APPENDIX I

Report on Estimated Sediment Volumes at Liddell Spring

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March 30, 2009 Job#08023

Mr. Todd Sexauer
County Planning Department,
Government Sector.
701 Ocean St,
Santa Cruz, CA 95060

SUBJECT: Appendix I
Report on Estimated Sediment Volumes
Liddell Springs
Davenport, California

Dear Mr. Sexauer;

During our turbidity analysis for the Bonny Doon quarry expansion EIR project, we performed a background investigation regarding sediment in-filling the spring box at Liddell Spring. The purpose of this investigation was to assess, in a semi-quantitative way, the sediment loading at Liddell Spring. For the study, we looked at Santa Cruz City Water Department (SCCWD) maintenance logs for recorded instances where sediment was cleaned out of the spring box. We also visited the spring box and interviewed Mr. Chris Berry, SCCWD Water Resources Manager, regarding sediment maintenance procedures.

Maintenance Procedures

During our conversation with Mr. Berry, we were told that the spring box was periodically cleaned of sediment, and that on some occasions the spring box has been observed to overflow with sediment. A variety of methods have been used to clear the spring box. In some cases, the sediment was cleared by hand or a "trash pump" was used to pump out a sediment and water mixture. The pumped sediment was formerly allowed to flow into Liddell Creek. Newly proposed procedures call for the pumped sediment to be detained behind temporary berms so that the sediment and water can separate, with the water being permitted to flow to the creek.
The spring box can also be flushed by way of a sump valve in the spring box that can be manually opened or closed. The City has begun leaving that valve partly open, which helps prevent sediment buildup within the spring box. We did infer from our conversation with Mr. Berry that at times this method was not sufficient in removing the sediment built up in the spring box and that it had to be pumped out as well. We understand that the practice of leaving the

sump valve partly opened was started in the last several years, but we do not know the precise date that this practice began.

During the site meeting we observed two piles of sand adjacent to the spring box consisting of a few cubic yards of sand. We were told that the sand piles probably came from cleaning of the spring box, although it was not known if the sand piles were from one cleaning or multiple cleanings. It is our understanding that all sediment from cleaning the spring box has been disposed of onsite, with no sediment hauled off.

Sediment Load at Liddell Spring Estimated from Maintenance Records

We reviewed SCCWD maintenance logs for Liddell Spring. During our review of these documents, we compiled all the documented instances of sediment being cleaned from the spring box, either by flushing through the sump valve or by manually removing sediment from the spring box. In some cases, the spring box was observed overflowing with sediment. At other times, the spring box appears to have been only partially full. We compiled the clean-out data in table format (Table 1) and graphed historical cleaning events by year (Figure 1). The number of clean-outs per year ranged from zero to five and averaged about two. We did not find any increasing or decreasing trend in the clean-out data.

We also noted the number of times the spring box was recorded as being full. About 27% of the clean-outs were associated with a notation that the spring box was full of sediment. The spring box generally had more records of being flushed or cleaned during wet years.

We have estimated the annual clastic sediment flux for Liddell Spring using the volume of the sediment box, estimated at 30 to 35 cubic yards from schematic drawings of the box provided by the City of Santa Cruz. We have assumed that the box is completely full of sediment 25% of the time and two-thirds full the rest of the time. Using a volume of 35 cubic yards, the average volume of sediment per flush is estimated to be about 27 yards. Average annual clastic sediment flux is therefore estimated to be about 54 cubic yards. Using an average density of 110 pounds per cubic foot for mixed-grain, moderately dense sand, this number is equivalent to about 73 metric tons per year. There is no evidence for stockpiling of this volume of sediment onsite.

