Research on bifurcations in rivers

by

R. Roosjen
C. Zwanenburg

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supervisors: Prof. Dr. Ir. M. de Vries
Dr. Ir. Z. B. Wang
Dr. Ir. H.L. Fontijn
Dr. R.J. Fokkink
Ir. B.C. van Zomeren

Preface

This report is written in the framework of our MSc. thesis at the department of Hydraulic Engineering of the Faculty of Civil Engineering at the Delft University of Technology (DUT). This MSc. thesis regarded the research on the morphological behaviour of bifurcations in rivers. The research work was done within the framework of a linkage project between DUT and the Bangladesh University of Engineering and Technology (BUET). This project is co-ordinated by the CICAT (Centre for International Co-operation and Appropriate Technology).

After preparing ourselves we spent three months in Dhaka, the capital city of Bangladesh, where we carried out experiments with a test rig at the BUET. After these three months we went back to the Netherlands, where the obtained data from the experiments were analysed. Our three months in Bangladesh were not only a good experience in a professional way, since nice results from the experiments were gained. Also the working and living in a different culture was a nice experience for both of us.

We would like to thank a number of people for their efforts and co-operation. As is always said in words of gratitude, but still is very true, without these people this MSc. thesis could never have been completed. First of all Prof. de Vries and the other members of our examination committee, Dr. Wang, Dr. Fontijn and Ir. van Zomeren for their intensive escort. In Bangladesh we would like to thank Ir. van Mierlo for his intensive escort and hospitality during our stay in Dhaka. Further we thank Prof. Hannan, Dr. Kabir and all others of the Water Resources Department for their escort and hospitality.
The experiments were carried out together with two MSc.students of the BUET, Ataul Hannan and Nazrul Howlader. We thank them for the good co-operation and the good atmosphere we worked in together. Finally we would like to thank Cees Timmers and others at the CICAT, who helped us getting all things set for our stay in Bangladesh.

Ronald Roosjen
Cor Zwanenburg

Summary

One of the unsolved problems in the water resource engineering is the morphological behaviour of bifurcations in rivers. Bifurcations can be found in deltas, in estuaries and in braided rivers. When modelling river reaches which contain a bifurcation, a nodal point relation is needed. The problem is to determine this nodal point relation. The distribution of sediment over the two branches is determined by local three-dimensional phenomena and it has to be specified explicitly at every bifurcation that is modelled. Nowadays nodal point relations are used, which are not based on thorough (experimental) research. In this report the search on the distribution of the sediment as a function of the discharge distribution is described.

An experimental model of a bifurcation in a river is designed and constructed. This experimental model is used to do experiments which lead to a better insight in the behaviour of the bifurcation. Before starting the experiments, all parts of the test rig were tested. Then several experiments have been designed and carried out with the test rig. The measurement errors, made during the experiments, are described, which gives a good view of the quality of the experiments.

Since it was time-consuming to obtain data from the experiments, a thorough statistical analysis of the found data is carried out. Several statistical techniques were used to obtain as much information as possible from the data. With the use of this statistical analysis, nodal point relations were found for the specific types of bifurcations in the test rig, for three different upstream discharges and two different shapes of the bifurcation. It appeared that the general nodal-point relation proposed by Wang et al (1993) was appropriate. The unknown parameters of this relation were found for the circumstances of the experiments; Three relations are found for the first shape of the bifurcation, with a respective upstream discharge of 20 l/s, 30 l/s and 40 l/s. Two relations are found for the second shape of the bifurcation, with a respective upstream discharge of 30 l/s and 40 l/s. It is statisticaly proven that some of the coefficients in these relations are comparable for the different circumstances, but others are not.

In order to see whether it is possible to carry out numerical simulations of a bifurcating river, the configuration of the experimental model and the found nodal point relations were used as input for simulations with WENDY. Thus, simulations were carried out of some of the experiments. It appeared that the results of these simulations were comparable to the measured data from the experiments. Therefore it is proven that if a good nodal-point relation is known, a good simulation of a bifurcating river can be carried out.

Recommendations are given how to continue this research project in the future. The relations that are found here are only valueable for the given circumstances of the experiments. The final goal, however, of this research is to get a relation of the distribution of the sediment over the two downstream branches which can be used in all circumstances. More research has to be done to obtain this.

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Chapter 1 General background

1.1 Introduction

In this report river bifurcations are studied. This study is carried out in the linkage project of BUET, the Bangladesh University of Engineering and Technology, and the DUT, Delft University of Technology. For this study a test rig is build in 1994 at the BUET in Dhaka, Bangladesh. The design and preparations were done by Den Dekker, Hannan and Van Voorthuizen, under supervision of ir. Van Mierlo. A detailed description of the test rig can be found in Den Dekker and Van Voorthuizen (1994). Following on the building of the test rig, experiments were carried out.

These experiments are described in this report. In the first chapter, the general background of the research is given, followed by a theoretical introduction in chapter two. In chapter three and four the calibration of the test rig and the experiments are described. From these chapters, the measurement errors can be determined. These mesurement errors are discussed in chapter five. In chapter six the results are given followed by a statistical analysis in chapter seven. The results are compared to computer calculations in chapter eight. At the end, conclusions and recommendations can be found in chapter nine.

1.2 Description of the problem

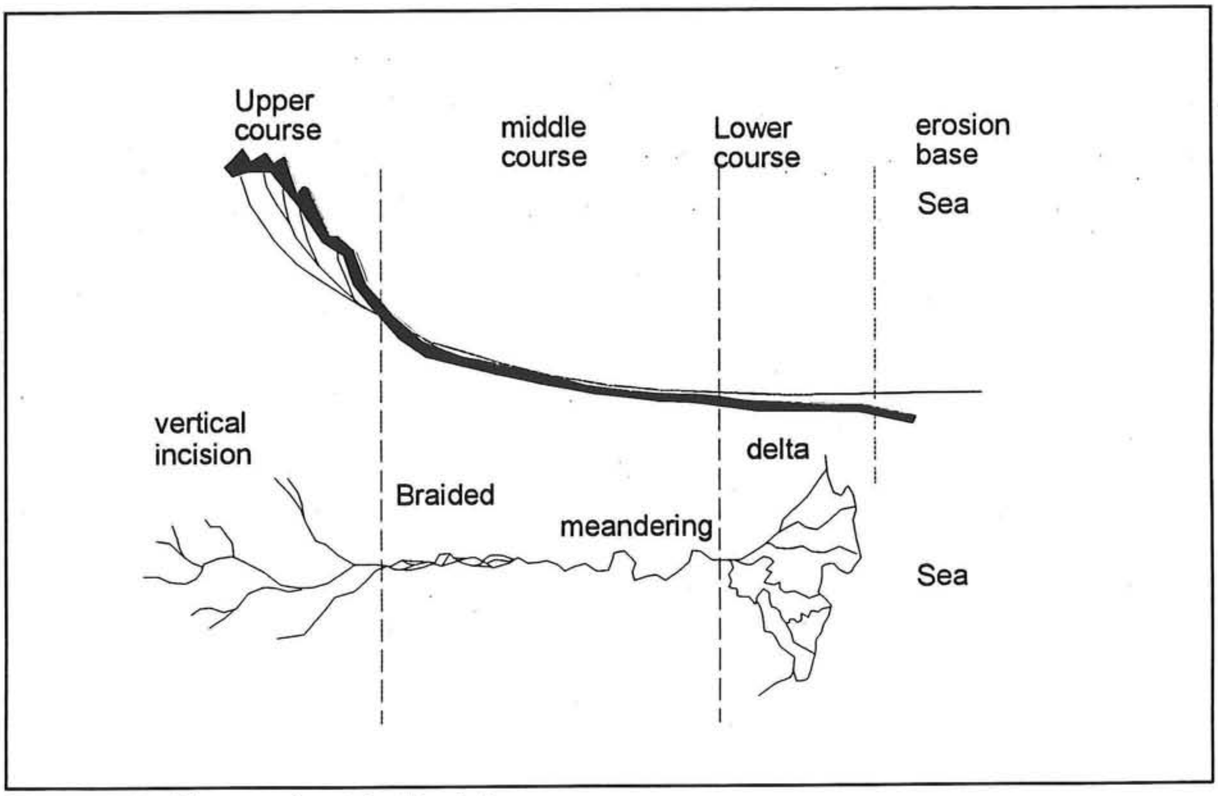


Figure 1.1 - Course of an idealized river

Confluences and bifurcations can be found at different places along the river. In figure 1.1 an idealized course of a river is depicted. Bifurctions can mainly be found in the braided part of the river as well as in the delta region.

In a braided river several channels parallel to each other occur. The succession of bifurcations and confluences, creates a multitude of islands in the river. The course of a braided river is unstable and hard to predict. As bifurcations effect the downstream branches, bifurcations are important for the morphological prediction of the river system as a whole. More insight into the behaviour of bifurcations will certainly contribute to the knowledge of the morphological behaviour of the islands and the channels of the braided river. This would improve the possibility to regulate the river system or to build successfully structures, such as bridges, in the river.

The delta is dominated by bifurcations. In the lower part of the delta, the tide creates an extra difficulty. The regular change of flow direction changes bifurcations into confluences and vice versa. Modelling these phenomena into a one dimensional morphodynamic (computer) model has proven to be difficult. Research on bifurcations will have a positive effect on the development of these computer models.

Along the river man-made bifurcations can be found at an off-take, for instance for irrigation purposes or flood regulation. These off -takes have sometimes the tendency to silt up. The reason for this phenomenon is not well understood, but it is supposed to be related to 'natural' bifurcations.

Above, the importance of bifurcations for river engineering is sketched. Despite all this, little is known about the behaviour of river bifurcations. This is examplified in the scarce availability of literature about this subject. Summarized the following problem definition is found: the morphological behaviour of bifurcations is poorly understood.

1.3 Objective of research

The main objective of this research is to get more insight into the behaviour of river bifurcations. Emphasis will be laid upon the relation between the ratios of the discharges and the sediment transports at the bifurcation.

1.4 Assumptions and Restrictions

For the mathematical analysis given in chapter two and to make the results usable, the problem of the river bifurcation is simplified by making some assumptions. To be able to compare the experimental results with the results of the mathematical analysis, the assumptions were also used when designing the tests rig. On the other hand the test rig itself implicates several restrictions. The following assumptions and restrictions were applied.

Assumptions

- The river bifurcates in only two downstream branches.

- No bank erosion occurs.

- The sediment transport consists of bed load only.

- The upstream discharge is constant in time, so seasonal effects are neglected.

- The water levels at the end of the branches are assumed to be constant in time. As will be explained later on, this represents the situation in which the bifurcated river discharges into a lake.

- Possible influences of tides and interactions between fresh and salt water are neglected.

Restrictions

- The width of the branches is fixed.

- Small deviations of the upstream discharges, water levels at the end of the branches and in the amount of sand, fed upstream, which are unavoidable, are neglected.

- All the sediment transport is assumed to be bed load. This creates restrictions for the upstreamdischarge and the ratio of the discharge in the down stream branches. This will be detailed later on.

