JOHN SPELLMAN
Governor

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STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
7272 Cleanwater Lane, LU-11 • Olympia, Washington 98504 • (206) 753-2353

MEMORANDUM
July 1, 1982

To: Dave Wright

From: Marc Heffner

Subject: Mukilteo Class II Inspection, March 2-3, 1982

Introduction

On March 2 and 3, 1982, a Class II inspection was conducted at the Mukilteo sewage treatment plant (STP). Personnel involved included Bill Yake and Marc Heffner (Washington State Department of Ecology [WDOE], Water Quality Investigations Section), Dave Wright (WDOE, Northwest Regional Office), and city maintenance personnel at Mukilteo who are presently running the treatment plant. In addition to the Class II inspection, a receiving water study was done on March 2, 1982 by Tim Determan and Dale Clark of the WDOE Water Quality Investigations Section. The receiving water study will be discussed in a separate report.

The Mukilto STP is a small primary plant consisting of flow measurement, comminution, clarification, chlorination, and anaerobic digestion facilities (Figure 1). Future enlargement of the chlorine contact chamber is planned to provide emergency disinfection of any flows coming to the plant as a result of pump station failure in a part of the nearby Olympus Terrace treatment system. The plant did not have a licensed plant operator at the time of the inspection.

The plant discharges via an outfall line into Possession Sound. The discharge is authorized by a letter of extension to NPDES Permit No. WA-002329-9(M).

Sampling Procedures

Automatic composite samplers were set up to collect influent and chlorinated effluent samples. The samplers were set to collect approximately 250 mls of sample every 30 minutes for 24 hours. The composite sample jugs were packed in ice to preserve samples as they were collected. Composite samples were split with the Olympus Terrace STP (Mukilteo STP laboratory analysis is done by Olympus Terrace) for analysis by Olympus Terrace and WDOE laboratories. Grab samples were also taken for field analyses and fecal coliform analysis. The data are summarized in Table 1.

WDOE flow monitoring was conducted using a Manning dipper at the plant Parshall flume for comparison with Mukilteo sonic meter flow measurement. Script charts of the flow are shown in Figures 2 and 3. Also, a sludge sample was taken for metals analysis.

Results and Discussion

Inspection of the plant and a brief discussion with city maintenance personnel at the plant revealed several problems at the plant. Those problems included:

1. The plant was being operated without a certified operator. A certified operator should be hired or trained to efficiently operate the facility.

2. The automatic composite samplers at the plant were in poor repair and not being used. The influent sampler lines were clogged with grit (see Item 3) and after they were cleared that sampler was functional. The effluent sampler needed parts before it could be used. Sampler repair and maintenance should be a high-priority item.

3. The influent sampler nozzle was located in the influent channel just below the comminutor. A 2x4 had been jammed into the channel just below the nozzel, apparently to keep the fluid level in the channel from getting too low. Grit was settling behind the 2x4 and being drawn into the sampler. Removing and replacing the 2x4 to allow the grit to flush out prior to collecting samples with the compositor is recommended.

4. The clarifier weir and skimmer arm needed attention. The weir was not level, resulting in unequal flows at different parts of the weir. This, in turn, typically results in substantially decreased clarifier efficiency. The roller at the end of the skimmer arm was airborne rather than riding on the track on the clarifier wall that appeared to be designed to support the skimmer bar. Also, the rate of rotation of the skimmer bar appeared fast. Skimmer/scraper arm peripheral speed is generally 5 to 7 feet/minute (WPCF, 1977). One might expect the speed to be on the lower end of the range for a small-diameter clarifier. The appropriate speed should be selected by the operator based upon sludge and effluent quality.

5. The sludge pump, responsible for removal of sludge from the clarifier and circulation of sludge in the digestor, had to be watched and oiled manually when being operated. This resulted in minimal operation of the pump and operation based on operator convenience rather than sludge management. Proper pump operation should be restored as soon as possible.

6. Floating grease on the chlorine contact chamber appeared to be a problem at the facility. A grease trough as part of the chlorine contact chamber upgrade might be considered.

7. Chlorination room operating procedures were inadequate. The chlorine canister being used and those being stored were not securely fastened and posed a safety hazard. Monitoring of chlorine usage was inadequate as a log was not kept. During the inspection, the chlorine supply tank was allowed to go empty, resulting in fecal coliform counts far exceeding NPDES limits (Table 1). The chlorine handling and monitoring procedures should be improved as soon as possible.

