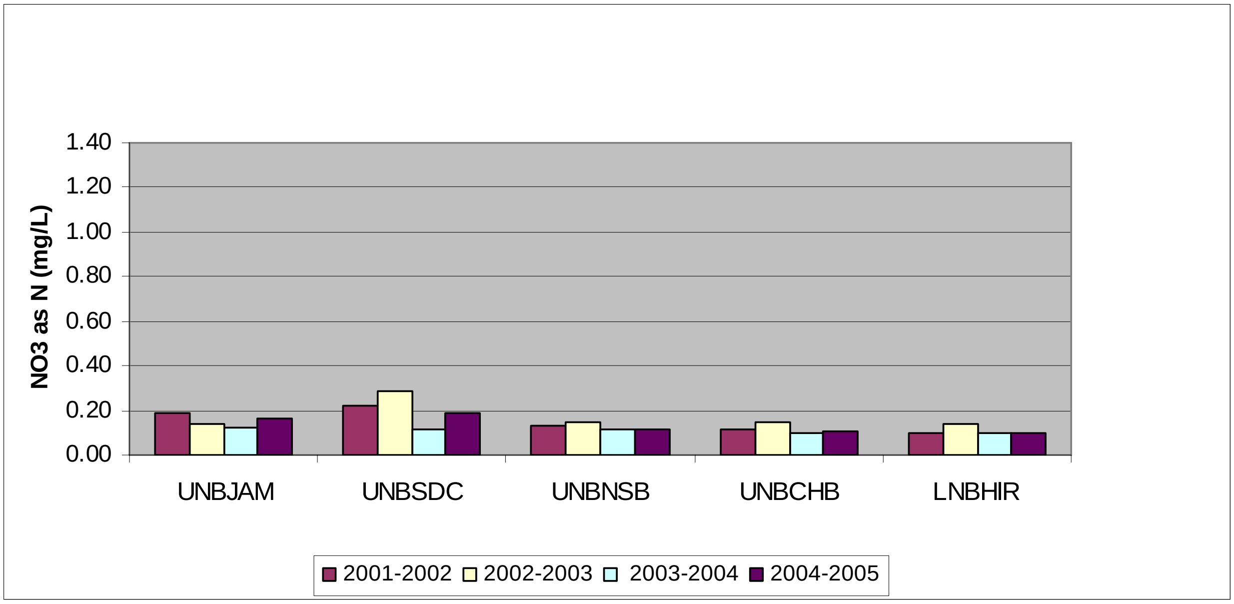


Figure 16. Bottom Depth Nitrate-Nitrogen Concentrations in Newport Bay (2000-2005).



