Terrence Fleming
U.S. Environmental Protection Agency Region 9, WTR-2
75 Hawthorne Street, San Francisco, CA 94105
Fax: (415) 947-3537

February 11, 2003

RE: Comments on the draft Total Maximum Daily Loads for Nutrients, Malibu Creek Watershed

Dear Mr. Fleming,

Heal the Bay is a nonprofit environmental group dedicated to making southern California coastal waters safe and healthy for people and marine life. Heal the Bay and the Santa Monica Baykeeper (collectively referred to "Heal the Bay") submit the following comments on the draft TMDL for Nutrients, Malibu Creek Watershed ("TMDL"), on behalf of our members.

The 2002 California Section 303(d) List of impaired water bodies identifies Malibu Creek as impaired for nutrients, algae, fish barriers, trash, scum/foam, high coliform bacteria and excess sediment. (The 303d list makes no reference to seasonality of the impairment and it is improper for EPA to reinvent the list as being impaired only in the dry season.)

EPA Response: *It is not the intent of EPA to reinvent the list. We note however that the data used to list Malibu Creek for algae was based on summer data. Federal regulations require consideration of critical conditions when calculating TMDL. Our assessment of the data indicates that algal coverage and biomass are much greater in the summer months than in the winter months and that the algae cover thresholds recommended by Biggs (2000) are exceeded much more frequently in summer than in winter (See Response to Regional Board 4 Comments)*.

Malibu Lagoon suffers from algal blooms and severely anoxic conditions during the summer. High levels of nutrients and the resulting high algal cover in the creek impairs the beneficial uses of contact recreation, non-contact recreation, and aquatic life. Excessive algae is unpleasant and dangerous for people wading or bathing in the creek. It can lead to low-dissolved oxygen conditions that harm aquatic life, especially fish, and it can grow to cover the substrates needed by benthic macroinvertebrates and other biota to survive in the creek.

EPA Response: *We concur with the assessment that there are low DO problems in the lagoon (see page 13) and that excessive algae can lead to impairment of beneficial uses*.

Heal the Bay has been working in the Malibu Creek Watershed for many years. We have conducted Stream Team monitoring, mapping, restoration and research activities in the watershed since 1998. We regularly participate in stakeholder groups and workgroups to develop regulations and monitoring plans, including AB 885 requiring the development of standards for onsite wastewater treatment plants, co-authored by Heal the Bay. We also comment on permits and environmental impact reports and use our expertise and data to advocate for environmental restoration and protection throughout the watershed. The Stream Team is one of Heal the Bay's largest programs and currently works with volunteers and state and national agencies to conduct high-quality water quality monitoring at 18 locations on a monthly basis. The Stream Team also maps waterbody characteristics and impairments throughout the watershed, and conducts habitat restoration projects.

We have reviewed the proposed TMDL and we are very concerned that it will not result in the elimination of the obvious impairments in the watershed due to excessive levels of nutrients. The EPA's conclusion that the algae impairment exists only in summer (April 15- November 15) is simply incorrect.

EPA Response: *We acknowledge that there is some evidence of excessive algae in streams (page 36). However our review of the data from Tapia and from HTB indicates that there is considerably less algae in the streams in the winter months and that the algae cover thresholds cited by the Regional Board (from Biggs, 2000) do not appear to be exceeded regularly (See Response to Regional Board 4 Comments).*

The TMDLs high nitrogen limits and complete lack of a phosphorous limit in winter will result in continued algal impairment in winter (November 16-April 14), and may contribute to continued algal impairment in summer, through storage of nutrients in sediments.

EPA Response: *We do not think it is appropriate at this time to impose summer time targets to the winter time because there are uncertainties associated with the 1) extent of impairment in the winter 2) the relationship between nutrient concentrations and algae in the winterand 3) the relationship between winter nutrient loads and sediment. EPA has opted to apply the existing concentration-based standard to the winter time conditions along with a margin of safety which will result in a substantial reduction in the annual nitrogen loadings to the system. We believe that this approach is appropriate given the uncertainties noted above.*

Therefore we strongly disagree with the seasonal approach to nutrient limits in this TMDL. The basis for disputing these aspects of the TMDL is our extensive database, which support the following conclusions on nutrients and algae in the watershed. Our data clearly show:

1. The creek and some of its tributaries are seriously impaired by algae all year long.
2. The reference background concentration of nitrate+nitrite measured as nitrogen (NO_3+NO_2-N) in the watershed is less than 0.05 mg/l in both wet and dry seasons.

3. The reference level of phosphate (PO_4) is about 0.1 mg/l phosphate in both wet and dry seasons.

EPA Response:
1. Our review of the Tapia data indicated that floating algae is rarely above the 30% algal cover value in either the summer or the winter. Our review of the Heal the Bay data revealed a similar pattern. The two possible exceptions are Cold Creek and Malibu Creek at Arizona Crossing (See Response to Regional Board 4 Comments). We were unable to evaluate the mat algae data since this reflected a combination of diatoms and filamentous algae. Biggs 2000 suggested a threshold of 60% for evalution of beneficial use impairments associated with diatoms and blue-green algae.

2. The targets we developed were based on total nitrogen and are not strictly comparable. We acknowledge that there are some sites where nitrate+nitrite values are much lower than the 1 mg/l total nitrogen value we have proposed. Based on data where all four forms of nitrogen were measured (i.e., nitrate, nitrite, ammonia, organic nitrogen), we find that organic nitrogen and ammonia can make up a signficant fraction of the total nitrogen. Unfortunately the HTB data does not include these other forms of nitrogen.

3. We concur with the use of 0.1 mg/l as a target for the summer and are pleased that this is consistent with the HTB data. However for the reasons stated above we do not feel that it is appropriate at this time to impose the 0.1 mg/l phosphate target in the winter season.

We therefore believe that strict nitrogen and phosphorous limits are necessary year-round to control the algae impairment in the watershed. The data analysis section below provides detailed information supporting year-round nutrient limits to mitigate the algae impairment.

In order to protect aquatic life in the watershed the EPA must apply stringent nutrient limits all year long. Winter limits for nitrogen and phosphorous should be the same as summer limits, since the existing level of algae impairment is comparable in summer and winter. The nitrogen limit for the watershed should be based on the reference background condition, which, as shown by our data, is lower than the proposed TMDL limit. The reference background concentration determined in the draft TMDL is far too high, which is not surprising in light of the anthropogenic influences on the EPA's selected reference sites. Data from Heal the Bay's reference sites clearly show the background concentration of nitrate+nitrite-N in the watershed is 0.05 mg/l. EPA must also limit phosphate in the winter season, since our data show that phosphate contribute to excess algae throughout the watershed.

EPA Response: *EPA is establishing only nitrogen TMDLs for the winter months because the Basin Plan contains a numeric objective for total nitrogen which the TMDLs must meet, and because the need for phosphorus TMDLs during the winter has not been firmly established*.

The wet weather nutrient limit chosen by the EPA is based on the Malibu Creek Watershed nutrient standard in the Basin Plan: 10 mg/l for nitrates. This standard was based on protection of municipal water supply, not aquatic life. The application of a 20% margin of safety to the MUN based water quality standard does not solve the problem. Using a reference location/anti-degradation approach to setting the TMDL for nitrates in wet weather is the only reational way to deal with the issue.

EPA Response: The language in the *Basin Plan (page 3-11) indicates that the 10 mg/l nitrate value also refers to stimuluation of algae in surface waters. We agree that use of the reference location/antidegradation appproach is a rational approach to deal with the issue in the summer. We disagree on two points. The first point is the need to apply this approach in the winter (see above). The second point is the application of data from Heal the Bay stations as reference values at this time. The reasons for this are explained in greater detail below.*

Determining Reference Condition in the Watershed

Heal the Bay agrees with the EPA's approach of using reference conditions to determine the TMDLs for nitrogen and phosphorous in the watershed. This was the approach the Regional Water Quality Control Board (Regional Board) used for the Santa Monica Bay fecal bacteria TMDL. However, the approach is only protective if true reference conditions are used to determine the TMDL. Most of the nutrient and algae data used to create this draft TMDL are based on approximately 11 sites, monitored by the Las Virgenes Municipal Water District (LVMWD) as required by their NPDES permit. Each of these sites is heavily impacted by upstream land uses. These land uses include urbanization; grazing and animal husbandry activities; discharges from the Tapia Wastewater Treatment Facility; over- irrigating with reclaimed water near the stream during the prohibition period; and inputs from the shallow groundwater generated by the sludge injection operation at the Rancho Composting Facility. No true reference condition has been used to derive appropriate nutrient limits in the draft TMDL. Further, only one of the two sites used to calculate reference nutrient conditions in the TMDL (R-9) is free of the influence of Tapia's operation and/or composting facility.

EPA Response: *We only used the data from Station R-9 in our consideration of targets for nitrogen and phosphorous in the streams and believe it is appropriate for consideration as a reference site. We note that EPA's selection of summer nutrient targets was based in part on data from this reference site and in part on recommendations from the literature.*

In contrast, Heal the Bay has objectively selected several reference locations to assist in establishing reference conditions for TMDL development (Figure 1). Heal the Bay's reference sites were selected based on upstream land use and lack of anthropogenic influences (Table 1). Reference sites 3, 8, 10, 14 and 18 drain open space and have virtually no upstream land uses that would impact nutrient loadings to the creek.

Reference sites 6 and 9 also drain open space and may be influenced only by the Lost Hills landfill. These seven reference sites provide the best possible indication of true background levels of nutrients and algae in the watershed, and at similar sites just outside the watershed (i.e. site 14 which is in lower Solstice Creek, and site 18 which is in lower Lachusa Creek).

Table 1. Heal the Bay water quality monitoring sites.