- For a proper working of the sand traps the sediment transport needs to be bed load.

- The height of the model walls is fixed. This restricts the maximum water level. Together with the assumption of bed load, this also restricts the upstream discharge.

- The sand is not uniformly feeded over the width of the model. Assumed is that the water movements distribute the sediment equally over the width before the sediment reaches the bifurcation.

Chapter 2 Theory

2.1 Introduction

In this chapter a theoretical analysis of the phenomena at a river bifurcation is given. A mathematical analysis was given by Wang, et al. (1993). In this chapter a summary of their analysis is given.
The definition of the basic variables can be found in figure (2.1):

- water depth $a(x,t)$
- bed level $z(x,t)$
- flow velocity $u(x,t)$. Using this velocity, the discharge $Q = u * a * B$ and $q = u * a$ can be found.
- sediment transport $S(x,t)$ and $s(x,t) = S(x,t)/B$.
- bed slope i.

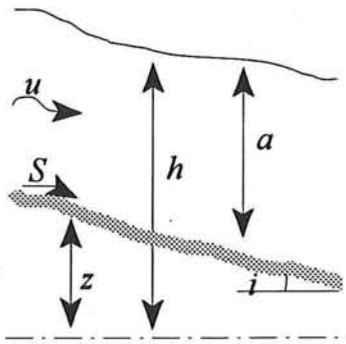


Figure 2.1 - Definition sketch

In one dimensional computer networks, bifurcations and confluences are both treated as nodal points. In both situations, two conditions have to be satisfied. These two are:

- mass balance of water

$$\sum_{i=1}^{n} Q_i = 0 \tag{2.1}$$

- mass balance of sediment

$$\sum_{i=1}^{n} S_i = 0 \tag{2.2}$$

In these two equations:

Q_i = discharge from branch i to the nodal point
S_i = sediment transport from branch i to the nodal point
n = the number of branches connected to the nodal point.

Confluence:

$$\Sigma Q_i = 0;$$
$$\hookrightarrow Q_1 + Q_2 = Q_0$$

$$\Sigma S_i = 0;$$
$$\hookrightarrow S_1 + S_2 = S_0$$

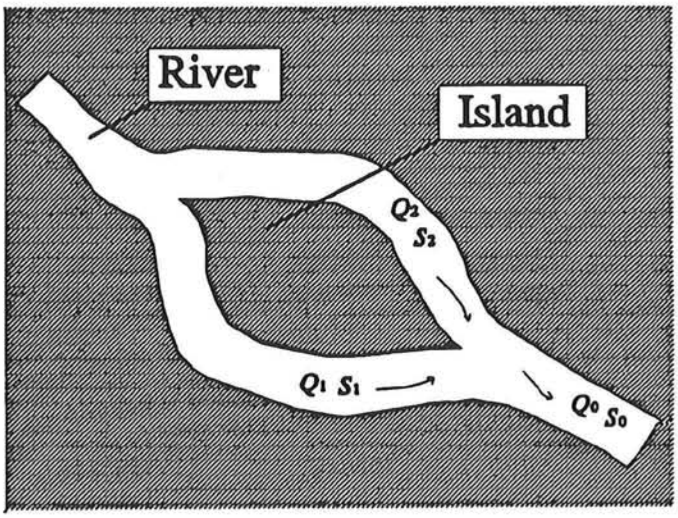


Figure 2.2 - A confluence in a river.

In figure 2.2 a schematized confluence is depicted. In the equations (2.1) and (2.2) the upstream discharges and the sediment transports are known. Downstream the discharges and the sediment transports are unknown. For a confluence with two upstream branches the equations can be solved, as the number of unknown variables equals to the number of equations.

Bifurcation:

$$\Sigma Q_i = 0;$$
$$\hookrightarrow Q_0 = Q_1 + Q_2$$

$$\Sigma S_i = 0;$$
$$\hookrightarrow S_0 = S_1 + S_2$$

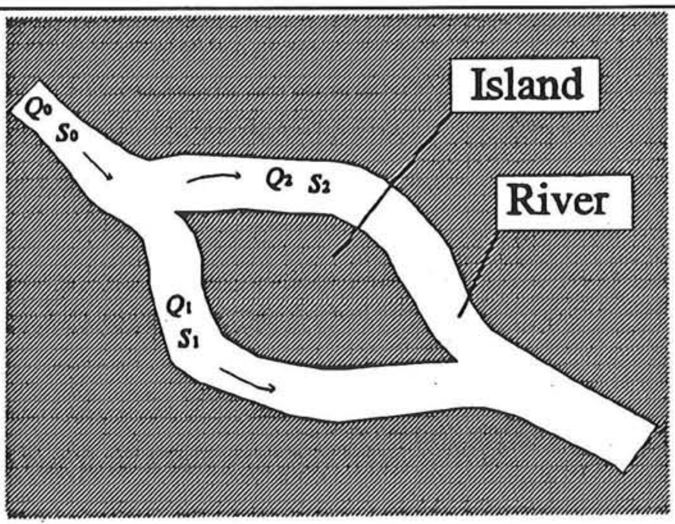


Figure 2.3 - A bifurcation of a river.

In figure 2.3 a schematized bifurcation is given. Again the upstream discharge and sediment transport are known and the downstream discharges and sediment transports are unknown. In this situation there is only one upstream branch and two downstream branches. For this situation the equations (2.1) and (2.2) are not sufficient anymore. The distribution of the discharges and the sediment transport rates over the two downstream branches has to be known. The distribution ratio of the discharges is determined by the geometry and the friction terms of the down-stream branches. The sediment transport ratio is determined by the local three-dimensional phenomena. This ratio has to be specified for every bifurcation separately. The relation of these ratios is known as the *nodal point relation*.

2.2 Nodal point relations.

The distribution of the sediment transport is governed by the local geometry. So it is difficult to give a general algorithm. In Wang et al. (1993) an inventory of the nodal point relations, used in computer models, is made. In the literature the following relations can be found:

- the sediment transport ratio equals the discharge ratio:

$$\frac{S_1}{S_2} = \frac{Q_1}{Q_2} \tag{2.3}$$

This relation is used in most operational models.

- the sediment transport ratio equals ratio of the widths of the two downstream branches:

$$\frac{S_1}{S_2} = \frac{B_1}{B_2} \tag{2.4}$$

In one dimensional models the widths are fixed. When using equation 2.4, a constant sediment transport ratio is simulated. This simulation leads to the situation where for an almost closed branch still the same sediment ratio is defined as in the beginning of the simulation period. It can easily be understood that this is a physically unrealistic behaviour of the bifurcation.

- the sediment transport ratio is a function of the discharge ratio:

$$\frac{S_1}{S_2} = \alpha\left(\frac{Q_1}{Q_2}\right) + \gamma \tag{2.5}$$

In this relation α and γ are constants to be given by the user. These user-defined constants should be given for every nodal point separately. For the situation γ does not equal zero, equation (2.5) also leads to an unrealistic behaviour of the bifurcation. This can be notified when branch one is closed. Then Q_1 equals zero, though according to equation (2.5) sediment transport is still present in branch one.

The analysis given in Wang et al. (1993), leads to a proposal of a general nodal point relation. This relation is a generalization of equation (2.3) and (2.4):

$$\frac{S_1}{S_2} = \left(\frac{Q_1}{Q_2}\right)^k \left(\frac{B_1}{B_2}\right)^{1-k} \tag{2.6}$$

or in a more general form:

$$\frac{S_1}{S_2} = M\left(\frac{Q_1}{Q_2}\right)^k \tag{2.7}$$

in which M represents the influence of the widths and other possible influences.

2.3 Stability of the nodal point relation

In Wang et al. the influence of the stability of the nodal point relation on the downstream branches, using equation 2.6, is studied. In order to study the stability of the nodal point relation, the bifurcation is simplified. For simplification, the assumptions given in section 1.4 are used. This leads to the schematization, given in figure 2.4. In this figure the length of branch one equals the length of branch two. The water levels at the end of the branches are assumed to be equal. This is represented by a situation, in which a river flows into a

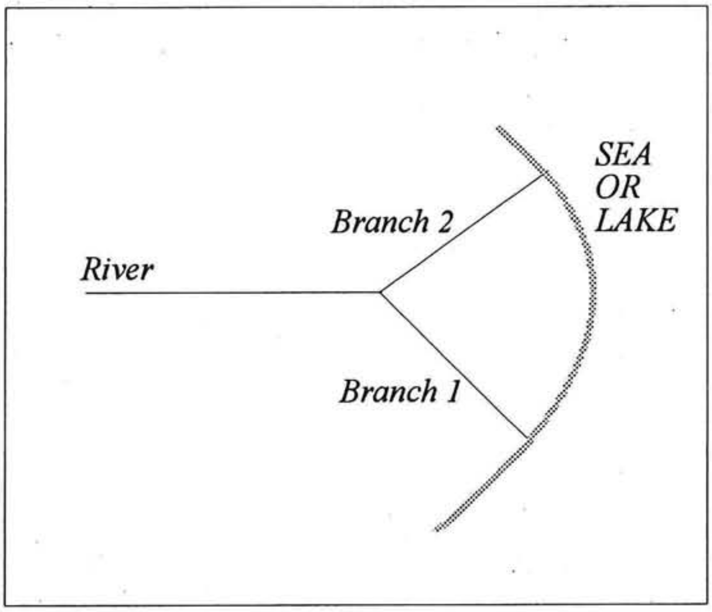


Figure 2.4 - Simplified bifurcation

sea or lake. Since tidal effects and interactions between salt and fresh water are neglected, a better simulation is given by a river flowing into a lake. In figure 2.4 the length of the branches are assumed to be small compared to the total length of the river.

The basis of the mathematical analysis is formed by the next four equations:

- the mass balance for the water movement:

$$\frac{\partial a}{\partial t} + u\frac{\partial a}{\partial x} + a\frac{\partial u}{\partial x} = 0 \tag{2.8}$$

- the momentum equation for the water movement:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + g\frac{\partial a}{\partial x} + g\frac{\partial z_b}{\partial x} = -g\frac{u|u|}{C^2 a} \tag{2.9}$$

- the mass balance for the sediment transport:

$$\frac{\partial z}{\partial t} + \frac{\partial s}{\partial x} = 0 \tag{2.10}$$

- the momentum equation for the sediment transport:

$$s = f(u, parameters) \tag{2.11}$$

The last equation can be exchanged by the power law:

$$S = Bmu^n \tag{2.12}$$

in which:

m = the sediment transport coefficient.
n = exponent

Rewriting the mass balance of sediment gives:

$$B_i L_i \frac{\partial a_i}{\partial t} = S_i - S_{ie} \tag{2.13}$$

with:

L_i = length of branch number i,
B_i = width of branch number i,
S_i = sediment transport rate into the branch determined by the nodal point relation,
S_{ie} = sediment transport capacity of the branch which is equal to the out flowing transport at the downstream end, which is determined by equation (2.11),
t = time.

