RECOMMENDED ACTIONS

The findings from the first three years of Channelkeeper's Goleta Stream Team water quality monitoring efforts highlight the need for action to address the impairments identified. Although three years of data are not necessarily conclusive, there are several reasons to implement proactive measures now to reduce pollution in this valuable watershed.

The Goleta Slough is listed as an impaired waterbody on the State's 303(d) List of Water Quality Limited Segments due to its contamination by pathogens, heavy metals, priority organics and sedimentation. Moreover, the surrounding area is poised to undergo significant land use changes in the near future, which may further impair water quality in the watershed. The new City of Goleta is currently formulating comprehensive plans for future land use and development, and the Santa Barbara Airport (located in the Goleta Slough) is set to undergo major construction to expand the runway and other airport facilities as part of its Aviation Facilities Plan.

The Central Coast Regional Water Quality Control Board (RWQCB) is required to develop Total Maximum Daily Loads (TMDLs) for pollutants of concern in impaired waterbodies, and development of TMDLs for Goleta Slough is scheduled to begin soon. Further, Santa Barbara County and the Cities of Goleta and Santa Barbara will soon be implementing Storm Water Management Programs (required pursuant to the State General Permit for Small Municipal Separate Storm Sewer Systems), and must demonstrate that the strategies therein are effectively reducing pollution in stormwater and runoff. However, due to resource limitations, the slough is not regularly monitored by any entity other than Channelkeeper, so water quality data to facilitate these efforts is sorely needed.

Continue and expand monitoring: Channelkeeper's data can continue to serve as an important resource for municipalities, regulatory agencies and other stakeholders to evaluate the need for and effectiveness of water quality protection and restoration efforts. It will also provide a useful baseline for the new City of Goleta as it plans for future land use and development, and for the Santa Barbara Airport as it undertakes its expansion plans. Therefore, Channelkeeper's Goleta Stream Team program should be continued, and should further be expanded to include more sampling sites in the slough itself and to conduct dry and wet season sampling for the full suite of pollutants, particularly metals, herbicides and pesticides known to occur in the watershed.

Conduct creek walks: The Goleta Stream Team data would be even more useful if it were supplemented by additional efforts to pinpoint sources of the nutrient and bacterial pollution identified through Channelkeeper's sampling program. This could be achieved by conducting creek walks to identify discharge points and discrete sources of runoff that may be contributing polluted water to the creeks or slough, testing the discharged water for pollutants, then consulting the County's land use and storm sewer maps to pinpoint potential sources contributing to the pollution.

Educate property owners and enforce ordinances: Once specific sources are identified, Channelkeeper and/or other environmental groups in cooperation with regulatory agencies should reach out to owners of properties from which discharges may be originating. The focus of the outreach efforts would be to educate business or property owners on the potential problems posed by their particular discharges and present solutions and best management practices (BMPs) that different types of business or property owners can implement to prevent pollution in the future. The County of Santa Barbara has already developed brochures targeting dog and horse owners, creekside residents, gardeners, restaurants, automotive service businesses, construction contractors and mobile cleaners; these could be distributed to business owners or residents that own property from which discharges may be originating. This outreach and education should be followed by targeted inspections and monitoring by relevant RWQCB, County or City (Goleta or Santa Barbara, depending on location) agency staff responsible for enforcement of existing water quality protection regulations and ordinances. If such monitoring efforts or inspections identify ongoing pollution problems from particular sources, the appropriate agencies should follow up with enforcement action, such as issuing fines or cease and desist orders, to ensure that illegal discharges cease. In the Goleta Slough watershed, these education and enforcement efforts should target agricultural operations, large horse facilities, and golf courses, all of which Channelkeeper believes contribute significant amounts of nutrients into many of the creeks monitored by Goleta Stream Team.

