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STATE OF WASHINGTON

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DEPARTMENT OF ECOLOGY

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M E M O R A N D U M
February 2, 1987

To: Greg Cloud

From: Will Kendra WK

Subject: Changes in Flow and Temperature Observed in Wildcat Creek
         and Sam's Canal in August 1986

The Water Quality Investigations Section (WQIS) conducted a water
quality survey of Wildcat Creek in August 1986 to assess effects of
the McCleary Wastewater Treatment Plant (WTP) discharge on the receiv-
ing environment. During the study we observed a 46 percent (0.6 cfs)
decline in flow as Wildcat Creek passed through property largely owned
by Simpson Timber Company. In Sam's Canal we saw a 400 percent (0.4
cfs) increase in flow and a 32 percent (6.2°C) increase in temperature
as the stream passed through town. The temperature increase was a
violation of state water quality standards. The attached mass-balance
analysis documents these findings and will appear in final form as an
appendix to the receiving water survey report scheduled for release in
early April 1987.

I asked Walt Bergstrom about the apparent withdrawal of 0.6 cfs from
Wildcat Creek. He indicated there are no existing water rights for
this portion of the stream. The water loss could be due to ground
water infiltration, particularly if the pumping of nearby wells causes
drawdown of the water table, producing a hydraulic gradient in the
direction of the wells. However, the loss may also be the result of
an illegal withdrawal. The latter possibility should be explored
further because the loss of 0.6 cfs reduces the receiving-water-to-WTP-
effluent dilution ratio by 33 percent (6:1 to 4:1).

I checked through the Southwest Regional Office files to determine if
there was a permitted discharge into Sam's Canal that could account
for the observed flow and temperature increases. Indeed, Simpson
Timber Company had an NPDES permit to discharge non-contact cooling
water to Sam's Canal via a municipal storm sewer. However, you indi-
cated this permit had expired and that Simpson was no longer discharg-
ing to the sewer. Upon further inquiry, you discovered that Simpson
did in fact have two existing illegal discharges to the storm sewer
and, ultimately, to Sam's Canal. The quality of these discharges may
explain both the increase in canal pH (6.7 to 7.4) and the abundance

of background microorganisms found in fecal coliform samples collected
at the canal mouth.

I understand that you are planning a field investigation of the illegal
discharges in the near future. Please inform me of your findings as
they may have a direct bearing on my receiving water study, particu-
larly if there is a relationship between the withdrawal of water from
Wildcat Creek and the increase in flow and temperature observed in
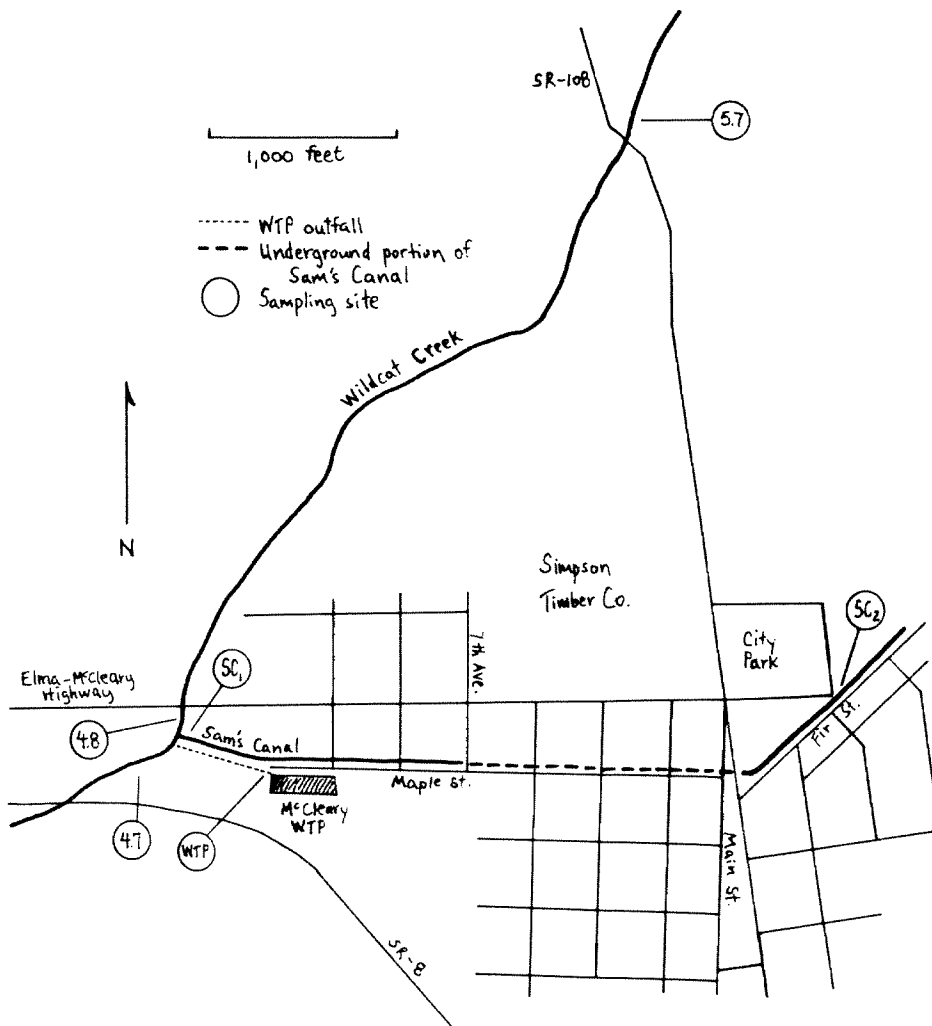Sam's Canal.