The quantities S_i and S_{ie} depend on the variables a_1 and a_2. The sediment transport is assumed to be related to the velocity by equation (2.12), in which the power n has the value 5. The transport rates S_1 and S_2 depend on the nodal point relation. When for the nodal point relation equation (2.6) is used, the differential equation (2.13) can be expressed in a_1 and a_2:

$$\frac{\partial a_1}{\partial t} = -\frac{mQ_0^5}{B_0^5 L_1}\left[\left(\frac{B_0}{B_1}\right)^k \frac{1}{a_0^5}\left(\frac{\beta_1 a_1^{3/2}}{\beta_1 a_1^{3/2}+\beta_2 a_2^{3/2}}\right)^k - \left(\frac{B_0}{B_1}\right)^5 \frac{1}{a_1^5}\left(\frac{\beta_1 a_1^{3/2}}{\beta_1 a_1^{3/2}+\beta_2 a_2^{3/2}}\right)^5\right] \tag{2.14}$$

$$\frac{\partial a_2}{\partial t} = -\frac{mQ_0^5}{B_0^5 L_2}\left[\left(\frac{B_0}{B_2}\right)^k \frac{1}{a_0^5}\left(\frac{\beta_1 a_2^{3/2}}{\beta_1 a_1^{3/2}+\beta_2 a_2^{3/2}}\right)^k - \left(\frac{B_0}{B_2}\right)^5 \frac{1}{a_2^5}\left(\frac{\beta_1 a_2^{3/2}}{\beta_1 a_1^{3/2}+\beta_2 a_2^{3/2}}\right)^5\right] \tag{2.15}$$

in which:

$\beta_j = B_j / L_j^{1/2}$

The subscripts 1 and 2 refer to branch one and branch two respectively. The subscript 0 refers to the upstream branch. The variables in this branch are assumed to be constant.

The equations (2.14) and (2.15) describe the morphological behaviour of a river at a bifurcation. These two differential equations are too complicated to solve analytically. By studying the nature of the singular points a qualitative insight into the behaviour of the equations can be obtained. A point (a_1, a_2) is named a singular point if both derivatives vanish. Physically, these points represent the equilibria of the river system. They can be either stable, neutrally stable or unstable. The singular points can be found by setting the derivatives equal to zero:

$$-\frac{mQ_0^5}{B_0^5 L_1}\left[\left(\frac{B_0}{B_1}\right)^k \frac{1}{a_0^5}\left(\frac{\beta_1 a_1^{3/2}}{\beta_1 a_1^{3/2}+\beta_2 a_2^{3/2}}\right)^k - \left(\frac{B_0}{B_1}\right)^5 \frac{1}{a_1^5}\left(\frac{\beta_1 a_1^{3/2}}{\beta_1 a_1^{3/2}+\beta_2 a_2^{3/2}}\right)^5\right] = 0 \tag{2.16}$$

$$-\frac{mQ_0^5}{B_0^5 L_2}\left[\left(\frac{B_0}{B_2}\right)^k \frac{1}{a_0^5}\left(\frac{\beta_1 a_2^{3/2}}{\beta_1 a_1^{3/2}+\beta_2 a_2^{3/2}}\right)^k - \left(\frac{B_0}{B_2}\right)^5 \frac{1}{a_2^5}\left(\frac{\beta_1 a_2^{3/2}}{\beta_1 a_1^{3/2}+\beta_2 a_2^{3/2}}\right)^5\right] = 0 \tag{2.17}$$

From the system of differential equations three singular points can be derived. One singular point represents an equilibrium with two open branches. The other two singular points represent an equilibrium in which one branch is open and one branch is closed. In the following analysis, the stability of the equilibria found is studied.

A system of differential equations of the form:

$$\begin{pmatrix} \dfrac{\mathrm{d}x}{\mathrm{d}t} \\[2ex] \dfrac{\mathrm{d}y}{\mathrm{d}t} \end{pmatrix} = \begin{pmatrix} f(x,y) \\ g(x,y) \end{pmatrix} \tag{2.18}$$

with singular point (x_0,y_0) can be locally linearized by taking the Jacobian:

$$\begin{pmatrix} \dfrac{\partial x}{\partial t} \\[2ex] \dfrac{\partial y}{\partial t} \end{pmatrix} = \begin{pmatrix} \dfrac{\partial f}{\partial x}(x_0,y_0) & \dfrac{\partial f}{\partial y}(x_0,y_0) \\[2ex] \dfrac{\partial g}{\partial x}(x_0,y_0) & \dfrac{\partial g}{\partial y}(x_0,y_0) \end{pmatrix} \begin{pmatrix} x-x_0 \\ y-y_0 \end{pmatrix} = J(x_0,y_0) \begin{pmatrix} x-x_0 \\ y-y_0 \end{pmatrix} \tag{2.19}$$

A singular point is stable if both eigenvalues of the Jacobian $J(x_0,y_0)$ have a negative real part. Before calculating the Jacobian, the following simplifications are carried out: $B_1 = B_2 = B/2$ and $L_1 = L_2$. For the equilibrium state with both branches open, the following Jacobian can be found:

$$\frac{mQ^5}{32 a_0^6 B_1^5 L_1} \begin{bmatrix} -\dfrac{3k+5}{4} & -\dfrac{15-3k}{4} \\[2ex] -\dfrac{15-3k}{4} & -\dfrac{3k+5}{4} \end{bmatrix} \tag{2.20}$$

For the above given matrix, the following eigenvalues can be found:

$$-5, \quad -\frac{3k-5}{2}$$

The first eigenvalue is negative. The sign of the second eigenvalue depends on the value of k. For the situation in which $k < 5/3$, the second eigenvalue is positive. The singular point at (a_0,a_0) becomes a saddle point resulting in an unstable equilibrium. In the case $k > 5/3$, both eigenvalues are negative. The singular point at (a_0,a_0) becomes a sink. This equilibrium represents a stable situation. This is illustrated in figure (2.5) and (2.6).

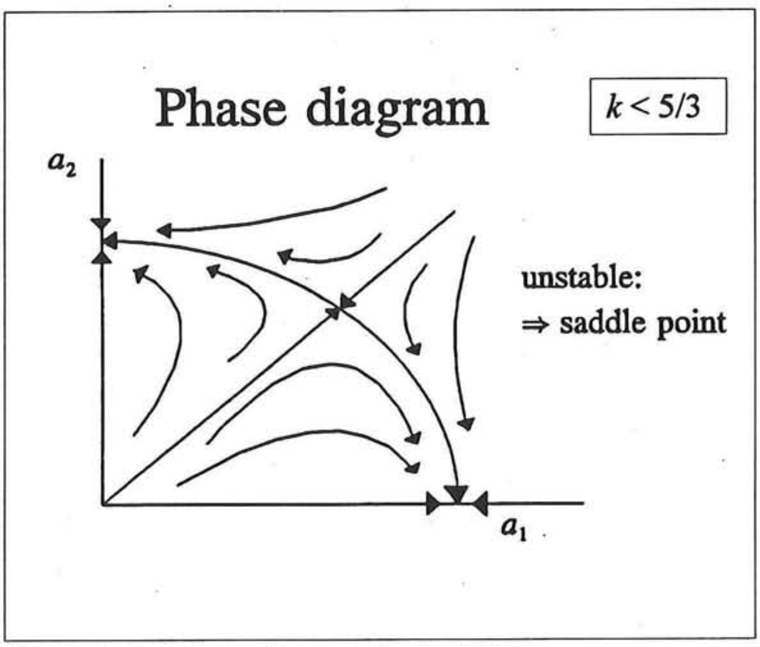


Figure 2.5 - Phase diagram for k <5/3

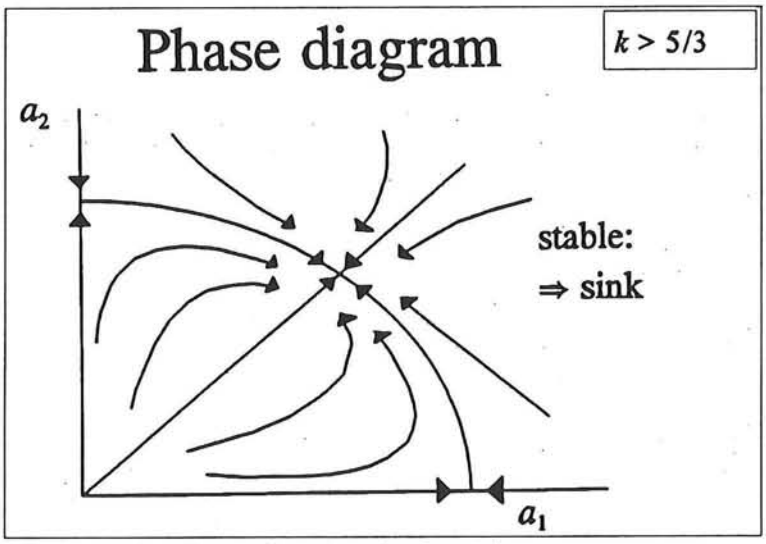


Figure 2.6 - Phase diagram for k > 5/3

The two equilibria, which represent the situation one branch open and one branch closed, are represented by the respective singular points $(a_1,0)$ and $(0,a_2)$. Using again the simplifications: $B_1 = B_2 = B/2$ and $L_1 = L_2$ the singular points found are $(2^{4/5}\,a_0\,,0)$ and $(0,\, 2^{4/5}\,a_0)$. The same analysis holds for these equilibria. Taking the Jacobian and studying the eigenvalues for these singular points, shows, that both equilibria are unstable for $k < 5/3$ and stable for $k > 5/3$, as can be seen in figure (2.5) and (2.6). The previous analysis is made under the assumptions; $B_1 = B_2 = B/2$ and $L_1 = L_2$. This leads to the fact that the line $a_1 = a_2$ represents a line of saddle points and sinks. In the analysis sofar the sediment transport formula of Engelund-Hansen is used, equation (2.12). Other transport formulas use threshold values for the flow velocity to carry sediment. An example of these kind of transport formula is the transport formula of Meyer Peter & Müller. Using this kind of formulas in the previous analysis gives more singular points. The tendency of the analysis does not change applying an other tranport formula. A more detailed describtion can be found in Wang and van der Kaaij (1994).

For the general analysis, using arbitrary values of B_1, B_2, L_1 and L_2 the analysis and figures become more complicated, but they do not change qualitatively.

2.4 Experimental set-up

In section 2.1 several possible nodal point relations are discussed. It was stated that equation (2.6) is likely to give the best results:

$$\frac{S_1}{S_2} = \left(\frac{Q_1}{Q_2}\right)^k \left(\frac{B_1}{B_2}\right)^{1-k} \qquad (2.21)$$

To verify this theoretical equation, experiments are carried out. The results of these experiments are used to find realistic values for *k* and to compare the results with computer simulations.

In the further analysis of bifurcations the nodal point relation (2.21) is used, in a rewritten shape, using sediment transports and discharges per unit of width at the bifurcation:

$$\frac{s_1}{s_2} = M\left(\frac{q_1}{q_2}\right)^k \qquad (2.22)$$

in which:

s_i = sediment transport per unit of width at the bifurcation in branch *i*.
q_i = discharge per unit of width at the bifurcation in branch *i*.
M = constant with value 'one'.

