

SUMMARY REPORT
PIT RIVER WATER QUALITY STUDY
2001-2002



**CA Regional Water Quality Control Board,
Central Valley Region**

**North Cal-Neva
Resource Conservation and Development**

I. INTRODUCTION AND BACKGROUND

The Upper Pit River watershed encompasses roughly 4,300 square miles. The watershed boundary occurs primarily in Modoc county, with decreasing amount of acreage in Lassen, Siskiyou, and Shasta County. Roughly one-half of the acreage base is privately owned, where timber, livestock grazing and agricultural production are the major land use practices. During 2001 and 2002, a water quality monitoring investigation was conducted on the upper Pit River in the reach from its headwaters downstream to McArthur. The Pit River is currently listed as impaired (Section 303d of the federal Clean Water Act) within this reach for several water quality constituents, i.e. temperature, dissolved oxygen, and nutrients. The purpose of this investigation was as follows:

- assess existing water quality in the Pit River and provide a basis for comparison with past and future studies
- evaluate to what extent existing water quality may be limiting aquatic resources and other beneficial water uses
- evaluate the appropriateness of the 303(d) listing
- provide input to the ongoing watershed assessment for the Pit River and protection/restoration efforts underway by the individual Resource Conservation Districts and the Pit River Alliance

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II. STUDY METHODS

Sample Locations

Eight sample locations were established on the Pit River within the study reach (Figure 1 and Figure 2). Where possible, sample sites were located on public road crossings to facilitate access and sampling under high flow events.

Sample Parameters

Table 1 shows the constituents sampled and the sampling frequency for the Pit River monitoring program:

Table 1 – 01/02 Pit River Monitoring Program Scope

<u>Parameter</u>	<u>Frequency</u>
Flow	Continuous @ USGS gauging stations (Canby and Fall River Mills) Periodic measurements at several sample locations
Temperature	Continuous (Apr-Oct)
Nutrients (nitrate, ammonia, total phosphorus)	Weekly (Apr-Sept) Monthly (Oct-Mar)
Total/Fecal Bacteria and/or E-coli Coliform	Weekly (Apr-Sept) Monthly (Oct-Mar)
Sediment	
• Turbidity	Weekly (Apr-Sept)
• Suspended Solids	Monthly (Oct-Mar)
Chemical	
• Dissolved Oxygen	Weekly (Apr-Sept)
• pH	Monthly (Oct-Mar)
• Conductivity	
Metals	July 2001 (2 Sites)
Standard Minerals	July 2001 (2 Sites)
Macro-invertebrates	Fall 2001 and Spring 2002
Fish Survey (USF&WS)	Oct 2002

III. OTHER PIT RIVER WATER QUALITY STUDIES

In discussing the findings of this study, reference is made to other past and ongoing Pit River water quality investigations. These are as follows:

- a. Upper Pit River Investigation (DWR, Bulletin No. 86, Nov. 1960) – 1956-57 water quality data from a DWR feasibility study for Allen Camp and Round Valley Reservoirs (near Lookout).
- b. Pit River Water Quality Investigation (Central Valley Regional Water Quality Control Board, 1962) – This study included sampling in September 1962 of selected water quality parameters from the North and South Forks of the Pit River downstream to Shasta Lake.
- c. Pit River Water Quality Study (Dept. of Water Resources, Dec 1982) – Field sampling of chemical, physical and biological (macroinvertebrate) constituents from North Fork and South Forks of the Pit River downstream to Lake Britton. Study duration was summer, 1977 to 1980.
- d. Muck Valley Hydroelectric Project – Ongoing sampling of Pit River temperature, dissolved oxygen, pH and turbidity at the project diversion dam in Muck Valley from 1993 through 2001.
- e. DWR Pit River Water Quality Monitoring – Quarterly sampling of Pit River water quality at three stations (NF @ Alturas, SF @ Likely, and Pit River @ Canby) from 1996 to the present (this work is ongoing).