Inventory agricultural operations and encourage enrollment in the RWQCB's agricultural waiver program: As Goleta Stream Team data and numerous other water quality monitoring efforts have shown, waterbodies in agricultural areas, including the Goleta Slough watershed and elsewhere, often contain highly contaminated runoff. In recognition of this problem, the RWQCB adopted a regulatory program for irrigated agricultural operations on the Central Coast, which requires farmers to develop farm water quality management plans that address, at a minimum, irrigation management, nutrient management, pesticide management and erosion control; begin implementing best management practices identified in their plans; conduct monitoring to ensure compliance; and complete 15 hours of farm water quality education within three years. An inventory of all sizeable agricultural operations in the Goleta area should be conducted to determine how many have enrolled in this program, and any that have not should be encouraged to do so.

Increase monitoring and consider treatment of golf course discharges: As noted above, Glen Annie, Hidden Oaks and Twin Lakes Golf Courses are located upstream of sampling sites (GA2, AT2, and SP1, respectively) where Goleta Stream Team has identified significant nutrient pollution problems. Relevant local agencies and/or environmental groups may want to conduct additional monitoring at golf course discharge points to ensure compliance with water quality standards and discharge ordinances. The City of Santa Barbara is building a stormwater detention basin at the Santa Barbara Golf Club to naturally treat runoff from the golf course before it enters Las Positas Creek; similar systems may well be needed at Glen Annie, Hidden Oaks and Twin Lakes Golf Courses, and these options should be considered by relevant County or City officials in cooperation with the golf course owners or operators.

Implement stormwater treatment controls: There are a variety of treatment technologies and methods available for reducing bacteria in creeks and storm drain systems, including active treatment systems, such as ultraviolet (UV) light and ozone treatment systems, and stormwater treatment BMPs, such as vegetated swales, infiltration basins, constructed wetlands, and permeable pavement, to name just a few. Both the County and City of Santa Barbara have already installed many such systems, such as bioswales at Bohnett Park and a UV treatment system at Escondido Pass. Other priority sites that would benefit from treatment controls have also been identified; local municipalities should continue to allocate and seek additional funding to implement more of these types of stormwater treatment controls in priority areas throughout the Goleta Slough watershed.

Encourage installation of low-impact development BMPs: In an effort to reduce the mobilization of pollutants in runoff, urban planners are increasingly looking to the use of structural BMPs such as infiltration practices. One example is the use of porous pavement as opposed to impervious asphalt or concrete. Regulatory agencies should seek to encourage the installation of such BMPs by developing and providing incentives, such as facilitated permitting or cash stipends or rebates, to property owners.

In conclusion, while there are many water quality problems throughout the Goleta Slough watershed, there are also many opportunities to address them. Santa Barbara Channelkeeper is committed to improving water quality throughout the South Coast area, and looks forward to working together with government agencies, environmental groups, and the public to achieve this goal.