In section 1.4, the assumptions and restrictions are given. One of the assumptions and restrictions is that the sediment transport consists of bed load. The transistion between bed load and suspended load, is given by the ratio of the shear velocity u_* and the fall velocity W. For bed load it holds:

$$\frac{u_*}{W} < 1 \qquad (2.23)$$

in which u_* is the shear velocity given by:

$$u = u_* \frac{C}{\sqrt{g}} \qquad (2.24)$$

Combining equations (2.23) and (2.24) gives a maximum flow velocity:

$$u_{max} = W \frac{C}{\sqrt{g}} \qquad (2.25)$$

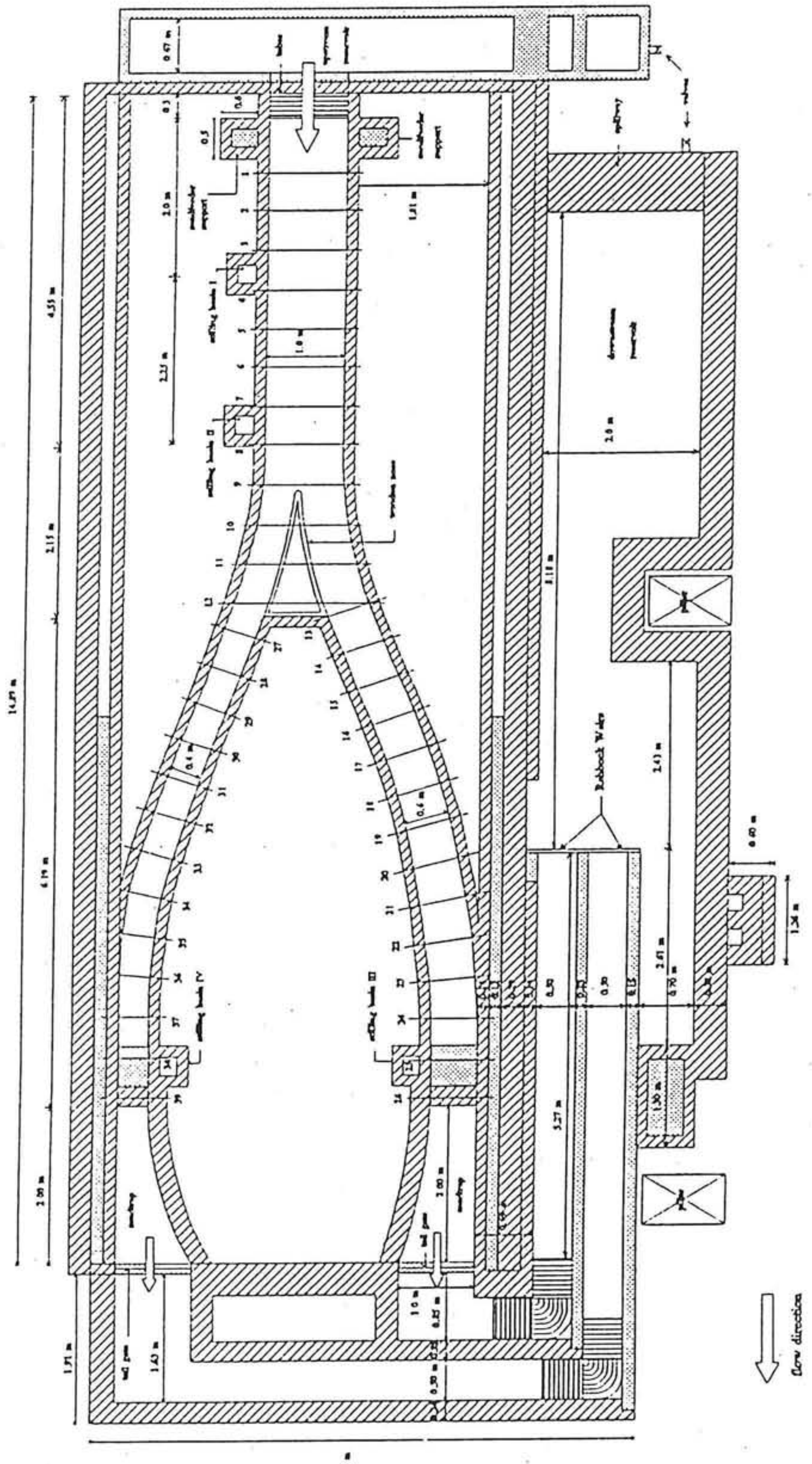


Figure 2.7 - General lay-out of the test rig

This theoretically obtained u_{max} is used as an indication, when a new experiment is designed. It is visually checked, whether the assumption of bed load is fullfilled, when an experiment is executed

The exact features of the test rig are described in Den Dekker/ Van Voorthuizen (1994). In chapter three of this report the most important parts of the test rig and their calibration are described. In this report the word 'model' and 'test rig' are both used to indicate the same. It should be stated clearly that the tests were not carried out in a scale model of a real bifurcation.

To fulfil the goal of the research as described in section (1.4), the actual sediment ratio that occurred during an experiment at the bifurcation, has to be determined. For one branch the amount of sand, which has passed the bifurcation during a test, can be determined from the volume of sand, found in the sand trap and the change of the bed level, in the respective branch downstream of the bifurcation, integrated along the length of the branch. The change in bed level is determined by measuring the bed level before and after the test, at the cross sections given in figure (2.7). Because of the discrete nature of the bed level measurements a considerable error is made in the determination of the bed level change; this is described in chapter five. In this manner a total volume of sand, which has passed the bifurcation, is found. When this is done for both the branches, the sediment ratio, s_1/s_2 can be found.

The discharge ratio can easily be found using the Rehbock flumes situated at the end of the test rig. See fig.(2.7). Since the discharges of the two branches remain separate from the bifurcation until the Rehbock flumes and no extra water enters the model, the sum of the discharge measured in the flumes is the same as the discharge passing the bifurcation.

In this test rig the influence of several variables on the behaviour of the bifurcations can be studied. First of all the shape of the nose can be changed. Since the nose is not a permanent part of the model, it can easily be replaced. In Den Dekker/ Van Voorthuizen (1994) three nose types are described. For the experiments discussed in this report only the first and the second nose type are used. Their lay-out and features are discussed in section 3.5 of this report.

Secondly, the upstream discharge can be changed. It is assumed that sediment transport occurs in both branches and that the sediment transport consists of bed load only. These assumptions lead to restrictions for the upstream discharge. The dimensions of the test rig itself also lead to restrictions of the upstream discharge. For low discharges, the water depth needed to create bed load transport in both branches, is also low. The water level is adjusted by the tail gates. These tail gates have a minimum level. The still-water level basins need a certain minimum water level. The restrictions lead to a minimum upstream discharge. For the experiments described in this report, the minimum discharge is chosen to be 20 l/s. Of course a higher bed level can be used for low discharges. For a higher bed level, more sand is needed, which was not available at the beginning of the experiments.
The upper bound of the discharge is restricted by the height of the model, the assumption of bed load in both the branches and the fact that the scour holes in the sand bed should not reach

the concrete floor of the test rig. In the experiments sofar a maximum discharge of 40 l/s is used. The maximum and minimum discharge led to the three upstream discharges applied; 20 l/s, 30 l/s and 40 l/s.

The third variable is the sand size. In the experiments described in this report, only one type of sand is used. This sand has a D_{50} of 270 μm. By washing the sand, before the experiments were carried out, it was possible to visualize the bed forms and their movement.Washing the sand led to a change of the sieve curve as the finer parts of the sand are also washed away.

The last variable is the water level at the end of the branches. This water level can be adjusted by the tail gates. The position of the tail gates together with the bed levels in the two branches, gives a certain discharge distribution. Changing of the discharge distribution is done by changing the tail gates or the bed levels. This is described in chapter four.

In the test rig two cyclic movements are present. First the water movement is described. In figure (2.7), it can be seen, that water is pumped from the downstream reservoir to the upstream reservoir. From the upstream reservoir, the water flows through the model. Next, the water flows through the sand traps and the Rehbock flumes into the downstream reservoir again.

The second cyclic movement is the movement of the sand. A part of the sand is used for the sand bed in the model. the other part of the sand is used for the sand feeder. The sand caught in the sand trap is first measured. Then it is dried to be used again in the sand feeder. Drying of the sand is done by spreading a thin layer of sand on a plastic sheet.

Chapter 3 The model: description and calibration

3.1 Introduction

The test rig in which the experiments were carried out, is located in Dhaka, Bangladesh. The building of the model has been carried out in 1994 by van Voorthuizen, den Dekker and Hannan. An overview of the model is described in the next section. For a detailed description of the model, see Den Dekker and Van Voorthuizen (1994).

Before running the experiments, first all essential parts of the model had to be tested. These tests showed that some parts of the model needed further attention, since they did not work properly. In the following sections the testing of the sand feeder, the sand traps, the stilling basins, the pump and the Rehbock flumes are described.

3.2 The overall model

The test rig consists of two separate parts: a temporary part and a permanent part. The permanent part is the experimental facility, necessary for the storage and regulation of the water circulation through the test rig, and the guidance of this water to and from the temporary part.

The temporary part contains the actual experimental model of a bifurcation in a river. It is a mobile-bed model with fixed banks. The lay-out of the river comprises three branches: a main branch, branch 0, which bifurcates into two separate branches, branches 1 and 2, see figure (3.1). To avoid accidental equilibria during experimentation, branches 1 and 2 have different widths.

A sand trap is situated at the end of each of these two branches, followed by a tail gate for the control of the water levels. The water that flows over the tail gates is led to Rehbock flumes, with which the respective discharges are measured. At the beginning of branch 0, at the bifurcation and at both ends of branches 1 and 2, 'stilling basins' are constructed to measure the water levels. In the following sections parts of the test rig are discussed in more detail.