Site	Type	Description
1	Impacted	Arizona crossing at Cross Creek Rd.
2	Impacted	Cold Creek Outlet, Piuma and Malibu Cyn Rd.
3	Reference	Cold Creek upper, at Stunt Rd.
4	Impacted	Malibou Lake Outlet
5	Impacted	Las Virgenes Creek Outlet at Crags Rd, MCSP
6	Reference	Cheseboro Creek at Cheeseboro Rd
7	Impacted	Medea Creek at Cornell/Kanan Rd.
8	Reference	Palo Comado Creek at Cheeseboro Rd
9	Reference	Las Virgenes Creek in upper LV Canyon
10	Reference	West Carlysle Creek, upstream of Westlake
11	Minimally impacted	Mid Cold Creek, downstream of a few houses
12	Impacted	Rock Pool at Crags Rd, MCSP
13	Impacted	Mid Las Virgenes Creek, Lost Hills Rd at Apartment Trail
14	Reference	Solstice Canyon Creek at bridge in NPS land
16	Impacted	Stokes Canyon Creek Outlet, upstream of first crossing, MCSP
17	Impacted	Triunfo Cyn Creek at Triunfo Cyn Rd./ Kanan Rd.
18	Reference	Lechusa Canyon Creek, Decker Rd/ PCH
19	Minimally impacted	Arroyo Sequit at Mulholland Dr.

EPA Response: We have no problem with the location of the reference stations defined by Heal the Bay. Unfortunately we have difficulty interpreting the Heal the Bay numbers for nitrogen because they measured nitrate rather than total nitrogen. The TMDL targets for the summer are based on total nitrogen. A comparison of the nitrate numbers indicates that the values found by Heal the Bay are comparable to those found upstream of Tapia and at the SCCWRP reference stations. The phosphate data presented by Heal the Bay and by Tapia also seems high relative to other parts of the country and high relative to values presented by SCCWRP. This may indicate methodological problems.

Year-Round Algal Impairment in the Watershed

Heal the Bay conducted stream mapping five days per week. In addition, Heal the Bay has conducted semi-annual benthic invertebrate and stream habitat surveys in April and October for the last two years (fall 2001 to present). These surveys provide data on canopy cover and further data on algal and diatom cover at the 18 water quality monitoring sites. Our peer-reviewed and state- and EPA-certified methods on measuring nutrients and algae are included in Attachment 1, and available on our website (www.healthebay.org/streamteam/pubs.asp).

Through our mapping activities, Heal the Bay's Stream Team has undertaken the only comprehensive study to determine the true extent of winter algae impairment in Malibu Creek. Our highly-trained field crew mapped algal impairment in Malibu Creek during the wet season. Whenever algae cover exceeded 30% total cover of the wetted stream channel, the field crew characterized the types and percentages of algae. They used a Trimble Pro-XR global positioning satellite systems (GPS) to map any areas with more than 30% algal cover. In addition, field crews photo-documented each stream segment that was mapped as impaired. All GPS data were differentially corrected to insure accuracy within one meter. Data were imported into ArcView GIS software for analysis. The ArcView shape files and photo documentation are available for review.

The stream mapping clearly demonstrates that Malibu Creek is significantly impaired for algae. In addition, Malibu creek was specifically mapped during the winter season to determine if algal impairment was truly limited to the summer season. Mapping data were collected on 97 days of mapping the creek in 1999, 2000 and 2001. Ninety-two of the mapping days used in this analysis were between November 15 and April 15 each year. The other five days were in October 2000 and November 2001. The total length of Malibu Creek is 9.57 miles and only 1865 feet were not mapped by the Stream Team. A total of 6.55 miles were impaired by algae (i.e. greater than 30% cover) out of 9.22 mapped. Therefore we determined that 71% of the creek was impaired by algae during the winter season.

In addition, more than two years of monthly algae surveys at 15 sites in the watershed clearly show year-round algal impairment. Heal the Bay data were used to conduct an identical analysis to that used by the EPA for the impairment determination in the draft TMDL. Table 2 summarizes this analysis and the algae impairment in Malibu Creek watershed. Tables in attachment 2 provide summary statistics (mean, median, range and sample size) for benthic algae/diatom data in Malibu Creek watershed, and our reference sites just outside the watershed.

EPA Response*: We believe that Heal the Bay has done a superb job documenting algal cover in the Malibu Watershed. However it is difficult to interpret the Heal the Bay data because of the relatively small data set, differences in methodologies (i.e, nitrate vs total nitrogen), uncertainty regarding the appropriate ecological endpoint (30% filamentous algae or 60% bottom algae), and uncertainty concerning the frequency of exceedances of the algal cover end points. The Heal the Bay data clearly document the presence of algae at many sites, often at levels of concern to EPA. As discussed in our response to the Regional Board's comments, we believe the data clearly support a conclusion of summer time impairment. The winter seasonal data do not clearly support an impairment finding. Moreover, in our review of the Heal the Bay data, we did not find the clear relationship between algae, nitrogen and phosphorous in the winter suggested by the commenter.*

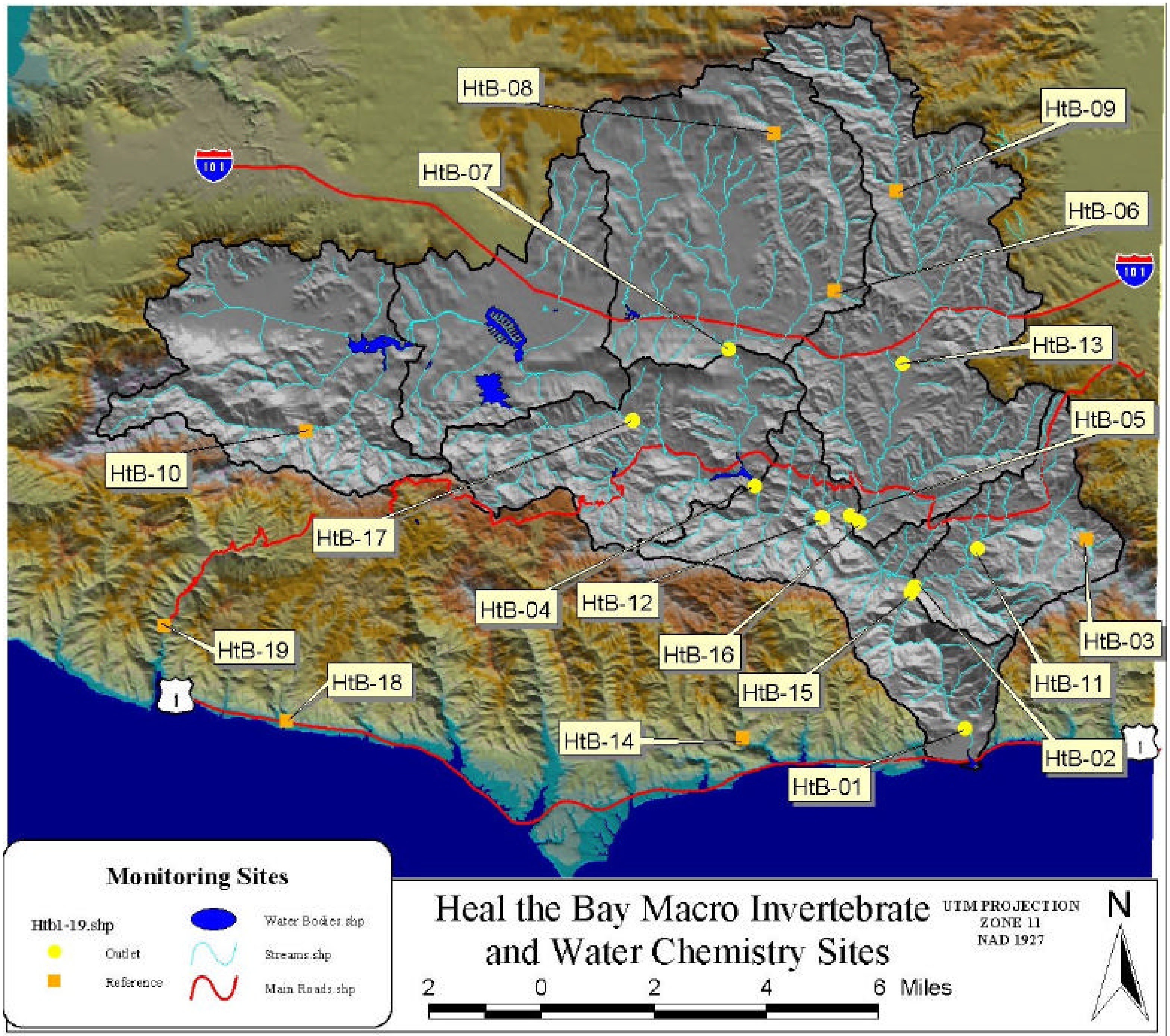


Figure 1. Map of Heal the Bay sampling sites.

Table 2. Percent benthic algal/diatom cover for Heal the Bay water quality monitoring sites, 2000-2002. Sites in bold show algal impairment.

