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July 24, 2009

Ken Landau, P.E., Assistant Executive Officer
Central Valley Regional Water Quality Control Board
11020 Sun Center Drive Suite 200
Rancho Cordova, CA 95670

RE: Donner Summit Public Utility District Biostimulatory Substances Study

Dear Mr. Landau,

On behalf of the Donner Summit Public Utilities District (DSPUD), ECO:LOGIC Engineering is submitting this work plan and time schedule for completing a Biostimulatory Substances Study as required by Order No. R5-2009-0034, Provision VI.C.2.d. Per this provision, DSPUD is to:

> *"conduct a study of the discharge and receiving water to evaluate the impact of the discharge on aquatic growths. The Study shall identify if the Facility discharge is causing or contributing to the algal growths as observed in Spring 2008."*

For DSPUD to stay on schedule with the overall compliance requirements of the Order, DSPUD needs to make important facilities design decisions in early 2010 prior to, or possibly concurrent with, the 2010 South Yuba River (SYR) potential biostimulation season (May/June 2010). Accordingly, DSPUD needed to start the biostimulation study in spring 2009, prior to development and approval of the work plan, in order to stay on schedule with the Order's compliance requirements. The work plan and schedule described, herein, include a discussion of work completed to date, and the schedule for additional work to be completed in May/June 2010. Hopefully, the May/June 2010 work will confirm what has been observed in May/June 2009. If the observations in 2010 are significantly different from those in 2009, then a major change in DSPUD planning may be needed, which would delay overall DSPUD compliance by at least one year.

WORK PLAN

The study and work plan are focused on providing evidence as to whether the current DSPUD effluent discharge practice complies with Receiving Water Limitation V.A.2:

> *"The discharge shall not cause the following in the South Yuba River:*
>
> 2. ***Biostimulatory Substances.*** *Water to contain biostimulatory substances that promote aquatic growths in concentrations that cause nuisance or adversely affect beneficial uses."*

This study is a result of a citizen complaint on or about 19 June 2008 that nuisance biostimulation was occurring in the South Yuba River. The complaint included several dated images of SYR conditions. The complaint also stated that the biostimulation was "highly unusual" and "I have witnessed many seasons and situations up here, but nothing like this."

ECO:LOGIC Engineering completed a field survey of the SYR on 2 July 2008 at the request of DSPUD based on Regional Water Board staff recommendations given to DSPUD on 30 June 2008. The ECO:LOGIC report (dated July 11, 2008, and provided as Attachment A) concluded:

> *"Based on the field observations, it is a reasonable conclusion that the DSPUD effluent discharge was at least a major contributing factor to a reportedly rare, highly unusual, transient growth of filamentous green algae in the South Yuba River in June 2008. . . . The filamentous biofilm tracks fairly well to the effluent discharge point."*

> *"Based on the conditions observed on 2 July, if Regional Board staff request additional investigation into this particular algae bloom, we recommend a review of effluent quality, effluent quantity, river flow, and/or air and river temperatures to determine if anything was unusual in the Spring of 2008 compared to previous years. Any conclusion, however, would be speculative."*

> *"Reducing effluent nutrient concentrations may or may not produce the desired result of preventing a repeat of the June 2008 growths. The coming and going of the June 2008 growths do not appear to be directly related to effluent nutrients (though, of course, nutrients are needed for any growth to occur). This is because:*
>
> - *Effluent nutrients are present in the South Yuba River every spring without causing June 2008 growths.*
> - *The June 2008 growths died back with the effluent nutrients being present throughout the die-off period.*
>
> *The rareness of the June 2008 growths, their limited spatial and temporal extent, their die-off under conditions normally conducive to biostimulation, and their relative absence at the effluent discharge point (compare Images 11 and 15) all suggest that this is not a typical effluent nutrient biostimulation problem; and accordingly, it is recommended that the problem not be addressed as such."*

In these contexts, the first task in the work plan was to monitor the SYR in spring 2009 to monitor if the effluent discharge appeared to cause or contribute to nuisance aquatic growths in the SYR. This has been completed, see Attachments B, C, D, and E. The DSPUD effluent discharge to the SYR does not appear to have caused any detectable stimulation of green filamentous algae growths in the SYR in spring 2009. Those minor growths of filamentous green algae seen at and about the effluent discharge point are typical of growths also documented to occur upstream of the discharge point. The effluent in spring 2009 appeared to cause no filamentous green algae biostimulation in the effluent/river mixing zone (where effluent concentrations were relatively high) or where the effluent appeared to be completely mixed into the SYR (in the vicinity of DSPUD monitoring location R2).

Filamentous green algae growths were evident in the SYR substantially upstream and substantially downstream of the effluent discharge point in June 2009. The patchiness of the biostimulation in the

SYR, and the absence of biostimulation in the effluent concentrated conditions of the mixing zone suggest that nutrients are not the primary control, limit, and/or initiator of biostimulation in the SYR. Therefore, the second task in the work plan is to try to correlate what was different between spring 2008 (biostimulation present) and spring 2009 (biostimulation absent). The specific correlations being investigated are:

A. Spring 2008 versus spring 2009 effluent flows and nitrogen loads.

B. Spring 2008 versus spring 2009 SYR flows as a function of calendar date. This is important because it appears that river flow may be a limiting factor on when significant/nuisance biostimulation can occur. The SYR stream gage data at Cisco Grove from May/June 2008 and May/June 2009 will be compared to determine how similar SYR flows were in the critical biostimulation time periods of these two years for which some photographic record of biostimulation exists.

C. Based on Tasks A and B, estimates of effluent percentages in, and nitrogen loads on, the SYR in spring 2008 and spring 2009 will be compared to determine if there is any material difference between the two years.

D. Because of the possibility of a temperature effect relative to flow, a correlation between river flow and river temperature will be developed for spring 2008 and spring 2009 to determine the magnitude of differences between the two years. The range of water temperatures over which these growths are known to be tolerant (based on the spring 2009 observations) will be superimposed on the correlations as an indicator of the possible significance/insignificance of temperature differences between the two years.

E. Task D will be repeated for pH.

These correlations are expected to provide some quantification for what is already known qualitatively: conditions in the SYR were conducive to filamentous green algae growth in June 2009 as evidenced by significant growths upstream and downstream of the effluent discharge. Though SYR conditions in 2009 were suitable for filamentous green algae growths, the effluent discharge did not contribute to these growths in 2009 as evidenced by the absence of such growths in the SYR in the effluent mixing zone, and immediately downstream of the effluent discharge point. Growths were very evident in these locations in June 2008.

The paradox is that if under June 2009 SYR conditions known to be conducive to biostimulation above and below the effluent discharge point, the effluent discharge did not cause biostimulation even in the mixing zone, then what caused the biostimulation in Jun 2008 that tracked via the mixing zone fairly well back to the effluent discharge point? Besides biostimulation in 2008, tracking back to the gravel bar containing the effluent discharge, butterflies also congregated on this gravel bar in 2008 presumably because nutrient salts were present. Though butterflies were seen in the forest in 2009, they were not seen congregated on the effluent discharge gravel bar in 2009. The biostimulation evidence and butterfly evidence suggest that something was different in or about the effluent discharge gravel bar between June 2008 and June 2009. What that difference was may never be known, which leads to Task 3.

Task 3 of the work plan is to repeat the 2009 surveys in 2010 to try to determine if 2008 or 2009 represents a more typical condition, and to gain additional insight regarding the patchiness of biostimulation in the SYR.

Task 4 is to compile the Task 1 through Task 3 results into a final report with a recommendation regarding whether the DSPUD effluent discharge is causing or contributing to algal growths as observed in spring 2008.

SCHEDULE

Task and Description		Task Submittal Date
1.	2009 Biostimulation Survey and Results	24 July 2009
2	Correlation of 2008 River and Effluent conditions to 2009 River and Effluent Conditions	15 August 2009
3.	2009 Biostimulation Survey and Results	24 July 2010
4.	Full Report	5 August 2010

Please feel free to contact me if you have questions and/or suggestions regarding this work plan. We are proceeding as planned in order to stay on schedule with overall Order compliance requirements.

Sincerely,

ECO:LOGIC Engineering

Richard E. Stowell

Richard E. Stowell, P.E., Ph.D.

cc: Tom Skjelstad, DSPUD
Robert W. Emerick, Ph.D., P.E., ECO:LOGIC Engineering
Diana Messina, State Water Resources control Board

Attachments:
A 2 July 2008 Field Survey
B 31 May 2009 Field Survey
C 14 June 2009 Field Survey
D 21 June Field Survey
E 26 June Field Survey

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July 11, 2008

Tom Skjelstad
Donner Summit Public Utility District
P.O. Box 610
Soda Springs, CA 95728

Re: Field Survey of Biostimulation in the South Yuba River at and about the Donner Summit Public Utilities District Effluent Discharge Point

Dear Tom:

The purpose of this letter report is to discuss the findings of a 2 July 2008 ECO:LOGIC field visual survey of biostimulation in the South Yuba River upstream, downstream, and at the effluent discharge point of the Donner Summit Public Utilities District (DSPUD) wastewater treatment plant. The field survey was conducted at your request per the suggestion of Ms. Patricia Leary, California Regional Water Quality Control Board (Regional Water Board), who conducted a similar survey on 30 June 2008 on behalf of the State in response to a citizen complaint that the DSPUD effluent discharge was causing objectionable growths in the river on and about 19 June 2008 based on dated images provided with the complaint. Water quality samples were not taken as part of the ECO:LOGIC survey because Ms. Leary had taken samples two days earlier which should be representative.

Per your request, this report has been forwarded to Regional Board staff (Pat Leary (enforcement) and Gina Kathuria (permit development).

BACKGROUND

Every year for decades, DSPUD has discharged effluent to the South Yuba River in the winter/spring period. The discharge to the river is stopped each summer once the effluent irrigation area (a north-facing, gentle ski slope) is free of snow, relatively dry (i.e., drained of snowmelt), and has emergent vegetation so that sprinkler irrigation of this sloped site with effluent does not cause excessive effluent runoff or soil erosion. Year-specific snowpack and weather conditions dictate the calendar date each year when the effluent discharge changes from the river to land, but the hydrologic/hydrogeologic conditions at or about the time of the change each year are similar and include:

- Virtually all snow has melted from the watershed.
- The bulk of the snowmelt has drained from watershed soils.
- Because of the foregoing, river flows have receded to relatively low values.

By definition, by the time the north-facing effluent irrigation area is dry enough to receive effluent, the whole watershed must be relatively dry, and therefore providing relatively little drainage water to the river. Consequently, each spring/summer period as the change from river discharge to land application approaches, the effluent dilution provided by the river decreases, which increases the potential for the effluent discharge to cause growths in the river. In the context of this relationship between hydrology, hydrogeology, and when effluent is discharged to land versus the river, there should be nothing particularly unusual about river flow and effluent dilution conditions in the South Yuba River in Spring 2008 compared to previous years.

At the time of the 2 July survey, the effluent discharge to the river was occurring and had been continuous for months previously. The snowmelt season was virtually complete such that river flows were less than, and probably warmer than, the river conditions present on 19 June that were associated with the citizen complaint.

THE COMPLAINT

The citizen complaint included images (see Images 1 and 2) dated 19 June 2008 of filamentous green algae in the South Yuba River downstream of the DSPUD effluent discharge point. The exact location of Images 1 and 2 are not known but their location is assumed to be as illustrated in Figure 1. The algae appear to be *Cladophera*, a common filamentous green algae in both river (lotic) and lake (lentic) systems. *Cladophera* have not been reported as representing a human health concern, but can adversely affect the aesthetic enjoyment of a water body like the South Yuba River. The flowing water environment associated with lotic systems is particularly conducive to the growth of *Cladophera* because flowing water keeps plants continually exposed to a fresh supply of nutrients. It is reported (Sze, 1986[1]) that

> "… nutrients are most often derived from runoff from the surrounding land and may rarely, if ever, become limiting in lotic (flowing) environments".