IV. DISCUSSION OF STUDY RESULTS

1. Flow

The data shows that during the 2001/2002 monitoring study, flows in the Pit River were substantially below the recorded historic average (as measured at the Canby and Pittville stations). Low flows in the River are partly explained by lack of precipitation in the watershed during the study period. Total precipitation measured at the USFS station in Adin over the course of the two water years (i.e. Oct 2000 through September 2002) was 19.3 inches which is 61 % of normal (relative to the historic average). However, water flow as measured at the Canby gauge for this time period was only 26 % of the historic average, and flow at Pittville was 31 % of the historic average. Therefore, it appears that the low flow in the Pit River during the study period (relative to the historic average) is not explained entirely by a direct relationship between precipitation and volume of surface water flow.

Regardless of the factors which contributed to the reduced River flow, low water levels would have an impact on many of the water quality constituents measured in this monitoring program. For this reason, 2001 and 2002 could be viewed as a 'worst case scenario' with regards to water quality in the Pit River. Conversely, watershed erosion, sediment discharge, deposition and transport levels would be expected to be lower than average due to the extended dry conditions during the study period. Future water quality monitoring during higher than normal precipitation and River flow conditions would be useful in better understanding overall water quality conditions in the Pit River.

2. Temperature

Temperature data is summarized in Table 2.

River temperature patterns were relatively consistent throughout the study reach, i.e. there was no significant increase or decrease in water temperature as one goes from the upstream stations to the downstream stations. Station 2 (SF Pit @ Likely) had the coldest water, i.e. maximum summer temperatures were less at Station 2 than the other River stations. In mid-summer, Station 2 also showed the least amount of daily temperature change, presumably a result of West Valley Reservoir releases just upstream of this station (this effect is less apparent in 2002 when Station 2 was moved approximately one mile downstream).

EPA National Water Quality Criteria for temperature provides useful information in trying to evaluate temperature influences on important aquatic species in the Pit River. Water quality criteria for temperature is summarized as follows:

EPA WATER QUALITY CRITERIA FOR TEMPERATURE

	<u>MWAT</u> ¹		Short Term ² <u>MAX</u>	
	<u>Adults</u>	<u>Embryos</u>	<u>Adults</u>	<u>Embryos</u>
Trout	66	48	75	55
Bass	84	70	95	81

¹MWAT for growth and spawning success

²Short term maximum for survival

In consideration of the temperature criteria above, and recorded temperatures in the Pit River, it can be surmised that, except at Station 2, River temperatures would not be supportive of cold water species (i.e. trout). If Pit River rainbow trout occupied the River's mainstem, spawning, egg incubation, and embryo emergence would be expected to occur in the period March to May. Both chronic (MWAT) and short term maximum temperatures appear excessive for embryo success. Mainstem temperatures also appear excessive for adult trout, both from the standpoint of chronic (MWAT) values and short term maximum (as represented by the 4 day average maximum). Maximum temperature levels may be within tolerance limits for warm water species (i.e. bass), however, more information on the life history patterns and requirements would be needed to make this assessment.

RWQCB Basin Plan objectives for temperature state that 'there shall be no temperature increase that adversely affects beneficial uses'. It would seem that the Basin Plan objective for temperature is not met as temperatures are not protective of cold water species (a listed Beneficial Use for this reach of the Pit River). However, two important issues bear on this determination:

- (1) There is question as to whether natural climatology and hydrology allow for the sustained presence of cold water species in this reach of the Pit River. Historical information on fish species presence in the Pit would help answer this question.
- (2) The Basin Plan provides that water quality objectives shall be attained for "controllable factors". Since the existing high temperatures in the Pit River are, in part, the result of low flow from authorized water storage and diversion, one interpretation might be that high summer temperatures in the River (do in part to authorized diversions) are not a "controllable factor".

3. Dissolved Oxygen

Dissolved oxygen readings ranged from 14 mg/l to 3.0 mg/l with the lower readings generally occurring in the early morning hours consistent with the process whereby plant growth produces oxygen in the daytime and uses oxygen at night. The diurnal sampling in July 02 showed a 24 hour variation of 12 mg/l to 4.0 mg/l.

The Regional Board's Basin Plan water quality objective for dissolved oxygen states – 'in waters designated WARM (supports warm water aquatic species), dissolved oxygen shall not be less than 5.0 mg/l, and for waters designated COLD (supports cold water aquatic species), dissolved oxygen shall not be less than 7.0 mg/l'.