SECTION 4.0

REGIONAL MONITORING PROGRAM
FOR
NEWPORT BAY ALGAL BIOMASS SURVEYS

Ceramium

Ulva

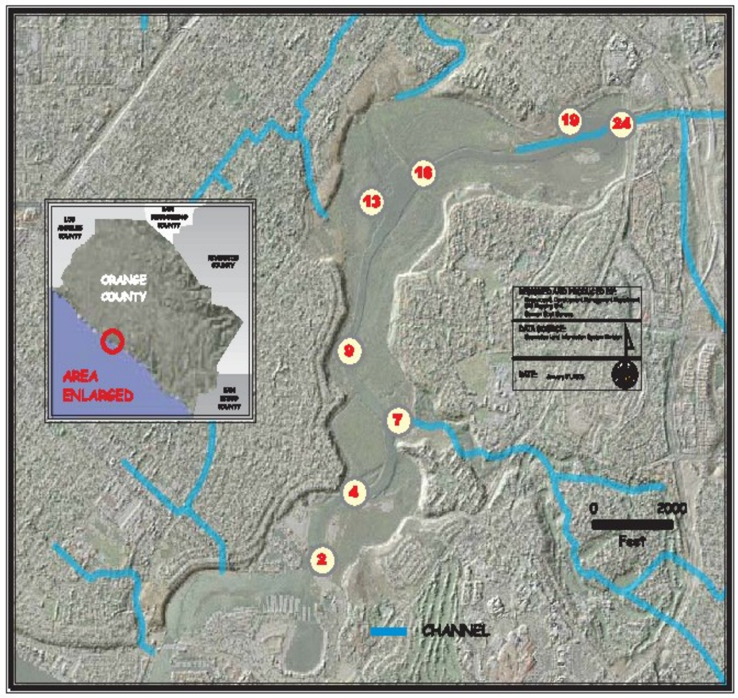
Enteromorpha

4.0 NEWPORT BAY ALGAL BIOMASS

4.1 DESCRIPTION

The third endpoint of the TMDL is to determine the extent, magnitude and the duration of the algal blooms in Newport Bay. Large macroalgal blooms resulting from nutrient over-enrichment may adversely impact aquatic system beneficial uses through reduction in water column dissolved oxygen concentrations. Therefore, algal biomass is measured due to the concern that aquatic life beneficial uses are impaired when dissolved oxygen levels are depressed below 3 mg/L (Horne, 1997; EPA, 1998).

Figure 17: Algae Sampling Locations in Upper Newport Bay



4.2 METHODOLOGY

Algae samples are collected from eight locations throughout Upper Newport Bay **(Figure 17** and **Table 5)**. Samples are collected when the tide conditions are less than two feet during daylight hours to ensure that algae samples are collected from the mid to upper intertidal zone. Three replicate samples are randomly collected by blindly tossing an approximately 0.1 m^2 quadrant onto the mudflat. Algae within the quadrant are collected by hand and all non-algae substances (twigs, bivalves, etc.) are removed. The algae sample is then cleaned (i.e. all mud is removed) and washed with bay water. Wash water is removed using a field centrifuge spun at a constant speed and duration for each sample. Samples are bagged and labeled in clean plastic zip-lock bags and kept on ice. Upon returning to the lab, samples are weighed wet, identified by percent species within each sample, and then placed in a 105° oven and dried for 24 hours. The samples are then weighed again to obtain the dry weight. Additionally, one of the three replicate samples from stations 4, 9, 16 and 24 are weighed wet, identified, and then delivered to a contract laboratory to be analyzed for total nitrogen and total phosphorus.

Table 5: **Algal Biomass Sampling Frequency per Year**

Station Code	Location	Weather	Annual Sampling Frequency: Temperature	Dissolved O2	Conductivity	Nutrients	Ortho-phosphate	Algae Biomass	Species Compositio
2	33.62047N, 117.89339W	Dry	12	12	12	12	12	12	12
4	33.62717N, 117.88983W	Dry	12	12	12	12	12	12	12
7	33.63203N, 117.8868W	Dry	12	12	12	12	12	12	12
9	33.63539N, 117.89008W	Dry	12	12	12	12	12	12	12
13	33.64408N, 117.88839W*	Dry	12	12	12	12	12	12	12
16	33.64636N, 117.88436W	Dry	12	12	12	12	12	12	12
19	33.6498N, 117.87239W	Dry	12	12	12	12	12	12	12
24	33.65031N, 117.86753W	Dry	12	12	12	12	12	12	12

From 2001 to late 2003, samples were collected once per month primarily between April and October. From 2003 to the present, the frequency has been increased to monthly sampling throughout the entire year. Additionally, also beginning in 2003, surface water samples are collected and physical measurements are recorded just off the mud flats coincident with algae sampling. Water samples are analyzed for the Standard Nutrient Suite.

4.3 RESULTS

The three main macroalgae identified in the bay are two nuisance green algae species, *Ulva* (sea lettuce) and *Enteromorpha* (sea confetti). The third, *Ceramium Rubrum*, commonly accepted as a non-nuisance species was identified this year by Dr. Steve Murray from Cal State Fullerton. See Appendix C for all algae biomass monitoring data for 2004-05.

The months of July and August are used as the index period for evaluating long term trends in algal biomass for Upper Newport Bay. This index period was selected because these months are expected to result in the peak biomass and baseline biomass measurements were conducted during this time period in 1996.

Initial biomass measurements were conducted in July 1996 and resulted in an average density of 1.8 kg/m^2 (Horne, 1997). Algae were present throughout the entire Upper Bay and were distributed unevenly. The highest densities were present in the middle to uppermost portion of the Upper Bay (0.70 – 5.3 kg/m^2). Algal biomass measurement over the past 10 years show that the overall trend in the Bay is a decrease in macroalgal density **(Figure 18)** but the Bay is still susceptible to large blooms when a flux of nutrients enter the Bay **(Figure 19).** Such blooms occurred in 1999 (dredging of the Bay resulting in a likely release of nutrients from sediment), in 2004 (unknown cause of localized increase at site 24) and in 2005 (record rainfall resulting in increased groundwater inputs).