The data collected are shown on Table 1. To help in analyzing plant efficiency, Table 2 was set up to show percent removals through the plant based on WDOE analysis of the composite samples:

Table 2. Percent removals through plant.

Parameter	Percent Removal	Percent Increase
BOD		44
COD		27
Total Solids		4
T. Non-vol. Solids		4
Total Suspended Solids	48	
Total Non-vol. Susp. Solids	65	
Turbidity	9	
NO_3-N	45	
NO_2-N	*	
NH_3-N	0	0
O-PO_4-P		27
T-PO_4-P		10

*Both values <.10

As Table 2 shows, concentrations increased through the plant for several of the parameters measured. The distribution and magnitude of the increases and removals suggest that labeling and analytical practices were probably not at fault. The sampling procedure appears to be the most likely explanation for apparent generation of some constituents at the facility.

Flow measured by the Mukilteo sonic meter (.267 MGD) and WDOE Manning dipper (.257 MGD) were comparable, indicating good accuracy by the Mukilteo meter. The script chart (Figues 2 and 3) from the WDOE and

Mukilteo flow meters have quite similar patterns. They both indicate a relatively consistent quantity of gravity flow with increased surges when a pump station is operating. Table 3 was set up to estimate the volume of flow from each of these sources based on the script charts:

Table 3. Flow sources coming into Mukilteo STP.

Source	WDOE Meter		Mukilteo Meter		Average of 2 Meters	
	Flow	Percent of Total	Flow	Percent of Total	Flow	Percent of Total
Total	257,000	100	267,000	100	262,000	100
Gravity*	72,000	28	115,200	43	93,600	36
Pump Station*	185,000	72	151,800	57	168,400	64

*Flows estimated based on script chart records.

From the table one might surmise that for a representative influent sample, at least 60 percent of the samples should be taken when the pump station is operating. The adequacy of the WDOE time composite samples was estimated using two methods. The first method estimated that the pump station ran roughly 10 to 11 hours during the inspection based on the script charts. This means that the 60 to 70 percent of the flow represented by the pump station occurred during 40 to 46 percent of the sampling period and indicates a probable under-representation of pump station flow in the composite sample. The second method involved marking script charts every 1/2 hour after the compositor was started and determining whether the pump station was running or not. It appeared that the pump station was running when 36 to 40 percent of the samples were taken on this basis; again indicating pump station flow was inadequately represented in the sample. If, as appears likely, influent samples did not proportionately represent gravity and pump station flows, the percent increases and removals through the plant probably represent differences in the influent characteristics of the pump station and gravity flows as well as treatment occurring within the plant.

The effect of the pump station on treatment in the plant could not be determined with the samples collected. As previously noted, the clarifier weir is not level causing potential short-circuiting problems. This, accompanied with surges from the pump station, probably hampers settling in the clarifier and likely results in reduced clarifier efficiency. It is suspected that although effluent quality may be degraded by pump station surges, variability in effluent quality caused by differences in pump station and gravity flow influent quality should be minimal due to clarifier mixing and detention time. Thus, effluent data are probably fairly representative of plant performance.

The results obtained from the composite samples suggest the possibility that those parameters found in increased concentrations after passing through the plant could be in high concentrations in the pump station flow and in low concentrations in the gravity flow. This strongly suggests that influent samples at Mukilteo should be obtained as a flow-weighted composite. This should assure sample representativeness. When automatic composite samplers are not functioning, 8-hour hand composite samples should be taken. Hourly samples of equal volume should be adequate for effluent sampling. Influent samples should be taken such that 10 equal volumes of sample are collected during the 8-hour period. Of these 10 samples, eight should be taken when the pump station is on (see Appendix A for calculation).

In comparing the plant effluent to NPDES limits (Table 1), it appears that the suspended solids discharge was in compliance. However, the BOD concentration (230 mg/L) and loading (493 lbs/day) exceeded weekly and monthly limits. The coliform counts on March 2 were in compliance, but on March 3 the chlorine tank was empty and the coliform count was estimated to be 2,100,000 col/100 ml. Care should be taken to provide a continuous chlorine source for disinfection. Also noted on the permit is the plant design flow of .25 MGD. Flow during the Class II was in the .257 to .267 MGD range (Table 3) indicating that the design flow is being exceeded. The February 1982 monitoring report also notes flows greater than .25 MGD. The repetition of equal flows for several days on the monitoring report suggests that the flow is read less than daily, then divided to give a daily flow. As listed in the NPDES permit, flows should be read daily.