All Seasons		*No. of samples*	*Median*	*# >30 %*	*% >30 %*
3	Cold Cr. upper	25	0	0	0
6	**Cheseboro Cr.**	**19**	**0**	**3**	**16**
8	Palo Comado Cr.	10	0	0	0
9	**Las Virgenes upper**	**17**	**35**	**9**	**53**
10	**Carlysle Canyon Cr.**	**10**	**5**	**2**	**20**
11	Cold Cr. middle	5	10	0	0
14	Solstice Cr. lower	7	0	0	0
18	Lachusa lower	9	0	0	0
19	**Arroyo Sequit lower**	**8**	**20**	**3**	**38**
1	**Cross Cr. road**	**27**	**33**	**13**	**48**
2	**Cold Cr. lower**	**22**	**55**	**16**	**73**
4	**Malibou L. outlet**	**25**	**90**	**15**	**60**
5	**Las Virgenes outlet**	**31**	**45**	**18**	**58**
7	**Medea Cr. outlet**	**29**	**85**	**24**	**83**
12	**Malibu Cr. rock pool**	**10**	**85**	**9**	**90**
13	**Las Virgenes middle**	**10**	**95**	**10**	**100**
16	**Stokes Canyon outlet**	**5**	**55**	**4**	**80**
17	**Triunfo Cr.**	**5**	**95**	**5**	**100**

Winter Months (November 15-April 15)		*No. of samples*	*Median*	*# >30 %*	*% >30 %*
3	Cold Cr. upper	11	0	0	0
6	**Cheseboro Cr.**	**11**	**0**	**2**	**18**
8	Palo Comado Cr.	4	0	0	0
9	**Las Virgenes upper**	**5**	**45**	**4**	**80**
10	**Carlysle Canyon Cr.**	**5**	**5**	**2**	**40**
11	Cold Cr. middle	2	8	0	0
14	Solstice Cr. lower	1	0	0	0
18	Lachusa lower	2	13	0	0
19	Arroyo Sequit lower	2	10	0	0
1	**Cross Cr. road**	**12**	**95**	**7**	**58**
2	**Cold Cr. lower**	**13**	**45**	**8**	**62**
4	**Malibou L. outlet**	**9**	**85**	**6**	**67**
5	**Las Virgenes outlet**	**11**	**0**	**4**	**36**
7	**Medea Cr. outlet**	**12**	**45**	**8**	**67**
12	**Malibu Cr. rock pool**	**2**	**75**	**2**	**100**
13	**Las Virgenes middle**	**2**	**95**	**2**	**100**
16	**Stokes Canyon outlet**	**1**	**55**	**0**	**100**
17	**Triunfo Cr.**	**2**	**75**	**2**	**100**

Summer Months (April 15 – November 15)		*No. of samples*	*Median*	*# >30 %*	*% >30 %*
3	Cold Cr. upper	14	0	0	0
6	**Cheseboro Cr.**	**8**	**3**	**1**	**13**
8	Palo Comado Cr.	8	0	0	0
9	**Las Virgenes upper**	**12**	**12.5**	**5**	**42**
10	Carlysle Canyon Cr.	5	5	0	0
11	Cold Cr. middle	3	25	0	0
14	Solstice Cr. lower	6	0	0	0
18	Lachusa lower	7	0	0	0
19	**Arroyo Sequit lower**	**6**	**35**	**3**	**50**
1	**Cross Cr. road**	**15**	**25**	**6**	**40**
2	**Cold Cr. lower**	**9**	**35**	**8**	**89**
4	**Malibou L. outlet**	**14**	**95**	**10**	**71**
5	**Las Virgenes outlet**	**18**	**65**	**12**	**67**
7	**Medea Cr. outlet**	**17**	**85**	**16**	**94**
12	**Malibu Cr. rock pool**	**7**	**95**	**6**	**86**
13	**Las Virgenes middle**	**7**	**95**	**7**	**100**
16	**Stokes Canyon outlet**	**4**	**55**	**3**	**75**
17	**Triunfo Cr.**	**3**	**95**	**3**	**100**

EPA Response: *We have independently reviewed this data. See Response to Regional Board 4 Comments*.

Heal the Bay has reviewed the 2000 UCLA *Lower Malibu Creek and Lagoon Enhancement and Management Study* and the 2000 *Evaluation of Nutrient Standards for Malibu Creek and Malibu Lagoon* prepared by CH2MHILL, which are the two most recent studies that examine algae impairment and the relationships between algae, stream flow, and nutrients. Our data demonstrate the conclusions in this study are incorrect in the following three ways.

The CH2MHILL study concludes that *Cladophora glomerata* is the primary species of algae in Malibu Creek. Based on the analysis of Heal the Bay's data this statement is false. *Cladophora* spp. are common in the creek, but we have observed that thick diatoms are a major cause of impairment, and that *Rhizoclonium* spp. and *Spyrogyra* spp. are approximately as common as *Cladophora* spp.

In addition, the CH2MHILL study states that *Cladophora* "can achieve saturated growth conditions with nitrate levels equal to or less than what occurs naturally in the creek." In areas that have not been impacted by upstream development (i.e. Heal the Bay's reference sites), nitrate levels are not increased above natural levels, and our data clearly show that algal impairment almost never occurs.

The CH2MHILL study also concludes that *Cladophora* is scoured away by flows greater than 1.5 fps. *Cladophora* mainly occurs in faster flowing, well-aerated waters that have substantial substrates, such as larger coarse gravel, cobble, boulder, bedrock or concrete. *Cladophora* algae is strongly attached to substrate and therefore it is logical that it would persist in faster flowing riffle stream areas. It takes substantial velocities, well in excess of the 1.5 fps suggested in the CH2MHILL study, to scour the algae. Heal the Bay has documented, on numerous occasions, *Cladophora* algal coverage of 90-100% of the stream channel with velocities well in excess of 1.5 fps (see individual transect data from our benthic macroinvertebrate and stream habitat surveys). Moreover, when velocities achieve the force necessary to scour *Cladophora,* only the long, hair-like strands that protrude into the water column are removed. The portion of *Cladophora* anchored near the substrate is almost impossible to remove. In fact it takes tremendous effort to scrape the *Cladophora* off the substrate by hand, as is required during our semi-annual benthic macroinvertebrate collections. In our experience in the creek, this root/anchoring portion of *Cladophora* quickly re-grows.

The assertion that stream velocities greater than 1.5 fps scour all algae also ignores the thick diatom growth which forms on willow roots that protrude into the stream. These roots serve to divert flows and protect diatoms from being scoured in velocities exceeding the 1.5 fps suggested in the study. Diatoms, even when scoured, rapidly return. At our Stream Team training location, we have observed re-growth within one week of nearly 100% diatom removal.

In our experience, and as illustrated by the data contained in this letter, algal impairment occurs year-round in the watershed, and can occur at high velocities like those seen in the winter season.

EPA Response: *No changes in the TMDL are suggested by the commenter or warranted based on the critique of the CH2MHill report. The debate on scour only underscores the need for a better understanding of the relationship between algae and flow*. *We believe that many of these disagreements in interpretation stem from the lack of definition. There is no consensus on what is meant by algal cover or how this data is interpreted. The CH2MHill Report focused primarily on filamentous algae. The Heal the Bay work includes both filamentous and bottom algae. The Regional Board has applied the 30% cover threshold to include both filamentous and bottom algae. Biggs (2000) used a threshold of 30% for filamentous alga and a threshold of 60% for bottom algae*.

Nutrients in the Watershed

Heal the Bay's Stream Team has collected water quality data in Malibu Creek Watershed since 1998. The number of sites sampled started at seven and has been expanded to 18 sites (Fig. 1). Fifteen sites are in the watershed, and three sites outside the watershed (lower Solstice Creek, lower Lachusa Creek, and mid Arroyo Sequit). Once each month, we measure nitrate-nitrite-N, phosphate, and algal cover at each site. Data are usually collected on the first Sunday and Monday of the month. The sites are listed in Table 1. For more detailed methods see Attachment 1.

Reference sites were selected for lack of upstream development or other anthropogenic impacts. Sites 11 and 19 were selected as minimally impacted sites because they are influenced by some upstream development. Algae and nutrient conditions at sites 19 and 11 should not be considered natural background conditions.

Heal the Bay's reference sites clearly show that the background nitrate+nitrite-N concentration in the watershed is less than about 0.05 mg/l in both wet and dry seasons (Figs. 2 and 3). The average background nitrate+nitrite-N concentration is **0.02 mg/l** in the dry season, and **0.03 mg/l** in the wet season. The only sites that regularly exceed 1.0 mg/l nitrate+nitrite-N in the wet season are Site 1, downstream of Tapia's main discharge; Site 5, downstream of Tapia's Rancho Composting facility; and Site 13, downstream of Tapia's discharge 002 (Tapia's site R6). Only site 1 (Cross Creek Road in Malibu Creek), site 2 (outlet of Cold Creek draining Montenido) and site 13 (Las Virgenes Creek at Lost Hills Road) exceed the proposed TMDL limit of 1.0 mg/l nitrogen. These sites are all highly impacted sites, and all show year-round algal impairment. For nutrient summary statistics see attached Table 5.

EPA Response: As discussed previously, o*ne of the issues confounding comparison between the HTB data and EPA targets is that the HTB data is based on NO3+NO2 while the EPA TMDL is based on total nitrogen (which also includes nitrogen species such as organic nitrogen and ammonia). The HTB data also included ammona in the data set. These added marginally to the magnitude of the HTB numbers but did not radically change the pattern. More significant however is the lack of organic nitrogen data. Organic nitrogen may make up a significant component of the total available nitrogen. We compared the HTB data to data collected by UCSB in the Malibu Creek watershed. The nitrate values are low and comparable to the HTB values but the total nitrogen values are much higher. TN values from reference sites in Cold Creek and Palo Comado Creek were 225 times and 50 times higher than the nitrate values*. *These methodological differences make it difficult or impossible to compare the HTB numbers to the numbers developed in the TMDL. For this reason,n o changes in the numeric target values are warranted.*

Heal the Bay's reference sites clearly show that the background phosphate concentration in the watershed is about 0.1 mg/l in both wet and dry seasons (Figs. 4 and 5). The average concentration in the dry season, excluding reference sites 6 and 9, is **0.12 mg/l**. The average concentration in the wet season, excluding sites 6 and 9, is **0.14 mg/l**.

EPA Response: *The HTB values for phosphate are consistent with the ambient data collected by Tapia. We note that these numbers are high compared to other parts of the country. These numbers also appear to be much higher than those measured by UCSB. This may indicate additional methodological issues that need to be resolved*.

The EPA's draft TMDL sets a nitrate limit that is higher than levels occurring in the creek at reference sites at any time of year. Moreover the nitrate limit is higher even than levels occurring at even the most impacted sites during the dry season and will violate the Clean Water Act's antidegradation requirements. Although the TMDL states a reference approach is used, no true reference sites were used in the analysis. Every site used was heavily impacted by urbanization, as discussed above. Therefore, this TMDL will result in water quality degradation at reference and impacted sites in the watershed.

