



RBC Flume 13.17.02

User manual

Contents

1. Introduction.....	1
2. The flumes of Eijkelpamp Soil & Water	1
3. Principles of discharge-measuring flumes	3
4. Selection and location of the flume	4
5. Measurements using the flume	5
6. Maintenance and measuring problems	5

Appendices

Appendix 1: References	6
Appendix 2: RBC Flume 13.17.02 Data	7
Appendix 3: Explanation of program output for computed rating table	8
Appendix 4-5 Data from computer program FLUME.....	9
Appendix 4: Rating table RBC flume 13.17.02	9
Appendix 5: Discharge graph	13

1. Introduction

For the management of irrigation systems it is important that the quantity of water flowing through canals can be measured accurately. In the field of irrigation this is called discharge (flow rate). Discharge is the amount of water flowing through a canal at a certain place at a certain time. The flow rate is usually expressed in litres per second or cubic meters per hour.

The flow rate data are used for the design and monitoring of irrigation canals. This allows for the design of an efficient water distribution system in which a surplus or waste of water is avoided as much as possible. The flow rate is measured frequently in particular at canal splitting or separation structures. At section level it is important to know the flow rate in order to determine whether the crop receives sufficient water.

These operating instructions give brief information on how to use the RBC flume. For detailed information on flumes is referred to literature as listed in appendix 1.

2. The flumes of Eijkelpamp Soil & Water

Flumes are designed in different types and sizes. Eijkelpamp Soil & Water offers a trapezium shaped RBC (Clemmens et al. 1984) flume for four flow rate ranges (0.16 - 9.0; 0.93 - 50; 1.55 - 86 and 2.0 - 145 l/s). Compared to the WSC and the Parshall flumes the RBC flume is the most accurate. Compared to other shapes, the trapezium shaped flumes have two more important advantages:

- Accurate for a wide range of flow rates;
- Fits better in canals which often are trapezium shaped by design (more reliable flow pattern upstream of the flume and inside the flume).