An effort to measure the detention time in the outfall line was made on March 2. Rhodamine-WT dye was placed in the outfall line at the chlorine contact chamber and was watched for in the outfall area. The dye was not found in the receiving water, so the detention time in the outfall line could not be estimated. This might be attempted again prior to the addition of chlorine contact chamber capacity.

The metals data fall within the range of data previously collected. Worth noting is the low percent solids value for the sludge (.19% solids) which might in part be attributable to the clarifier skimmer/scraper arm speed and sludge pumping schedule items previously noted.

Results of the sludge analysis are summarized in Table 4.

Table 4. Sludge analysis (mg/Kg dry weight).

Metal	Mukilteo**	Previous Primary Plants Sampled*	
		Geometric Mean	Range
Cd	6.3	6.93	1.8- 17
Cr	13	56.8	11 - 540
Cu	758	434.3	137 -1190
Pb	110	324.7	73 -1090
Ni	74	49.1	18 - 120
Zn	842	1283.8	180 -2680

*April 1982 summary of metals data previously collected at municipal STPs by WDOE, Water Quality Investigations Section.
**.19 percent solids in sludge.

Laboratory Discussion

Laboratory work for the Mukilteo STP is done at the nearby Olympus Terrace STP. Martha Spears is responsible for laboratory work there and laboratory procedures were reviewed with her. The WDOE composite samples were split for BOD and suspended solids analysis by WDOE and Olympus Terrace.

Presently, grab samples are being taken at Mukilteo until the automatic compositors are repaired. As previously discussed, hand composite samples should be taken until the compositors are repaired. When compositors are used, the area where influent samples are taken should be flushed and the influent compositor should be adjusted to take a flow-weighted composite sample. The compositors should be repaired and practices to assure adequate flushing and representative sampling instituted.

Items discussed as part of the BOD procedures review were:

1. The use of fresh nutrient buffers in dilution water is desirable. The buffers being used were over a year old. Making fresh buffers every three to six months is advisable.

2. The pH of the sample should be between 6.5 and 8.0. Adjustment to approximately pH 7 should be made if the sample is not within the 6.5 to 8.0 range (WDOE, 1977, p. 11, #5).

3. A dilution water blank should be run. Oxygen depletion in the blank should not be more than .2 mg/L (WDOE, 1977, p. 19 #5b).

4. A valid BOD test involves a D.O. depletion of at least 2.0 mg/L with at least 1.0 mg/L of D.O. remaining at the end of the test. Recent Mukilteo DMR submissions have caused some concern as to the accuracy of the D.O. meter being used by Olympus Terrace for D.O. measurements, particularly when measuring low D.O. values. Dilutions, in which a five-day D.O. of zero could be expected, have been prepared but after five days D.O. was measured using the meter. It appears that the D.O. meter was giving positive D.O. readings when, in fact, there was probably no D.O. in the BOD test solution. It is thought that this problem at the low end of the D.O. meter scale could be the cause of low DMR BOD values (October-November 1981 BOD values ranged from: influent 8.6 - 83.7 mg/L; effluent 5.15 - 30 mg/L). An attempt to compare the D.O. meter measurements to Winkler method measurements for a range of values (ex. 1, 4.5, 8) would be useful in determining D.O. meter accuracy.

5. Dilutions of 10 and 40 mls of sample per 300 ml BOD bottle would probably be appropriate for both the influent and effluent samples being run.

Items discussed as part of the suspended solids discussion included:

1. Selection of the amount of sample to be filtered for solids analysis should be made in advance of filtering. This allows rinsing of any solids that have settled in the measuring/pouring container into the filter for more accurate analysis. Duplicate samples should be run when less than 50 mls of sample can be filtered.

2. Sufficient drying time should be allowed for samples to be completely dried. Samples should be dried, cooled, and weighed, then dried again for at least an hour, cooled, and weighed. This cycle should be repeated until weight loss is less than .5 mg (APHA, et al., 1975).

Table 5 was set up to compare the laboratory results from the WDOE and Olympus Terrace laboratories.

Table 5. WDOE-Olympus Terrace laboratory comparison.

		Laboratory	
Parameter	Sample	Olympus Terrace	WDOE
BOD	Influent	167*	160
	Chlorinated Effluent	42*	230
Susp. Solids	Influent	280	180
	Chlorinated Effluent	149	93

*Sample not seeded.