ENDNOTES

1. The sections on the South Coast were adapted from Veirs et al. (1998), USACE (2002), USBR (2002), Questa (2003) and USDA-FS (2004). A reference list is included at the end of the report; when available, references with web addresses were chosen so documents can be easily accessed for ad ditional information. In addition to general references, specific citations were used when warranted.
2. Climate data for the Santa Barbara region are available from a number of internet sources: DRI-WRCC, CDEC, CCDA and JISAO. Data is also available from the County of Santa Barbara (CSB-PWD). The discussions that follow reference the "water-year" instead of using a calendar year; the water-year begins on October 1 and ends the following September 30, e.g., water-year 1998 began on Oc tober 1, 1997 and ended on September 30, 1998. Hydrologists and agencies concerned with water in California use a water-year to present and analyze data because it better fits the seasonal progression of annual precipitation: rainy to dry, snowfall to snowmelt.
3. This section used SBC-DPD (1998, 2002) and Nelson as references.
4. This creek is known by two names: Glen Annie and Tecolotito. Throughout this report the name Glen Annie will be used.
5. Perhaps the best way to view the Atascadero sampling scheme is that at CG1, urban runoff from the rela tively small area between upper State Street and Foothill Road is sampled. At AT3 we observe the change in water quality when runoff from the more commercial uses around Modoc and Hollister are added. Next, additional impacts are measured at AT2 when agricultural and golf course runoff are included, and compared with what is expected to be cleaner flow from a less impacted creek (MY1). And finally, we look at what happens when plant nurseries and more agriculture are added to the mix, and when the creek is converted into a long skinny lake (AT1) during the dry season.
6. Such as Cladophora, Rhizoclonium, Enteromorpha and Spirogyra.
7. US-EPA (1997), Deas and Orlob (1999) and Heal the Bay (2003) were used in the preparation of the sec tions on water quality parameters.
8. It is often simpler to think of mg/L as "parts per million," since a liter of water weighs a million milli grams, 1 mg/L is the same as one part of dissolved oxygen in a million parts of water.
9. The meter makes this calculation based on measured temperature and an entered value of sampling site elevation.
10. A percent saturation above 100 simply indicates that water is not at equilibrium but in the process of releasing oxygen into the atmosphere, just like a glass of recently poured soda sheds an over-satura tion of carbon dioxide as streams of bubbles.
11. Three sets of data were combined to make the pH charts: field measurements up until July 2003, labora tory measurements made from collected samples from July 2003 to March 2005, and finally, field measure ments again from April 2005. pH is a difficult measurement to make, even in the laboratory, and the portable meters initially used by Stream Team proved unreliable. Newer, higher quality meters are now available and have been used since April 2005. During the intervening period, laboratory measurements were made with a meter borrowed from the UCSB-LTER program; these measurements were made in conjunction with field measurements using the old meters, but only the laboratory data is used in Figure 19.
12. Given that the suggested EPA eutrophication limits are typically measured as total nitrogen and total phosphorus, some explanation as to why we used phosphate instead of phosphorus, and nitrate instead of total nitrogen in the previous discussions is warranted. The UCSB-LTER project analyzes the nutri ent samples collected by Goleta Stream Team for Channelkeeper. Nitrate and phosphate (and ammo nium) are analyzed as soon as possible (typically within a few days; see methodology appendix), but total nitrogen and total phosphorus are analyzed months or even a year later (samples undergo initial

processing as soon as possible, but are then stored in a preserved condition – no 2005 samples have yet been analyzed for total dissolved nitrogen or phosphorus). Therefore, nitrate and phosphate results are used in this report because these results are available sooner. Nitrate and phosphate results are generally available two months after the sampling date, and total nitrogen and phosphorus 5-10 months thereafter. Error and imprecision are part of all laboratory analysis; a result is never simply a number but a number plus or minus some error. Total nitrogen and total phosphorus are analyzed to determine the concentrations of organic nitrogen and organic phosphorus in a sample. The inorganic concentration is simply subtracted from the total – phosphate from total phosphorus, inorganic nitrogen (nitrate + ammonium) from total nitrogen – what remains is the organic fraction. Sometimes the analysis error or the precision of the result is such that the inorganic concentration is higher than the total concentration, e.g., a larger number has to be sub tracted from a smaller. For example, the total phosphorus concentration may end up being lower than the phosphate in a sample. Obviously, this kind of result cannot be true; it represents either imprecision or error. It happens about 4% of the time with nitrogen (an acceptable rate, particularly when concentrations are high), but 50% of the time with phosphorus. The phosphorus results present a real problem, one that the UCSB laboratory has not been able to solve. Something in our local stream water removes phosphorus from solution during the test procedure, and since the total phosphorus results are undependable, phosphate is used instead. This is not an important distinction. Phosphate makes up a large majority of total phosphorus in Goleta samples, and nitrate is the dominant nitrogen fraction at most locations. Analysis of filtered vs. un filtered samples to determine nutrient composition is another difference without a distinction. Tests on filtered and unfiltered samples at most of the Goleta Stream Team sites show no statistical difference be tween these two types of samples. Except for those rare rainy days, Goleta creek water is relatively sedi ment free (Figures 24 and 25). Summarized results of the overall nutrient analysis (through September 2004) are presented in Table 3, and Figure 32 shows a temporal comparison between nitrate and dissolved organic nitrogen for three sites exemplifying the range of Goleta conditions. The variation of nutrient concentrations and other constituents during storms is not part of the Channelkeeper sampling program, nor is it discussed in any detail in this report. However, it remains an important topic since the vast majority of the annual load of pollutants flushed into the neighboring ocean occurs during these events. Figure 31, showing variations in concentration during the major storm of 2004 (data from UCSB-LTER), was included to give some idea of what does happen.