Meet the difference

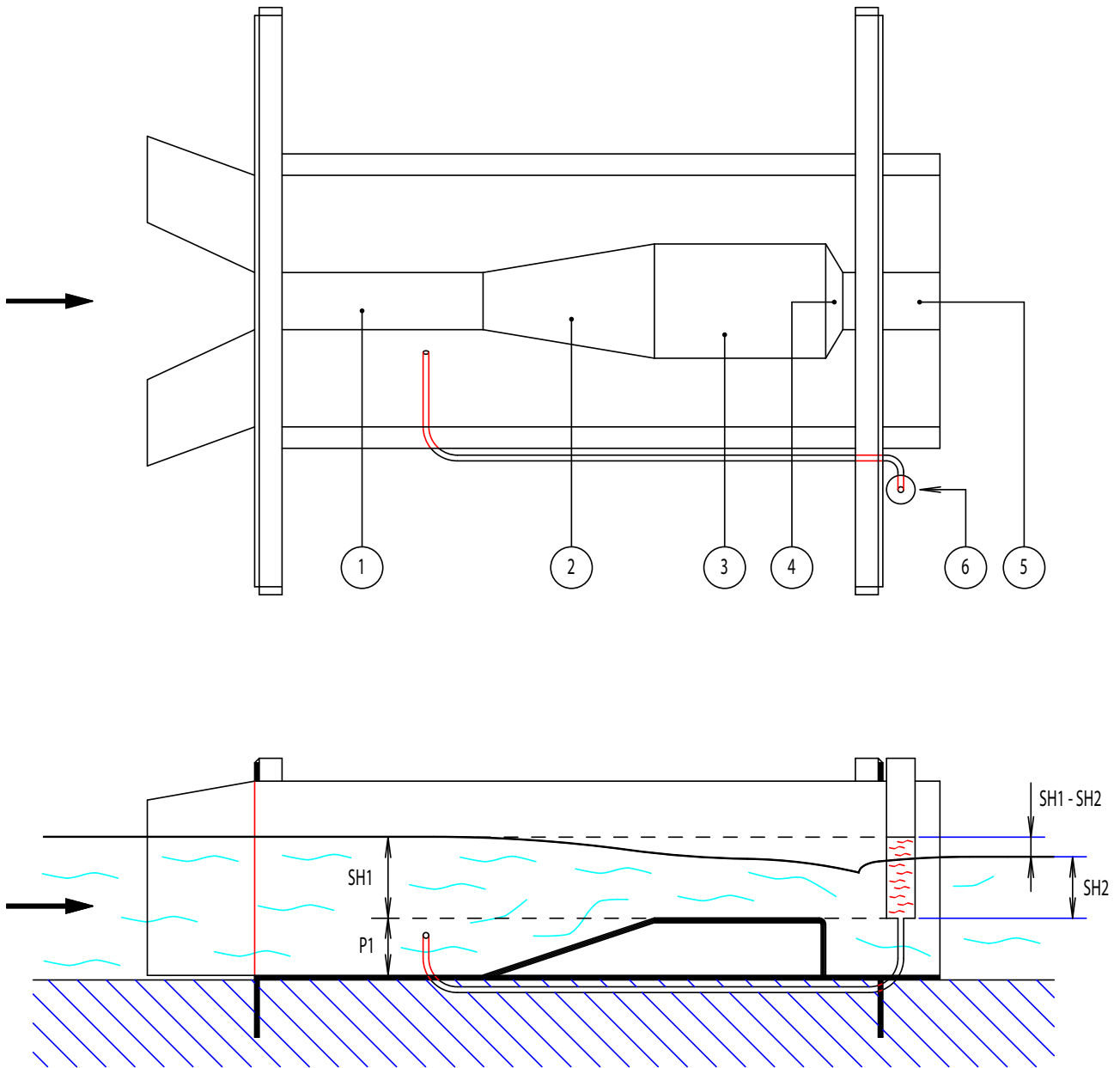


Fig. 1. Top view (above) and side view of the flow profile in the RBC flume.

The RBC flumes are designed mainly for use in furrows or other small earthen canals. All flumes can be equipped with a data logger and a pressure sensor. This allows for automatic measuring (or activation), storage and reading.

3. Principles of discharge-measuring flumes

For field measurement of the flow rate in small, usually earthen, irrigation canals, discharge-measuring flumes can be applied. Discharge-measuring flumes for small canals usually are compact and easy to use and transport.

A discharge-measuring flume is illustrated in figure 1 and consists of:

1. Approach section.
2. A converging section in which the speed of the water increases.
3. A throat section, a sill where the speed is increased further.
4. The throat section discharges into a diverging outlet where the flow rate is reduced to its original value.
The Eijkelkamp flume has an abrupt transition: the diverging section has a length of 0 cm.
5. A tail water section where the water level is controlled by flow downstream.
6. A measuring tube (stilling well).

In figure 1, the mechanism of a discharge-measuring flume is illustrated:

Water enters the approach section of the flume (1) as indicated by the arrow. The converging section (2) causes an increase of the flow rate in the flume. This flow rate is further increased in the throat section (3). The diverging section (4) of the Eijkelkamp flume has a length of 0 cm, so the water drops immediately to its original value.

The increase of the flow rate causes a reduction of the water level in the tail water section (5), and results in a drop in water stage (SH1 - SH2) inside of the flume. By constructing a flume in this way, the theoretical preconditions are realised allowing the flow rate to be determined by only measuring the water level (SH1) in the flume.

The water level is measured using a stilling well, which has its inlet upstream of the flume. The measured water level is referenced to the sill level (P1).

The sill-referenced water level is converted to discharge or flow rate, using tables or graphs.

The relation between water level SH1 and flow rate (specific to the 13.17.04 Eijkelkamp RBC flume) is given in appendices 4 and 5.

Data in this table and graph are determined using the computer program FLUME (1993), which is developed for assisting in the design and calibration of flumes. For instance, FLUME gives information on the required head loss needed to create optimal measuring conditions.

It can also be used for predicting the flow rate through the flume.

An explanation of the output parameters of the FLUME software is given in appendix 3.

If an automated flume is used, and data are already stored in (spreadsheet importable) files, it is much more convenient to calculate the flow rate in stead of using tables or graphs.

Based on the regression line of the graph in appendix 5, the following equation is used for the
13.17.02 Eijkelkamp flume

$$Q = 7E-07 \cdot (SH1)^3 + 0.000626 \cdot (SH1)^2 + 0.01569 \cdot (SH1) - 0.0665$$

With Q (discharge) in litres per second
and SH1 (sill referenced water level) in millimeter.

4. Selection and location of the flume

Selection

Before starting discharge measurements the best type of flume for the chosen application has to be selected. Usually, from a point of view of economy as well as accuracy, the smallest possible type of flume is selected for the flow rate measurement in a canal. As a general rule this is a flume with a top width of approximately 1/3 or 1/2 times the width of the canal. As no flow rate measurements are possible without a water-level head, a flume must be used which allows the passage of the 'estimated' flow and which provides the required sill-referenced head. The following table can be used as an indication of the discharge capacity of the flume and the required sill-referenced head.

flume type (art. no)	minimum flow (l/s)	maximum flow (l/s)	required head (SH1 - SH2) (mm)
13.17.02	0.16	9.0	20
13.17.04	0.93	50.0	40
13.17.06	1.55	86.0	50
13.17.08	2.00	145.0	60

In addition of the type of flume, also the type of data registration has to be selected: manually versus automatically.

In case of an automated flume, the sill-referenced water level is recorded using a very accurate pressure sensor connected to a data logger.

Advantages of automatic registration over a manual determination of the flow rate are:

- Maximum and minimum values are recorded in relation to time, from which the response rate of the discharge can be deduced.
- Average discharge rates as well as the cumulative discharge are accurately determined by continuous recording.
- Automatically recording flow rates is less time consuming and is very convenient in remote areas.
- High flow rates during rain periods can selectively be recorded.

Location

The flume is placed in the centre of the flow with the stilling well located at the end of the tail water section. The supply flow should preferably be straight and without any head over a substantial distance (a distance of 10 times the average channel width).

The channel bed in the approach section to a certain extend must not be porous because:

- a. all the water must flow through the flume in order to obtain reliable measurements.
- b. the flume can be undercut and will subside by erosion.