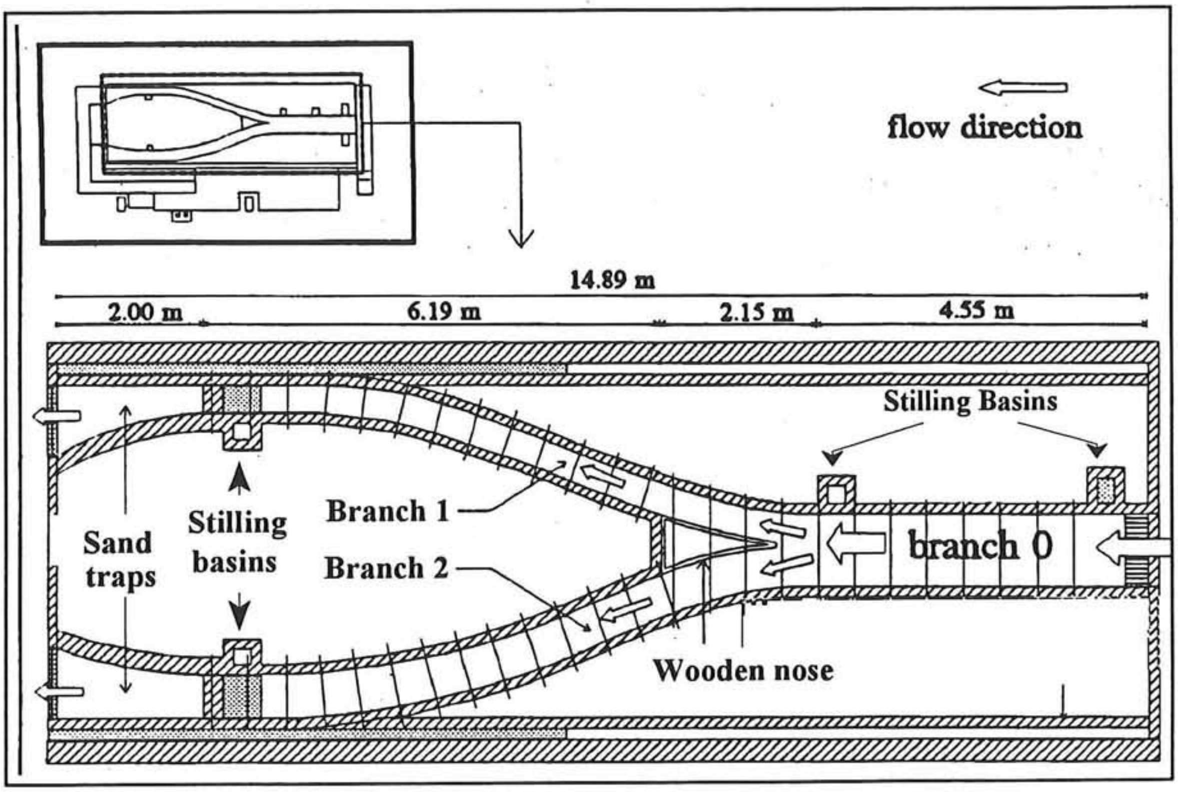


Figure 3.1 - An overview of the test rig

3.3 The water supply

One of the important boundary conditions is the upstream discharge. This upstream discharge has to be constant during an experiment, to ensure that the experiment is not influenced by a variation in the upstream discharge. The magnitude of the discharge is regulated by a distribution system. A pump takes care of a constant discharge of 90 l/s. This discharge is divided into two parts: one part flows to the test rig, while the other part is flowing back into the reservoir. The distribution can be regulated by a valve in the pipe leading back to the reservoir and a valve in the pipe leading to the test rig.

Before the start of every experiment the valves are set in the proper position before the new bed level is laid in the model. This is done by creating a high water level in the test rig, by turning up the tail gates at the ends of branch 1 and 2. Then the discharge is slowly raised up to the desired discharge.

For the measurement of the total discharge, an orifice was constructed. Due to a leakage problem in the orifice, it was, however, not possible to use it. That is why the total discharge is measured using the two Rehbock weirs. The total discharge is simply obtained by adding the two respective discharges.

During the first experiments the problem arose that the total discharge was not constant during the experiment. Two phenomena can cause this problem.

- During the experiments the washing of sand was going on. This was done by people who took clean water out of the reservoir to wash the sand. Taking water out of the reservoir causes lowering of the water level in the reservoir. This causes a changing head for the pump, which causes a lowering discharge. It was decided to stop the sand washing while running an experiment, to remove this influence
- It is possible that a small water wave occurs in the model, due to the fact that the tail gates are adjusted once in a while. Adjusting the tail gates causes a long wave, which propagates through the model with a long damping-time. It is difficult to get rid of this wave.

3.4 The sand feeder

3.4.1 Distribution of the sand over the width

To get the sediment more or less equally distributed, several ideas were tried. Pipes with small holes (a kind of shower device) were tried in several positions. They did not work sufficiently.

Then a triangle board was designed and made. (See figure 3.2). The sand is being dropped at the top. By the upstanding boards the sand is forced to go to the sides. The boards can be turned, to influence the flow of the sand.

Tests were carried out with this triangle board. At five points, equally distributed over the width, the sand was caught in small buckets. Afterwards the sand in every bucket was weighed. It appeared that the buckets near the wall caught less sand than the buckets in the middle.

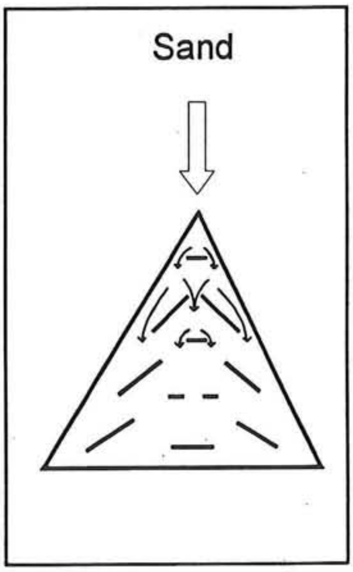


Figure 3.2 - The sand distributor

It is assumed, that the sediment is equally distributed after cross section 4 by the water movement itself, i.e. before the sediment reaches the nose. This is visually observed by looking at the shapes of the bed forms.

3.4.2 Calibrating the sand feeder.

To be able to change the boundary condition of the test rig, the sediment transport at the upstream boundary has to be adjustable. This can be done by varying the sand flow from the sand feeder. The amount of sand that flows out of the sand feeder can be regulated by regulating the voltage supply to the sand feeder. A regulator was therefore installed, with a range from zero to one hundred. For every step of five, the sand supply per unit of time has been measured. The capacity of the sand feeder lies between zero and 50 kg per hour.

While operating of the sand feeder, it appeared, however, that after a few experiments the flow of sand was changing, thus that the calibration was not valuable anymore. That is why it is was decided to measure the flow of sand from the sand feeder before, during and at the end of an experiment, to check whether the good boundary condition still remained.

3.5 The nose

The distribution of the sediment transport rates to the downstream branches is governed by the local flow pattern at the bifurcation. The shape of the bifurcation point influences the local flow pattern and thus has a great influence on the nodal point relation. That is why three types of noses were built:

- one symmetrical nose (see figure 3.3)
- two asymmetrical noses. From them the first tip is directed towards branch 1 reducing the inflow area of this branch with 50 percent with respect to the symmetrical tip (see figure 3.4). Experiments, using this nose were already carried out. The second tip is directed oppositely and reduces the entrance of branch 2 by 50 percent (see figure 3.5). With this nose no experiments are done untill now.