For comparison, Best and Griggs (1991) provide annual bed load estimates for the adjacent watersheds of San Vicente and Laguna creeks, equivalent to 234 and 299 metric tons per year, respectively. Normalized for drainage area, the annual bed load fluxes for each watershed are 8 metric tons per square kilometer (km^2) for San Vicente Creek and 14.4 metric tons per km^2 for Laguna Creek. PELA (2005) estimated a tributary area for Liddell Spring of about three square miles, or about 7.8 km^2. This area includes:1) the area of Laguna Creek above the sinking reach at Ice Cream Grade, 2) the area of Reggiardo Creek above the sinking reach, 3) the area of the Whitesell Creek above the sinking reach, and 4) the area of the quarry drainage. Using these figures, we calculate expected bed loads of 62.4 and 112.3 metric tons per year for the Liddell Spring drainage.

There are a number of qualifications to consider when viewing these numbers. The sedimentary characteristics of a karst spring are not directly comparable to those of surface streams. Bed load in a surface stream includes pebbles and cobbles, while the bed load fraction at Liddell Spring is almost entirely sand or granule size. The bed loads for different drainages are a function several variables, such as slope, exposed rock types, and rainfall distribution, which vary from basin to basin. In addition, a portion of the Laguna Creek drainage is included within the drainage for Liddell Spring. The drainage basin for Liddell Spring is also an "open basin", in that some of the flow in the tributary areas continues downstream, by-passing the sinkholes that recharge the spring, and not all of the downstream flow issues from Liddell Spring. Nevertheless, as a first-order approximation, these numbers indicate that the coarse fraction of the sediment load at Liddell Spring is within the range expected for other drainages in the area.

Balance Hydrologics (2007; 2008) performed a suspended sediment load study for Liddell Spring discharge. They developed a rating curve for suspended sediment vs. turbidity and calculated annual suspended sediment loads of 17 and 28 tons for water years 2005 and 2006, respectively, corresponding to loading rates of 2.2 to 3.6 tons per km^2. The corresponding average loading rates for San Vicente and Laguna Creeks are 106 and 62 tons per km^2 (Best and Griggs, 1991), one to two orders of magnitude greater.

These comparisons indicate that the Liddell springflow that by passes the City's diversion is of much higher quality than typical surface streamflow, even with the quarry in operation. The City's spring box appears to act as an effective sediment trap. Provided that the City follows its proposed guidelines for maintenance of the spring box, downstream impacts of the quarry due to sedimentation at Liddell Spring are not considered to be significant.

Please call me if you have any questions or require additional information.

Sincerely,

Jeffrey M. Nolan, CEG #2247
Principal Geologist

Aaron Powers, MS.
Staff Geologist

Attachments: Table 1
Figure 1

References

Best, T.C., and Griggs, G.B., 1991, A sediment budget for the Santa Cruz Littoral Cell, California. In Osbourne, R.H., ed., SEPM Society for Sedimentary Geology, Special Publication 46, pp. 35-50.

Chartrand, S., Hastings, B., Hecht, B., 2007, Annual Hydrologic record for Liddell Spring #1 Santa Cruz County, California: Data Report for Water Year 2006. Consulting report prepared for City of Santa Cruz Water Department by Balance Hydrologics, Berkeley California, 25 p.