EPA Response: *EPA has based its summer dry weather nutrient targets for total nitrogen (not nitrate) based on values from the scientific literature that are consistent with reference conditions in streams and lakes in the Regional Board 4 area. The summer targets are based on total nitrogen rather than nitrate. EPA does not feel there is compelling enough information that would require that these targets be established for the winter time. The TMDL simply applies the existing water quality standard for nitrate to the winter with an additional margin of safety. This will result in improvements to the quality of effluent from the Tapia plant and significant reductions in the overall nitrogen loadings to the system (See Response to Tapia Comments). There is no violation of the antidegradation standard. The TMDL emphasizes the need for compliance with the existing nitrate standard in the watershed during the winter. Nothing in the TMDL increases the loads to the watershed and the wasteload allocations for the Tapia discharge are being made more stringent than the existing permit limits. For these reasons, EPA disagrees that the TMDLs would result in nutrient loading increases that would trigger potential antidegradation concerns.*

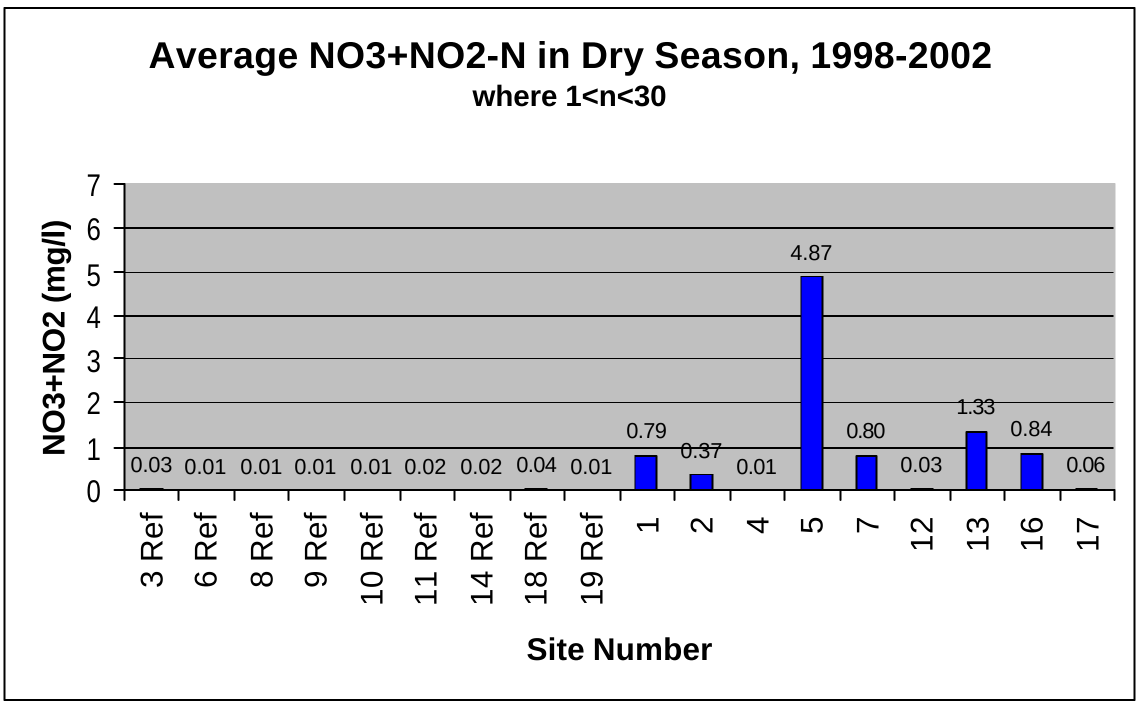


Figure 2. Average dry season nitrate-nitrite-N concentrations in Malibu Creek watershed.

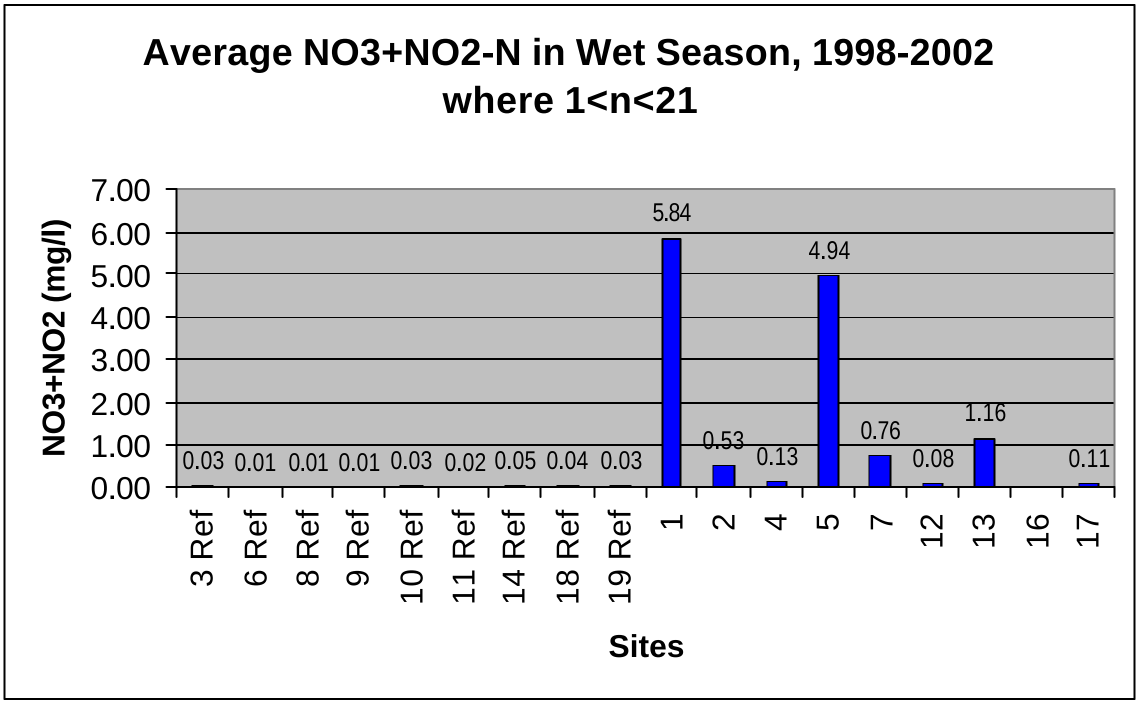


Figure 3. Average wet season nitrate-nitrite-N concentrations in Malibu Creek watershed.

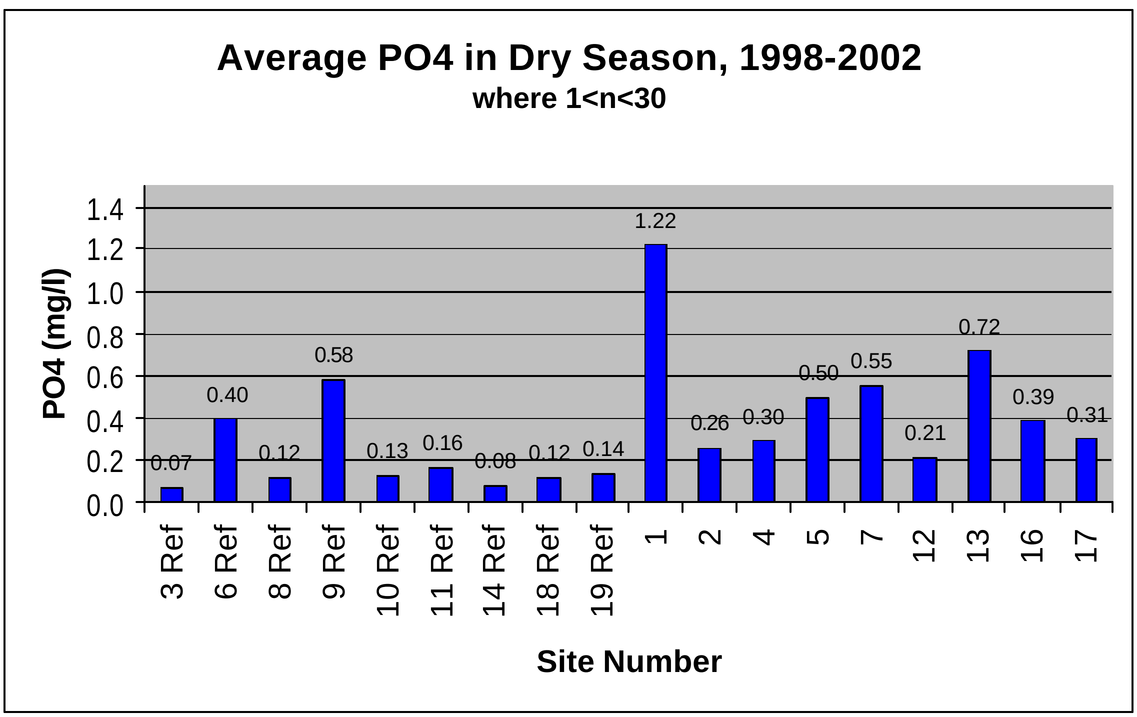


Figure 4. Average dry season phosphate concentrations in Malibu Creek watershed.

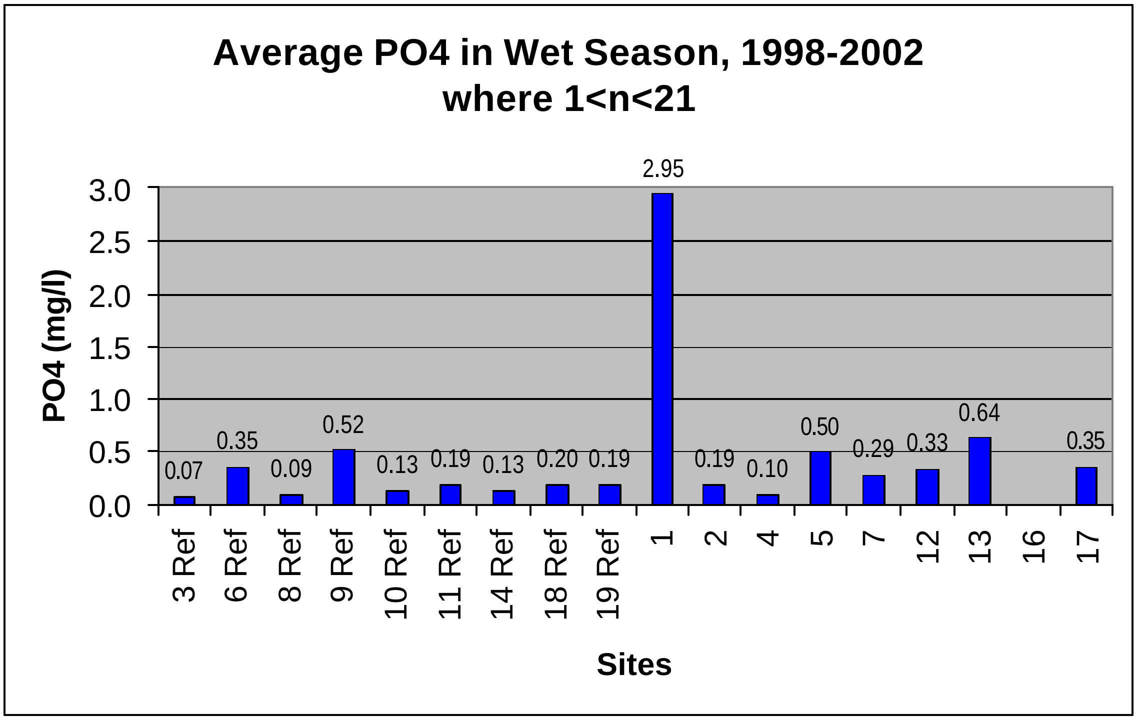


Figure 5. Average wet season phosphate concentrations in Malibu Creek watershed.