As of 19 June, the effluent discharge to the river had been continuous for months. From the images, 19 June river flows appear to be substantial compared to the flows observed during our survey on 2 July. Under 19 June conditions at the site shown in Image 1, actively growing filamentous green algae cover much of the river bottom in what appears to be about 1 to 3 feet of flowing water. In shallower and/or more quiescent water on 19 June, algae appear to be under stress with some death and decay being evident (Images 1 [foreground] and 2). The death and decay shown in Images 1 and 2 are relevant to the conditions observed on 2 July, as will be discussed.

An important note in the complaint is that the growth conditions in Images 1 and 2 are reported by the complainant to be "highly unusual" and "I have witnessed many seasons and situations up

[1] Sze, Philip (1986), **A Biology of the Algae**, Wm. C. Brown Publishers, Dubuque, Iowa.

here, but nothing like this." This observation is corroborated by Paul Schott, a long-time employee of DSPUD, who states that in his 20+ years of observing the effluent discharge to the river each spring, the June 2008 algae blooms are the worst he recalls.

The apparent rareness of the June 2008 algae bloom event may have some bearing on how the State addresses this matter. As an example, the State Implementation Policy regulates aquatic toxicity based on 1Q10 (lowest daily flow that occurs over a ten year period) and 7Q10 river flows (lowest daily flow sustained for a week over a ten year period). Regulation of one-in-ten year biostimulation may be a reasonable extension of established State policy to an area where no policy exists to our knowledge.

FIELD SURVEY OBSERVATIONS

The survey began at Lake Van Norden, roughly 2 river miles upstream of the effluent discharge point, and continued to the Kingvale Bridge (roughly 3 river miles downstream of the effluent discharge point). Locations where photographs were taken and reported herein are illustrated in Figure 1 (Appendix A). The solar exposure of the lake coupled with nutrients in lake sediments have the potential to produce conditions stimulating filamentous algae growth that could, then, impact a significant downstream reach of the South Yuba River. As shown in Images 3, 4, and 5, filamentous green algae were not evident in the lake, on the spillway, or in the river immediately downstream of the lake. Growths and films are present on the rocks as evidenced by the uniform color of the river bottom rocks (see Image 5) indicating some nutrient and/or organic enrichment of the water; but the types of growths shown in Images 1 and 2, and prompting the complaint are not present.

Small tributaries to the river in the Soda Springs area were orange as of 2 July (see Image 6), suggesting addition of nutrients and other contaminants in Spring 2008 to the South Yuba River in this reach upstream from the effluent discharge point. These tributaries would have had greater flow during the Spring of 2008 than on 2 July. The river below Soda Springs (but above the effluent discharge point) did not show evidence of either significant filamentous growths, or residuals from recent filamentous growths (see Image 7) resulting from nutrients or other contaminants flowing into the river from the Soda Springs area on or before 2 July 2008. The river bottom rocks have a uniform color indicating a biofilm is present, but not a filamentous biofilm. Conditions shown in Image 7 are typical of river conditions down to the point of effluent discharge with some reduction in bottom rock biofilms as shown in Image 8, just upstream of the effluent discharge point.

Image 9 is immediately downstream of the effluent discharge point (the image was taken looking upstream). Effluent is coming out of the gravel and entering the river in the upper right corner of Image 9. As shown in Image 9, river bottom rocks on the right side (effluent side) of the river have more biological film (i.e., more uniform color) than bottom rocks on the left side of the river (which is still virtually free of effluent at this point). Image 10 is a view looking straight at where the effluent enters the river. Upstream is to the left in Image 10. In Image 10, it is evident that a biological film has spread across the river bottom rocks from left to right, denoting the immediate mixing zone of this effluent discharge into the river. Image 11 is a view looking straight down at the leading edge of where the effluent (at the very top of the image) enters the river, which is flowing from left to right, in the image. Again, the spreading of a biofilm on the river bottom rocks being influenced by the effluent discharge into the river is evident.

It is significant to note that at the point of effluent discharge where maximum effluent concentrations occur, the growths are not similar to those shown in Image 1, or those shown downstream of the effluent discharge (e.g., see Images 12, 13, and 14). It is also significant to note in Image 11 that filamentous biofilms are most evident in the deeper water at the edge of the effluent discharge mixing zone (see the lower right-hand corner of Image 11), not in the area dominated by the effluent plume.

Image 12 is further downstream of the effluent discharge point. The river is flowing from right to left in the image, and the effluent side of the river is in the foreground. As shown in Image 12, a biofilm is on the bottom rocks on the side of the river containing effluent. This biofilm is more filamentous than at the point of effluent discharge (compare Images 11 and 12). This more filamentous biofilm probably represents a decaying state of the vibrant green filamentous green algae shown in Image 1. This more filamentous biofilm spreads from the effluent side of the river to completely across the river by monitoring station R2 (see Images 13 and 14). This filamentous decaying biofilm was still evident, though to a lesser extent, roughly 1 river mile downstream of the effluent discharge point at the Towle Mountain Estates Bridge, see Image 15. At the Kingvale Bridge (roughly 3 river miles downstream of the effluent discharge point), no filamentous biofilms were observed (see Image 16). At the Kingvale Bridge, river bottom rock conditions were more like those shown in Images 4, 5, 7, and 8 upstream of the effluent discharge point. Conditions similar to those observed at Kingvale were also observed at the subsequent downstream locations of Hampshire Rocks, Rainbow Lodge, Big Bend, Cisco Grove, and Eagle Lakes Road. No extensive filamentous biofilms similar to those in the R2 area were evident at any of these locations.

In summary, at the effluent discharge point, a biofilm on river rocks began, and spread across the river. This biofilm initially was thin, not filamentous. It transformed into a decaying filamentous biofilm present uniformly across the river by monitoring station R2. As of 2 July 2008, the vibrant green growths shown in the 19 June 2008 images (see Image 1) did not exist. It is presumed that the decaying filamentous biofilms seen on 2 July 2008 (see Images 12 through 15) are a residual from the vibrant green growths shown in the 19 June 2008 images. The stressed and decaying filamentous growths seen in the more exposed, shallow and quiescent areas of the river on 19 June 2008 (see Image 1 [foreground] and 2) are similar to, but less decayed than, the filamentous biofilms seen throughout the river at and around monitoring station R2 on 2 July

2008. The lower river flows of 2 July 2008 may have made the entire river rather exposed, shallow, and quiescent at and around R2. This change in river physical habitat conditions may have caused or contributed to the die-off of the 19 June 2008 algae bloom. Other factors, such as water temperature, may also have been involved.

CONCLUSIONS

Based on the field observations, it is a reasonable conclusion that the DSPUD effluent discharge was at least a major contributing factor to a reportedly rare, highly unusual, transient growth of filamentous green algae in the South Yuba River in June 2008 in the reach from the DSPUD effluent discharge point, downstream through the Towle Mountain Estates area, but not as far downstream as Kingvale. The filamentous biofilm tracks fairly well to the effluent discharge point.

As of 2 July 2008, the vibrant green filamentous algae of 19 June 2008 appeared to be in a general state of decay for reasons unknown. Effluent discharge to the river had been continuous throughout Spring 2008, up through 3 July 2008. Therefore, the absence of effluent from the river was not the cause of the die-off and the die-off occurred while any nutrients that might be present in the discharge were still present.

River flows had decreased during June suggesting that the river had become more effluent dominated. Water temperatures in the river had also likely increased between 19 June and 2 July. In general, all of these factors (increase in water temperature, greater solar exposure, presence of nutrients, and shallower water depths throughout the river) should increase rather than decrease general effluent biostimulation potential. In this case, these factors (or other factors unknown) appear to have instead caused the growths to die back.

Reduced water velocity, reduced water depth (i.e., increased solar exposure), a change in pH, and/or increased water temperature from 19 June to 2 July may have been unsuitable for the particular species of algae shown in Image 1. Water temperature (and possibly pH) may be a significant factor as suggested by the absence of filamentous biofilms at the effluent discharge point where biostimulation potential is greatest. Something about how the effluent was diluted by river water appears to have allowed the observed filamentous green algae to grow, whereas they did not grow on undiluted (or minimally diluted) effluent, or river water free of effluent. Based on 3-tier chronic bioassay results, DSPUD reports that the effluent is free of toxicity that could hinder formation of growths in undiluted effluent. This leaves habitat factors such as increasing water temperature, changed pH, shallow water depths, and/or reduced water velocities as the cause of the dieback of the June 2008 algae bloom. For example, the climatic conditions of Spring 2008 may have caused the river water to be warmer than usual as a function of river flow. This rare and transient combination of natural factors could allow algae in the river to rapidly take advantage of effluent nutrients that were available resulting in a rare and transient algae bloom.

It is also possible that the cause of the rare and temporary algae bloom of June 2008 was due to surface runoff from snowmelt this season that added some limiting nutrient (or micro-nutrient) that is not typically present in the river system (including the effluent discharge). The presence of the limiting nutrient, when combined with the effluent, prompted the growths observed. Once snowmelt (with the limiting nutrient) was no longer causing surface runoff into the river, the effluent, alone, could no longer sustain the growths. Any limiting nutrient could have been from the more urbanized Soda Springs area and/or from disturbances of the soil adjacent to the river in the monitoring station R2 area. It is not possible at this time to identify the presence of a limiting nutrient that may have been present during the snowmelt surface runoff conditions.

The actual cause(s) of the spatially and temporally limited, filamentous green algae bloom of June 2008 may never be known. When considering causes, it must be recognized that this effluent is present in this river every spring under generally similar conditions without causing growths comparable to the June 2008 event according to eye witnesses.

RECOMMENDATIONS

DSPUD's current Waste Discharge Requirements (Order No. R5-2002-0088) require that the discharge shall not cause in the South Yuba River "fungi, slimes, or other objectionable growths". The discharge was ceased on 3 July 2008 so no further study is possible at this time. Because die-off of the algae occurred prior to cessation of the discharge, it is likely that the exact cause of the algae bloom cannot be determined.

Based on the conditions observed on 2 July, if Regional Board staff request additional investigation into this particular algae bloom, we recommend a review of effluent quality, effluent quantity, river flow, and/or air and river temperatures to determine if anything was unusual in the Spring of 2008 compared to previous years. Any conclusion, however, would be speculative.

We do recommend a revision in the monitoring of the facility. Downstream locations from R2 should be visually monitored for growths and/or the presence of filamentous green algae beginning in about May and continuing until cessation of the discharge. Should growths become evident, consideration should be made to cease the discharge and initiate irrigation of the ski slope if at all possible. If cessation of the discharge is not possible, detailed visual record keeping of time and location and additional monitoring of nutrient and temperature conditions within the identified plume and outside the identified plume (Images 9 – 12) would aid in modifying facility design and/or diffuser design to prevent further occurrences.

Reducing effluent nutrient concentrations may or may not produce the desired result of preventing a repeat of the June 2008 growths. The coming and going of the June 2008 growths do not appear to be directly related to effluent nutrients (though, of course, nutrients are needed for any growth to occur). This is because:

- Effluent nutrients are present in the South Yuba River every spring without causing June 2008 growths.
- The June 2008 growths died back with the effluent nutrients being present throughout the die-off period.