Erosion of the supply channels must be limited in order to prevent pollution or blockage of the flume. The flume must be installed level in vertical as well as in horizontal direction in order to avoid that the flow profile (and thus the measurements) is influenced. If the flume is not installed level in the longitudinal direction then this can easily yield a measuring error of 3%. The vertical direction yields a less important error (approximately 0.5%). Placing the flume upright in the vertical direction of flow of the water can be realised by holding the upstream side of the flume parallel to the water surface. In the longitudinal direction a level can be used.

Both sides of the flume must be sealed (filled up with earth) to prevent water from flowing along side of it. The effluent water must be able to run off unobstructedly and should not hinder the influent water. The flume should not be placed at a depth at which it disappears under the water level (submerged condition). Installing the flume too shallow is not a real problem as the water will soon accumulate in front of the flume (damming up) and an equilibrium water level will soon establish itself.



In case of an automated flume, the pressure sensor protrudes from under the flume. This should be taken into account when installing the flume in order to avoid damaging the sensor. Avoid kinking of the sensor cable during installation.

The complete stilling well can be demounted as to facilitate installation. The data logger is placed on a separate mounting base which allows to read the data logger without having to stand in the canal.

5. Measurements using the flume

After the flume is placed into the canal, the conditions as described in chapter 4 are met and the water level in the flume has become in equilibrium with the new situation, discharge measurements can be started. As already described, using the Eijkelkamp RBC flume, only the sill-referenced water level has to be measured to determine discharge.

The water level in the approach section of a flume can be measured in several ways:

- Graduation fitted on the side of the approach section.
- Level measurement via surface level measurement (for instance ultrasonic).
- Level measurement applying a stilling well.

In the Eijkelkamp RBC flumes, the stilling well is used for measuring the water level without the need to measure inside the flume itself and disturbing the level in the process (wave action caused by current and wind). The still also dampens water level fluctuations caused by longitudinal flowing water in the flume. The passage towards the stilling well is provided in the wall of the approach section under the sill height. In order to avoid blocking by debris or sediment, the opening is located slightly raised from the bottom of the flume. After the water level has been measured in the stilling well and referenced to the sill height, the discharge is determined, either by using the table in appendix 4, the discharge graph in appendix 5 or the formula in chapter 3.

The frequency of measurements, or the time interval between successive measurements, completely depends on the user wished application of the flume.

If one wants to make a continuous registration of the discharge rate of a natural stream, it is important to carry out measurements at the same points of time, as to minimise the effect of natural daily discharge fluctuations. If one wants to determine maximum discharge rates after heavy rainfall, the frequency of measurements will be low during dry periods, but very high during splash rains.

6. Maintenance and measuring problems

Inside the flume and the stilling well pollution in the form of sediment, waste, algal growth, weeds etc. may accumulate in time. For this reason the flume and in particular the stilling well and the supply must be checked for pollution frequently. In case of blockage of the supply towards the measuring opening this line can be blown through. In case of measuring problems with the automated flume the pressure sensor should be handled with care. The sensor can only sustain limited over pressure. By slackening the lower ring of the stilling well the sensor can be demounted for cleaning.

To prevent damage of the sensor this must be removed when temperature drops below zero.

If the flume is not working properly, or if there is any doubt regarding the flow profile or the installation, the necessary flow profile can be obtained by raising the entire flow a small amount. Or if that is not feasible, the same result may be obtained by lowering and cleaning the canal for a short distance downstream so that the water may flow freely away below the flume.

Appendix 1: References

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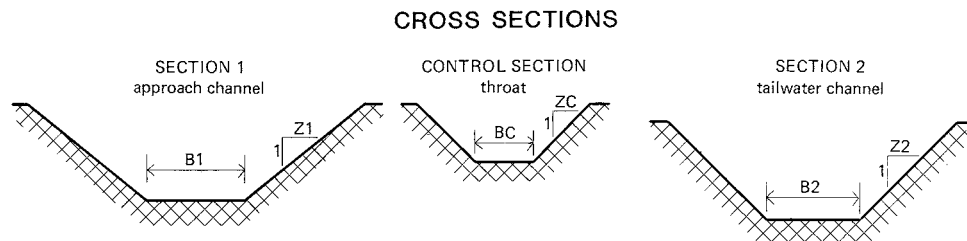
Eijkelkamp. Operating Instructions 13.17.10.06 Flume Software.

Withers, B. and S. Vipont. 1988. Irrigation: Design and Practice. BT Batsford Limited. Londen.