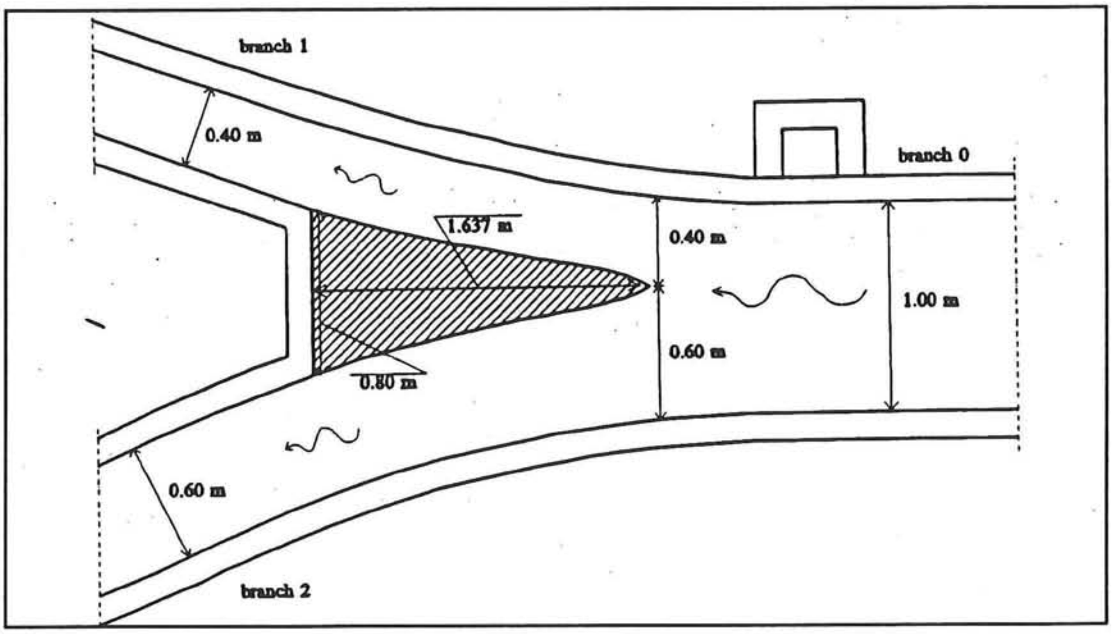


Figure 3.3 - Symmetrical nose

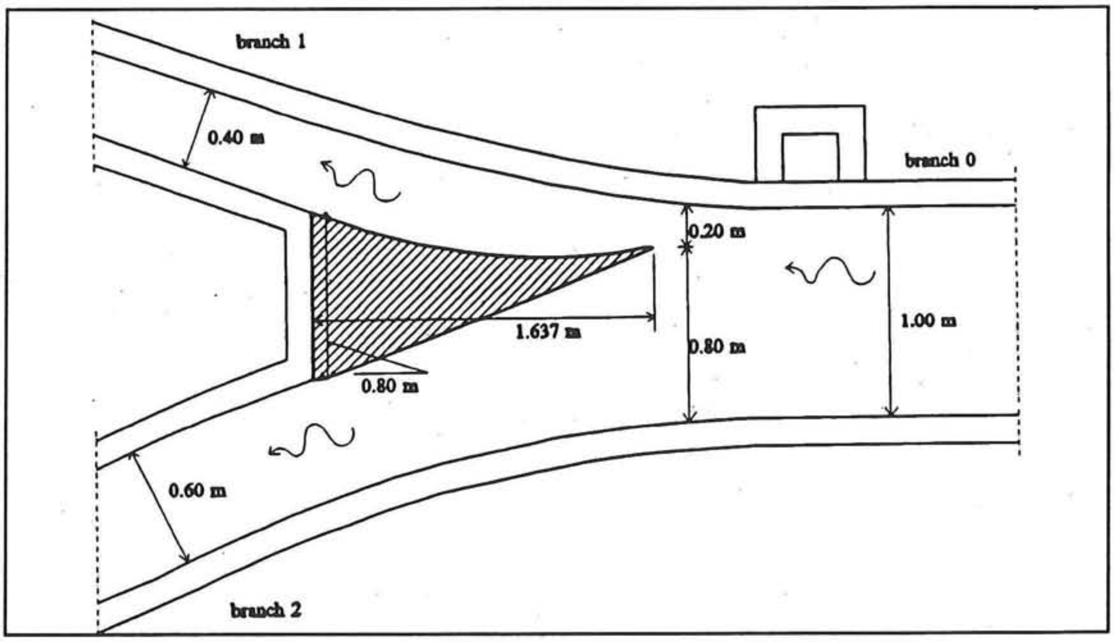


Figure 3.4 - Asymmetrical nose; branch 1 50% closed

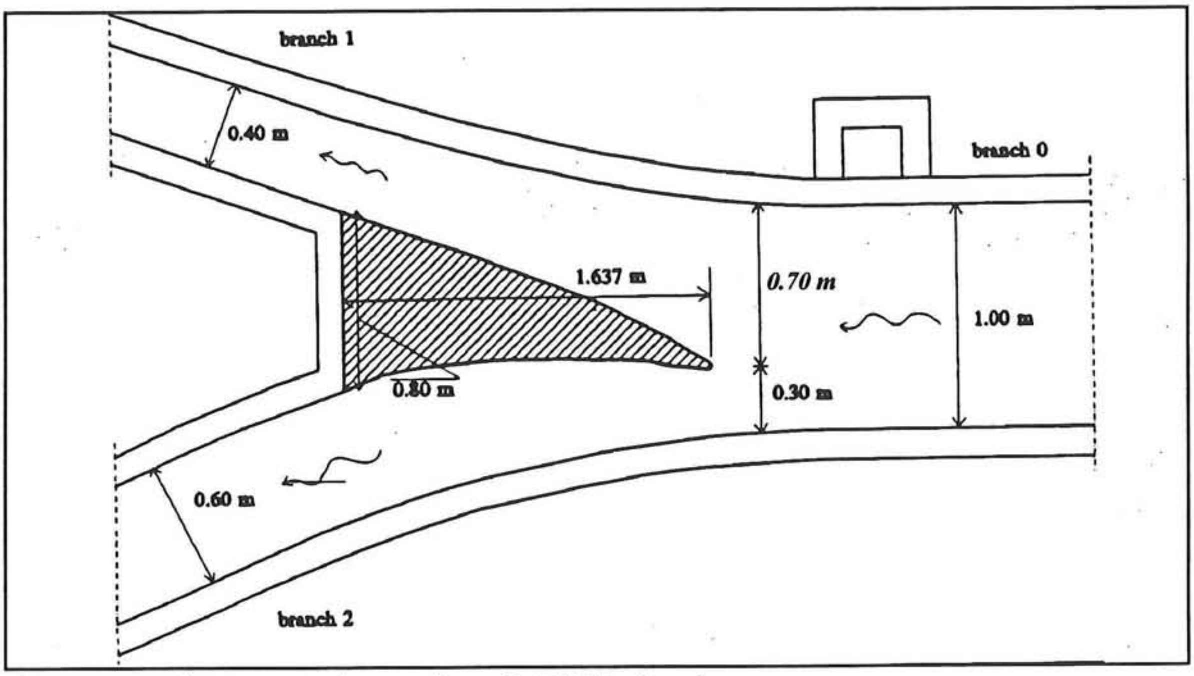


Figure 3.5 - Asymmetrical nose; branch 2 50% closed

3.6 The sand traps

The sand traps are used to measure the sediment transports in both branches by catching all the sand that has been transported towards the ends of branch 1 and branch 2.

Problems occurred in previous experiments, because sand had come in the Rehbock flumes, and thus passed the sand trap. In this experiment a discharge in branch 0 of 50 l/s had been used.

Therefore the sand traps had to be tested. The first test was done by putting the calculated discharge with its normal depth from the first designed experiment on branch 1. The second test was done with a higher discharge and a larger depth. The sand transport was measured in three ways:

- by measuring the volume of sand in the sand trap,
- by measuring the change in bed level,
- by calculating with the Engelund-Hansen formula.

The first test was done for 4.5 hours and the second one for 4 hours. The results are expressed in the table (3.1). The sediment transports are expressed in the mass of sand that is transported during the test.

Test	Time	Q[l/s]	a[cm]	u[m/s]	Transported sand (E-H) [kg]	Sand in sand trap [kg]	Bed change [kg]
I	Begin	14	10	0.35	0	0	0
I	End(4.5 h)	14	11	0.32	98.6	100.9	111.3
II	Begin	18.7	13	0.36	0	0	0
II	End(4 h)	18.1	13.5	0.34	109.1	103.3	71.2

Table 3.1 - Testing the sand traps: sand transports

In both experiments the weight of sand that passed the sand trap was 0.7 kg.

From this test the following conclusions can be drawn.

- The sand trap in branch 1 satisfies for the velocities that were imposed on the model. It is assumed that the sand trap in branch 2 will also satisfy for these velocities.
  During the experiments, care has to be taken that the velocities will not exceed 0.36 m/s. Another way to avoid sand passing the sand trap is to ensure that there is no suspended load in the flow. This can be checked visually.
- The predicted sand transport using the Engelund-Hansen formula is almost the same as the measured sediment transport in the sand trap.

3.7 The Rehbock weirs

The discharge in the branches one and two were measured by two Rehbock weirs. The upstream discharge is obtained by adding the discharges of branch 1 and 2. The two Rehbock weirs were calibrated using the discharge equation of a Rehbock weir (ISO, 1975):

$$Q_R = C_e \frac{2}{3}\sqrt{2g}.B.h_e^{\frac{3}{2}} \tag{3.1}$$

with:

$h_e = h + k_h = h + 0.0012$
$C_e = 0.602 + 0.083h/p$

where

Q_R is the discharge measured over the Rehbock weir;
C_e is the coefficient of discharge;
b is the measured width of the weir;
h_e is the effective piezometric head with respect to the crest level;
h is the measured head;
k_h is an experimentally determined quantity which compensates for the influence of surface tension and viscosity;
p is the apex height in metres.

To test the discharge measurements a certain discharge was installed in branch 1, and the water level in the stilling basin of the Rehbock weir of branch 1 gave a value for the head over the Rehbock weir. With the earlier calculated calibrations the discharge could be found. Then the same discharge was put on branch 2 and the water level in the stilling basin of the Rehbock weir of branch 2 gave a value of the head over the Rehbock weir. This also gave a value of the discharge.

The difference between the two readings in this experiment was only 0.05 l/s, while the discharge was 28.5 l/s, so the variation between both Rehbock weirs appeared only 0.2%.

The following conclusion can be drawn from this test.

The discharge measurements are relatively accurate. The tests gave an error of 0.2%. It is assumed that because the two Rehbock weirs measured almost the same discharge, this discharge is the proper discharge, since little errors can be made with discharge measurements with Rehbock flumes.

Care has to be taken against blockage of the tubes that connect the Rehbock flumes with the stilling basins by sand and dirt. It was decided to clean these tubes before every experiment to be run.

3.8 Characteristics of the sand

3.8.1 Distribution of the diameter

The sand used in the model has a certain distribution of the diameter. To be able to do visual observations of the bottom, it was decided to wash the sand, to remove the small particles that make the water dirty. After washing it appeared that the water remained clear during the experiment. In figure 3.6 the distribution of the sand diameter is given. The line with the least fine particles is the distribution of the sand after washing it. The other line is the distribution of the sand before washing it.

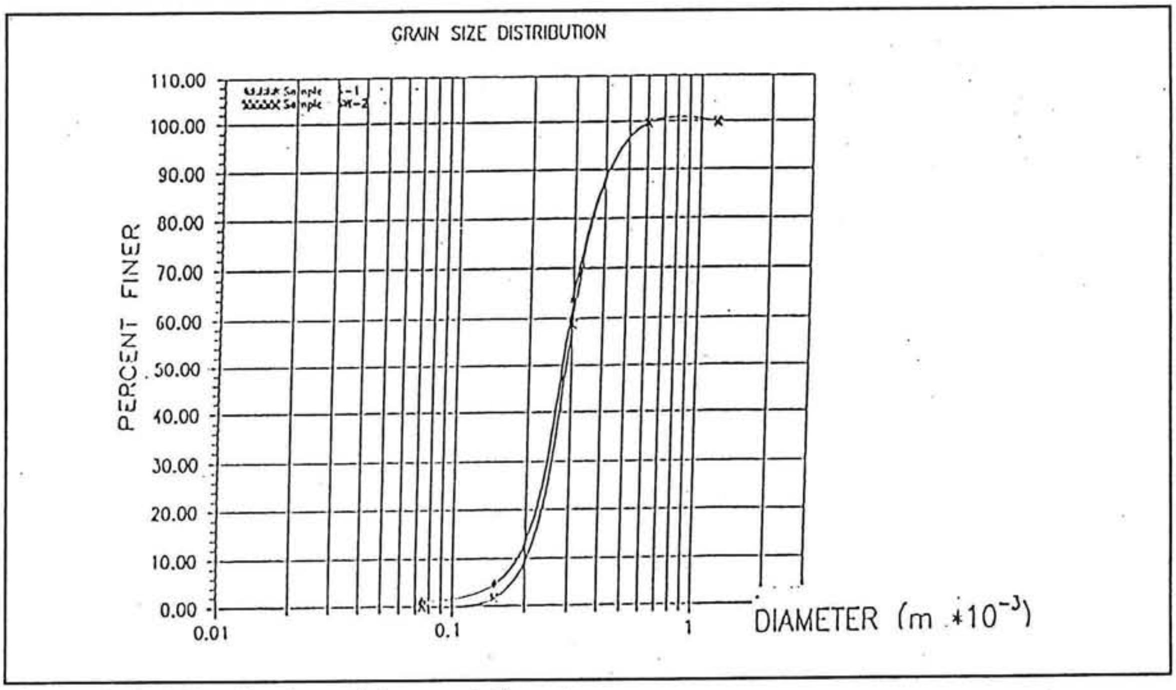


Figure 3.6 - Distribution of the sand diameter

From figure 3.6 it can be seen that after washing the sand:
$D_{10} = 200$ μm
$D_{50} = 270$ μm
$D_{90} = 400$ μm

3.8.2 The void ratio

The void ratio of the sand used in the model was experimentally determined.
First all the dimensions of a bucket were determined and the weight of the empty bucket was measured. Then a certain volume of submerged sand, taken from different places out of the model, and water were put in the bucket. It is assured that the sand level was flat.
Then the level of the water and of the submerged sand was measured
Together with the dimensions of the bucket, the volume of the submerged sand and of the water standing above are is known.
Then the bucket filled with the sand and the water was weighed.
This weight consists of the following parts:

$$W_b = W_{b,e} + V_w \rho_w + V_s \rho_s (1-\epsilon) + V_s \rho_w \epsilon \tag{3.2}$$

where

W_b is the measured weight of the bucket filled with sand and water,
$W_{b,e}$ is the weight of the empty bucket,
V_w is the volume of the water that stan,ds above the sand
ρ_w is the mass density of the water,
V_s is the volume of the submerged sand, including the pore volume,
ρ_s is the mass density of the sand,
ϵ is the void ratio of the sand.

In equation (3.2) the void ratio is the only unknown, so it can be solved. This procedure is done four times, which gave the following results:

$\epsilon_1 = 43.7\ \%$
$\epsilon_2 = 44.7\ \%$
$\epsilon_3 = 39.5\ \%$
$\epsilon_4 = 42.6\ \%$

This gives a mean value for the void ratio of 42.6 %, which is used in all further analyses.