Results of the influent BOD sample test compare well, but this was not the case for the other samples. The effluent BOD sample correlation was poor, with the problem thought most likely to be related to a misunderstanding resulting in the Olympus Terrace sample not being seeded and/or the effluent BOD dilution used by Olympus Terrace resulted in a final D.O. of 2.0 mg/L which is in the range where D.O. meter accuracy is questionable. The poor solids correlation is probably associated with failure by Olympus Terrace to adequately dry the samples. Since the test had been run, longer drying times were being utilized to assure adequate drying.

Many of the problems noted with laboratory techniques may have been present for some time. Discretion in the use of previously-submitted DMR data is advisable.

Summary and Recommendations

Numerous comments have been made throughout the results and discussion section of the report citing areas needing attention at the treatment plant. These comments point to the need for a certified operator to maintain and operate the plant. Along with the need for a certified operator, other recommendations that have been discussed include:

1. Repairing and adjusting composite samplers to provide representative samples for operational and compliance data. This includes repairing the compositors, flushing out deposits near the influent compositor intake nozzle, and setting compositors to collect representative samples.

2. Adjusting solids removal components of the plant for optimum operation. This includes repair and adjustment of the skimmer/scraper arm and sludge pump. Also, any weir adjustments possible to allow for more even loading of the clarifier overflow weir should be made.

3. Care should be taken to provide a continuous chlorine source for adequate disinfection.

4. Changes in the BOD and suspended solids testing procedures were discussed with Olympus Terrace STP laboratory personnel. The changes as mentioned in the "Laboratory Discussion" section of this report could help with more accurate laboratory analysis. Discretion in the use of previously submitted DMR data is advisable.

5. Flow measurements should be made daily.

MH:cp

Attachments

REFERENCES

APHA.AWWA.WPCF., 1975. *Standard Methods for the Examination of Water and Wastewater*, 14th Ed., 1193 pp.

Washington Department of Ecology, 1977. Revised January 1982 and April 1982. *Laboratory Test Procedure for Biochemical Oxygen Demand of Water and Wastewater*, WDOE 77-24, 29 pp.

Water Pollution Control Federation (WPCF), 1977. *Manual of Practice/8, Wastewater Treatment Plant Design*, 333 pp.

APPENDIX A

Estimation of percentage of samples that should be taken when pump station is on.

Given: 35% of average daily flow is gravity flow*
65% of average daily flow is pump station flow*
pump station runs 10.5 hours/day

Percent of average daily flow coming from pump station when pump station on:

$$\frac{65\% \times 24 \text{ hrs.}}{10.5 \text{ hrs.}} = 150\%$$

Percent of average daily flow coming into plant when pump station on:

$$150\% + 35\% = 185\%$$

Percent of flow coming into plant from pump station when pump station on:

$$\frac{150\%}{185\%} \times 100 \simeq 80\%$$

Percentage of samples to be taken while pump station is on:

Let x = % of samples with pump on
Let y = % of samples with pump off

$$\begin{array}{rrl} & (80x + 20x) + 100y & = 100 \\ - & 20x + 100y & = 35 \\ \hline & 80x & = 65 \end{array} \qquad x \simeq 80$$