In addition, our data show that nutrients impact algal cover, but canopy does not. We measured canopy (amount of vegetation overhanging the creek) as a percent of the visible sky that is blocked by vegetation (or other shade-causing objects). A densiometer was used to accurately and reliably quantify canopy. For more detailed methods see Attachment 1.

Only five sites (reference sites 3, 8, 11, 14, 18) had zero algae and all those sites had NO_3+NO_2-N concentrations less than 0.05 mg/l and PO_4 concentrations less than 0.2 mg/l. The five sites that had NO_3+NO_2-N concentrations less than 0.2 mg/l and PO_4 concentrations greater than 0.2 mg/l (sites 6, 9, 4, 12, and 17) all had algal impairments. Only three (site 1, 5 and 13) had NO_3+NO_2-N concentrations greater than 1.0 mg/l and PO_4 concentrations greater than 0.1 mg/l, and all three of those sites also had algal impairments year round. This is illustrated in Table 3.

EPA Response: *This data presentation is interesting but not compelling enough for EPA to re-define the targets we established in this TMDL. We have seen equally interesting data presentations from Tapia (See Response to Tapia Comments). There may be other factors that contribute to the differences in algal cover. Tthe HTB data set is simply too limited to explain these factors. We believe that HTB has done a commendable job in generating high quality data to assist in the problem definition and target setting process. If future studies better characterize the relationship between algal cover, nutrient levels and other factors that may affect algae growth, we would support a re-evaluation of the targets in the future TMDL revisions by the State.*

Table 3. Comparing algal impairments and average nutrient concentrations (for both wet and dry seasons) at all 18 monitoring sites.

Site	$NO_3 > 1.0$ mg/l	$NO_3 >$ 0.1 mg/l	$PO_4 > 0.1$ mg/l	$PO_4 > 0.2$ mg/l	Algae impaired in summer	Algae impaired in winter
3						
6			X	X	X	X
8			X			
9			X	X	X	X
10			X			X
11			X			
14			X			
18			X	X		
19			X		X	
1		X	X	X	X	X
2		X	X	X	X	X
4		X	X	X	X	X
5	X	X	X	X	X	X
7		X	X	X	X	X
12			X	X	X	X
13	X	X	X	X	X	X
16		X	X	X	X	X
17		X	X	X	X	X

Table 3 clearly demonstrates that reference locations with low nutrient levels do not have algal impairments. Also those sites with high nitrate and /or high phosphate levels always have algal impairment year-round. This same pattern is illustrated in Figs. 6 and 7, which show median algal cover and average NO_3+NO_2-N and PO_4 concentrations.

EPA Response: *The pattern illustrated in this table suggests some correlation between algal cover and nitrate concentrations above 0.1 mg/l. We also agree that the data presented in Figs. 6 and 7 also suggest a pattern. We note that station 5 has high nitrate and phosphate in the winter but essentially no algae. We note that station 4 has low nitrate but high algal coverage in the summer. We note that station 12 has high algal coverage in both summer and winter in spite of low nitrate concentrations. Clearly there are other factors that are affecting algal coverage. Since we do not have total nitrogen data for these sites it is impossible to assess these patterns relative to the summer targets for the TMDL.*

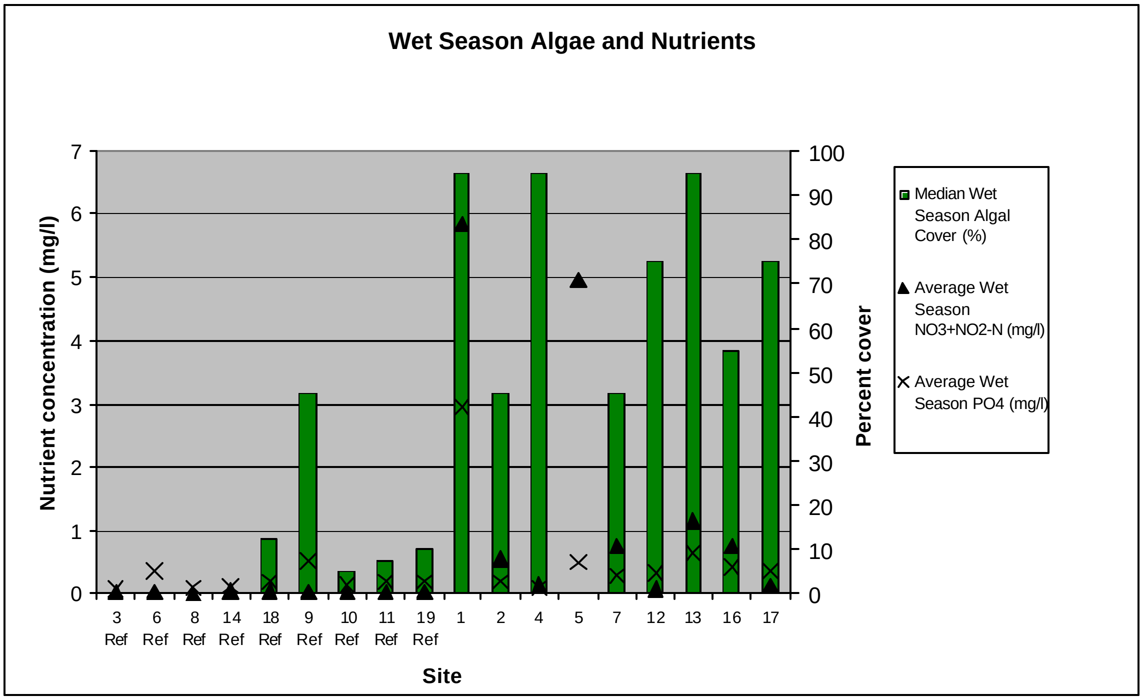


Figure 6. Benthic algal/diatom cover and nutrient concentrations in the wet season (Nov. 15-Apr.14). See Table 1, Attachment 1 for data.

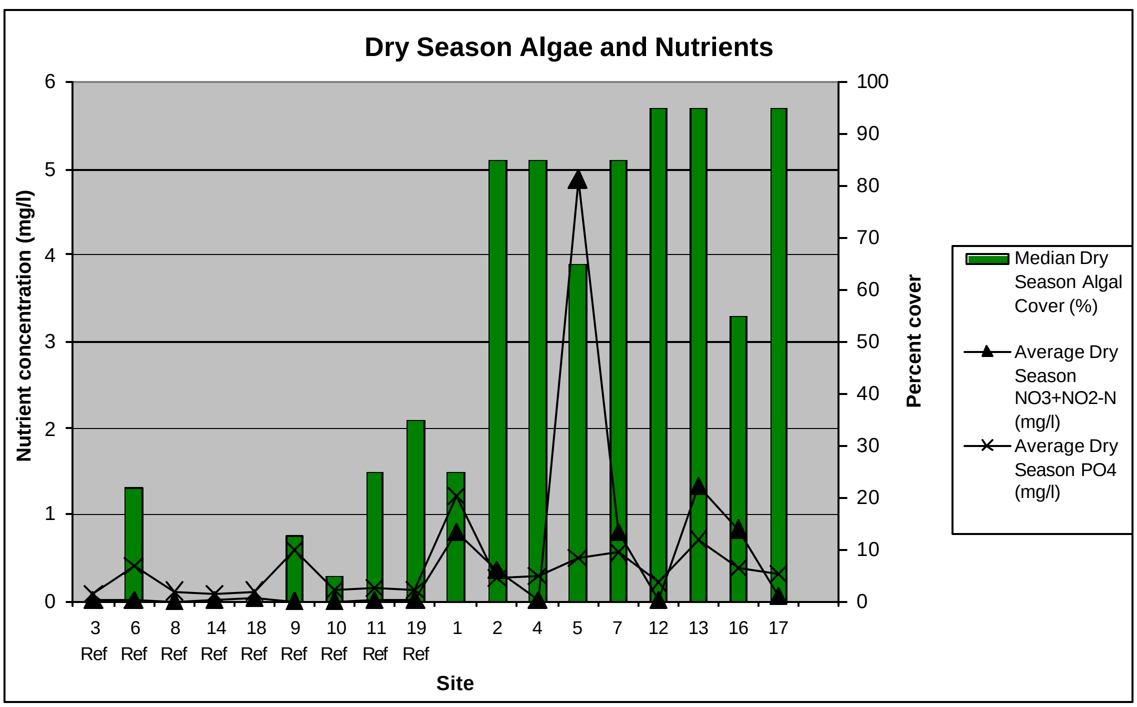


Figure 7. Benthic algal/diatom cover and nutrient concentrations in the dry season (Apr. 15-Nov.14). See Table 1, Attachment 1 for data.

Figures 8 and 9 show that canopy cover does not affect algal cover. Canopy cover is high at most of our monitoring sites, while algal cover is only high at the impacted sites. The presence of canopy does not inhibit algal growth where nutrients are high. Benthic algal/diatom cover is substantially higher at impacted sites than at the reference sites. Nutrients are also generally higher at the impacted sites.