Chapter 4 Design and measurements of the experiments

4.1 Introduction

The goal of this research is to get more insight into the behaviour of the sediment distribution at bifurcations. To get more insight into this behaviour, an equation which gives the relation between the discharges and the sediment distribution has to be found. Some equations are mentioned that could describe this distribution. The most likely equation to describe this process is the following, as mentioned before in chapter two.

$$\left(\frac{s_1}{s_2}\right) = M.\left(\frac{q_1}{q_2}\right)^k \tag{4.1}$$

where s_i is the sediment transport and q_i the discharge in branch i, both per unit of width.

To test equation (4.1) and to get more insight into the behaviour of the sediment transport at bifurcations, measurements have been carried out in a test rig.

From equation (4.1) it can be seen that it is necessary to measure s_1, s_2, q_1 and q_2, to get relations between (s_1/s_2) and (q_1/q_2).

The water levels at the beginning of branch 0, at the nose and at the ends of branch 1 and branch 2 were measured, to determine the slopes in branch 0, 1 and 2. The water levels at the ends of branches 1 and 2 are also necessary for the adjustment of the downstream boundary conditions (see figure 2.1).

The magnitudes of the upstream discharge, the upstream sediment transport, the slopes, the bed levels of the branches, and the water levels at the end of branch 1 and branch 2 have to be fixed before an experiment can be done. The design of these magnitudes is explained in the next section.

4.2 Design of an experiment

4.2.1 Introduction

Before running an experiment a certain starting condition has to put on the model. Therefore it is necessary to have some idea of the equilibrium situation that will occur with the given boundary conditions. A disturbance will be put on this equilibrium to get variable discharge ratios. The depths that follow from this disturbance will be put in the model before running the experiments.

In fact, it is impossible to predict the equilibrium situation, because of the fact that at the time before the start of an experiment, the distribution of the sediment in the two branches downstream of the bifurcation is not known; it is the goal of these experiments to find this distribution!

To start somewhere, however, before starting the first experiment, a relation between the discharge distribution and the sediment distribution is assumed. After some experiments, more insight was obtained into this relation, so more valuable normal depths could be found.

4.2.2 Calculation of the equilibrium situation

The sequence of the design is the following.

- Choose an upstream discharge.
- Choose the ratio Q_1/Q_2.
- From Q_1/Q_2 and Q_0 follow the values of Q_1 and Q_2.
- From Colebrook-White follows:

$$C = 18\log\frac{12R}{k} \tag{4.2}$$

  The k value according to Nikuradse is assumed to be 0.02 m. Using a water depth of 0.1 m and the widths of the branches gives, with $R_0 = A/P = 0.1*1/1.2 = 0.09$ and $R_1 = A/P = 0.1*0.4/0.6 = 0.07$, the average $R = 0.08$. Substituting these values in equation 3.2 gives $C = 30$ m$^{1/2}$/s, which is used in all further analyses.

  Thus, calculation gives $C = 30$ m$^{1/2}$/s. The first experiments proved that when using $i_0 = 1.3\ 10^{-3}$, good results were obtained. Substituting these values in the Chézy equation gives the value for the depth in branch 0.

- With the depth in branch 0 the velocity in branch 0 can also be calculated, using $Q=u.A$
- With this velocity the sediment transport in branch 0 can be calculated, using the Engelund-Hansen equation.
- At this point, Q_0, a_0, S_0, u_0 and i_0 are known. Now the depths and the slopes, the discharges and the sediment transports of branch 1 and 2 have to be determined. Thus, there are still eight unknown variables. These unknowns can be found by using 8 equations. Four equations follow from the combination of the Chézy equation and the transport equation for both branches. The fifth equation follows from the fact that the water levels at the bifurcations are the same for both branches. The sixth and seventh equation express the continuity for discharge and sediment at the bifurcation and the eighth equation is the nodal

point relation at the bifurcation. In sub section 8.5 the actual equations can be found.

The solution of these 8 equations gives the following solution for q_1/q_2:

$$\left(\frac{q_1}{q_2}\right)=M^{\left(-\frac{3}{3k-5}\right)}.\left(\frac{b_1}{b_2}\right)^{\left(-\frac{2}{3k-5}\right)}.\left(\frac{L_2+R}{L_1}\right)^{\left(\frac{5}{3k-5}\right)} \tag{4.3}$$

The ratio of the discharges varies with the difference between the respective water levels downstream of branch 1 and 2 (Δh). This Δh follows from equation 4.3, using $\Delta h = i_2.R$. This variable R is explained also in chapter 8.
With these equations iteratively Q_1/Q_2 has to be found, while varying Δh.
Note that a positive Δh is related to the fact that $h_2 > h_1$.

- When the chosen ratio of the discharges is found, the depths, slopes, sediment transports and discharges of branch 1 and 2 can be solved from the eight equations too.

- From the discharges, the depths and the widths, the velocities follow. These velocities should be between the ranges that have been chosen to ensure bed load in both branches. If one of the velocities exceeds the chosen range, the experiment should be redesigned, by choosing another ratio of the discharges, or another slope in branch zero.

4.2.3 The actual design

With the above-mentioned method, the equilibrium situation is known. On this equilibrium situation a disturbance has to be introduced. If the bifurcation is a stable one, the model will return to this equilibrium. While returning to the equilibrium situation, the discharge ratio and the sediment transport ratio will change. Thus, during the experiment, several relations between the discharge ratio and the sediment transport ratio will occur, giving more points in the relation that is studied.

The disturbance has to be introduced in such a way, that new points will be obtained in the region where at that moment no points have been found.

4.3 The discharge measurements

The discharges of branch 1 and 2 are measured using Rehbock weirs. These weirs were made locally according to the specifications mentioned in ISO (1975). The water level at the crest of the weirs was measured in stilling basins. The approach channels to the Rehbock weirs are connected with the stilling basins by a tube. In the stilling basins the water levels were measured with point gauges. This method induces an accuracy of 0.05 mm. The zero levels of the point gauges were set by filling the two approach channels with water, up to the crest level of the weirs; the point gauges were then adjusted, and the zeros fixed.

4.4 The sediment transport measurements

4.4.1 Introduction

The measurements of the sediment transport consists of two parts.

1 The sediment that passes the end of a branch, was caught in a sand trap. The volume of this sediment is called V_s.

2 In the branch itself, the bed level was changing during the running of an experiment. To get the sediment transport at the bifurcation (= the 'nose'), it is necessary to take the bed-level change during the experiment into account. By integration of the bed-level changes over the length and over the width of the branch, the change of volume is known:

$$V_b = \int_L \int_B \Delta z . \mathrm{d}l . \mathrm{d}b \tag{4.4}$$

where V_b is the change of volume in the branch and Δz is the bed-level change at every point in the branch. The positive direction of Δz is upwards.

Then, s_i follows from:

$$s_i = \frac{(V_b + V_s)}{(\Delta t * B_i)} \tag{4.5}$$

In this equation, Δt is the duration time of an experiment.

4.4.2 Measurements of the sand traps

The sand traps were emptied after one day of running the experiment. Therefore the sand traps were cut off from the branches, using stop locks with bicycle tubes. Then the water was syphoned out of the sand traps, while good care was taken that the sand was not being syphoned out with the water. When the water was removed out of the sand traps until it was impossible to syphon out more water without leaving the sand, the syphoning was stopped. Then the sand with water was put in buckets. Care is taken that the water level in the bucket was above the level of the sand in the bucket. Thus, the sand remained saturated with water. For every bucket the following procedure is used.

Buckets filled with sand and water were compared with buckets filled with only water to the same level. The buckets filled with water only had been calibrated earlier, by weighing the bucket for different water levels. The weight of the bucket filled with only water was subtracted from the weight of the bucket filled with sand and water. The weight found is the submerged weight of the sand. This follows from:

if W = weight of bucket.
V_1 = total volume.
V_2 = volume of sand.

the weight of the bucket with only water is:

$$W + V_1 * \rho$$

the weight of the bucket, filled with water and sand is:

$$W + (V_1 - V_2)\rho + V_2(1-\epsilon)\rho_s + V_2\epsilon\rho$$

Subtracting these from each other gives:

$$(W + (V_1 - V_2)\rho + V_2(1-\epsilon)\rho_s + V_2\epsilon\rho) - (W + V_1 * \rho)$$

$$= - V_2\rho + V_2(1-\epsilon)\rho_s + V_2\epsilon\rho$$

$$= V_2(1-\epsilon)\rho_s - V_2(1-\epsilon)\rho = V_2(1-\epsilon)(\rho_s-\rho)$$

The first part of the equation represents the weight of dry sand, the second part the buoyancy caused by the water. The result then was a certain number of buckets with a weight of submerged sand. This had to be translated into the volume of sand in the sand trap. This is done using the following equation:

$$V_s = \frac{\sum_{i=1}^{n} B_i}{(\rho_s - \rho)(1 - \epsilon)} \tag{4.6}$$

where B_i is the submerged weight of one bucket, n is the number of buckets and V_s the total volume of sand in the sand trap, including the pores.

4.4.3 Measurement of the bed level

Introduction

The bed level was measured using a point gauge in which a special pin was used. A square plate of 2x2 cm^2 was fixed to the point of the pin to prevent it from sinking in the sand bed and to be able to see accurately whether the plate had reached the sand bed. All measurements had to be related to a certain reference level. This is treated in the next section.
The question arises how many points per cross section should be measured to get a reasonable accuracy. This is treated further on in this section

Reference level

The bed level has to be measured in relation to a reference level. Therefore one certain point at the laboratory floor was chosen as the reference level to which all bed-level measurements were related. The bed level was measured with a measurement frame. This frame was laid on the sidewalls of the flumes. Thus, the walls of the flumes also had to be related to the reference level. Therefore the model was filled with water to a certain arbitrary level above the reference level.
Since there was no water movement at that moment this provided a perfectly horizontal reference level. Now at every measuring point this water level was measured with the equipment used. With this method the level of every measuring point was related to the reference level.

Number of points per cross section

Since the bed is not a flat plane, the bed level had to be measured at several points to get an accurate overview of the bed level. It was decided to measure the bed level at cross sections that had a distance in between of 50 cm. To decide how many measurements had to be taken in one cross section, an experiment was carried out.

In branch 0 two cross sections were measured at three, five and ten points. In branch 1 and 2 two cross sections were measured at three and five points. One cross section was a cross section with a reasonably flat bed. The other cross section was a cross section with a deep hole. With these points the average bed level was calculated in two ways:

- With the first method the average bed level was obtained by simply averaging the respective number of points.
- The second method was to compute the transverse surface of the bed with the respective number of points. The average bed level was obtained by dividing this surface by the width of the branch.

The results were all compared with the results of the measurement with ten points. It was assumed that the measurement with ten points gave almost the exact average bed level.

The results lead to the following conclusions.

- A trivial conclusion is that more points measured per cross section give a more accurate bed level.
- The accuracy decreases when the bed is rough.
- With a flat bed level the accuracy does not change much, when more points are measured per cross section; with a rough bed it does.

