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MEMORANDUM
April 25, 1983

To: Ken Mauermann

From: Dale Clark DC

Subject: Buckley STP Parshall Flume and Flow Measurement Survey

On March 24, 1983, a field survey was carried out on the new Buckley sewage treatment facility in order to determine flow accuracy for the facility's Parshall flume and automatic flow-measuring system. Department of Ecology (WDOE) personnel present included Ken Mauermann of the Southwest Regional Office and Dale Clark of the Water Quality Investigations Section. The City of Buckley was represented by Gerald Loomis, chief operator of the plant.

The treatment plant is an activated-sludge, secondary treatment facility that contains two aerated circular channels, two secondary clarifiers, and a chlorine contact chamber. Chlorine is added to the effluent and thoroughly mixed using a flash mixer prior to entering the contact chamber. Flow is measured by a Parshall flume located six feet downstream from the flash mixer in a two-foot-wide channel.

Due to the action of the flow mixer, the effluent in the channel and flume is extremely turbulent. The turbulence creates conditions that decrease the accuracy of flow measurement in the flume. The WDOE "Criteria for Sewage Works Design" (WDOE, 1980) states that "the flume should not be installed too close to turbulent flows, surging or unbalanced flow, or a poorly distributed velocity pattern." Accurate measurement in a flume requires non-turbulent flow.

Physical measurements of the flume indicate that it has a throat width of approximately six inches. Actual measurements indicate that the throat is 6-1/16" wide at the top and 5-1/2" near the bottom. A carpenter's level was used to determine if the flume throat walls were vertical. The leveling bubble was 1/5 and 3/4 off center, indicating the walls are slightly off from true vertical.

Flow measurement accuracy was verified using two separate methods: (1) a Marsh-McBernie Magnetic Flow Meter; and (2) physical measurement of water height within the flume (with the flash mixer off), and computation of flow using a 6" Parshall flume flow measuring table (Stevens Water Resource Data Book, 1st Ed.).

Results of flow measurement indicate that the two methods compared favorably with each other. The Marsh-McBernie flow meter indicated a flow of .277 MGD while the table method indicated a flow of .285 MGD. Rounding of the two methods gives the same result of .28 MGD. Flow measurements were then compared between the flume and the plant flow metering system with the following results:

Liquid Height	Flow as Measured	Plant Flow Chart
4.75"	.3 MGD	.45 MGD (flash mixer off)
4.5"	.285 MGD	.35 MGD (flash mixer on)
4.5"	.285 MGD	.38 MGD (flash mixer off)
4.5"	.285 MGD	.425 MGD (flash mixer off)

The plant script chart appeared to be reading too high by 40 percent based on an average of the four runs. Interestingly, the plant flow relative to the measured flow dropped when the flash mixer was turned on. This may be due to the water in the channel being displaced unevenly, with a larger proportion of the water being thrown out to the sides of the channel. Physical measurement of channel wave action seemed to bear this out. A water level measured with the flash mixer off of 4-1/2" was displaced by anywhere from 4" to 7" along the sides but only 4" to 5-1/2" in the center when the mixer was turned on. The sonic detector may have responded to this variation by "seeing" a water level less than the actual water height of 4-1/2" under non-turbulent conditions. It must be emphasized, however, that the printout of the flow meter was still high since the system appeared to be out of calibration. Except for the single measurement noted in the table above, measured flows were taken under laminer conditions with the mixer off.

Another factor that may result in flow measurement error is that the ultrasonic detector is not placed correctly in the flume. In order to determine flows, the device should be located at a focal point 2/3 the distance of the throat mouth (Figure 1). The detector as measured appeared to be upstream 1-1/2" from the focal point.

Conclusions and Recommendations

1. The Buckley STP flow metering system was inaccurate, reporting flows approximately 40 percent greater than actual flows at the time of this inspection.

2. Placement of a flash mixer directly upstream of a Parshall flume is not a good engineering practice as the accuracy of flows measured by the flume is predicated on the assumption of non-turbulent flow approaching the flume.

3. The flow-measuring system at the Buckley STP should be recalibrated and tested over a range of flows from 0.1 to 0.3 MGD. Accuracy of both script chart recorder and totalizer should be maintained over this range within manufacturer's specifications, but in any case, accuracy should be within 10 percent at all flows between 0.1 and 0.3 MGD. If calibration does not achieve the required accuracy under normal operating conditions (i.e., with the flash mixer on), the system should be modified or replaced to achieve this accuracy.