Appendix 2:

RBC Flume 13.17.02

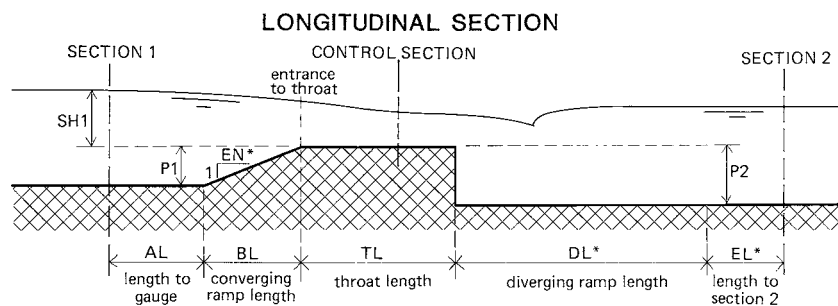
Data



Cross section data:

Cross section data:

Approach channel, simple trapezoid:	Bottom width	B1	=	.050 m
	Side slope	Z1	=	.490 : 1
Throat section, simple trapezoid:	Bottom width	BC	=	.100 m
	Side slope	ZC	=	.490 : 1
Tailwater channel, simple trapezoid:	Bottom width	B2	=	.050 m
	Side slope	Z2	=	.490 : 1



Longitudinal section data:

SH1	=	Sill-referenced head	=	
AL	=	Distance between converging ramp and gauging station	=	0.049 m
BL	=	Converging ramp length	=	0.147 m
TL	=	Throat length	=	0.154 m
P1	=	Sill height relative to approach channel	=	0.051 m
P2	=	Sill height relative to tail water section	=	0.051 m
EN*	=	Converging transition ratio (hor./vert.)	=	2.875:1
DL*	=	Diverging ramp length	=	0
EL*	=	Length to section 2	=	1.280 m
SH2	=	Sill-referenced head in tail water section	=	
SH1-SH2	=	Head loss	=	
RK	=	Absolute roughness height of material	=	0.0002 m

An * indicates that these data are not specified by the user

Appendix 3: Explanation of program output for computed rating table

Column	Value	Description
1	SH1 = h_1	The sill-referenced head. This is the head measured at the gauging station for determining discharge.
2	Q	The predicted flow rate for the given h_1 .
3*	FR1 = Fr_1	The Froude number of the flow in the approach channel. This value should be less than 0.5 in all cases and less than 0.45 when the approach conditions are not totally smooth.
4	H1/TL = H_1/L	The ratio of energy head to throat length. The head, h_1 , over which rating can be reliably computed is limited to $0.075 < H_1/L < 0.75$
5	CD = C_d	Discharge coefficient, the ratio between actual and ideal flow.
6	CV = C_v	The velocity coefficient which is computed for reference purposes only. It is the ratio between flow based on energy head, H_1 , and water depth h_1
7	DH = Dh	This is the required energy loss across the flume, $H_2 - H_1$. This may differ from the required difference in water levels, $Dh = h_2 - h_1$
8	Y2 = y_2	This is the maximum flow depth in the tail water channel for which there is no influence of this depth on the Q - h_1 relationship, $y_2 = h_2 + p_2$
9	ML	This is the modular limit defined in terms of the ratio of downstream to upstream energy heads, H_2/H_1 , at the limit between modular and nonmodular flow. Modular flow exists when the Q - h_1 relationship is not affected by the flow in the tail water channel.

* = the Froude number F1 at the gauging station is defined as:

$$Fr_1 = \frac{v_1}{\sqrt{(gA_1/B_1)}}$$

with:

v_1	=	the average flow velocity at the gauging station
g	=	the acceleration due to gravity
A_1	=	the cross sectional area perpendicular to the flow
B_1	=	the water surface width at the gauging station.

The Froude number gives an indication for the expected turbulence. When there is a rapid change in depth of flow from a low to a high stage, the water level will rise abruptly, creating a hydraulic jump, visible through its turbulence. The higher the Froude number, the higher the turbulence.

To obtain a relatively smooth water surface for which the elevation can be determined accurately, the Froude number should not exceed 0.5.

For channels with high sediment loads, the Froude number should be kept high in order to prevent sedimentation.