The Basin Plan Beneficial Use designation for this reach of the Pit River includes COLD. A number of dissolved oxygen readings fell below the 7.0 mg/l level and levels were generally consistent with the findings from previous Pit River monitoring (i.e. 1980 Pit River Water Quality Study (DWR), 1962 Pit River Water Quality Investigation (RWQCB), and Muck Valley Hydro Project monitoring (1990-).

It can be concluded that dissolved oxygen levels found in this study are reflective of River conditions which commonly occur now and in the recent past. No fish mortality was observed during this study and the presence of several fish species throughout this reach of the River was confirmed in the Oct. 02 USF&W survey. Some crayfish mortality was noted in the River but it is not known if this mortality is at all related to low dissolved oxygen levels.

4. Nutrients

Table 3 shows the range of nutrient concentrations monitored:

Table 3—Nutrient Concentration Range and Average

	<u>Range*</u>	<u>Ave.</u>
Ammonia	ND (.02) – 1.52	0.1
Nitrate	ND (.05) – 2.0	0.05
Phosphorus	ND (.02) – 2.23	0.3-0.5

*All values are in mg/l

There were no obvious upstream/downstream trends in nutrient concentrations. There were no observed seasonal trends in nutrient concentrations except that nitrate concentrations were somewhat higher in winter than in summer.

Nutrient concentrations found in this study were generally consistent with levels reported in other investigations (i.e. 1980 DWR study and DWR Pit River Monitoring, 2000 and 2001).

The Regional Board Basin Plan objective for nutrients states that – ‘nutrients shall not promote aquatic growths (i.e. weeds and algae) to levels which adversely impact beneficial uses’. The Basin Plan has no quantitative nutrient objective. EPA Water Quality Criteria does not specify numeric limits on nutrients (with regard to biostimulation) but does provide that - ‘a desired goal for prevention of plant nuisances in streams or other flowing waters is 0.10 mg/l total phosphorus’. Total phosphorus concentrations in the Pit River are in excess of this recommended 0.10 mg/l level.

Nitrate and ammonia concentrations in the Pit River appear to be in the range typically found in other surface waters. The higher nutrient concentrations in the winter months are presumably the result of less plant growth activity (and uptake of nitrate).

The source of the high level of biostimulation (i.e. excessive weed and algae growth) in the Pit River during the summer months is unknown. Livestock wastes and agricultural irrigation return flows may be a significant source of nutrient loading, but site specific data is lacking. Information is also lacking on natural (or background) nutrient input from tributary drainages. This relatively high level of biostimulation does impact beneficial uses, i.e. lowers dissolved oxygen levels, adversely impacts River aesthetics, contributes to taste and odor problems downstream, and reportedly impacts irrigation uses by clogging sprinkler systems. Relevant issues in this discussion are (1) to what extent do current land and water use practices elevate nutrient loading and weed/algae growth over natural, background levels, and (2) what level of nutrient loading reduction would be needed to significantly alter current levels of biostimulation?

5. Bacteria

The Regional Board Basin Plan water quality objective (prior to May 2002) for bacteria states – ‘for protection of water contact recreation (a designated Beneficial Use for this reach of the Pit River), fecal coliform bacteria concentrations shall not exceed 400 maximum and 200 mean (based on a minimum of five samples in a 30 day period). After May 2002, the bacteria objective was changed to – ‘e-coli concentrations shall not exceed 235 maximum and 126 mean’.

Levels of fecal coliform and e-coli bacteria periodically exceeded the water quality objective maximum concentrations (sampling frequency did not allow for determining compliance with the mean objective). Of a total of 168 individual fecal coliform samples, 13 exceeded the maximum of 400 MPN. Of a total of 96 e-coli bacteria samples, 8 exceeded the maximum of 235 MPN.

There was no observed upstream/downstream trend in bacteria concentrations, though Station 7 @ Lookout had the highest total number of water quality objective

exceedences. Overall, bacteria concentrations in the Pit River are not particularly high relative to other surface waters with comparable land and water management practices (i.e. high levels of water diversion, livestock grazing and irrigation return flows).