Again in 2005, Site 24 experienced an increase in density not displayed at any other monitoring site and thereby increased the average density for the entire Bay. This increase seems to be an anomaly potentially attributable to the unusual rainfall year localizing increased nutrient concentrations mostly in the upper bay at that site, or for other unknown factors. **Figure 12** (Newport Bay Section) shows an increase in the mean nitrate nitrogen concentrations measured in the Unit I Basin which is where Site 24 is located.

Consistent with previous monitoring years, the composition of the algae in the Bay is changing. Whereas the two nuisance species *Ulva* and *Enteromorpha* used to dominate the Bay **(Figures 22, 23, 24)** , *Ceramium Rubrum* is now the predominate species in the lower Bay **(Figures 20 and 21).**

Figure 18. Newport Bay Macroalgal Biomass Excluding Certain Years (1996-2005).

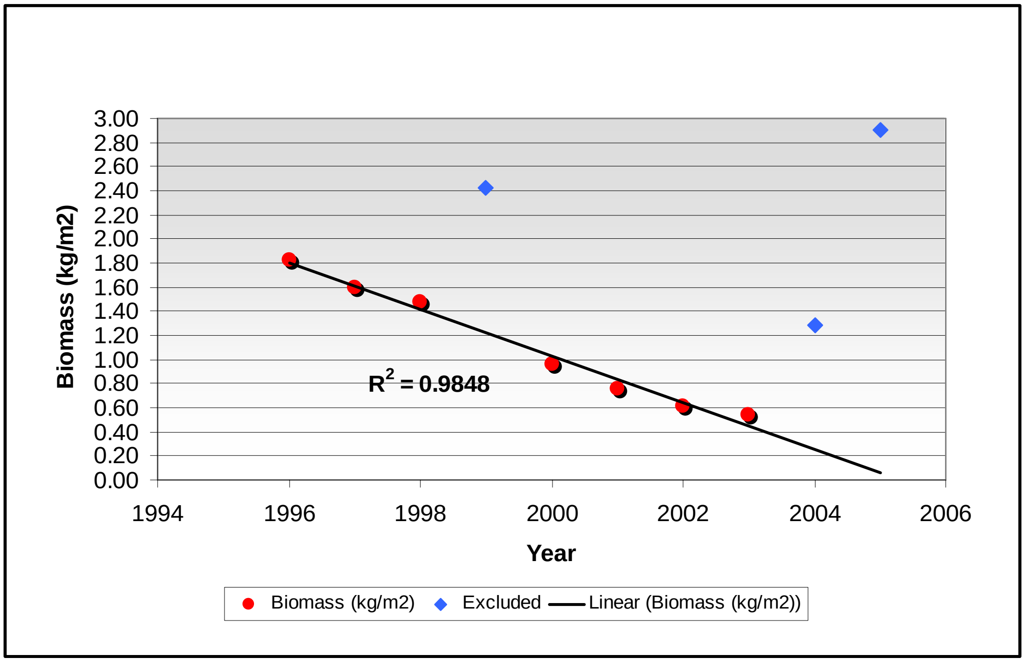


Figure 19. Newport Bay Macroalgal Biomass Trend Including All Years (1996-2005).