The rareness of the June 2008 growths, their limited spatial and temporal extent, their die-off under conditions normally conducive to biostimulation, and their relative absence at the effluent discharge point (compare Images 11 and 15) all suggest that this is not a typical effluent nutrient biostimulation problem; and accordingly, it is recommended that the problem not be addressed as such. If you have any questions about this report, please feel free to call.

Sincerely,

ECO:LOGIC ENGINEERING

Richard E. Stowell, P.E., Ph.D.

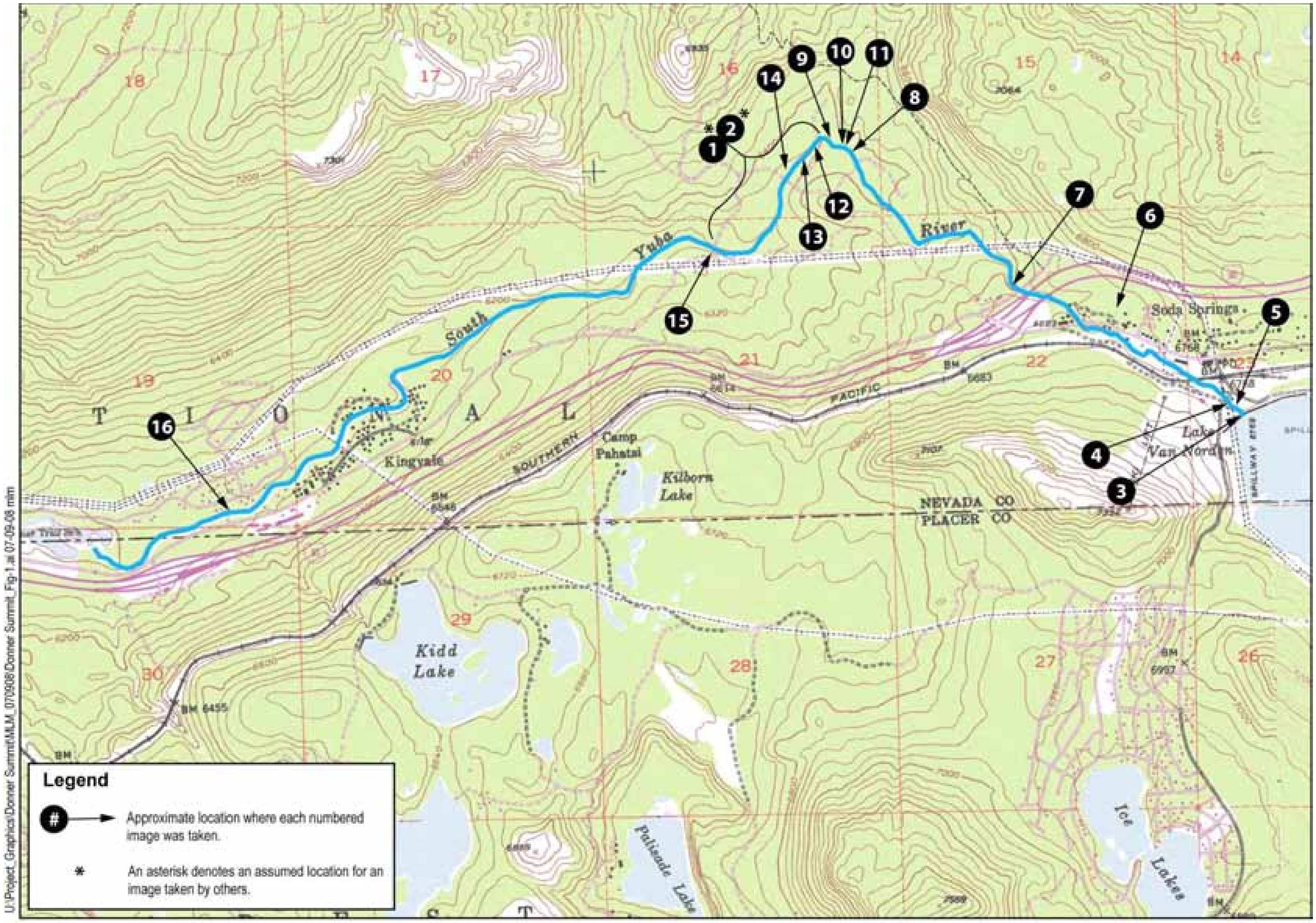
Attachment A: Photographs

cc: Robert W. Emerick, P.E., Ph. D, ECO:LOGIC Engineering
Patricia Leary, Regional Water Quality Control Board, Central Valley Region
Gina Kathuria, Regional Water Quality Control Board, Central Valley Region