6. Sediment

Both turbidity and suspended sediment showed no particular upstream to downstream trend. There were occasional spikes in both turbidity and TSS which occurred at various times and stations. During the 2001 summer irrigation season, Station 2 @ Likely showed elevated levels of turbidity which is due to releases of turbid water from West Valley Reservoir. This trend is less apparent in summer 2002 when the Station 2 sample site was moved approximately 1 mile further downstream from this point of turbid water input.

The Regional Board Basin Plan objective for suspended sediment states that – ‘the suspended sediment load and discharge rate shall not be altered to cause nuisance or adversely affect beneficial uses’. There is no quantitative objective for suspended sediment.

The Basin Plan objective for turbidity states – ‘waters shall be free of turbidity changes that cause nuisance or adversely impact beneficial uses’, and, ‘where natural turbidity is between 5 and 50 NTU, increases shall not exceed 20 percent’. Given that we do not know what the “natural turbidity” level is for the Pit River, we could also say that there is no quantitative objective for turbidity.

Turbidity and suspended sediment levels in the Pit River are high relative to most other waters in northern CA. This is somewhat characteristic of rivers and streams in northeastern CA and is, in part, a reflection of natural erosion and sediment transport processes. The occasional spikes recorded in this study are probably not related to natural processes but to unknown water management activities. Throughout the watershed, there are many reaches of actively eroding channel (both in the tributaries and mainstem Pit River). This channel erosion undoubtedly contributes to elevated turbidity and suspended sediment in the Pit River.

The extent of beneficial use impairment (impacts to aquatic species and other uses) resulting from high turbidity, sediment transport, and sediment deposition in the Pit River is presently unknown. Studies on salmonid species have found, in general, when turbidity levels exceed 15 to 20 NTU’s, the ability of predator species to find and capture prey is impacted (this also impacts recreational fishing). Other potential issues associated with sediment levels would include deposition of fine sediment impacting bottom dwelling species (including egg survival), and the issue of water column light penetration and impediments to the primary production process.

Throughout the two year sample period, only one sample run was conducted coinciding with what would be considered a moderate to high flow event in the River. This was on 31 December 2001. A calculation of sediment transport rate during that event is

illustrative of the high level of sediment transport that can and does occur in the Pit River. Combining the TSS concentrations (in mg/) with the reported flow at the USGS Canby gauge for that day (566 cfs) one can calculate sediment transport in lbs/day. This is done using the formula $226 \text{ mg/l TSS (the mean TSS that day for Stations 3,4,5 and 6)} \times 566 \text{ cfs converted to gpm (254,134 gpm)} \times .012 = 689,165 \text{ lbs/day}$. This is the calculated sediment transport rate for the Pit River @ Canby on 12/31/01. One can assume that the ultimate fate of that sediment would include deposition downstream in the Pit River channel, deposition in Lake Britton and other downstream PG&E reservoirs, and deposition in Lake Shasta. It should be noted that 566 cfs does not represent an extreme runoff event. The historic average flow at Canby for that date is approximately 300 cfs.

The above discussion is only to illustrate that relatively high rates of sediment transport do occur in the Pit River coinciding with high flow events. No conclusions are made as to whether this transport rate is reflective of “natural, properly functioning” River processes, impaired watershed condition and “accelerated” sediment transport/deposition, or something inbetween.

7. Other Parameters

A. pH

pH levels appear somewhat higher during the low flow summer season at all stations. pH at Station 8 @ Pittville was consistently lower than other River stations during both summer seasons. The pH at Station 4 on the North Fork @ Alturas was consistently higher than other stations during the 2001 summer season.

pH readings in the Pit River during the low flow summer season frequently exceed the Basin Plan water quality objective maximum of 8.5. However, pH of eastside waters tends to be relatively high and the readings for the Pit River may be within a ‘normal’ range for these waters. Also, readings from this study appear somewhat higher when compared to DWR data collected during the same time period.

Interestingly, the high pH readings at Station 4 occurred concurrent with elevated conductivity readings at this station during summer 2001, indicating that perhaps the observation is real and not the result of analytical error. There is no known cause for the elevated pH and conductivity at Station 4.