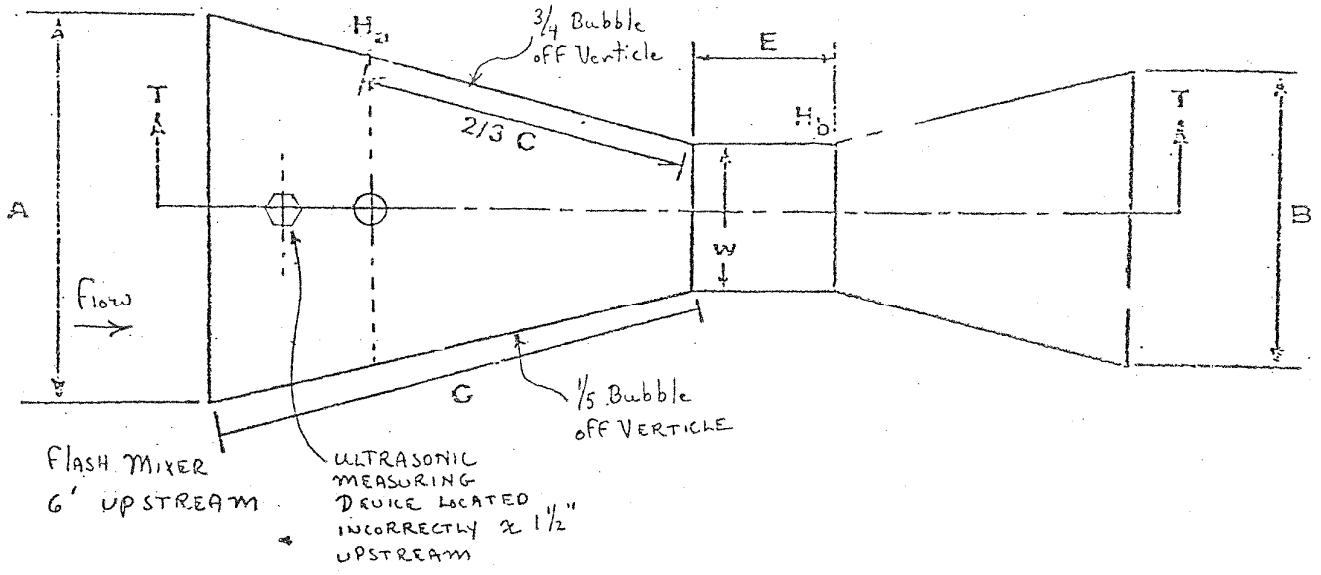
DC:cp

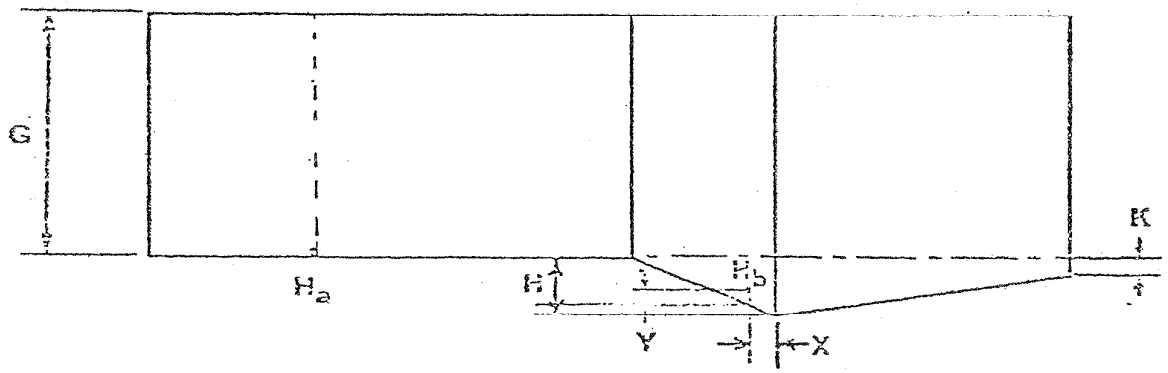
Attachment

Buckley SLT - 3-24-83

PARSHALL FLUME:

Dimensions & Flow





Code	Spec's	Measured			Time	H_a	ΔX	OURS Theoretical Flow	THEIRS Recorded Flow
A						4.75"		.30 MGD	.45 MGD (MIXER OFF)
B						4.5"		.285 MGD	.35 MGD (MIXER ON)
C	24 7/16"	Rt. Side 24 7/16	Left 24 3/8			4.5"		.285 MGD	.38 MGD (MIXER OFF)
2/3C	16 5/16"	16 1/4"				4.5"		.285 MGD	.425 MGD (MIXER OFF)
E									
G		23 7/8"							
H									
K		Top	M.o	Bottom					
W	6"	6 1/16	5 5/8	5 1/2					
X									
Y									