Appendix 4-5 Data from computer program FLUME

Appendix 4: Rating table RBC flume 13.17.02

SILL REFER. HEAD	FLOW RATE	FROUDE NO.		DISH. COEFF.	VELOC. COEFF.	REQ'D HEAD LOSS	MAX. T-WATER DEPTH	MODULAR LIMIT
SH1 MM	Q LIT/SEC	FR1	H1/TL	CD	CV	DH MM	Y2 MM	
6.5	0.076	0.026	0.042	0.8279	1.004	2.5	55.0	0.619
7.0	0.086	0.029	0.046	0.8411	1.004	2.6	55.3	0.629
7.5	0.097	0.033	0.049	0.8525	1.005	2.7	55.7	0.638
8.0	0.109	0.036	0.052	0.8622	1.006	2.8	56.1	0.646
8.5	0.121	0.039	0.055	0.8709	1.006	2.9	56.5	0.654
9.0	0.133	0.043	0.059	0.8785	1.007	3.1	56.9	0.662
9.5	0.145	0.046	0.062	0.8853	1.008	3.2	57.3	0.669
10.0	0.159	0.049	0.065	0.8913	1.009	3.3	57.7	0.676
10.5	0.172	0.053	0.069	0.8968	1.009	3.4	58.1	0.682
11.0	0.186	0.056	0.072	0.9017	1.010	3.5	58.5	0.688
11.5	0.200	0.060	0.075	0.9061	1.011	3.5	58.9	0.694
12.0	0.215	0.063	0.079	0.9103	1.012	3.6	59.3	0.700
12.5	0.230	0.067	0.082	0.9140	1.013	3.7	59.7	0.706
13.0	0.246	0.070	0.085	0.9175	1.014	3.8	60.1	0.711
13.5	0.261	0.074	0.089	0.9206	1.015	3.9	60.6	0.716
14.0	0.278	0.077	0.092	0.9235	1.016	4.0	61.0	0.721
14.5	0.294	0.081	0.095	0.9262	1.017	4.0	61.4	0.726
15.0	0.311	0.084	0.099	0.9286	1.018	4.1	61.8	0.730
15.5	0.329	0.088	0.102	0.9310	1.019	4.2	62.3	0.735
16.0	0.346	0.091	0.105	0.9330	1.020	4.2	62.7	0.739
16.5	0.365	0.094	0.109	0.9351	1.021	4.3	63.1	0.743
17.0	0.383	0.098	0.112	0.9370	1.022	4.4	63.5	0.747
17.5	0.402	0.101	0.115	0.9388	1.023	4.4	64.0	0.751
18.0	0.421	0.105	0.119	0.9405	1.024	4.5	64.4	0.755
18.5	0.441	0.108	0.122	0.9422	1.026	4.5	64.9	0.759
19.0	0.461	0.112	0.125	0.9437	1.027	4.6	65.3	0.762
19.5	0.481	0.115	0.129	0.9452	1.028	4.6	65.7	0.766
20.0	0.502	0.119	0.132	0.9466	1.029	4.7	66.2	0.769
20.5	0.523	0.122	0.136	0.9478	1.030	4.7	66.6	0.773
21.0	0.544	0.125	0.139	0.9490	1.031	4.8	67.1	0.776
21.5	0.566	0.129	0.142	0.9502	1.032	4.8	67.5	0.779
22.0	0.588	0.132	0.146	0.9512	1.033	4.9	68.0	0.782
22.5	0.610	0.135	0.149	0.9522	1.035	4.9	68.4	0.786
23.0	0.633	0.139	0.153	0.9533	1.036	5.0	68.9	0.789
23.5	0.656	0.142	0.156	0.9543	1.037	5.0	69.3	0.791
24.0	0.680	0.145	0.160	0.9551	1.038	5.1	69.8	0.794
24.5	0.704	0.149	0.163	0.9560	1.039	5.1	70.2	0.797
25.0	0.728	0.152	0.166	0.9568	1.041	5.1	70.7	0.800
25.5	0.753	0.155	0.170	0.9578	1.042	5.2	71.2	0.802
26.0	0.777	0.158	0.173	0.9586	1.043	5.2	71.6	0.805
26.5	0.803	0.162	0.177	0.9593	1.044	5.2	72.1	0.808
27.0	0.828	0.165	0.180	0.9601	1.045	5.3	72.5	0.810
27.5	0.854	0.168	0.184	0.9608	1.047	5.3	73.0	0.812
28.0	0.881	0.171	0.187	0.9614	1.048	5.3	73.5	0.815
28.5	0.908	0.174	0.191	0.9621	1.049	5.4	73.9	0.817
29.0	0.935	0.177	0.194	0.9627	1.050	5.4	74.4	0.819