B. Conductivity

Conductivity generally ranged from 50 to 200 at the headwater stations (Stations 1 and 2) and 200 to 400 on the mainstem River stations. There was a moderate increase during the low flow summer months. An exception to this pattern was found at Station 4 (SF Pit @ Alturas) and to a lesser extent at Station 3 (NF Pit @ Alturas) during much of 2001.

Conductivity readings peaked at 1783 at Station 4 in Dec 2001. This pattern did not repeat in 2002 (Station 4 maximum in 2002 was 459 in Dec 2002).

Conductivity (which is a function of total dissolved minerals) in the Pit River seems to be in a 'normal' range for eastside waters. Conductivity data collected as part of this study is generally consistent with levels monitored in previous investigations. The abnormally high 2001 conductivity readings at Stations 3 and 4 are unexplained.

C. Standard Minerals and Metals

Levels of individual mineral constituents are representative of good water quality and are consistent with levels monitored in previous investigations. There is no indication that these constituents are at levels which would adversely impact beneficial uses.

Total and dissolved metal concentrations are also at levels which would not adversely impact aquatic life or other beneficial uses. Metals data from the DWR monitoring program on the Pit River also shows levels which would not be considered a problem for aquatic life or other beneficial uses.

8. Macroinvertebrates

Table 4 shows a summary of selected metrics for purposes of comparing macroinvertebrate communities at the eight River stations. (River conditions, i.e. localized ponding, precluded macroinvertebrate sampling at Station 7 in 2001 and Station 5 in 2002.)

Examination of the five individual metrics included in Table 4 shows a somewhat consistent pattern. Macroinvertebrate communities at Sta. 3 (NF Pit @ Alturas), Sta. 4 (SF Pit @ Alturas), and Sta. 7 (Pit River @ Lookout) were less robust compared to communities at the other River stations. This trend is apparent in each of the selected metrics (i.e. Taxa Richness, % EPT, Shannon Diversity, % Tolerant Taxa, and % Intolerant Taxa). The factors most likely responsible for the depressed macroinvertebrate populations at Stations 3, 4, and 7 would be water quality, water quantity, and/or habitat quality. It appears that one or more of these factors were impacting macroinvertebrates at these three stations.

9. Fish

(results of the Oct. 2002 USF&WS survey were not available at the time of Final Report preparation)

V. SUMMARY CONCLUSIONS AND RECOMMENDATIONS

Following is a brief summary of conclusions and recommendations for each of the constituents monitored in this study.

1. Flow

Conclusions

- Flows in the Pit River during the 2001 and 2002 monitoring study were much lower than the historic average
- With the exception of sediment discharge and sediment concentrations, lower than normal River flows in 01/02 would contribute to a 'worst case scenario' regarding concentrations of most water quality parameters
- Low flows through the summer irrigation season are likely a major stressor for water quality, aquatic habitat and aquatic life in the mainstem of the Pit River

Recommendations

- Establish additional gauging sites on the Pit River to better track River flow conditions and better understand the impacts of modified River flow
- In conduct of its watershed management program, the Pit River Alliance and other local management entities should look for opportunities to enhance instream flow. Potential actions to accomplish this would include:
 - dedication of existing water rights to instream flow
 - investigate and address illegal diversions, if any
 - implement projects to address overly dense vegetative conditions (i.e. juniper and others)
 - improve hydrology through stream channel and meadow restoration

2. Temperature

Conclusions

- Except at Station 2 (SF Pit River near Likely), River temperatures exceed tolerance levels for cold water species (i.e. trout)
- Except at Station 2, temperature regimes are similar for all River stations monitored in this study

Recommendations

- Temperature monitoring should be continued over the long-term, including monitoring under a ‘wet year – high flow’ scenario to evaluate the influence of River flow
- The current 303(d) listing for temperature should be maintained pending additional information on the River’s potential for support of cold water species
- The 303(d) listing should be reevaluated based on historical information on the presence or absence of cold water species, and in consideration of the “controllable factors” issue (i.e. is it possible to maintain a colder water regime with the existing pattern of water diversion/use and the influence of meteorological factors)
- In lieu of complete understanding of the River’s temperature regime potential, watershed groups should continue to pursue implementation of projects which improve channel and riparian conditions with the expectation that this will enhance temperature conditions