DONN07-003-3b

Attachment A

Images



U:\Project_Graphics\Donner Summit\MLM_070908\Donner Summit_Fig-1.ai 07-09-08 mlm

Figure 1
Location of Images from the South Yuba River

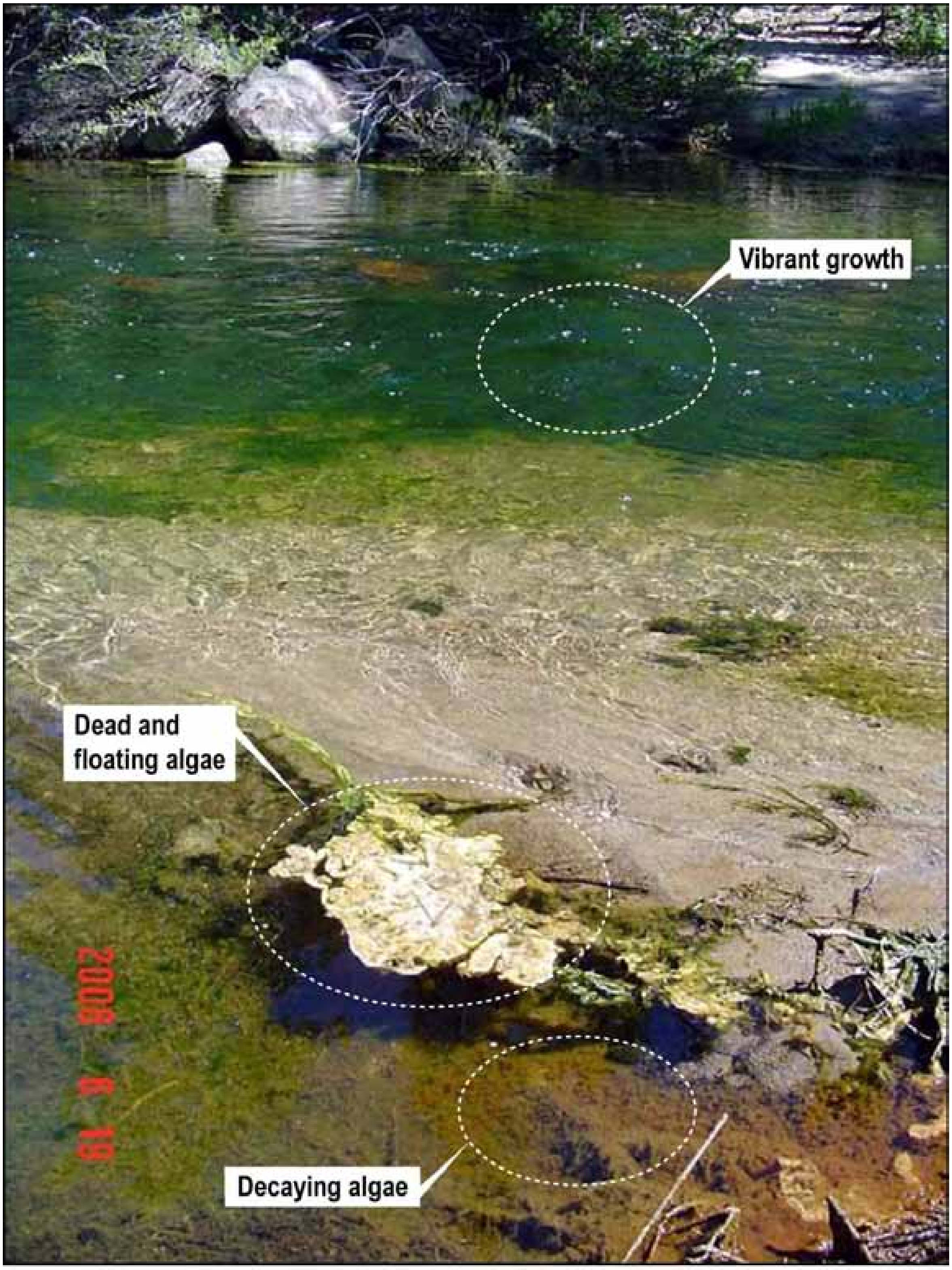


Image 1
Complaint

Image 2
Complaint

Image 3
Discharge from Lake Van Norden, Upstream of Discharge

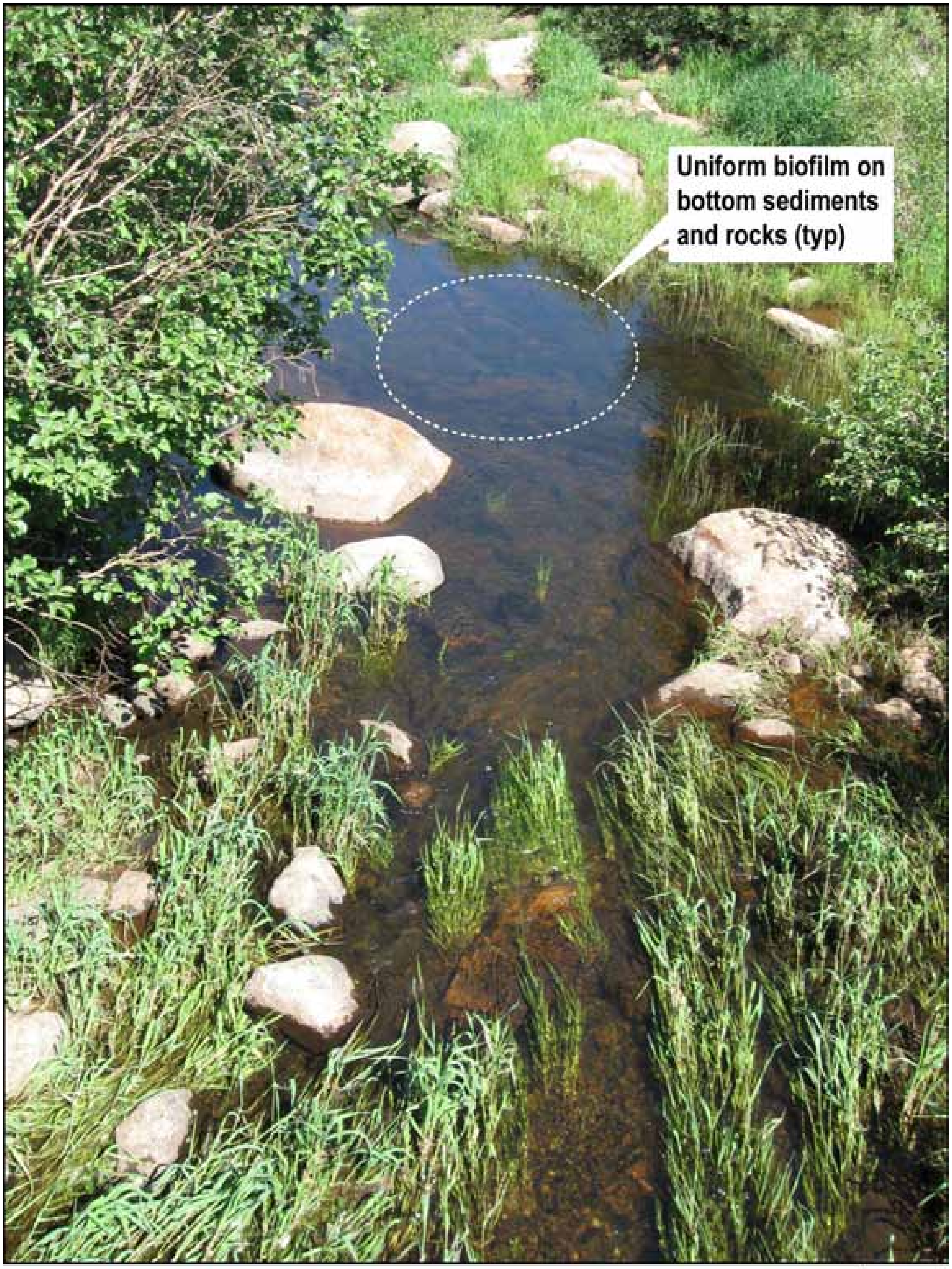


Image 4
Upstream of Discharge

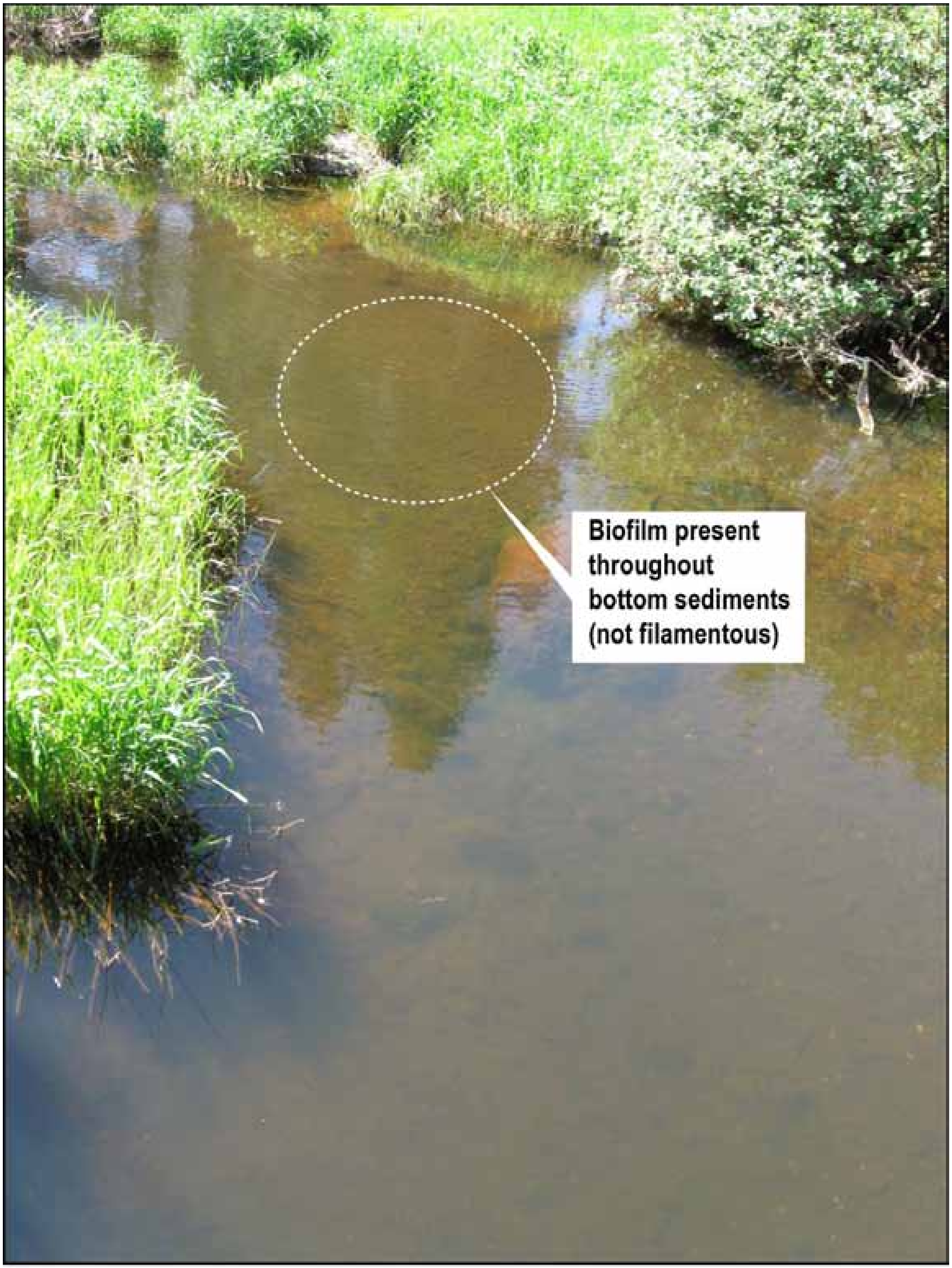


Image 5
Upstream of Discharge

Image 6
Upstream of Discharge
Storm Drainage Course from Residential Areas

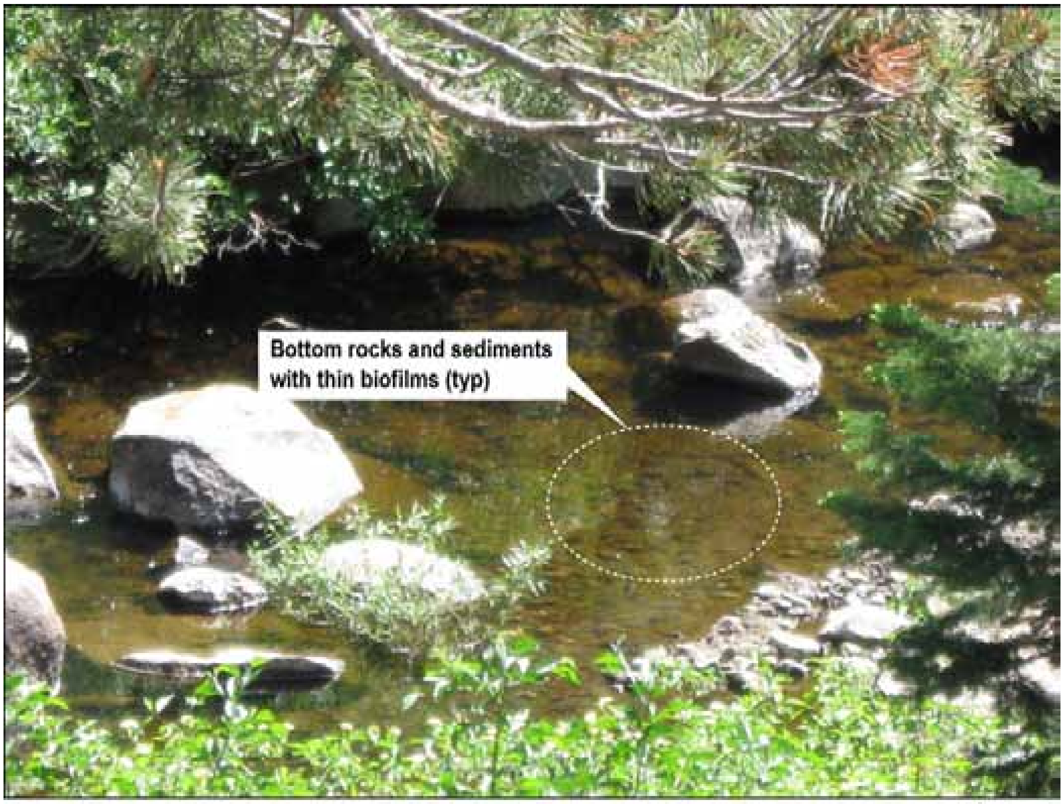


Image 7
Immediately Upstream of Discharge

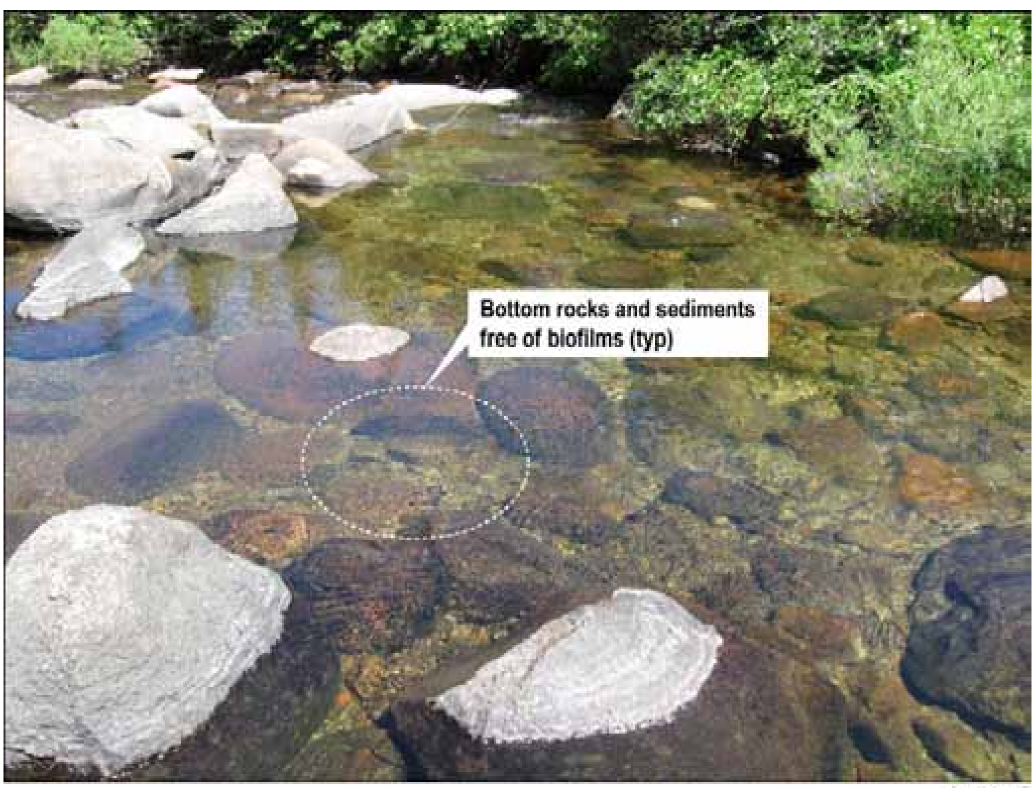


Image 8
Immediately Upstream of Discharge

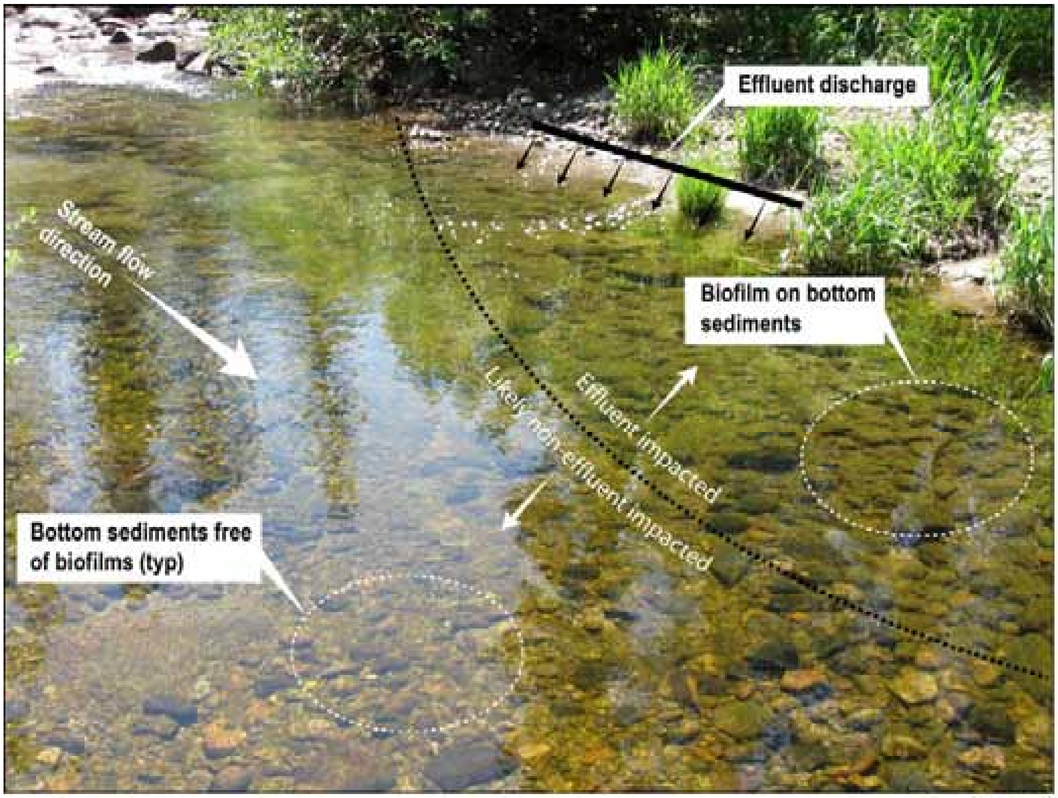


Image 9
Discharge Location

Image 10
Discharge Location

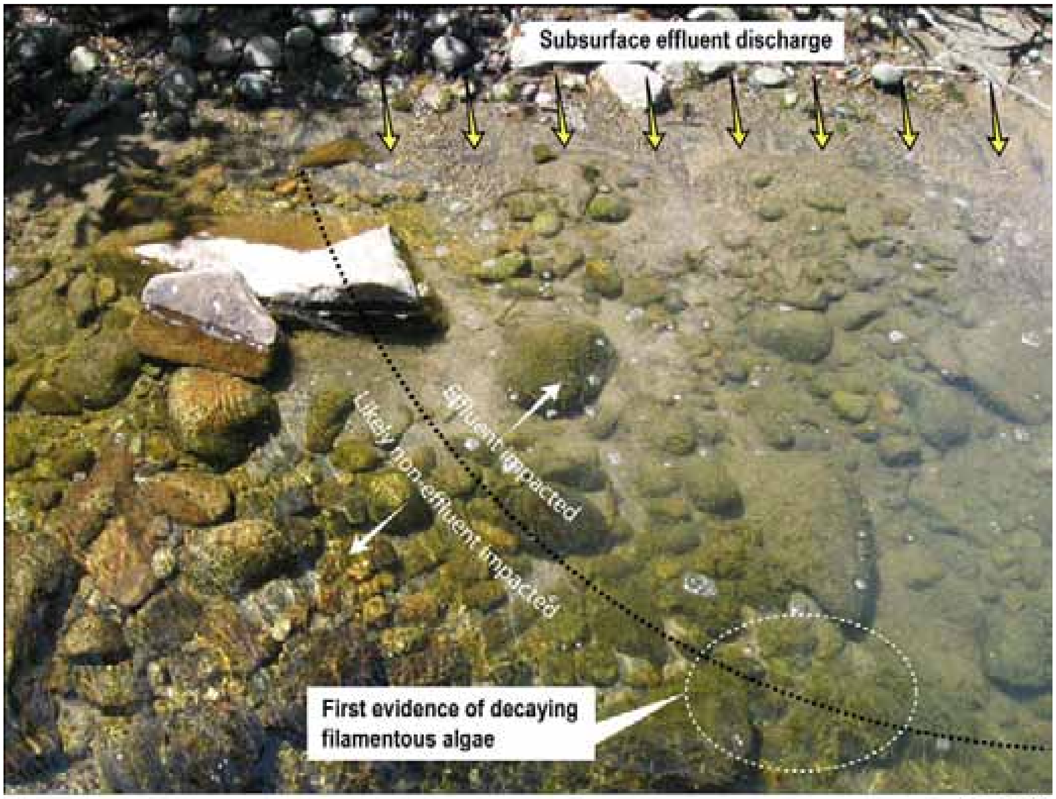


Image 11
Discharge Location

Image 12
Immediately Downstream of Discharge Location

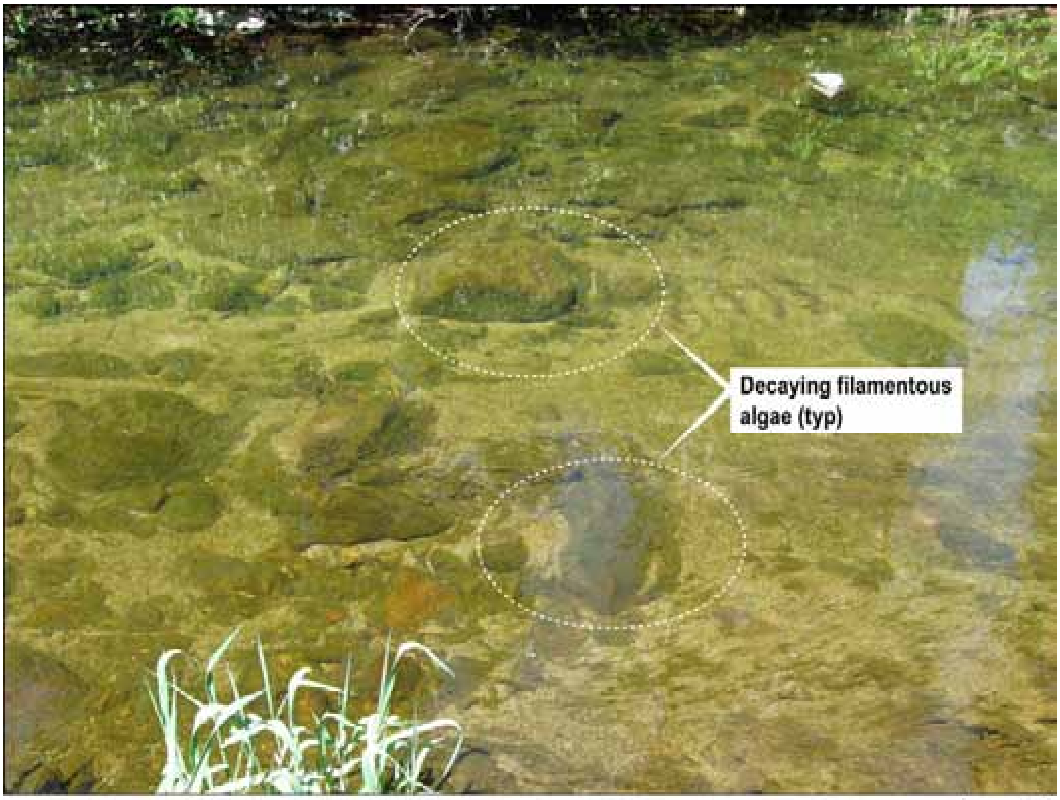


Image 13
Downstream of Discharge - Complete Mix

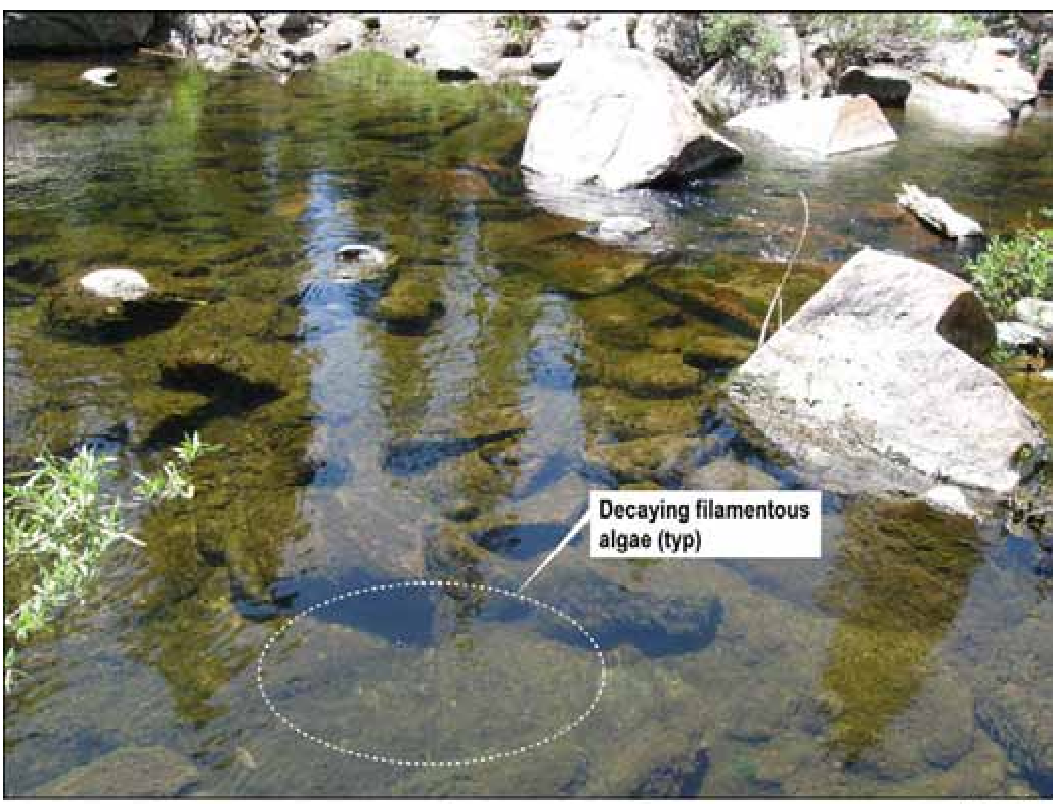


Image 14
Downstream of Discharge - Complete Mix

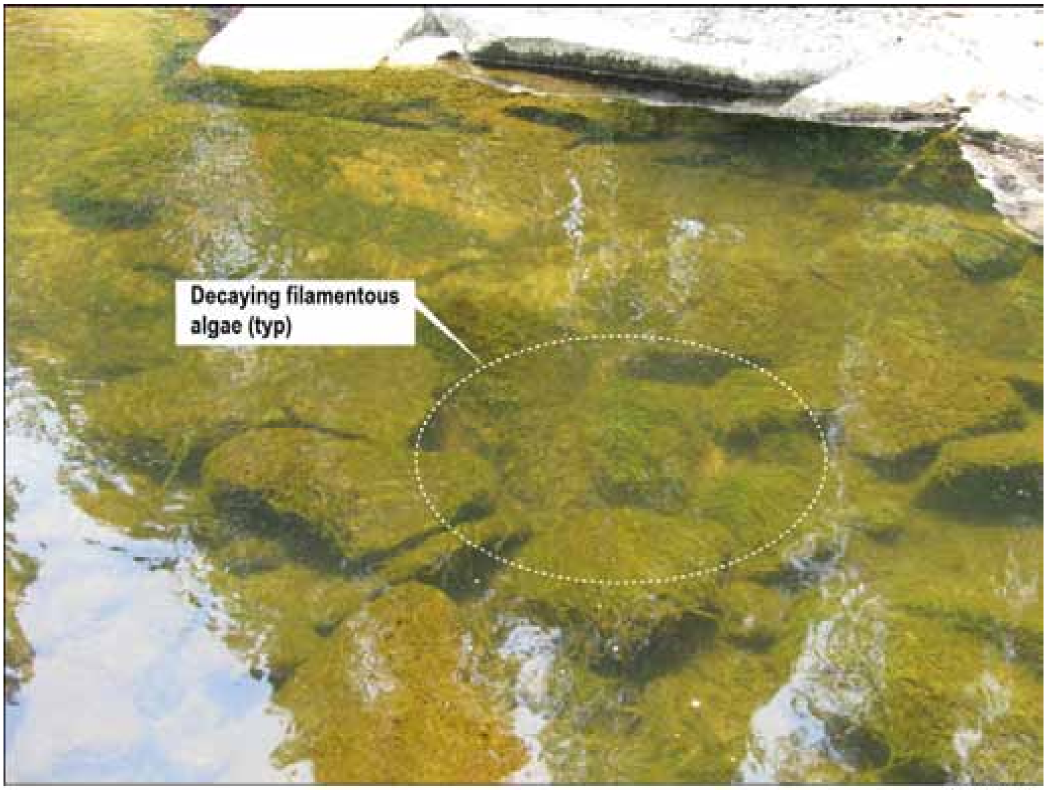


Image 15
Downstream of Discharge - Complete Mix

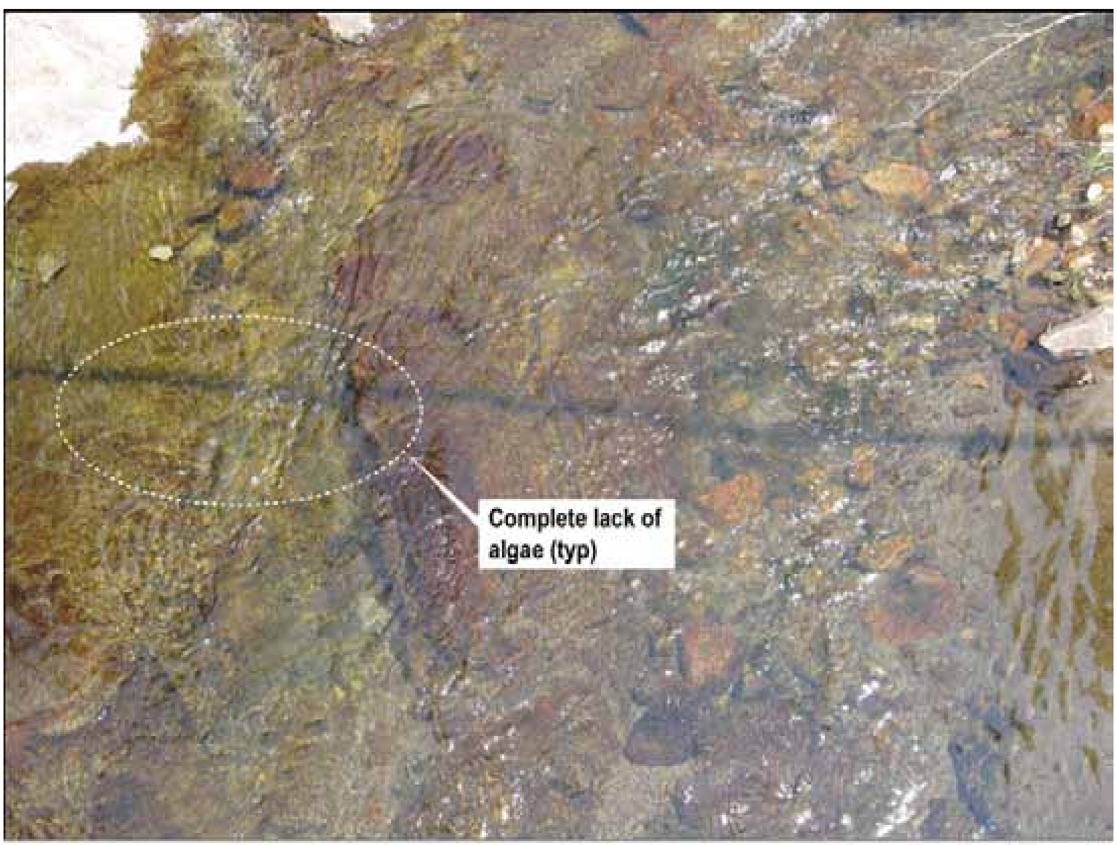


Image 16
Downstream of Discharge - Complete Mix

Donner Summit Public Utility District
2009 Photo Essay Report No. 3

South Yuba River Field Survey 31 May 2009

Prepared By: Rich Stowell, Ph.D., P.E.

Reviewed By: Robert Emerick, Ph.D., P.E.

Date: 31 May 2009

INTRODUCTION