SILL REFER. HEAD	FLOW RATE	FROUDE NO.	DISH. COEFF.	VELOC. COEFF.	REQ' D HEAD LOSS	MAX. T-WATER DEPTH	MODULAR LIMIT	
SH1 MM	Q LIT/SEC	FR1	H1/TL	CD	CV	DH MM	Y2 MM	
29.5	0.962	0.181	0.198	0.9633	1.052	5.4	74.8	0.822
30.0	0.990	0.184	0.201	0.9639	1.053	5.5	75.3	0.824
30.5	1.018	0.187	0.205	0.9645	1.054	5.5	75.8	0.826
31.0	1.047	0.190	0.208	0.9650	1.055	5.5	76.2	0.828
31.5	1.075	0.193	0.212	0.9656	1.056	5.5	76.7	0.830
32.0	1.105	0.196	0.215	0.9661	1.058	5.6	77.2	0.832
32.5	1.134	0.199	0.219	0.9666	1.059	5.6	77.6	0.834
33.0	1.164	0.202	0.222	0.9671	1.060	5.6	78.1	0.836
33.5	1.194	0.205	0.226	0.9675	1.061	5.6	78.6	0.838
34.0	1.225	0.208	0.229	0.9680	1.063	5.7	79.1	0.840
34.5	1.256	0.211	0.233	0.9684	1.064	5.7	79.5	0.842
35.0	1.287	0.214	0.236	0.9688	1.065	5.7	80.0	0.843
35.5	1.319	0.216	0.240	0.9693	1.066	5.7	80.5	0.845
36.0	1.351	0.219	0.243	0.9697	1.067	5.7	80.9	0.847
36.5	1.384	0.222	0.247	0.9701	1.069	5.8	81.4	0.849
37.0	1.417	0.225	0.251	0.9704	1.070	5.8	81.9	0.850
37.5	1.450	0.228	0.254	0.9708	1.071	5.8	82.4	0.852
38.0	1.483	0.231	0.258	0.9712	1.072	5.8	82.8	0.854
38.5	1.517	0.234	0.261	0.9716	1.074	5.8	83.3	0.855
39.0	1.551	0.236	0.265	0.9719	1.075	5.8	83.8	0.857
39.5	1.586	0.239	0.268	0.9722	1.076	5.9	84.3	0.858
40.0	1.621	0.242	0.272	0.9726	1.077	5.9	84.7	0.860
40.5	1.656	0.245	0.276	0.9729	1.078	5.9	85.2	0.861
41.0	1.692	0.247	0.279	0.9732	1.080	5.9	85.7	0.863
41.5	1.728	0.250	0.283	0.9735	1.081	5.9	86.1	0.864
42.0	1.764	0.253	0.286	0.9738	1.082	5.9	86.6	0.866
42.5	1.801	0.255	0.290	0.9741	1.083	5.9	87.1	0.867
43.0	1.838	0.258	0.293	0.9744	1.085	6.0	87.6	0.868
43.5	1.876	0.261	0.297	0.9747	1.086	6.0	88.1	0.870
44.0	1.914	0.263	0.301	0.9750	1.087	6.0	88.5	0.871
44.5	1.952	0.266	0.304	0.9753	1.088	6.0	89.0	0.872
45.0	1.991	0.268	0.308	0.9756	1.089	6.0	89.5	0.873
45.5	2.030	0.271	0.312	0.9758	1.091	6.0	90.0	0.875
46.0	2.069	0.273	0.315	0.9761	1.092	6.0	90.5	0.876
46.5	2.109	0.276	0.319	0.9763	1.093	6.0	90.9	0.877
47.0	2.149	0.279	0.322	0.9766	1.094	6.0	91.4	0.878
47.5	2.189	0.281	0.326	0.9768	1.095	6.1	91.9	0.879
48.0	2.230	0.284	0.330	0.9771	1.097	6.1	92.4	0.881
48.5	2.271	0.286	0.333	0.9773	1.098	6.1	92.9	0.882
49.0	2.313	0.288	0.337	0.9775	1.099	6.1	93.3	0.883
49.5	2.355	0.291	0.341	0.9778	1.100	6.1	93.8	0.884
50.0	2.397	0.293	0.344	0.9780	1.101	6.1	94.3	0.885
50.5	2.440	0.296	0.348	0.9782	1.103	6.1	94.8	0.886
51.0	2.483	0.298	0.352	0.9785	1.104	6.1	95.3	0.887
51.5	2.526	0.301	0.355	0.9787	1.105	6.1	95.8	0.888
52.0	2.570	0.303	0.359	0.9787	1.106	6.1	96.2	0.889
53.0	2.659	0.308	0.366	0.9792	1.108	6.1	97.2	0.891