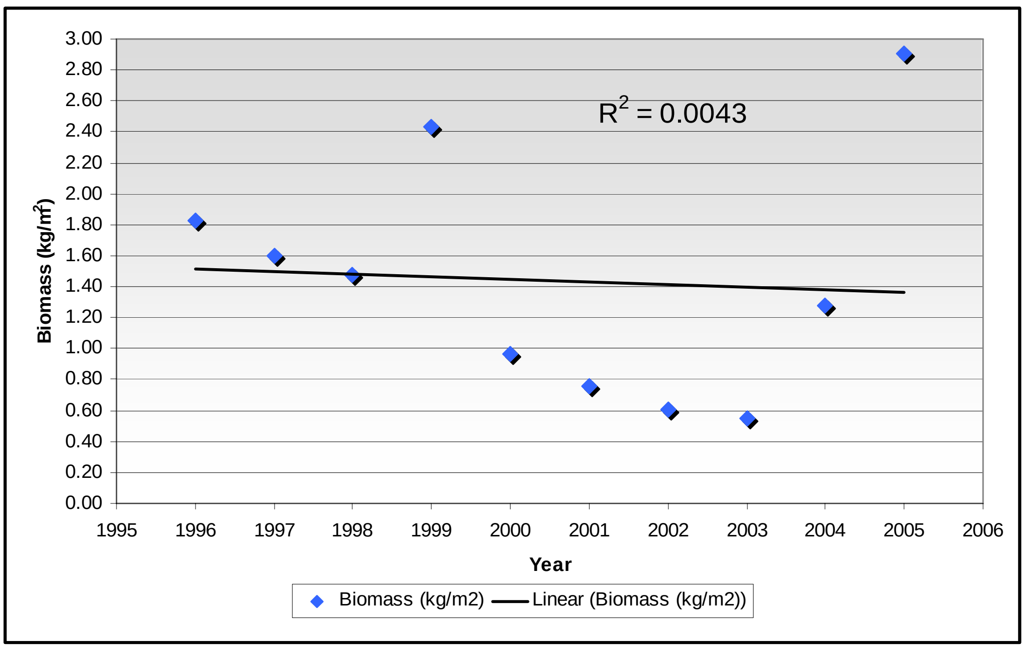


Figure 20. Algae Biomass From All Station – July 2005.

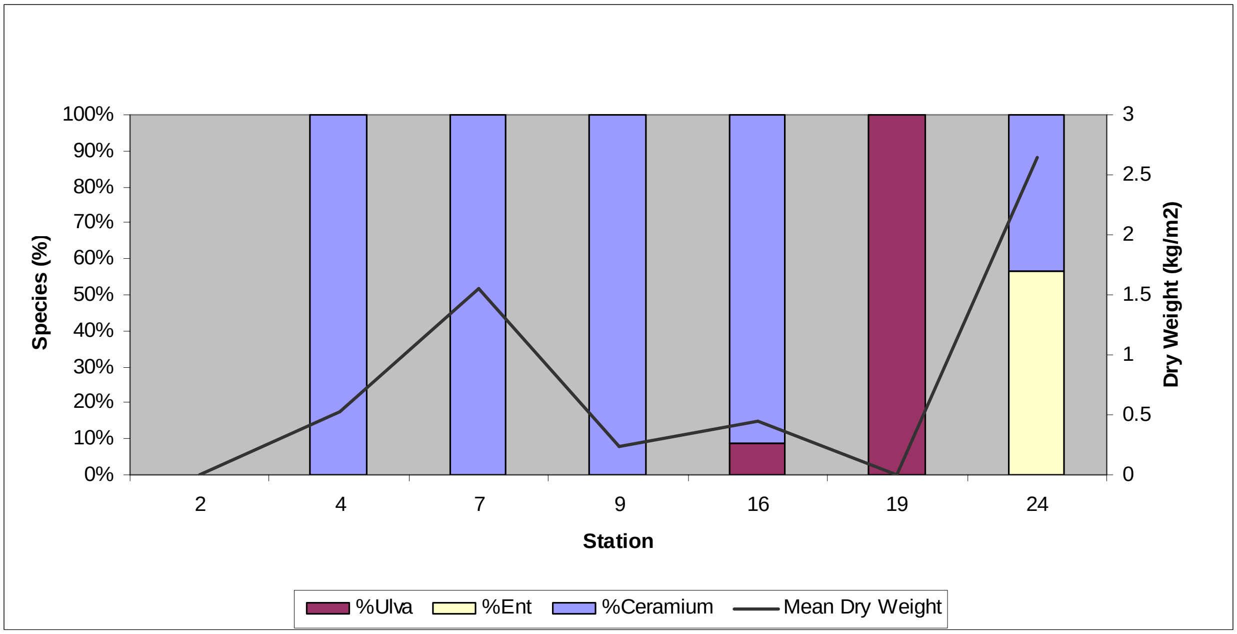


Figure 21. Algae Biomass From All Station – July 2004.