This report present the results of a visual field survey of biostimulation within the South Yuba River (SYR). The field survey was conducted on 31 May, 2009. This survey was conducted based on Donner Summit Public Utility District (DSPUD) staff reports on 26 May 2009 that green filamentous algae were observed in the SYR just below Lake Van Norden (Area A of Figure ES-1, Section 1) roughly 2 miles upstream of the effluent discharge (Area D of Figure ES-1, Section 1). The images taken as part of this survey are numbered as a continuation of the 16 images taken as part of the 2 July 2008 survey (Section 2 of this report). Accordingly, the first image taken on 31 May 2009 is Image 17. Specifically, it is Image 17 (A), with the "(A)" denoting that the image was taken at Area A, as shown and discussed on Figure ES-1 of Section 1 of this report.

RESULTS

Images 17 (A), 18 (A), 19 (A), and 20 (A) were taken just downstream of Lake Van Norden. Submerged macrophytes are abundant, here. The water has a green cast, presumably from suspended algae growing in Lake Van Norden. Filamentous algae were not evident in the river, on the dam spillway, or on the in-lake face of the dam at the spillway.

Image 17 (A)

Image 18 (A)

Image 19 (A)

Image 20 (A)

Images 21, 22, and 23 are below Soda Springs just downstream of the I-80 crossing. In this deeper water, the green color of the river water is more evident. Filamentous algae were not evident.

Image 21 (B)

Image 22 (B)

Image 23 (B)

Images 24 and 25 are just above the effluent discharge point. No filamentous algae are evident.

Image 24 (C)

Image 25 (C)

Image 26 is the gravel bar where effluent enters the SYR. Effluent is entering the SYR roughly in the area shown I the center of the image. No filamentous growths are evident. The submerged macrophytes in the upper center of Image 26 correspond to the exposed macrophytes on the effluent discharge gravel bar shown in Images 9 and 10 (Section 2). Small lavender butterflies