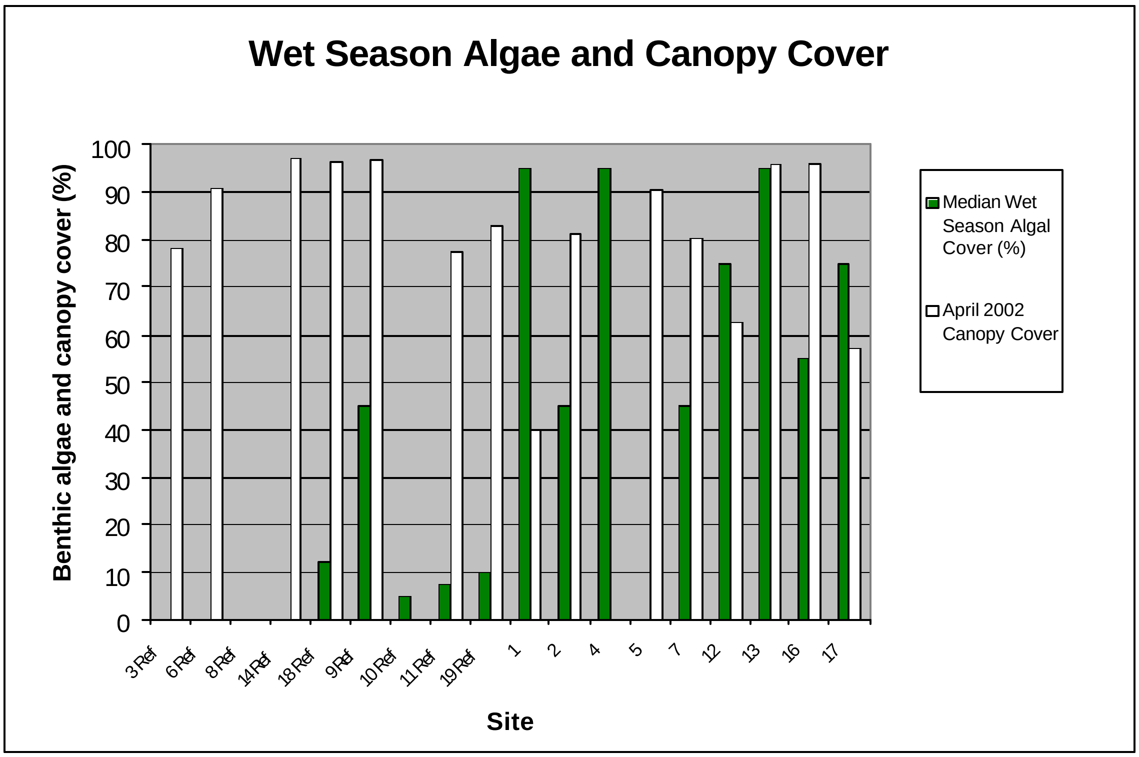


Figure 8. Benthic algal/diatom and canopy cover in the wet season (Nov. 15-Apr.14). Canopy data were not available for sites 4, 8 or 10. See Table 1, Attachment 1 for data.

EPA Response: *The data in Figs. 8 and 9 suggest no relationship between canopy and algal cover. However, the data provided by Tapia and summarized in the CH2MHill report suggest a clear connection. Again this underlies the uncertainty in our understanding of the factors controlling algae and suggests that additional research is desirable.*

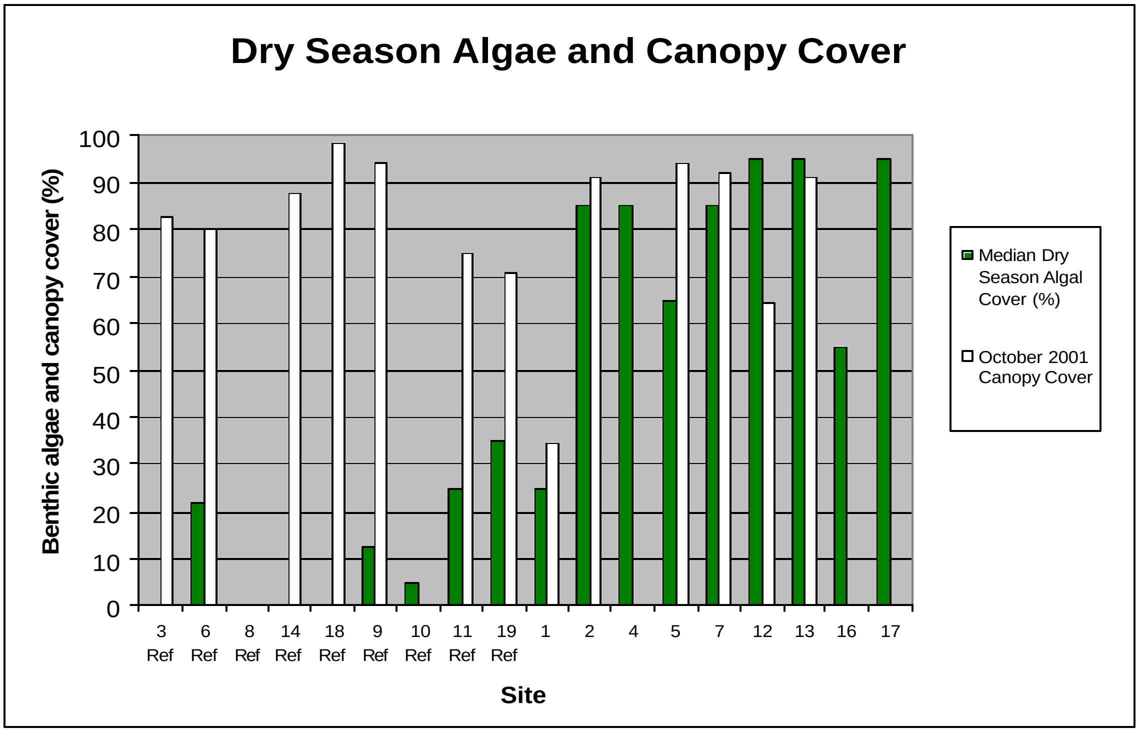


Figure 9. Benthic algal/diatom and canopy cover in the dry season (Apr. 15-Nov.14). Canopy data were not available for sites 4, 8, 10, 16 or 17. See Table 1, Attachment 1 for data.

There are several other issues of concern to us in the draft TMDL.

1. Data used in TMDL development

A large amount of data is readily-available to the EPA and the modeling consultants through the Heal the Bay website (www.healthebay.org). These data include nutrient and algae data, are updated monthly, and can be downloaded in an Excel spreadsheet. EPA ignored the last two and a half years of watershed data including data from 11 of our 18 sites. Heal the Bay monitors 15 stations in the watershed and three additional reference stations just outside the watershed, but data from only seven of our stations were used. The draft TMDL states that Heal the Bay submitted benthic algae data for the period June-December 2000, with only three winter season data points. Since this time, we have continued monthly algae sampling year-round. Our data have been accessible continuously via the web, and updated monthly, since May 2001. We believe this is the most extensive dataset available, and the only data on true reference conditions. For these reasons, the Stream Team should have been incorporated into the TMDL and the modeling effort.

EPA Response: *We have reviewed the data we received and have incorporated the data where appropriate in the response to comments and the TMDL.*

2. Assumptions in the model

We have problems with numerous assumptions in the nutrient modeling done for this draft TMDL (Tetra Tech, December 31, 2002). One that we will focus on is the flows used for load calculations. It does not make sense that EPA did not consider monthly averages from the LA County stream gage for the last 50 years. Data from the last 50 years should be used, taking into account the fact that Tapia is no longer allowed to discharge from April 15th to November 15th of each year, so Tapia's discharge volumes should not be part of the dry weather flow estimates. Dam releases also need to be accounted for. Only then can you determine loadings. EPA cannot rely on flow data from only a few years.

EPA Response: *We had access to about 25 years of flow measurement in the Malibu Creek watershed. We used four years of data to set up and calibrate the model. The assessment of critical summer low flow was based on the most recent data (1998-2001) which reflects the time since the discharge prohibition began. These data were evaluated and used in our assessment of the critical flow condition. We evaluated both the winter and summer periods. The summer flows were evaluated with and without the Tapia discharge.*

Loads should be calculated using the 90th percentile low flow, rather than the mean flow.

EPA Response: *For the purpose of estimating loadings of nutrients delivered to the creeks, the more conservative approach would be to base the estimates on a high flow year. Loads were estimated using flow data from four years (1992-1995). These four years include data from the 1993 storm year which represents the 90th percentile high flow.*

The mean flow is too high because of a few very high flows that occur during and after storm events. The large differences between mean, median flows and 90th percentile low flow (14.5 cfs, 5 cfs and 2.5 cfs respectively) reflect the influence of storm events. The draft TMDL states that "it is also necessary to determine the assimilative capacity of the receiving water under critical conditions". The use of stream flow data from 1998-2001 seriously over-estimates flow since the discharge prohibition originally allowed Tapia to discharge until May of 1998 and 1999. Since most studies acknowledge the increased abundance of algal growth during lower flow conditions, Heal the Bay believes that the lowest or critical average low flow condition should be the 90th percentile low flow (2.5 cfs). It would be impossible to control algae impairment if loading calculations are based on median flows and outlying values that occur infrequently during the dry season. This is also an important component of any margin of safety, which this TMDL ignores.

EPA Response: *For the purpose of defining the critical low flow condition in the draft TMDL we used the average flow of 14.5 cfs based on the last three years when the discharge prohibition began. We have changed this to reflect the median condition of 5 cfs over this time period since it is less sensitive to infrequent high flow and more accurately reflects the general flow within the stream. We also believe the* *median flow is appropriate because the assessment threshold cited by the Regional Board is based on recommendations to focus on monthly or seasonal averaging periods for nutrient and biomass indicators (Biggs, 2000). Calculation of the TMDL based on the 90th percentile low flow is not warranted based on the timeframes in which effects appear to occur. Use of the 4-year average summer flow for estimating loadings and the median flow for dilution provides sufficient margin of safety*.