13. This ratio, 16:1, is named after its discoverer, the "Redfield ratio" (Sterner and Elser, 2002).
14. The vertical nitrate and phosphate scales in Figure 33 were set in a proportion of 20:1; e.g., a concentration of 100 µM on the nitrate scale is located directly across from 5 µM on the phosphate scale, 400 opposite 20, etc. The unit is micro-moles per liter (µM – "M" is the symbol for moles per liter). Redfield ratios are pro portions between atoms. Previously, nutrient concentrations were shown as mg/L, a unit based on the weight of nitrogen or phosphorus in water. The µmole, a measure of the number of atoms, is more useful when comparing the proportions of nutrients; 1 mg/L of nitrate as nitrogen is equal to 72 µM, 1 mg/L of phosphate as phosphorus equals 31 µM.
15. In this figure, the vertical nitrate and phosphate scales are similarily set in proportions of 20:1, 3,000 µM of nitrate opposite 150 µM of phosphate, etc.
16. A possible exception may be greatly increased export during El Niño years when the upwelling and circula tory processes that normally provide a large supply of nitrogen to the Channel are greatly diminished in warmer ocean waters.
17. The following documents were used as references in the preparation of the bacteria section: US-EPA, 2002 and 2004; SWRCB, 2003 and 2004; RWQCB-LA, 2001. There are significant differences between EPA guidelines for indicator bacteria and current California State regulations, as well as variations among the dif ferent Regional Water Quality Control Boards and counties within the state. The regulatory situation is in the process of changing as some of these differences are resolved, and the following narrative should be considered a reasonable overview only.

18. To calculate the geomean, bacteria counts are converted into logarithms, averaged, and then the average log value is converted back into a regular number; the geomean reduces the influence of very high or low numbers which might unfairly represent aberrant samples. For freshwater recreational use, total coli form must not exceed 10,000 MPN per 100 ml in a single sample, and the average must not exceed 1,000. For E. coli, the "average" limit is 126 bacteria/100 ml of water, and the single sample limit varies from 235-500 depending on intensity of use (235 for beach areas, 500 for occasional recreational use). For enterococcus, the limit for the average of five or more samples is 33 MPN/100 ml, and the single sample limit can vary from 61-151, again depending on frequency of water use. The total coliform av erage and single sample limits of 1,000 and 10,000, respectively, are only valid as long as the fecal/total coliform ratio is less than 0.1 (in other words, if less than 10% of the coliforms are of fecal origin). If the ratio rises above 0.1, the single sample limit is lowered to 1,000. Although Channelkeeper does not actually test for fecal coliform, the E. coli values have been multiplied by 1.7 to estimate fecal coli form concentrations. This assumes that a sample tested for fecal coliform would have approximately 60% E. coli; this equivalency is the value assumed by most regulatory standards and is a conservative estimate; see also Cude, 2005.
19. It was found that river-bank soil was the principal source of dry weather E. coli in a Florida stream, and that E. coli exhibited a competitive advantage over predators as soils dried (Solo-Gabriele et al., 2000).
20. However, UCSB-LTER sampled nutrient concentrations and recorded flows in 2004 and 2005, so this data should be available soon.
21. 8.3 is the Central Coast Regional Water Quality Control Board's upper limit for water contact recre ation.