were observed in the woods, but there were no large butterflies, or a concentration of small butterflies on the dry-moist areas of gravel in this area suggesting that the effluent was entering the river exactly at this point. Effluent probably is entering at this point; however, there was no confirmation from the butterflies at this early date. Growths were first evident in this location at lower flows in June/July 2008.

Image 26 (D)

Image 27 is just downstream of the effluent discharge gravel bar, at the bend in the river which is the head end of the first pool downstream of the effluent discharge point. With higher SYR flows, it was thought that effluent may enter the river from the gravel bar at this more downstream location (i.e., the effluent flows in the gravels parallel to the SYR for awhile before entering into the river proper at this bend). In any event, at this location the effluent is thought to be in the river and at highest concentrations in the immediate foreground of Image 27 based on river hydraulics. Some macrophytes are evident at mid-photo. No filamentous algae growths were evident in this location at this time. Filamentous algae growths were evident here in June/July 2008.

Image 27 (D 50% E)

Images 28 and 29 are further downstream in the first pool on the "effluent side" of the river. No filamentous algae growths are evident at this time. Growths were evident in this location in June/July 2008. Some macrophytes are present.

Image 28 (E)

Image 29 (E)

Images 30 through 35 are from the vicinity of R2 where the filamentous growths were very heavy in June/July 2008. As shown in the images, as of 31 May 2009, no filamentous algae growths are evident.

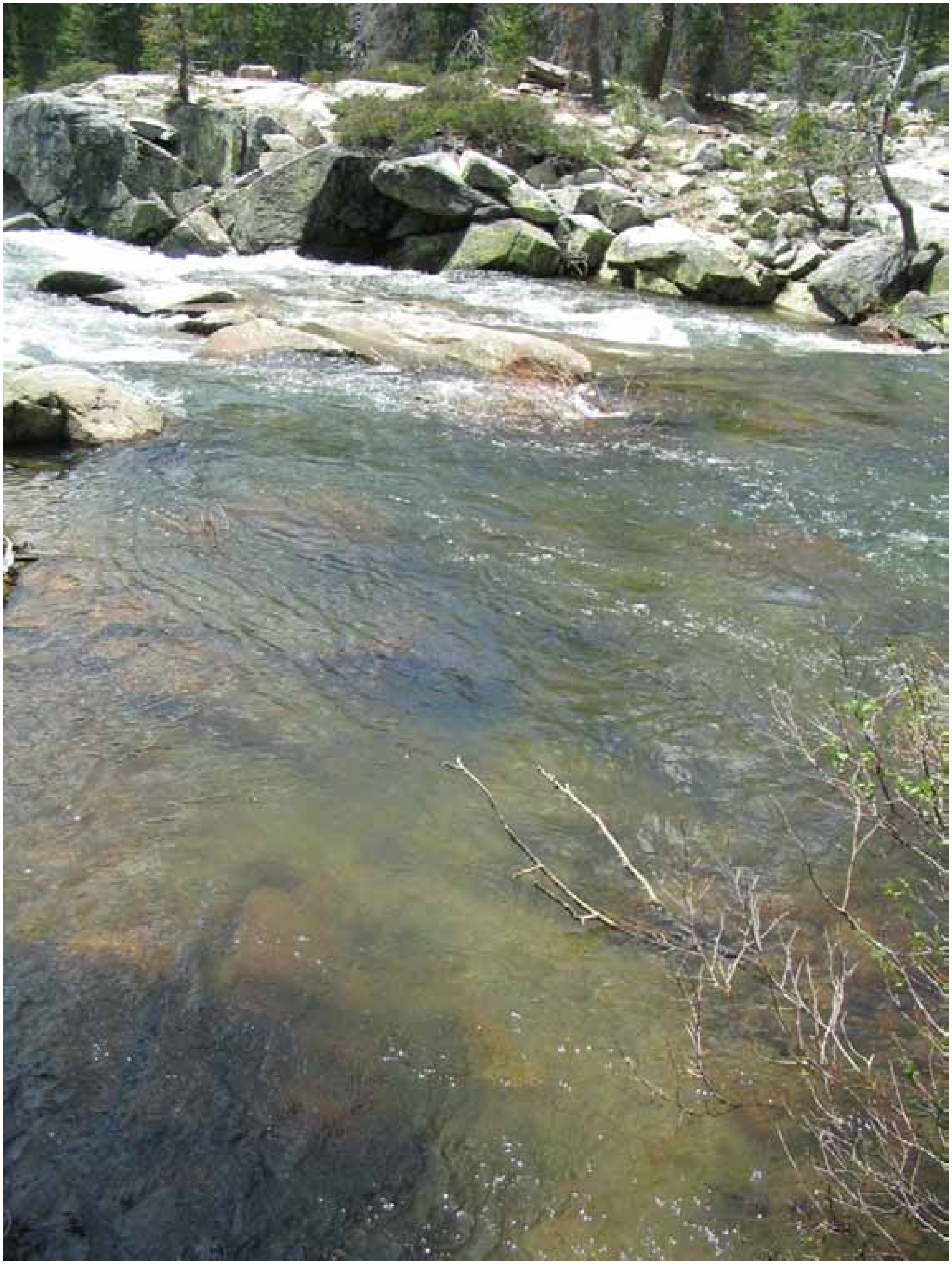


Image 30 (F)