Nutrient load estimates are also based on unjustified assumptions. Net nitrogen loading to the creek from septic systems is assumed to be 50 % of the total load after plant uptake, and net phosphorous loading to the creek from septic systems is assumed to be 10 % of the total load after plant uptake. How were these numbers derived? Why were maximum failure rates of septics assumed to be 20% when the Regional Board reports failure rate of 20 to 30%? Finally, the modeling did not use all available data. Only seven of Heal the Bay's 18 monitoring sites were included in the modeling.

EPA Response: *Please refer to the Tetra Tech report, page 7-19 (data sourcs and explanation) and page 8-5 (calibration) for a comprehensive discussion of how septics were handled in the model. The assumption of 20% failure rate used in the model was provided to EPA and Tetra Tech by the Regional Board. We believe the stream data collected by HTB may be useful for future calibration and validation of the model. We encourage the Regional Board to consider these data in future TMDL reviews. We note that the TMDL load allocation calculations were not dependent upon the results of the source analysis*.

Peer-review of the modeling should have been completed and the results of this review presented as supporting documentation for the TMDL. In fact, the EPA and the Regional Boards should establish a peer-review mechanism for models completed for TMDLs. Few stakeholders or regulatory agencies have the in-house expertise to thoroughly review these models, yet significant decisions which have potentially large associated costs will be made based on the results of these models. It is critical that the modeling methodology and assumption are reviewed by qualified experts to ensure quality results, reduce litigation risks and aid implementation.

EPA Response: *The basics of the model are the HSPF which has been extensively peer-reviewed in the scientific literature. The application of this model for the Malibu Creek TMDLs was performed by Tetra Tech under contract to US EPA. Tetra Tech is a leader in the development and application of watershed models such as the one used in this TMDL. Model application and assumptions that went in to the model were based on discussions between Tetra Tech and Regional Board staff. Interim products were shared with the Malibu Creek Watershed Council. The final product was reviewed by Regional Board staff and staff at EPA Region 9. The application of the model for the Malibu Creek TMDL has not undergone any formal peer review. We agree that there should be a mechanism to provide the public the assurance that models developed for TMDLs are used appropriately.*

3. Loading from Lakes

The lakes in the watershed are currently storing nutrients and contributing nutrient loads to the creek at different times of the year, during dam releases (water releases from the lakes to prevent flooding, etc.). Dam releases are a source of nutrients to the creeks, and there is a need for a dam release management plan throughout the watershed. Currently there are seven dams in the watershed and nearly as many agencies in charge of dam management. A comprehensive dam release management plan is critical to controlling nutrient loads and to prevent greater spread of algae in the watershed.

EPA Response: *Our review of the data below Malibou Lake suggests that releases from the lake are not a significant source of nutrients to the creeks.*

4. Need for a Public Hearing

Given the importance of this TMDL to the stakeholders of Malibu Creek watershed and the multitude recreational users throughout the region that routinely visit this unique watershed, we believe a hearing is the appropriate way to allow the public an opportunity to vet issues related to this TMDL.

EPA Response: *In addition to soliciting written comments, EPA held a public workshop during the comment period to answer any questions that the public might have on the TMDL and give members of the public the opportunity to discuss the TMDLs with EPA. There is no requirement that EPA hold a public hearing and we did not believe that holding a hearing as well as a public workshop was necessary.*

Heal the Bay concurs that site-specific conditions are critical to establishing this and other TMDLs. Our data clearly demonstrate that reference locations with similar canopy cover as our impacted sites almost never suffer from algae impairment in any season. These reference sites have very low nutrient concentrations. In addition, page 3-27 of the CH2MHILL report states the long-term record of various upstream and downstream stations shows the general pattern of increasing algae abundance over time in the creek and the upstream stations (above Tapia) show the greatest increase. A quick review of the data analysis in figures 3-2 and 3-4 of this study clearly show an increase in both nitrate and phosphate at these same "upstream" locations. These data suggest that as nutrient concentrations have increased throughout the watershed so has algal abundance. Algal abundance below Tapia has remained relatively constant but nutrient levels well in excess of Heal the Bay's reference locations have persisted throughout the study period.

EPA Response: *EPA agrees that there is a relationship between algae and nutrient concentrations. However the conclusion of the CH2MHill report was that algal cover is higher upstream of Tapia where nutrient concentrations are lower. This suggests that factors other than nutrients are affecting algal growth. We did not develop site-specific or reach-specific numeric targets because the data was too limited to do so.*

Heal the Bay also concurs with the allocations of zero wasteload for the spray irrigation and sludge injection activities in the watershed, and for new development. These are major sources of nutrients to the creek. Spray irrigation and sludge injection currently contribute to algal impairments in Las Virgenes and Malibu Creeks. Urbanization is a major source of nutrients and contributor to algal impairment in Las Virgenes, Malibu, Medea and Triunfo Creeks as well as others. The zero wasteload allocation in this TMDL will insure that alternatives to the over-spraying of reclaimed water are found, and that new developments use appropriate BMPs and other techniques to prevent increased nutrient loads to the creeks.

EPA Response: *EPA concurs with the comment*.

To conclude, the complete set of nutrient and algae data for the watershed demonstrate that algae impairment exists year-round. The nitrate and phosphate TMDLs must be set at levels that will eliminate this impairment and fully restore the beneficial uses of the Malibu Creek watershed. When true reference conditions are used, background concentrations of NO_3+NO_2-N are less than 0.05 mg/l, and background concentrations of PO_4 are less than 0.14 mg/l. Heal the Bay's reference sites are the only sites that do not show chronic algal impairments. Since the TMDL was developed with a reference location/anti-degradation approach, it must apply the nutrient levels found at the reference sites throughout the watershed.

Sincerely,

Mark Gold, D.Env. Executive Director	Shelley Luce Staff Scientist
Mark Abramson Stream Team Manager	Steve Fleischli Executive Director, Santa Monica Baykeeper

Attachment 1. Detailed Data Collection Methods

Nutrient and Algae Methods

1. Nutrients:

- Water samples are collected at the site and kept on ice.
- Nitrate-nitrite-N and phosphate are measured in the Heal the Bay laboratory using the LaMotte SMART Colorimeter and reagents, with detection limits of 0.01 mg/l for both tests.

More information on quality assurance/quality control procedures is available in our QAPP, "Shattering the Myths of Volunteer Monitoring", which is online at www.healthebay.org/streamteam/pubs.asp.

2. Algae:

- A tape measure is stretched across the creek
- Areas of the creek bottom that are covered by algae and/or medium to thick diatoms (greater than 0.5 cm thick) are measured.
- The percentage of the creek bottom transect that is covered by algae is calculated.

A more detailed Stream Team algae measuring protocol and diagram are included below.

3. Stream Habitat Surveys:

- A reach is defined at each site, depending on the width of the creek and the distance between riffles at the site.
- Each reach is divided into five equal parts, resulting in six transects per reach.
- At each transect, densiometer readings are taken according to the EPA methodology (Kaufmann, P.R., P. Levine, E.G. Robinson, C. Seeliger, D.V. Peck. 1999. Quantifying physical habitat in wadeable streams. EPA/620?R-99/003. U.S. Environmental Protection Agency, Washington, D.C.). Densiometer readings are taken on the left and right banks, and in the center of the stream facing upstream, downstream, left and right.
- Algae cover is also determined at each transect. A tape measure is stretched across the transect and algal and/or diatom cover is recorded at evenly-spaced points along the tape measure.

4. Mapping Data:

- The Stream Team field crew walk up the creek, using a backpack-mounted GPS unit with sub-meter accuracy to record various stream features, including algae impairment.
- Stream Team crew identify reaches of the creek that have greater than 30% cover of algae or medium-to-thick diatoms using the tape-measure method above, and maps those reaches using GPS.
- The GPS data are used to calculate lengths of the creek that are impaired by algae. The length of the mainstem of Malibu Creek was mapped on 97 days in 2000-2002.

Stream Team Algae Protocol and Diagram
(excerpted from the Stream Team training manual)

1. Find an area at your monitoring site that is a long glide (slow steady flowing relatively shallow area) or a combination of glide and riffle (fast flowing shallow area with some turbulence).
2. Make sure the area you select is representative of the entire stream reach. **Do not choose an area that has either unusually high or low amounts of algae.**
3. Choose the starting location where you will begin your algae measurement and place one of the stakes contained in the *Stream Team Field Kit* into the ground at the edge of the water.
4. Using either the tape measure or the leveling rod (stick used to measure stream depth) measure out a 20 ft. distance downstream and place a second stake into the ground.
5. Attach the tape measure to the first stake that was placed along the edge of the stream and stretch the tape across the stream channel to the opposite side of the stream on a 90-degree angle. You can also extend the leveling rod and lay it across the stream just in front of the stake.
6. When standing directly above the tape measure or leveling rod calculate the amount of algae that the tape measure or leveling rod passes through. See figure below. For example if the stream is 10 ft. wide and the first 3 ft. is solid algae and then no algae for 1 ft. followed by 4 ft. of algae and 1 ft of no algae the calculation would be done as follows:

Total algae cover = amount of stream with algae
e.g. 3 + 4 = 7 total feet of algae.
Total algae cover ÷ Stream width x 100 = % Total algae cover
e.g. 7 ÷ 10 = .70 x 100 = 70%

7. Record the result(s) on your field sheet in the *Biological floatable* section. The field sheet has a location for floating algae (algae not attached to the stream bottom) and mat algae (algae that is attached to the stream bottom). **You can have more than 100% coverage if you add both floating and mat algae together.**

8. Determine the percentage of the different types of algae that make up the algae coverage.

Floating algae is almost always one of two types: *Enteromorpha* (EN) is lime green to dark green in color and when examined closely has a hollow tube shape that resembles an intestine or sausage casing. *Diatoms* can be green or brownish in color and generally have small bubbles throughout. Diatoms will easily break up when rubbed between your fingers. If the diatoms are between 1 and 2 millimeters thickn (1 mm is approximately the thickness of your thumbnail) that is considered medium diatom, recorded as *DM*. If the diatom layer is thicker than 2 mm it is considered thick, recorded as *DT*.