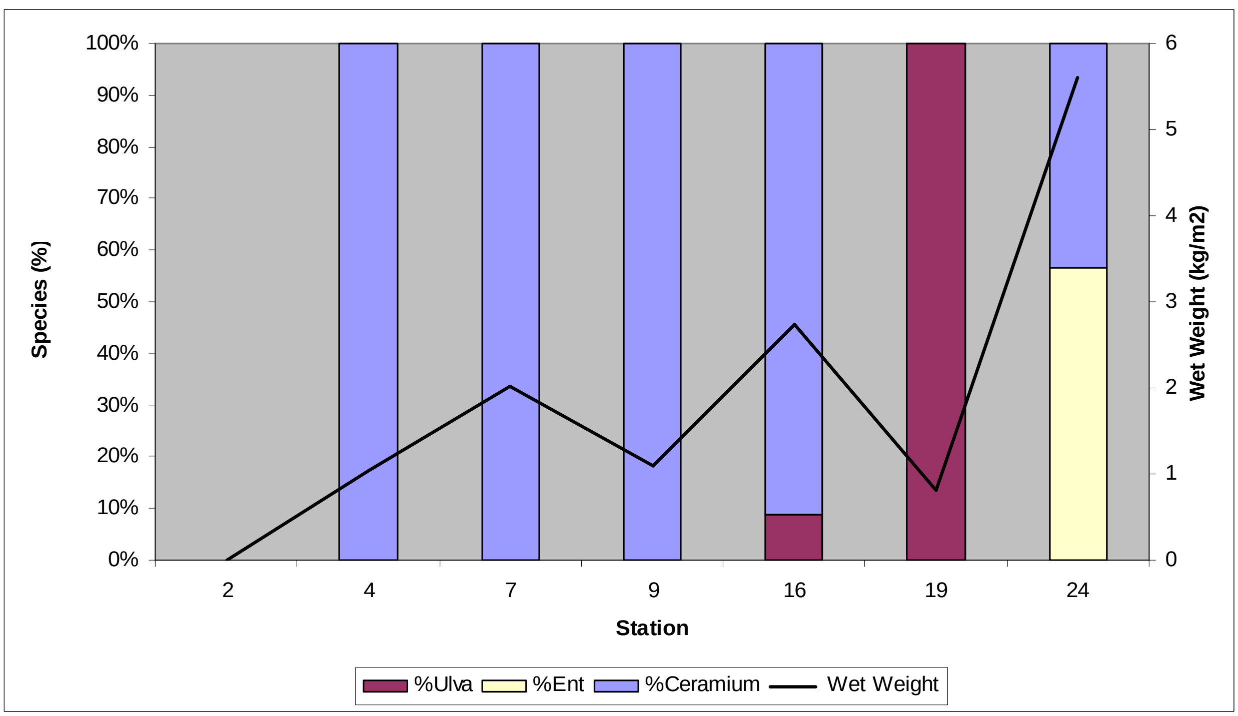


Figure 22. Algae Biomass From All Station – July 2003.