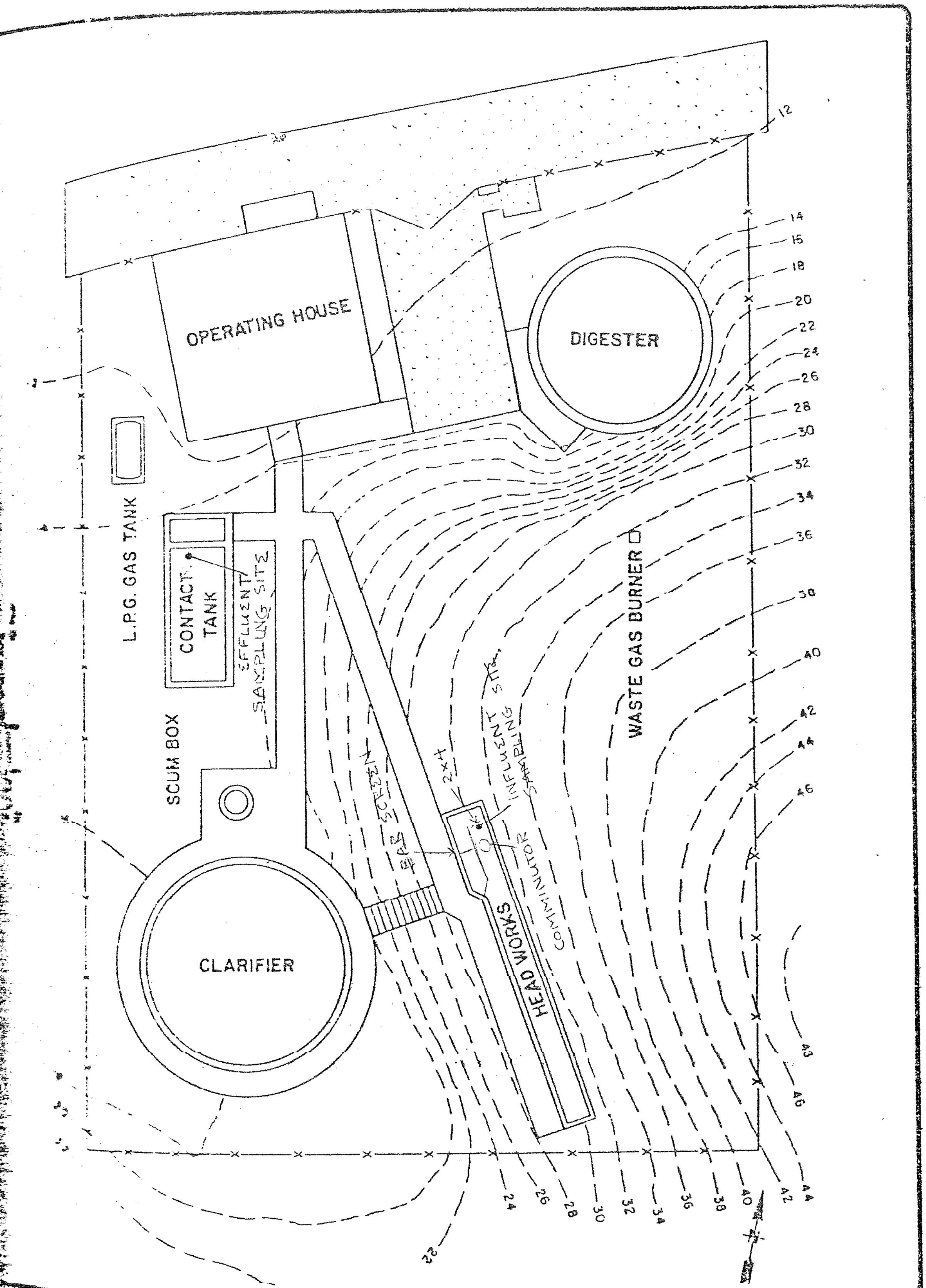
Therefore, ≃ 80% of the samples should be taken while the pump station is on.

*Rounded values from Table 3.

Table 1. WDOE data. Mukilteo Results.

Sample	Date	Time	BOD_5 (mg/L)	BOD_5 (lbs/day)	COD (mg/L)	Temperature (°C)	pH (field)	pH (lab)	Conductivity (umhos/cm) (field)	Conductivity (umhos/cm) (lab)	Total Solids (mg/L)	Total Non-vol. Solids (mg/L)	Total Susp. Solids (mg/L)	Total Susp. Solids (lbs/day)	T. Non-vol. Susp. Solids (mg/L)	Turbidity (NTU)	Nutrients: NO_3-N (mg/L)	NO_2-N (mg/L)	NH_3-N (mg/L)	O-PO_4-P (mg/L)	T-PO_4-P (mg/L)	Total Chlorine Residual (mg/L)	Fecal Coliform (col/100 ml)	Flow (MGD)
Influent	3/2	1010				11.3	7.2		187															
Influent	3/2-3	Comp.√	160	343	300	1.9*	7.5	7.7	420	417	440	250	180	386	55	110	1.1	<.10	10	2.6	6.2			.257††
Effluent	3/2	1100				11.3	6.7		480													2.2	110	
Effluent	3/2	1340																					<4	
Effluent	3/2-3	Comp.√√	230	493	380	2.0*	7.0	7.1	490	475	460	260	93	199	19	100	.60	<.10	10	3.3	6.8			.257††
Effluent	3/3	1120																				0†	2,100,000 Est.†	
Outfall√* Manhole	3/3	1200			310	11.0	7.1	7.5	440	486	410	230	110		21	90	.55	<.05	11	3.4	6.9	0†		
Permit Limits Weekly			180	320			6.5-8.5						170	305									1500	**
Monthly			165	300									150	280									700	

*Composite samples preserved with ice.
**Plant designed for average dry weather flow of .25 MGD.
†Chlorine tank empty.
††WDOE flow measurement with Manning dipper.
√Influent sampler started March 2, 1982 at 1010.
√√Effluent sampler started March 2, 1982 at 1100.
√*Outfall manhole is the furthest downstream manhole on the effluent line.