3. Dissolved Oxygen

Conclusions

- Summertime dissolved oxygen levels periodically fall below the Basin Plan DO objective (i.e. 7 mg/l for COLD waters, and 5mg/l for WARM waters)
- Summertime DO levels in the River typically range from 8 to 12 mg/l in mid-day to 3 to 5 mg/l in the early morning hours
- Low DO is currently not causing direct mortality of resident fish species but may be an important stressor to those species and a limiting factor for other species which are not now present

Recommendations

- Maintain the existing 303(d) listing for dissolved oxygen
- Evaluate minimum DO levels under ‘wet year – high flow’ conditions
- Future DO monitoring should focus on diurnal variation (as opposed to single measurements typically taken during daylight hours)

4. Nutrients

Conclusions

- Ammonia and nitrate levels appear in the ‘normal’ range, relative to other northern CA waters

- Total phosphorus levels appear elevated, relative to other northern CA waters
- Nutrient levels are similar throughout the reach of the Pit River from North Fork/South Fork above Alturas downstream to McArthur
- Excessive summer season growth of weeds and algae (i.e. biostimulation) is a problem for Pit River beneficial uses

Recommendations

- Maintain the existing 303(d) listing for nutrients, pending additional information
- Conduct studies to evaluate “background” levels of nutrients in the watershed, and evaluate potential sources of high nutrient loading
- In lieu of complete understanding of nutrient issues (i.e. natural background levels, principal sources, and limiting concentrations/constituents), the watershed groups should continue to pursue project opportunities which reduce nutrient loading

5. Bacteria

Conclusions

- Fecal coliform bacteria levels periodically exceed Basin Plan objectives for protection of contact recreation
- Bacteria concentrations are not substantially elevated given the predominant land and water use practices in the watershed

Recommendations

- Do not add a 303(d) listing for bacteria
- Conduct additional bacteria monitoring in areas of existing or potential high recreational use (i.e. primarily tributaries)

6. Sediment

Conclusions

- Sediment discharge and sediment transport rates were relatively low for the Pit River during this study period primarily due to low rainfall/runoff
- Data collected during an isolated high flow event indicates that sediment transport in the River can periodically be very high relative to other northern CA rivers and streams
- Turbidity levels in the Pit River are consistently high relative to other northern CA waters and this could be an important issue affecting protection/enhancement of Pit River beneficial uses

Recommendations

- Continue sediment monitoring throughout the watershed to try to evaluate significant loading sources
- Further evaluate to what extent sediment is limiting or otherwise impacting other beneficial uses

7. Other Water Quality Parameters

Conclusions

- Water quality constituent levels for pH, conductivity (except as noted below), standard minerals and metals were in the 'normal' range and were at levels which would not be considered adverse for beneficial uses
- Periodic 'excursions' from the normal range do occur for conductivity (and possibly specific mineral constituents), however longer term monitoring is required to better understand the frequency of these excursions, their cause(s), and their implications

8. Macroinvertebrates

Conclusions

- Metrics commonly used to evaluate macroinvertebrate community structure consistently showed poorer communities at Station 3 (NF Pit @ Alturas), Station 4 (SF Pit @ Alturas), and Station 7 (Pit River @ Lookout), relative to the other River stations
- The macroinvertebrate community found at each of the River stations is assumed to reflect conditions of water quality, water quantity, and/or habitat quality/quantity

Recommendations

- Because of their high information value, macroinvertebrates should be part of any future monitoring program plans for the River and the tributaries

9. Overall Program Recommendations

- Information collected from this study (and future studies) will be of limited value unless it is repeated in a long-term, consistent monitoring program

- The Pit River Monitoring and Assessment Committee should develop a long-term, coordinated Pit River watershed monitoring program plan and seek support for a monitoring coordinator to assume overall responsibility for implementing that plan
- There is need to establish a center for Pit River Watershed data collection, storage, analysis and dissemination