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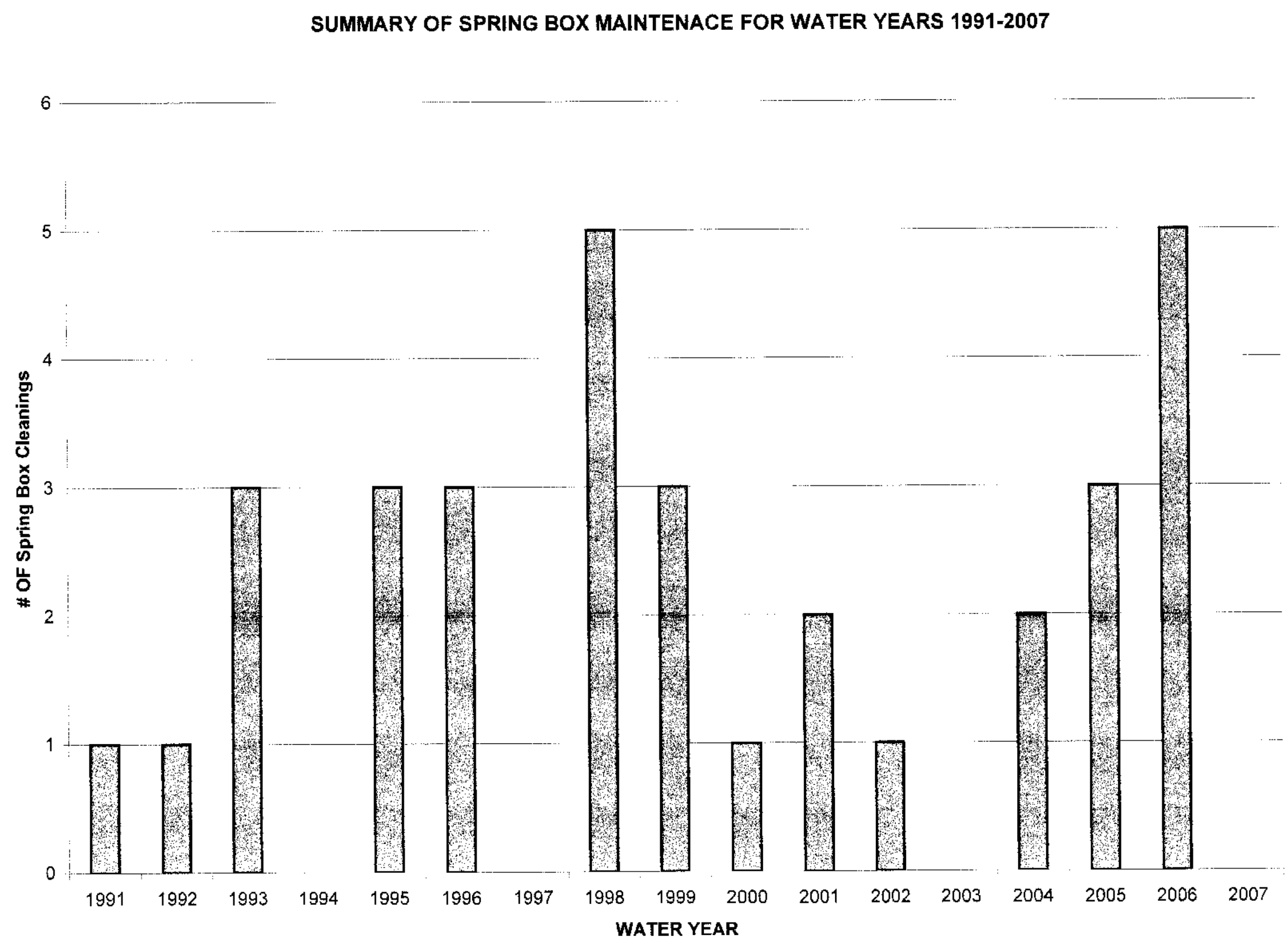

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Figure 1. Summary of Spring Box Maintenace
Liddell Springs
CEMEX Limestone quarry
Davenport, California

SUMMARY OF SPRING BOX MAINTENACE FOR WATER YEARS 1991-2008

SUMMARY SPRING BOX MAINTENANCE				
Water Year	Total Spring box overflows	Total Spring box flushes	Total Manual Cleanings of Spring Box	Total flushes and Manual cleanings
1991	2	1	0	1
1992	0	1	0	1
1993	2	3	0	3
1994	0	0	0	0
1995	1	3	0	3
1996	0	2	1	3
1997	0	0	0	0
1998	1	4	1	5
1999	0	2	1	3
2000	0	1	0	1
2001	1	1	1	2
2002	1	0	1	1
2003	0	0	0	0
2004	0	1	1	2
2005	0	1	2	3
2006	0	2	3	5
2007	1	0	0	0

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Table 1. Summary of Spring Box Maintenace
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