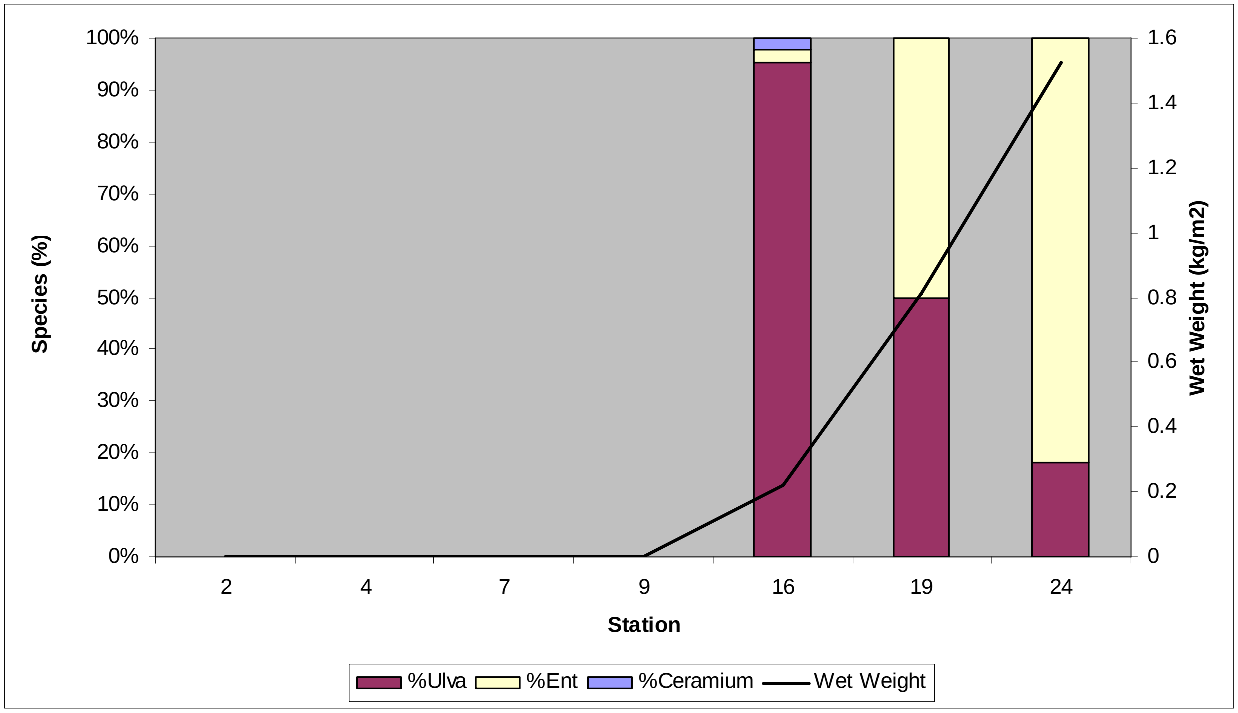


Figure 23. Algae Biomass From All Station – July 2002.

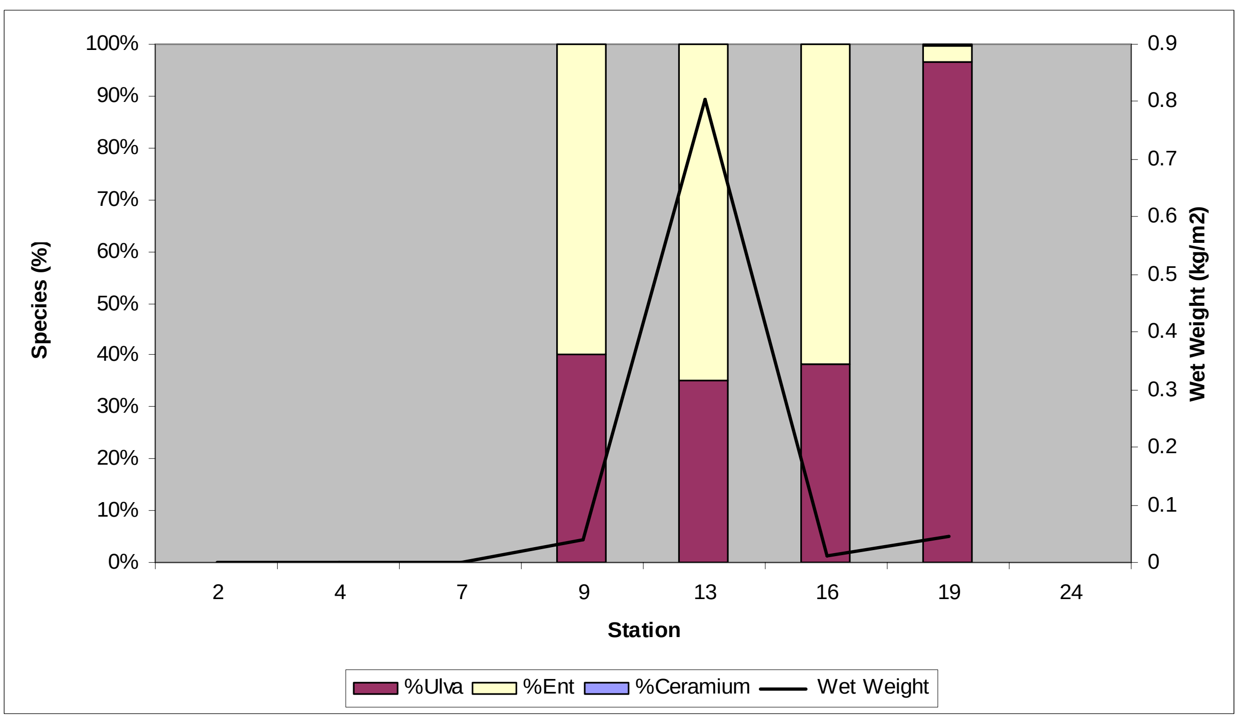


Figure 24. Algae Biomass From All Station – July 2001.