Mat algae can be one of 6 types:

Diatoms are brown and may be a thin film on rocks and sandy bottoms. We do not record diatom film as an impairment. Diatoms may also be a thicker (greater than 2 mm) fuzzy coating on rocks, plants or sandy bottom, or they may be long strands streaming in the water.

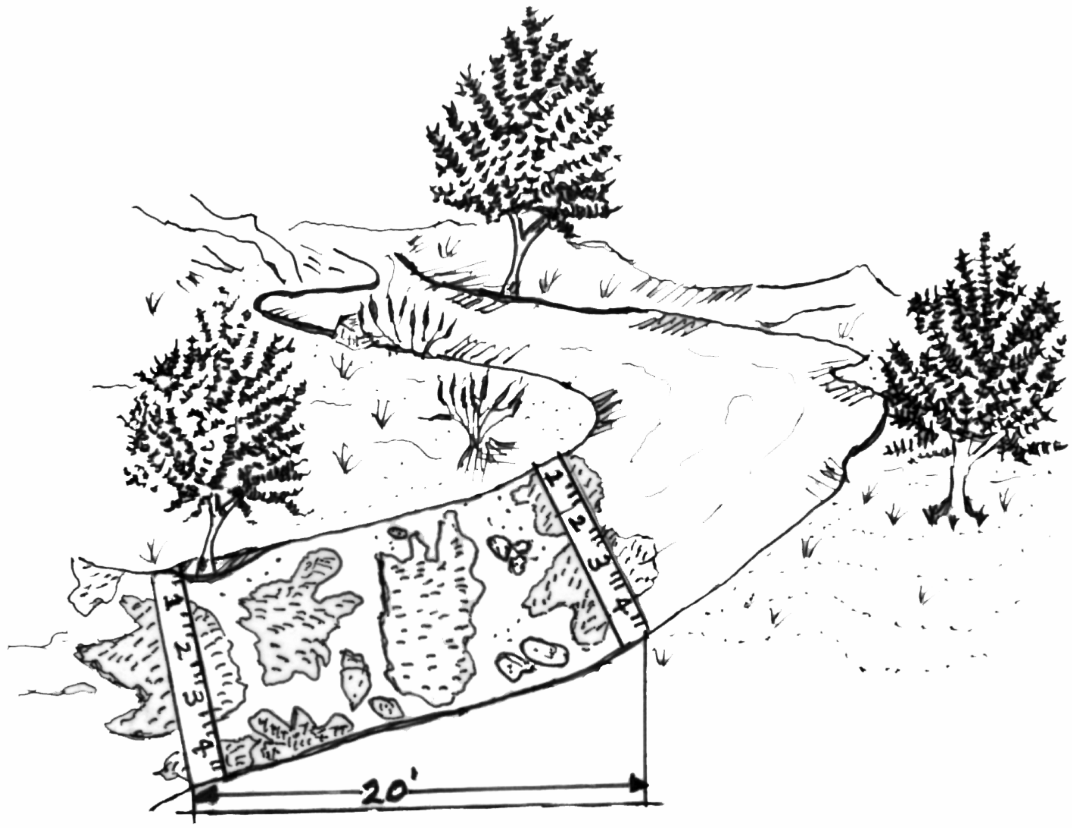
***Chara* (CH)** has a stalk with thin "branches" along it in rings. It could be mistaken for a vascular plant. It attaches to the bottom and grows up toward the surface.

***Cladophora* (CL)** is fine and stringy, or filamentous. It may float on the surface, attached by a stalk to the substrate (the dark green "hair" algae), or it may grow more like a mat on a shallow rock. Either way it is recorded as mat algae.

***Rhizoclonium* (RZ)** is usually attached to the bottom or rocks, and grows like a turf or mat.

***Spyrogyra* (SP)** is similar to *Cladophora* but is very slimy and usually lighter green.

***Enteromorpha* (EN)** is a bright green bladder filled with air, and floats on the surface. It looks a bit like green intestines.
Unidentified macroalgae is what we call algae that we can see but cannot identify.



Use the same procedure described above for determining Total Algae cover to assign percentages to each of the algae types. Record the results in your notes adjacent to biological floatable section on your field sheet. ***Make sure to denote floating vs. mat algae.* NOTE never record the brown film of diatoms (less that 1mm or less than the thickness of your thumbnail).**

Attachment 2. Nutrient and algae summary data

Dry weather summary statistics for benthic algal/diatom cover in Malibu Creek watershed. Mean, median, minimum and maximum values are percent cover.

Dry Weather Summary Statistics							
Site	**Type**	**Mean**	**Median**	**SD**	**Min**	**Max**	**Count**
3	Reference	3.6	0	5.3	0	15	14
6	Reference	15.6	2.5	34.5	0	100	8
8	Reference	NA	NA	NA	0	0	8
9	Reference	27.5	12.5	33.4	0	95	12
10	Reference	12	5	12	0	25	5
11	Reference	18.3	25	11.5	5	25	3
14	Reference	3.3	0	6.1	0	15	6
18	Reference	3.6	0	5.6	0	15	7
19	Reference	37.5	35	29.3	0	75	6
1	Impacted	29.7	25	33.5	0	95	15
2	Impacted	69.4	85	29.2	25	95	9
4	Impacted	65	95	44.0	0	95	14
5	Impacted	53.5	65	36.4	0	95	20
7	Impacted	80	85	23.7	0	95	17
12	Impacted	77.9	95	29.8	25	95	7
13	Impacted	85	95	18.3	45	95	7
16	Impacted	52.5	55	36.9	5	95	4
17	Impacted	95	95	0	95	95	3

Wet weather summary statistics for benthic algal/diatom cover in Malibu Creek watershed. Mean, median, minimum and maximum values are percent cover.

Wet Weather Summary Statistics							
Site	**Type**	**Mean**	**Median**	**SD**	**Min**	**Max**	**Count**
3	Reference	3	0	4.6	0	15	11
6	Reference	17.7	0	35	0	95	11
8	Reference	3.8	0	7.5	0	15	4
9	Reference	59	45	33.6	25	95	5
10	Reference	30	5	16.4	0	75	5
11	Reference	7.5	7.5	10.6	0	15	2
14	Reference	NA	NA	NA	0	0	1
18	Reference	12.5	12.5	17.7	0	25	2
19	Reference	10.0	10.0	7.0	5	15	2
1	Impacted	55.8	95	49.3	0	100	12
2	Impacted	38.5	45	34.4	0	85	13
4	Impacted	50	85	48	0	95	11
5	Impacted	19	0	28	0	75	11
7	Impacted	45	45	35.4	0	95	12
12	Impacted	75	75	0	75	75	2
13	Impacted	95	95	0	95	95	2
16	Impacted	NA	NA	NA	55	55	1
17	Impacted	75	75	14.1	65	85	2

Table of summary data for nutrient, algae and canopy cover. These data were used to generate figures 5 through 8 above.

Site	Average Dry Season NO3+NO2-N (mg/l)	Average Dry Season PO4 (mg/l)	Average Wet Season NO3+NO2-N (mg/l)	Average Wet Season PO4 (mg/l)	Median Dry Season NO3+NO2-N (mg/l)	Median Dry Season PO4 (mg/l)	Median Wet Season NO3+NO2-N (mg/l)	Median Wet Season PO4 (mg/l)	Average Dry Season Algal Cover (%)	Median Dry Season Algal Cover (%)	Average Wet Season Algal Cover (%)	Median Wet Season Algal Cover (%)	October 2001 Canopy Cover	April 2002 Canopy Cover
3 Ref	0.028	0.072	0.029	0.072	0.005	0.07	0.01	0.045	3.6	0	7.3	0	82.84	78.27
6 Ref	0.011	0.397	0.014	0.346	0.005	0.43	0.005	0.3	2.5	21.8	0	0	90.69	0.011
8 Ref	0.005	0.124	0.009	0.085	0.005	0.11	0.01	0.08	3.8	0	3.8	0	0.005	0.124
14 Ref	0.022	0.079	0.045	0.125	0.01	0.08	0.045	0.125	3.3	0	0	0	87.91	97.22
18 Ref	0.042	0.119	0.040	0.195	0.005	0.09	0.04	0.195	3.6	0	12.5	12.5	98.37	96.57
9 Ref	0.006	0.580	0.014	0.522	0.005	0.54	0.01	0.495	27.5	12.5	59	45	94.28	96.90
10 Ref	0.009	0.128	0.028	0.132	0.005	0.12	0.01	0.12	12	5	39	50	-	-
11 Ref	0.018	0.163	0.015	0.190	0.01	0.13	0.015	0.19	18.3	25	7.5	7.5	74.84	77.45
19 Ref	0.014	0.143	0.030	0.190	0.005	0.14	0.03	0.19	37.5	35	32.5	32.5	70.92	83.17
1	0.789	1.224	5.843	2.947	0.025	1.19	5.02	2.92	29.7	25	55.8	95	34.31	40.03
2	0.366	0.264	0.531	0.194	0.2	0.25	0.37	0.18	69.4	85	36.5	45	91.18	81.21
4	0.015	0.296	0.132	0.101	0.005	0.32	0.01	0.08	65	85	50	85	-	-
5	4.872	0.498	4.942	0.501	4.64	0.425	5.2	0.44	53.5	65	19	0	94.12	90.52
7	0.797	0.554	0.765	0.289	0.765	0.46	0.735	0.26	80	85	45	45	91.99	80.23
12	0.029	0.211	0.075	0.330	0.03	0.23	0.075	0.33	77.9	95	75	75	64.54	62.58
13	1.334	0.724	1.155	0.640	1.52	0.77	1.155	0.64	85	95	95	95	91.18	95.75
16	0.835	0.393	0.760	0.430	0.805	0.38	0.76	0.43	52.5	55	95	95	-	96.08
17	0.057	0.307	0.110	0.345	0.05	0.31	0.11	0.345	95	95	75	75	-	57.19

Attachment 3. Raw Nutrient Data