WK:cp

Attachment

cc: Norm Glenn
     Lynn Singleton
     Walt Bergstrom
     Darrel Anderson

Appendix A. Changes in flow and temperature observed in Wildcat Creek
            and Sam's Canal in the vicinity of McCleary on August 26–
            27, 1986.

The map below shows Wildcat Creek and Sam's Canal as they flow through
McCleary in a west–southwest direction. Two-day means for flow and
temperature at the various sampling sites are as follows:

Sampling Site	Flow (cfs)	Temp. (^{o}C)
5.7	1.3	16.7
4.8	0.7	17.2
4.7	1.6	19.8
SC_1	0.5	25.3
SC_2	0.1	19.1
WTP	0.3	20.4

There was a loss of 0.6 cfs of stream flow in Wildcat Creek as it
passed through property largely owned by Simpson Timber Company.
However, there was 0.4 cfs increase in flow and a $6.2^{o}C$ increase in
temperature in Sam's Canal as it passed through town. The increase in
flow between SC_1 and SC_2 apparently occurs in the portion of the canal
which is underground. Several municipal storm sewer outfalls are
located in this reach. In order to cause a temperature increase of
$6.2^{o}C$ between SC_1 and SC_2, the storm sewer discharge(s) would need to
have a temperature (T) of:

$$(0.1)(19.1) + (0.4)(T) = (0.5)(25.3) \qquad T = 26.8^{o}C$$

However, the canal is slow-moving and fully exposed to sunlight between
7th Avenue and its confluence with Wildcat Creek. Thus it is possible
that solar warming accounts for all or part of the observed temperature
increase in the canal. To test this hypothesis, we can turn to data
generated by Musgrove (1977). She measured flow and temperature in
Sam's Canal near 7th Avenue and the mouth in August 1977:

Sampling Site	Flow (cfs)	Temp. (^{o}C)
Near 7th Avenue	0.5	22.7
Canal Mouth	0.9	21.0
WTP	0.5	19.4

Data from McCleary WTP are included because it formerly discharged to
Sam's Canal between 7th Avenue and the mouth. The expected temperature
(T) at the mouth of the canal in 1977 should be:

$$(0.5)(22.7) + (0.5)(19.4) = (0.9)(T) \qquad T = 23.4^{o}C$$

Since the actual temperature measured in 1977 was $21.0^{o}C$, it would
seem that cooling (evaporative) processes exerted a greater effect
than solar warming. One might argue that the above equation is inap-
propriate because 0.5 cfs plus 0.5 cfs does not equal 0.9 cfs. If we
assume the 0.9 cfs was an artifact of rounding and that the actual
flow at the mouth was 1.0 cfs, the expected temperature (T) can be
recalculated as:

$$(0.5)(22.7) + (0.5)(19.4) = (1.0)(T) \qquad T = 21.0^{o}C$$

In this instance, the actual and expected temperatures equate. Still,
both scenarios point to the same conclusion; namely, that Sam's Canal
is not appreciably warmed by solar radiation in its exposed lower
reach. Thus the calculated $26.8^{o}C$ temperature of the storm sewer
discharge(s) in 1986 is likely a close approximation.

State water quality standards (Chapter 173-201 WAC) for Class A waters
specify that "temperature shall not exceed $18.0^{o}C$ . . . due to human
activities." Further, "when natural conditions exceed $18.0^{o}C$ . . . no
temperature increase will be allowed which will raise the receiving
water temperature by greater than $0.3^{o}C$." The observed temperature

increase of 6.2°C in Sam's Canal violates the latter criterion. In addition, mass-balance calculations show the expected temperature (T) of Wildcat Creek below the canal mouth but above the WTP outfall to be:

$$(0.7)(17.2) + (0.5)(25.3) = (1.2)(T) \qquad T = 20.6°C$$

Thus Sam's Canal raises the temperature of Wildcat Creek by 3.4°C. In the absence of storm sewer discharge(s), the canal would raise the temperature (T) of Wildcat Creek to:

$$(0.7)(17.2) + (0.1)(19.1) = (0.8)(T) \qquad T = 17.4°C$$

Clearly, the storm sewer discharge(s) cause(s) the temperature of Wildcat Creek to exceed the water quality criterion of 18.0°C. The actual temperature below the WTP outfall mixing zone was 19.8°C, which is 0.8°C cooler than above the outfall (20.6°C). The temperature drop can be attributed to dilution with WTP effluent (20.4°C) and evaporative cooling in the long, shaded pool below the outfall.