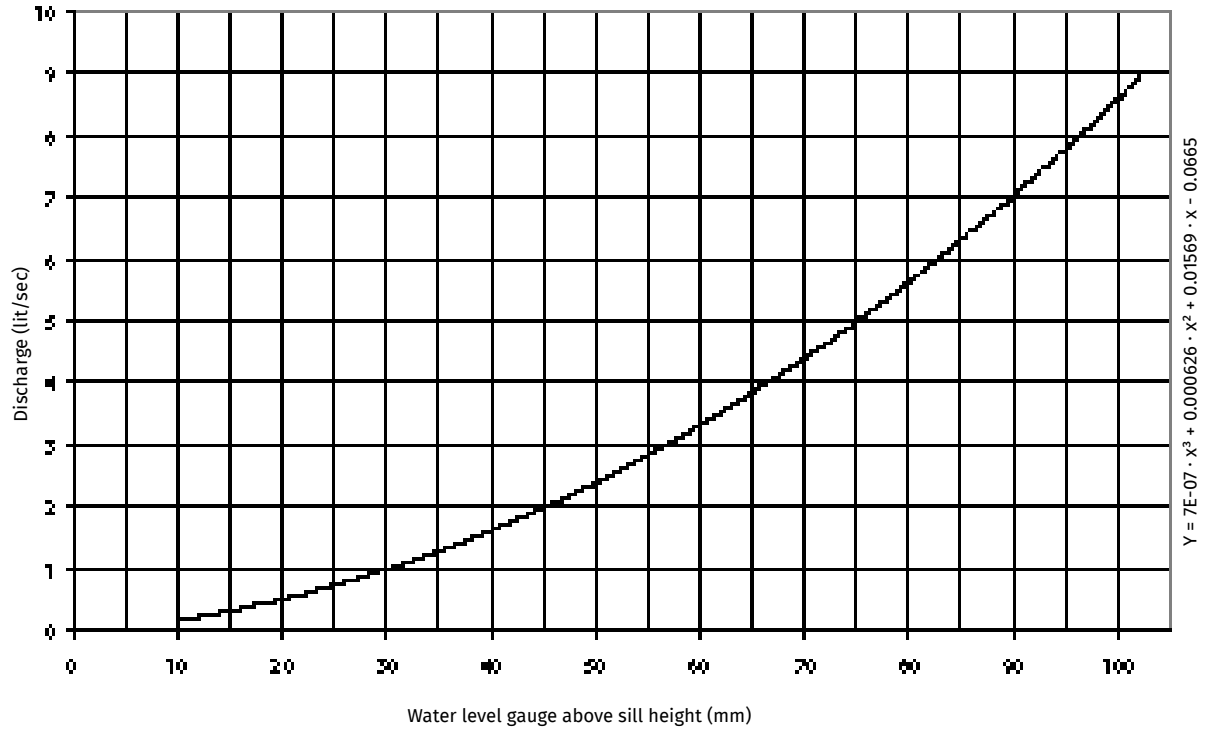
SILL REFER. HEAD	FLOW RATE	FROUDE NO.		DISH. COEFF.	VELOC. COEFF.	REQ'D HEAD LOSS	MAX. T-WATER DEPTH	MODULAR LIMIT
SH1 MM	Q LIT/SEC	FR1	H1/TL	CD	CV	DH MM	Y2 MM	
53.5	2.704	0.310	0.370	0.9794	1.110	6.2	97.7	0.892
54.0	2.749	0.312	0.374	0.9796	1.111	6.2	98.2	0.893
54.5	2.795	0.315	0.377	0.9798	1.112	6.2	98.6	0.894
55.0	2.841	0.317	0.381	0.9800	1.113	6.2	99.1	0.895
55.5	2.887	0.319	0.385	0.9802	1.114	6.2	99.6	0.896
56.0	2.934	0.321	0.388	0.9804	1.115	6.2	100.1	0.897
56.5	2.981	0.324	0.392	0.9806	1.117	6.2	100.6	0.898
57.0	3.029	0.326	0.396	0.9808	1.118	6.2	101.1	0.898
57.5	3.077	0.328	0.399	0.9810	1.119	6.2	101.5	0.899
58.0	3.125	0.330	0.403	0.9812	1.120	6.2	102.0	0.900
58.5	3.174	0.332	0.407	0.9814	1.121	6.2	102.5	0.901
59.0	3.223	0.335	0.410	0.9815	1.122	6.2	103.0	0.902
59.5	3.272	0.337	0.414	0.9817	1.124	6.2	103.5	0.903
60.0	3.322	0.339	0.418	0.9819	1.125	6.2	104.0	0.903
60.5	3.373	0.341	0.422	0.9821	1.126	6.2	104.4	0.904
61.0	3.423	0.343	0.425	0.9823	1.127	6.2	104.9	0.905
61.5	3.474	0.345	0.429	0.9824	1.128	6.2	105.4	0.906
62.0	3.526	0.347	0.433	0.9826	1.129	6.2	105.9	0.907
62.5	3.577	0.349	0.437	0.9828	1.130	6.2	106.4	0.907
63.0	3.630	0.352	0.440	0.9829	1.131	6.2	106.9	0.908
63.5	3.682	0.354	0.444	0.9831	1.133	6.2	107.3	0.909
64.0	3.735	0.356	0.448	0.9831	1.134	6.2	107.8	0.910
64.5	3.788	0.358	0.451	0.9833	1.135	6.2	108.3	0.910
65.0	3.842	0.360	0.455	0.9834	1.136	6.3	108.9	0.911
65.5	3.896	0.362	0.459	0.9836	1.137	6.3	109.3	0.912
66.0	3.950	0.364	0.463	0.9837	1.138	6.3	109.8	0.912
66.5	4.005	0.366	0.466	0.9840	1.139	6.3	110.3	0.913
67.0	4.061	0.368	0.470	0.9843	1.140	6.3	110.8	0.914
67.5	4.116	0.370	0.474	0.9843	1.141	6.3	111.3	0.914
68.0	4.172	0.372	0.478	0.9844	1.142	6.3	111.8	0.915
68.5	4.229	0.374	0.481	0.9845	1.144	6.3	112.3	0.916
69.0	4.286	0.376	0.485	0.9847	1.145	6.3	112.7	0.916
69.5	4.343	0.377	0.489	0.9848	1.146	6.3	113.2	0.917
70.0	4.401	0.379	0.493	0.9851	1.147	6.3	113.7	0.917
70.5	4.459	0.381	0.496	0.9852	1.148	6.3	114.2	0.918
71.0	4.518	0.383	0.500	0.9853	1.149	6.3	114.7	0.919
71.5	4.576	0.385	0.504	0.9853	1.150	6.3	115.2	0.919
72.0	4.635	0.387	0.508	0.9854	1.151	6.3	115.7	0.920
72.5	4.695	0.389	0.512	0.9856	1.152	6.3	116.2	0.920
73.0	4.755	0.391	0.515	0.9857	1.153	6.3	116.7	0.921
73.5	4.815	0.393	0.519	0.9858	1.154	6.3	117.1	0.922
74.0	4.876	0.394	0.523	0.9860	1.155	6.3	117.6	0.922
74.5	4.937	0.396	0.527	0.9861	1.156	6.3	118.1	0.923
75.0	4.999	0.398	0.530	0.9862	1.157	6.3	118.6	0.923
75.5	5.061	0.400	0.534	0.9864	1.159	6.3	119.1	0.924
76.0	5.123	0.402	0.538	0.9865	1.160	6.3	119.6	0.924
76.5	5.186	0.403	0.542	0.9866	1.161	6.3	120.1	0.925
77.0	5.250	0.405	0.546	0.9868	1.162	6.3	120.6	0.925
77.5	5.313	0.407	0.549	0.9869	1.163	6.3	121.0	0.926