Image 31 (F)

Image 32 (F)

Image 33 (F)

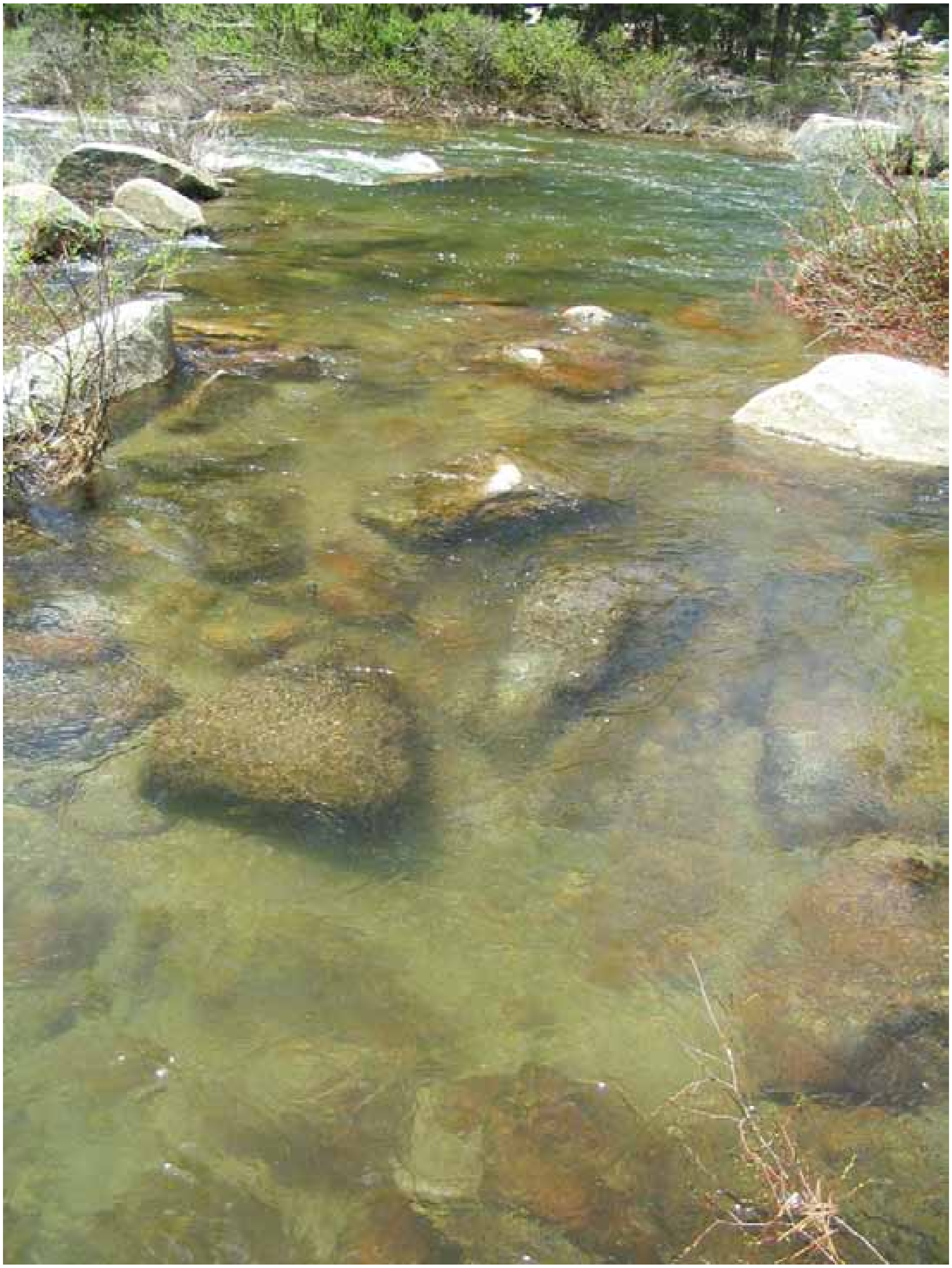


Image 34 (F)

Image 35 (F)

Images 36 and 37 are the SYR at the Kingvale bridge. Again, no filamentous algae growths were evident, here, or at more downstream location on 31 May 2009: Hampshire Rocks, Rainbow Lodge, or Cisco Grove.

Image 36 (H)

Image 37 (H)

SUMMARY

The District has images of tufts of filamentous algae in the SYR on 26 May 2009 just below Lake Van Norden. These growths were not evident as of 31 May 2009. The 31 May river survey involved several hours bracketing solar noon to get maximum light penetration into the river. There was a at the complete absence of biostimulation-type films and growths at the effluent discharge point. The submerged macrophytes are indicators of where river banks and shallows will occur later in spring/summer. The exact locations of the filamentous algae growths seen in Spring 2008 are out beyond these macrophytes, i.e., in the deeper locations of the river not visible on this date because of the greenish color of the water, presumably caused by suspended algae growing in Lake Van Norden with nutrients available there.

Filamentous algae growths may occur in the SYR in later spring as SYR flows recede. Hypotheses (which are not mutually exclusive) explaining the lack of evident filamentous algae growths as of 31 May 2009 are:

1. River flows are too high, i.e., light penetration, scour, and/or drag are limiting filamentous algae growth (or visibility of growths occurring in deep water).
2. River nutrient concentrations are too low to stimulate filamentous algae growth, e.g., as a result of effluent dilution and/or reduced effluent nutrient concentrations.
3. Conditions in Spring 2008 were in some way unique so as to trigger the nuisance biostimulation observed at that time.
4. The streambed areas visible as of 31 May are normally dry, and therefore, are relatively unsuitable for colonization by filamentous algae. Growths may occur in roughly the same locations as Spring 2008 to the extent permitted by Spring 2009 conditions: flow, temperature, nutrient, etc. The following analyses are recommended:
   A. A comparison of Cisco Grove SYR flows in Spring 2008 and Spring 2009. If 2009 flows are higher than 2008 flows, filamentous algae growths may occur later in 2009 than in 2008. (Comment: this recommendation was accepted by DSPUD and the results are presented in Section 8.)
   B. A comparison of effluent nitrogen emissions to the SYR in Spring 2008 and Spring 2009. (Comment: this recommendation was accepted by DSPUD and the results are presented in Section 7.)

As of 31 May 2009, there was nothing in the SYR to study, other than conditions not causing nuisance filamentous algae biostimulation.

Donner Summit Public Utility District
2009 Photo Essay Report No. 4

South Yuba River Field Survey June 14 2009

Prepared By: Rich Stowell, Ph.D., P.E.

Reviewed By: Robert Emerick, Ph.D., P.E.

Date: June 14, 2009

INTRODUCTION

This report present the results of a visual field survey of biostimulation within the South Yuba River (SYR). The field survey was conducted on 14 June, 2009 as a follow-up to the 31 May 2009 survey during which no filamentous algae growths were evident. The images in this section are numbered as a continuation of the images presented in the previous surveys. Again, the capital letter following the image number denotes the location the image was taken as shown in Section 1, Figure ES-1.

All images taken in this survey focus on documenting "worst case" algae biostimulation found at each location.

RESULTS

This date, cloud cover at Donner Summit was extensive (≥ 80% coverage) which made photographs without glare very difficult except for those moments with sunshine.

Images 38 and 39 are just downstream of Lake Van Norden. The water has a very light greenish color, presumably from phytoplankton growing in the very shallow lake. Bottom rocks have films retaining silt and other small debris. Macrophytes are present Filamentous algae are absent.

Image 38 (A)

Image 39 (A)

Image 40 shows small rivulets (barely visible in the roads) flowing off the Soda Springs slopes. These will need to dry before effluent irrigation begins.

Image 40

Images 41 and 42 show relatively minor populations of filamentous algae on rocks in the river just downstream of the I-80 crossing box culvert (upstream of the discharge). Rocks in the bottom of the pool are tan with silt. Image 41 shows growths that appeared to be limited to about the upper 6 inches of water depth on some shoreline rocks.

Image 41 (B)

Image 42 is the end of the pool showing relatively clean rocks (all have a slightly greenish-tan color) with some filamentous algae being evident on the upstream faces of some boulders. These growths are at depths greater than 6 inches, suggesting possibly a different algae species, though of similar appearance, from those on shallow, shoreline rocks (Image 41)..

Image 42 (B)

Image 43 is just upstream of the effluent discharge point. The rocks are very clean as shown in the image. No growths of any sort are evident in the river, or on the rocks.

Image 43 (C)

Image 44 is looking upstream at the gravel bar from which the effluent emerges into the river. The exposed macrophytes in Image 44 are the same as those submerged in Image 26; thus, showing the extent to which SYR stage has receded since 31 May 2009.

Image 44 (D)

Image 45 is a close-up showing the small sandbars (with black iron deposits) where the effluent enters the river (and pushes sand from the gravel bar that was deposited, there, by the river under higher river stage conditions). The effluent does not appear to cause any biostimulation at the immediate effluent discharge point under good solar exposure conditions where effluent concentrations and biostimulation potential, in theory, would be greatest. If biostimulation were to occur, it would be expected in the less sandy, deeper water just beyond the macrophytes shown in Image 45.

Image 45 (D)

Image 46 is immediately downstream of the effluent discharge area. The effluent is still concentrated on the right side of Image 46, and is flowing in and amongst the macrophytes. No filamentous algae growths are evident. In the "mixing zone" shown in Image 46 there are stable rocks present (the orangish objects in the water) which could support filamentous algae growth.

Image 46 (d 50% E)

Image 47 is the effluent side of the river in the first pool just downstream of the river bend. Last year dead residues of filamentous algae were very evident on the rocks just beyond the clumps of emerging vegetation. This vegetation was on the river bank at the time of last year's survey 2 July 2008; and, by this time the algae had grown and were in an advanced state of decay. As evident in the image, sands and other fines tend to be deposited on the inside, downstream bank of this river bend, as is typical.

Image 47 (E)

Image 48 is just downstream of Image 47 on the effluent side of the river. Again the river bottom is completely free of any evidence of filamentous algae growths.

Image 48 (E)

Image 49 is the back end of the first pool below the effluent discharge point. Decaying filamentous algae growths were very evident last year at this location. No growths are present. The deposition of sands and silts is evident in the tan area in the foreground.

Image 49 (E 50% F)

Image 50 is the pool just downstream of the large rock with the dinette set (the R2 area). This is where filamentous algae residues were worst in July 2008. As shown, the rocks are very clean as of 14 June 2009.

Image 50 (F)

One small area of brown filamentous algae was seen in this area (see Image 51).

Image 51 (F)

Image 52 shows a small area of shallow water green filamentous algae at R2. These growths are comparable to those in Image 41.

Image 52 (F)

At Kingvale bridge, no growths are evident, see Image 53. At this location last year a few tufts of filamentous algae were evident in the deepest flowing water.

Image 53 (H)

Image 54 is from the Highway 40 bridge west of Kingvale. As shown, silt deposition is evident on rocks; filamentous growths are not evident. The greenish color is from the water, its depth, and green reflection from riparian vegetation.

Image 54 (J)

Image 55 is from the old concrete bridge located between Highway 40 and I-80. There is minor silt deposition, and no filamentous growths. Solar exposure, stream, and substrate conditions are favorable for filamentous algae at this location. Color from reflection is very evident (white clouds, blue sky, and green vegetation).