SNOHOMISH BASIN FACILITIES PLAN

EXISTING TREATMENT PLANT LAYOUT

CITY OF MUKILTEO

R. W. BECK and ASSOCIATES

Figure 1. Mukilteo STP layout.

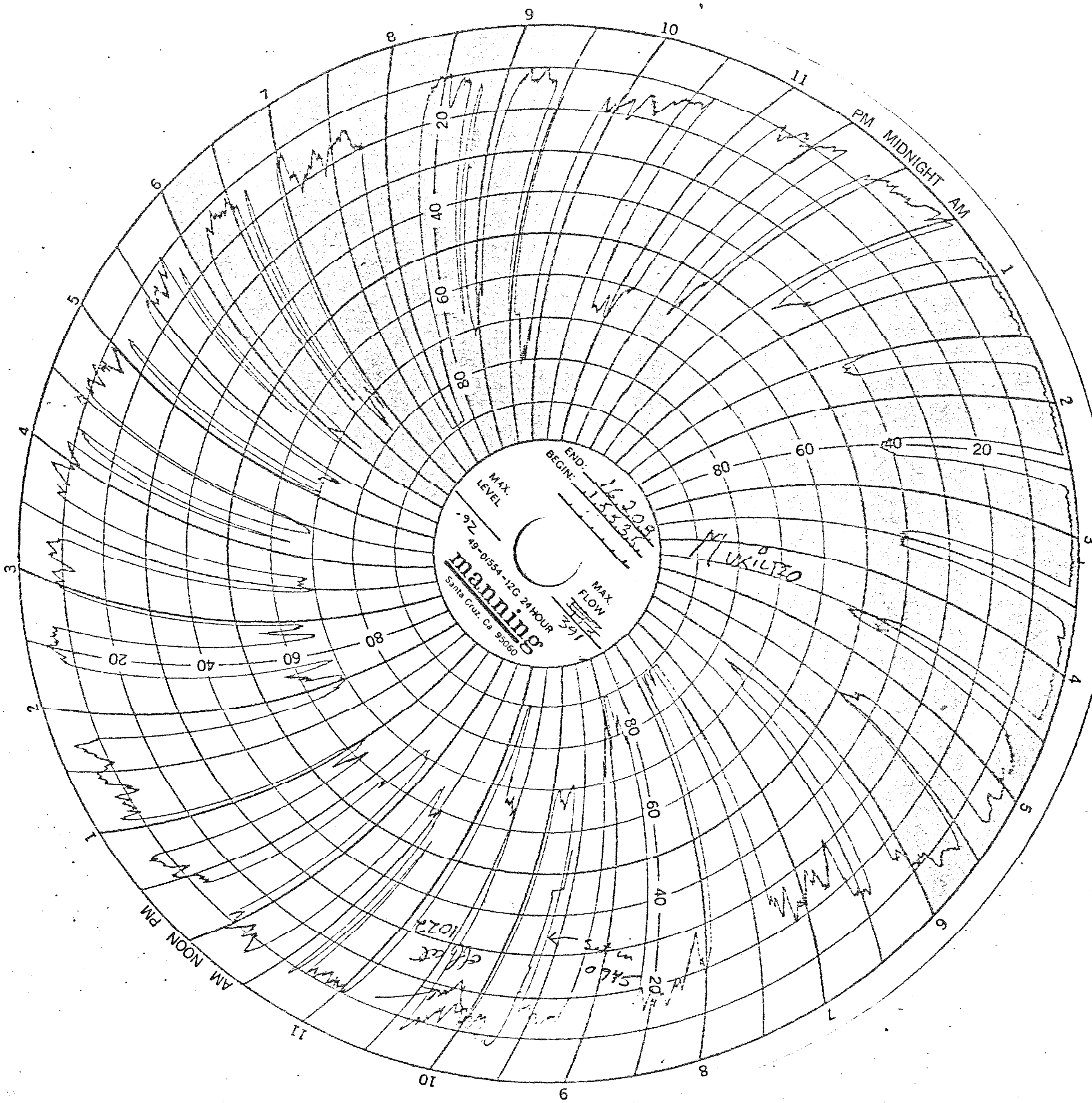