SILL REFER. HEAD	FLOW RATE	FROUDE NO.		DISH. COEFF.	VELOC. COEFF.	REQ' D HEAD LOSS	MAX. T-WATER DEPTH	MODULAR LIMIT
SH1 MM	Q LIT/SEC	FR1	H1/TL	CD	CV	DH MM	Y2 MM	
78.0	5.377	0.409	0.553	0.9870	1.164	6.3	121.5	0.926
78.5	5.442	0.410	0.557	0.9872	1.165	6.3	122.0	0.927
79.0	5.507	0.412	0.561	0.9873	1.166	6.3	122.5	0.927
79.5	5.572	0.414	0.565	0.9873	1.167	6.3	123.0	0.928
80.0	5.638	0.416	0.568	0.9877	1.168	6.3	123.5	0.928
80.5	5.704	0.417	0.572	0.9877	1.169	6.3	124.0	0.929
81.0	5.770	0.419	0.576	0.9879	1.170	6.3	124.5	0.929
81.5	5.837	0.421	0.580	0.9880	1.171	6.3	125.0	0.930
82.0	5.905	0.422	0.584	0.9882	1.172	6.3	125.4	0.930
82.5	5.972	0.424	0.587	0.9883	1.173	6.3	125.9	0.931
83.0	6.041	0.426	0.591	0.9885	1.174	6.3	126.4	0.931
83.5	6.109	0.427	0.595	0.9886	1.175	6.3	126.9	0.932
84.0	6.178	0.429	0.599	0.9886	1.176	6.3	127.4	0.932
84.5	6.247	0.431	0.603	0.9887	1.177	6.3	127.9	0.933
85.0	6.317	0.432	0.607	0.9888	1.178	6.3	128.4	0.933
85.5	6.388	0.434	0.610	0.9889	1.179	6.3	128.9	0.933
86.0	6.458	0.435	0.614	0.9891	1.180	6.3	129.4	0.934
86.5	6.529	0.437	0.618	0.9892	1.181	6.3	129.8	0.934
87.0	6.601	0.439	0.622	0.9893	1.182	6.3	130.3	0.935
87.5	6.673	0.440	0.626	0.9894	1.183	6.3	130.8	0.935
88.0	6.745	0.442	0.630	0.9895	1.184	6.3	131.3	0.935
88.5	6.818	0.443	0.633	0.9897	1.185	6.3	131.8	0.936
89.0	6.891	0.445	0.637	0.9898	1.186	6.3	132.3	0.936
89.5	6.964	0.447	0.641	0.9899	1.187	6.2	132.8	0.937
90.0	7.038	0.448	0.645	0.9900	1.188	6.2	133.3	0.937
90.5	7.113	0.450	0.649	0.9901	1.189	6.2	133.8	0.937
91.0	7.188	0.451	0.653	0.9902	1.190	6.2	134.2	0.938
91.5	7.263	0.453	0.656	0.9904	1.191	6.2	134.7	0.938
92.0	7.339	0.454	0.660	0.9905	1.192	6.2	135.2	0.939
92.5	7.415	0.456	0.664	0.9907	1.193	6.2	135.7	0.939
93.0	7.492	0.457	0.668	0.9908	1.194	6.2	136.2	0.939
93.5	7.569	0.459	0.672	0.9909	1.195	6.2	136.7	0.940
94.0	7.646	0.460	0.676	0.9910	1.196	6.2	137.2	0.940
94.5	7.724	0.462	0.680	0.9911	1.197	6.2	137.7	0.941
95.0	7.802	0.463	0.683	0.9912	1.198	6.2	138.2	0.941
95.5	7.881	0.465	0.687	0.9914	1.198	6.2	138.6	0.941
96.0	7.960	0.466	0.691	0.9915	1.199	6.2	139.2	0.941
96.5	8.040	0.468	0.695	0.9916	1.200	6.2	139.7	0.942
97.0	8.120	0.469	0.699	0.9917	1.201	6.2	140.2	0.942
97.5	8.200	0.470	0.703	0.9918	1.202	6.2	140.7	0.942
98.0	8.281	0.472	0.707	0.9918	1.203	6.2	141.2	0.943
98.5	8.362	0.473	0.711	0.9919	1.204	6.2	141.7	0.943
99.0	8.444	0.475	0.714	0.9920	1.205	6.2	142.2	0.943
99.5	8.526	0.476	0.718	0.9921	1.206	6.2	142.7	0.944
100.0	8.608	0.477	0.722	0.9922	1.207	6.2	143.2	0.944
100.5	8.691	0.479	0.726	0.9923	1.208	6.2	143.7	0.944
101.0	8.775	0.480	0.730	0.9924	1.209	6.2	144.2	0.945
101.5	8.859	0.482	0.734	0.9925	1.210	6.2	144.6	0.945
102.0	8.943	0.483	0.738	0.9926	1.211	6.2	145.1	0.945
102.5	9.028	0.484	0.742	0.9927	1.211	6.2	145.6	0.946

Appendix 5:

Discharge graph

Discharge graph RBC Flume 13.17.02



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