Image 55 (K)

Image 56 is upstream of Hampshire Rocks Campground in the big pool adjacent to the frontage road. Here filamentous green algae are evident on many boulders in deep water. This is the first area where filamentous algae growths would be noticed by a causal observer in my opinion.

Image 56 (L)

Images 57, 58, and 59 are at Rainbow Lodge bridge. As shown in Image 57, some rocks had silt.

Image 57 (M)

Some rocks had relatively minor amounts of filamentous green algae (Image 58 shows the greatest growths seen at this location).

Image 58 (M)

Image 59 is the riffle downstream from the bridge. With some scour velocity, the rocks are relatively clean and no filamentous algae are evident.

Image 59 (M)

Image 60 is at the Big Bend bridge. Some silt on the rocks is evident giving them a tan tint. Filamentous algae are not present.

Image 60 (N)

Images 61 and 62 are just downstream of the I-80 crossing between Cisco Grove and Rainbow Lodge. The solar exposure, substrate, stream conditions, and canyon-like conditions (i.e., canyon glare) make this site ideal for attached algae. As shown, filamentous algae were present in the river.

Image 61 (O)

Image 62 (O)

Image 63 is from the Cisco Grove bridge. As shown, filamentous growths are not evident at this location.

Image 63 (P)

SUMMARY

SYR flow conditions as of 14 June 2009 appeared to be low enough and clear enough to be conducive to filamentous algae growth. Visually, 14 June 2009 SYR flow conditions appear to be comparable to those shown in the 19 June 2008 complaint images (Images ES-1 and ES-2, Section 1). However, as of 14 June 2009 the only observed significant (i.e., readily noticed) in-river filamentous algae biostimulation was in the big pool upstream of Hampshire Rocks Campground, and in the rapids just downstream of the I-80 crossing of the SYR between Cisco Grove and Rainbow Lodge bridge. These sites and growths are several miles downstream from the effluent discharge point. The effluent discharge point and immediately downstream waters were free of significant in-river biostimulation. It would appear that if DSPUD is to be held accountable for these distant downstream growths in any way, then the procedure is by listing the South Yuba River as being impaired by biostimulatory substances under Section 303(d) of the Clean Water Act. This procedure requires all land users on the watershed to be a party to the solution.

The effluent discharge to the river may stop in 1 to 2 weeks without causing any significant biostimulation at or about the effluent discharge point. This leaves DSPUD with evidence of conditions that do not cause nuisance biostimulation, but provides no information as to what causes nuisance biostimulation in the vicinity of the effluent discharge, such as occurred in June 2008.

I suggest that we get a profile of nitrate and orthophosphate concentrations in the river 1) upstream of the discharge, 2) within the effluent mixing zone (i.e., gradients), and 3) at several locations downstream to determine if there is a nutrient increase downstream correlated to the areas of filamentous algae growth. If there is no increase, it would appear that factors other than nitrate or orthophosphate are the causal agents. With time being of the essence, sampling should occur this week if possible. (Comment: this recommendation was accepted by DSPUD, and the results are presented in Section 7).

We may wish to approach the Regional Water Board regarding the possibility of continuing the discharge to the river after land disposal if possible so as to try to find conditions causing filamentous growths at or about the effluent discharge point. We would need this direction in writing because it otherwise would be a violation of the Order. (Comment: this concept was rejected on legal grounds that Regional Water Board staff are not empowered to amend or waive requirements of adopted Orders).

Donner Summit Public Utility District
2009 Photo Essay Report No. 6

South Yuba River Field Survey 26 June 2009

Prepared By: Tiffany Knapp, P.E.
Rich Stowell, Ph.D., P.E.

Reviewed By: Robert Emerick, Ph.D., P.E.

Date: June 26, 2009

INTRODUCTION

This report presents the results of a visual field survey of biostimulation within the South Yuba River (SYR) as of 26 June 2009. This was a follow-up survey to the 21 June 2009 survey in which it was noted that filamentous green algae were present in limited amounts at most river locations, and that these growths had the potential to grow rapidly. Additionally, Donner Summit Public Utility District (DSPUD) effluent discharges to the SYR were scheduled to end (and did end) on this date; thus, the maximum extent of any filamentous algae biostimulation caused by the DSPUD effluent discharge to the SYR would be evident on this date based on the algal growth trends noted during the 14 June and 21 June surveys.

As with the previous survey reports, the 26 June images are numbered as a continuation from the previous surveys, and each image has a letter code denoting where the image was taken based on the location map provided in Section 1, Figure ES-1. All images taken in this survey focus on documenting "worst case" algae biostimulation found at each location.

RESULTS

River flow on this date was less than in previous 2009 field surveys based on shallower water depths in the river.

Filamentous green algae were evident on the Lake Van Norden spillway crest and face as shown in Images 99 and 100. Filamentous algae were also evident in the river at this location in various states of vitality and decay, see Images 101 and 102.

Image 99 (A)

Image 100 (A)

Image 101 (A)

Image 102 (A)

At the I-80 crossing of the SYR downstream of Soda Springs, the rocks were covered with brown fuzzy films, see Image 103. Green filamentous algae were evident at the air/water interface of some rocks, see Images 104 and 105. These are the shallow water green filamentous algae noted in previous surveys.

Image 103 (B)

Image 104 (B)

Image 105 (B)

Immediately upstream of the effluent discharge point, the river rocks are generally clean (see Images 106 and 107), with relatively minor amounts of filamentous green algae being present on some rocks, such as shown on the rocks in the lower right-hand corner of Image 107. Image 108 is a close-up of these rocks showing the nature and extent of these growths in greater detail.

Image 106 (C)

Image 107 (C)

Image 108 (C)

Image 109 shows the effluent discharge point in the SYR. Image 110 is a close-up of one of the sandbars denoting where effluent is leaving the gravel bar and entering the river. As shown, at the immediate effluent discharge point there are no filamentous algae or other signs of biostimulation.

Image 109 (D)

Image 110 (D)

Image 111 shows the SYR immediately downstream of the effluent discharge point. The effluent is still concentrated in the river water in the foreground of the image. As shown in Image 111, there are no filamentous growths, and the rocks are of diverse colors denoting the absence of any films on the rocks in both the foreground (effluent present in these waters) and the background (effluent absent from these waters).

Image 111 (D)

Image 112 shows the first pool downstream of the effluent discharge pint. The rocks are free of algae, films, or any other signs of biostimulation.

Image 112 (E)

At DSPUD SYR monitoring station R2 (aka, Dinette Set Rock), the black-brown growths were very evident as a result of the reduced flows, see Image 113. Where exposed by decreasing river flows, these growths died to form grayish-white residuals (center of Image 114) on the tannish boulders. When dried by the sun, these residuals turn into the white crush shown in the lower right-hand corner of Image 114. With Image 114 as a guide, in Image 113 some dried crust can be seen on the rock in the center foreground. Grayish residues are also present.

Image 113 (E)

Image 114 (E)

The pools at R2 were generally free of films and filamentous algae as shown in Image 115. Small amounts of filamentous green algae were visible on rocks in these pools.

Image 115 (E)

At the Kingvale bridge, some filamentous green algae were visible on the downstream side of the bridge (see Image 116). However, the SYR at this location was generally free of filamentous green algae as shown by Image 117.

Image 116 (H)

Image 117 (H)

At the Plavada I-80 interchange, SYR conditions were free of films and growths (see Image 118), except for one small area of filamentous green algae shown in the foreground of Image 119.

Image 118 (I)

Image 119 (I)

At the US 40 bridge downstream of Cold Springs Campground, the rocks were generally clear of films and filamentous growths as shown in Images 120 and 121. Small tufts of green algae could be seen on the edges of some rocks (e.g., see lower right-hand corner of Image 120). One bloom of filamentous green algae was observed (see the center of Image 121), which is shown in close-up in Image 122.

Image 120 (J)

Image 121 (J)

Image 122 (J)

From the small private concrete bridge between US 40 and I-80, brown films and some green growths were evident in the upstream still water (see Image 123). Some more filamentous green algae were evident in the more rushing downstream waters (see Image 124).

Image 123 (K)

Image 124 (K)

Above Hampshire Rocks Campground, long filamentous algae continued to be vital and evident as shown in Images 125, 126, and 127.

Image 125 (L)

Image 126 (L)

Image 127 (L)

At Rainbow Lodge bridge pool, brown films and relatively sparse growths of filamentous green algae were evident as shown in Image 128. The depth of the water at this location allowed the overall greenish color of the water to be more evident as shown by Images 129 and 130. In flowing, shallower water just downstream of the Rainbow Lodge bridge pool the SYR is relatively clear and clean with green filamentous algae being present on the edges of some rocks (see the base of the large emergent rock in the upper center of Image 131, shown close-up in Image 132).

Image 128 (M)

Image 129 (M)

Image 130 (M)

Image 131 (M)

Image 132 (M)

At Big Bend bridge, general coatings of filamentous green algae were evident on many rocks as shown in Image 133.

Image 133 (N)

In the gorge between Rainbow Lodge and Cisco Grove, green filamentous algae growths continued to be vital and evident as shown in Image 134.

Image 134 (O)

At the Cisco Grove bridge, brown films covered many of the rocks, and tufts of filamentous algae were present as shown in Images 135 and 136. these tufts tended to be in areas of deeper flowing water, and on the edges of rocks, possibly suggesting a sensitivity of over exposure to sunlight.

Image 135 (P)

Image 136 (P)

SUMMARY

As of the 26 June 2009 survey, conditions were similar to those observed during the 21 June 2009 survey except that more growths, in general, had occurred, and that some growths were dying back from exposure to sunlight resulting from the receding hydrograph. As examples, filamentous green algae growths on and immediately downstream of the Lake Van Norden dam increased substantially from 21 June to 26 June.

An example of the occurrence of new growth was observed at the Plavada interchange on 26 June (see Image 119). This growth was completely absent as of 21 June (see Image 85, the 26 June growth shown in Image 119 occurred in the rocks 21 mm above the (I) image locator portion of the Image 85 title).

The most evident example of dieback was of the black growths in the cataract at R2.

As in all 2009 field surveys, there was no evidence that the DSPUD effluent discharge caused any noticeable filamentous green algae biostimulation in the SYR in either the immediate mixing zone where effluent concentrations (and therefore nutrient concentrations) were relatively high, or in immediately downstream waters (the R2 area).

The cause(s) of the general patchiness of biostimulation in the SYR is unknown. During spring 2009, the greatest biostimulation observed immediately below Lake Van Norden (2 miles upstream of the effluent discharge), above Hampshire Rocks Campground (roughly 7 miles downstream of the effluent discharge), and in the gorge between Rainbow Lodge and Cisco Grove (roughly 9 miles downstream of the effluent discharge). Many SYR reaches between these locations were monitored for growths. Several of these locations appeared to have conditions suitable for biostimulation, and yet, few to no growths occurred. In these regards, the R2 pools (see Image ___) appear to have all of the conditions needed for filamentous algae growth: good solar exposure, flowing to still water conditions, stable bedload structure in the form of rocks and boulders, and a wide range of water depths to accommodate a wide range of filamentous growth solar exposure sensitivities. Heavy growths were in these pools in 2008; virtually no filamentous green algae growths were in these pools in 2009 under seemingly similar SYR and effluent discharge conditions.

Widespread biostimulation in a river is good evidence of a general river nutrient problem. Patchy biostimulation from reach-to-reach and even from rock-to-rock at a specific site suggest limits other than nutrients on biostimulation. What those other limits are is unknown, and how those limits vary from year-to-year in any given reach is unknown.