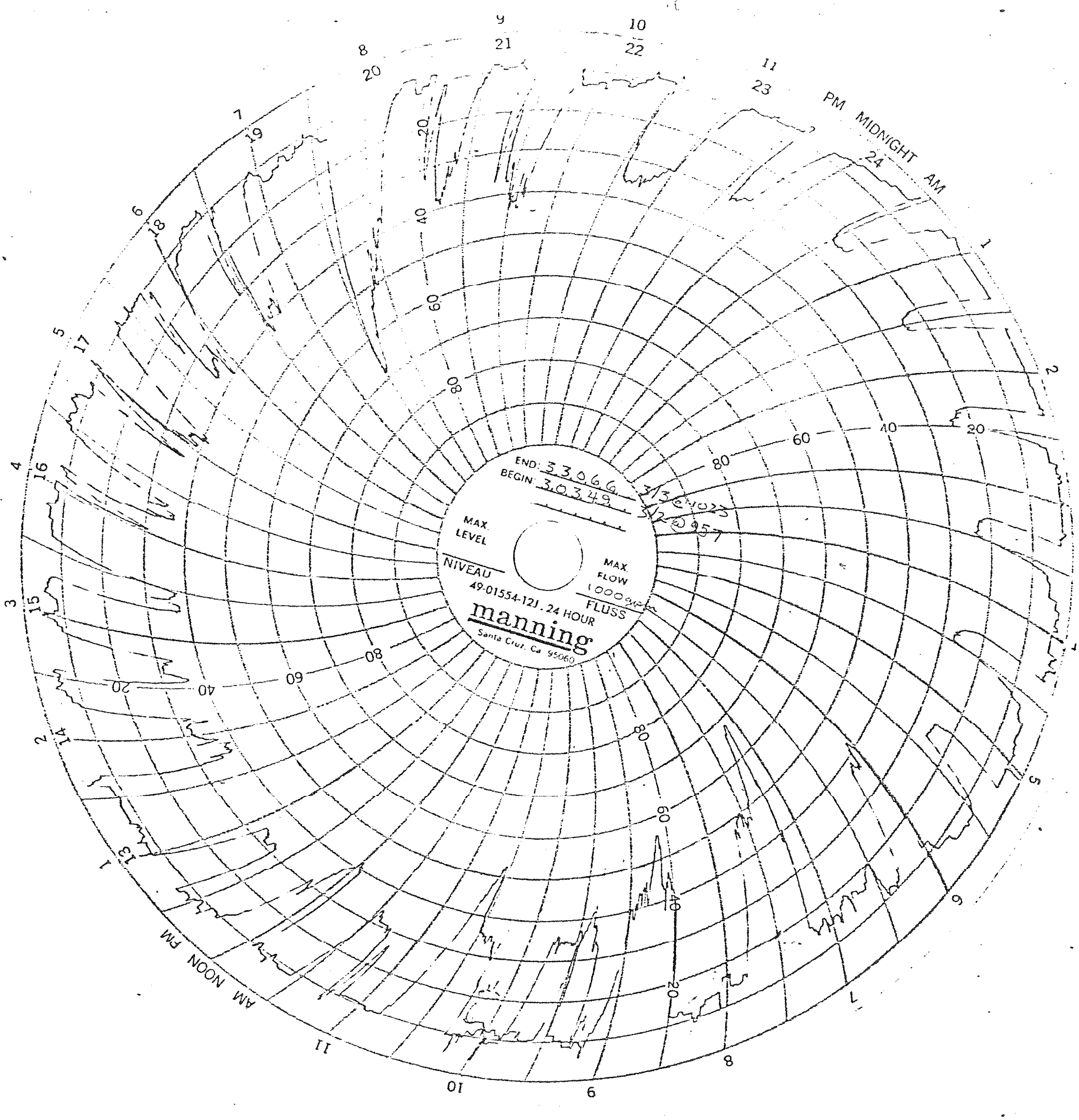


Figure 2. WDOE Manning dipper script chart.



Mukilteo's Sonic Meter 3/2-3/82

Figure 3. Mukilteo Manning sonic meter script chart.