Finally it was decided to measure the bed level in branch zero at ten points per cross section. In branch one and branch two, five points per cross section were measured, since the accuracy decreased significantly when less points were measured in case of a rough bed. To keep things clear, also when there is a flat bed, the same number of points was measured.
This decision was made after two experiments, so the first experiments were carried out with the following number of points: in branch zero five points per cross section were measured; in branch one and branch two, three points per cross section were measured.

4.5 Measurements of the sand feeder

At the upstream side of the model, sand was fed at cross section 1 of branch 0. The amount of sand fed had to be measured during the experiments. Every experiment was designed before running it. This gave an upstream discharge, a slope in branch 0, 1 and 2, the bed levels in branch 0, 1 and 2 and the upstream sediment transport. This upstream sediment transport was simulated by a sand feeder, which fed a certain weight of sand per unit of time. The experimental design, however, gave a volume per unit of time. These two values can be compared using:

$$W_s = \frac{V_s \cdot \rho_s}{(1-\epsilon)} \tag{4.7}$$

Here ρ_s is the mass density of the sand, 2650 kg/m^3, ϵ is the void ratio, 42.6%, W is the weight of the sand and V_s is the volume of the sand, including the pores.

The amount of fed sand wass also used to check the sand balance after every experiment. The amount of fed sand should be equal to the amount of sand in the sand traps plus the volume change due to bed-level change.

The checks of the sand feeder were carried out by catching the sand in a bucket during 10 minutes, and weighing this sand. This was done just after the start of an experiment and just before ending an experiment. It is important to put the sand back in the model afterwards, at the point where the sand was fed. It appeared that the amount of fed sand varied somewhat during the experiment. The maximum variation measured was 10% during eight hours of experimenting.

4.6 Measurements of the water levels

The water level in the model was measured at four places, in stilling basins placed at the beginning and the end of each branch.

The water levels at the end of branch one and two were used together with the tail gates to regulate the downstream water level. This water level was checked every time the water level was measured. The water level changed during the experiment, because of the fact that the Q_1/Q_2 ratio was changing during an experiment. This induced a change in the head over the tail gates. If the tail gates should remain at the same level, the water level would also change. That is why every time the water level was changed, the tail gates had to be adjusted, to ensure the correct downstream boundary condition.

The stilling basins I, III and IV were 'fixed' stilling basins: they represented the water level at a fixed place of the adjacent branch, namely the water level immediately in front of it. The water seeps through a hole in a wooden plate fixed in the wall of the branch. This wooden plate could be moved upwards and downwards to ensure that the seepage hole remained always located between the water level and the bed level. It is important to check at regular times whether the seepage holes to the stilling basins were still open.

Stilling basin II, which was located near the bifurcation, was a 'flexible' stilling basin: water levels at different places in the neighbourhood of the stilling basin could be measured. This stilling basin was completely closed. The water was syphoned into the stilling basin via a Pitot tube. The Pitot tube could be moved to different spots in the channel so it was possible to measure the water level at different places near the bifurcation. This was necessary, since different nose types were applied which each induce different local flow patterns. It must be noted that the Pitot tube was merely used as a syphon, and not as a measuring device: the readings were done using a point gauge in the stilling basin, which gave more accurate readings.

The water levels in the stilling basins were measured with a point gauge. The zero levels of the four point gauges were set with the same method and at the same time as setting the zero levels of the bed level measurements. Thus the model was filled with water, which made a horizontal reference level to which all four gauges were related. The water level was related to a certain (known) level at the laboratory floor, so all measurements could be related to a reference level.

During the analysis of the measured data it appeared that the water-level measurements were not accurate. Especially the water level in stilling basin II could not be trusted. A reason for this can be that the syphoning with the Pitot tube acts slowly, so the water level in the stilling basin does not follow the water level in the test rig. While doing further experiments the method of measuring the water levels should be improved.

4.7 Measurement programme

4.7.1 Introduction

In section 4.2 the design of an experiment was treated. This design was performed in the model. Then the actual experiment could start. Since the discharge was changing during the running of an experiment, it appeared in practice that one experiment consisted of three days running the model. After three days of running the discharge ratio was not changing significantly anymore, so a new experiment was designed and carried out. Thus, a difference has to be made between an experiment and one day of running the model: One experiment consisted of three days of running the model.

Before the experiment was executed, several parameters were measured: the upstream discharge, the flow from the sand feeder and the bed levels. During one day of running the model, at certain time intervals the discharges and the water levels were measured. After every day of running, the bed levels and the sand traps were measured. In the following sections this will be explained in more detail.
To get all measurements well collected, measurement forms have been designed. They can be found in the appendix A.

4.7.2 Measurements before running an experiment

Before the first run of an experiment, the bed levels had to be measured to be able to calculate the bed level change after one day of running. Before the second and the third run of the experiment, the bed levels also had to be measured. The bed levels, however, were also measured at the end of the first and second run of the experiment. The measurement after the first and second experiment could also be used as the measurement before the second and third experiment, respectively, since the bed levels did not change in the time in between.
The bed was measured at 39 cross sections with a mutual distance of 50 cm. In branch 0 ten points per cross section were measured, while in branch 1 and branch 2 five points per cross section were measured.

Before the first run of the experiment, the upstream discharge that followed from the design of the experiment had to be adjusted After the first and second run, the valves that adjusted the upstream discharge, were not touched, so the same discharge occured during the second and third run of the experiment.

At last, the sand feeder had to be adjusted, to get the good upstream boundary condition that followed from the design of the experiment. The sand feeder had to be adjusted before every run of the experiment, since it might be possible that the feeding capacity of the sand feeder was changing somewhat during the experiment. The maximum change that occurred is 5%.

4.7.3 Measurements during an experiment

During the running of an experiment, the following parameters were measured.

- The discharges of branch 1 and branch 2 were measured every 15 minutes, to get a good overview of the development of the experiment.

- The water levels at the beginning of branch 0, at the nose and at the ends of branch 1 and 2 were measured every 30 minutes. If the water levels at the ends of branch 1 and 2 had been changed, then the tail gates had to be readjusted.

- After four hours of running the sand feeder rate was measured, to test whether it still was feeding the designed amount of sand. If it was changed considerably, the sand feeder had to be adjusted again. This could be done during the running of the experiment. After eight hours of running the experiment was interrupted. Just before the interruption, the sand feeder rate was measured again. The sand feeder rate during the running was assumed to be the average value of the measured values before, in the middle and at the end of the running.

4.7.4 Measurements after running an experiment

After eight hours of running the model, the tailgates were lifted and the pump was stopped. The following day the sand traps were emptied, the weight of the sand was determined and the bed levels were measured. With this the total volume of sediment flowing through the branches 1 and 2 could be calculated, so one point in the graph of the relation between (S_1/S_2) and (Q_1/Q_2) was found.

4.7.5 Check list during the experiments

All descriptions above are given in a check list. This list was used during the experiments, to be sure that all procedures were carried out correctly:

Check list

Before running an experiment

Check whether:
- the bed level has been measured
- the sand traps are empty
- the tubes from the Rehbock flume to the stilling basin are clean
- there is enough water in the downstream reservoir
- there is enough sand in the sand feeder
- the sand feeder gives the right sand flow
- the bed level in the model is correct
- the model is filled with water
- the valves are in the correct position to get the right discharge
- the pitot tube has been installed
- the seepage holes to the stilling basins are open
- the zero levels of the stilling basins and the 2 measuring frames have been determined

Starting an experiment

- Start with filling in form 1 through 4 (Date, experiment number)
- Start the pump and the sand feeder at the same time
- Adjust the tail gates as soon as possible, so that the design discharge ratio is reached

During running an experiment

- Measure at the start and at the end of the experiment the sand feeder capacity
- Check whether the pitot tube is still in operation
- Check whether the seepage holes to the stilling basins are still open
- Measure the discharges every 15 minutes
- Measure the water levels every 30 minutes and adjust the tail gates if neccesary
- Check the sand feeder every hour, whether there is enough sand in it
- Check every hour if the sand distributor is running smoothly

Stopping an experiment:

- Lift the tail gates
- Stop the pump and the sand feeder at the same time

After an experiment:

- Complete the forms 1 through 4
- Install the stop locks with tubes; be sure that they are watertight
- Syphon the sand traps
- Measure the volume of sand in the sand traps
- Measure the bed levels

What to do when a power cut occurs:

- Lift the tail gates
- Write down the starting time of the power cut
- Turn off the pump
- Wait until the power cut is over
- Write down the duration time of the power cut
- Start the pump again
- Lower the tail gates immediately to their previous position
- Continue the experiment

Chapter 5 Measurement errors

5.1 Introduction

In this chapter the measurement errors are treated. The determination of the error in the discharges is simple: it follows from the measurement error of the Rehbock flumes. The determination of the error in the sediment transport is more complicated: the measurements consist of two parts:
- the measurements of the bottom level, leading to a volume change in branch 1 and 2.
- the measurements of the sand traps, leading to a volume in sand trap 1 and 2.

Calculation of the standard deviation can be done using equation 5.1:

$$\sigma_z^2 \approx \sigma_x^2 \left(\frac{\partial f}{\partial x} \right)^2 + \sigma_y^2 \left(\frac{\partial f}{\partial y} \right)^2 \tag{5.1}$$

where z is a non-linear function $f(x,y)$ and σ the standard deviation of z.
It is assumed that $\mathrm{cov}(x,y) = 0$

Using this equation the calculation of the standard deviation in (q_1/q_2) and (s_1/s_2) will be done step by step.

5.2 Calculation of the standard deviation in q_1/q_2

The individual discharges are measured using Rehbock weirs. These weirs were made locally according to the specifications mentioned in ISO (1975). In Van Voorthuizen & Den Dekker (1994) a description is given of these specifications.

q_i is determined by $q_i = Q_i/B_i$.

Combination with (5.1) gives:

$$\sigma_{qi} = \sigma_{Qi} / B_i \tag{5.2}$$

It is assumed here, that the error in B_i is zero.

The method of measuring the discharge using Rehbock-flumes implies a relative error of 2%, thus the absolute error in Q_i is $0.02*Q_i$. The error in q_1/q_2 equals, using this relative error and equation 5.1:

$$\sigma_{\frac{q_1}{q_2}} = 0.02\left(\frac{q_1}{q_2}\right).\sqrt{2} \tag{5.3}$$

The results of this is given in section 5.4. For every experimentally determined q_1/q_2 the standard deviation is given.

5.3 Calculation of the standard deviation in s_1/s_2

5.3.1 Introduction

The measurement of the sediment transport consists of two parts (for a more detailed description, see chapter four):

1 In the branch itself, the bed level is changing during an experiment. To get the sediment transport at the point of the bifurcation (= the 'nose'), it is necessary to take the difference of the bed level into account. By integration of the bed-level changes over the length and over the width of the branch, the change of volume is known.

2 The sediment that passes the end of a branch, has been caught in a sand trap. This volume is called V_s.

The total sediment transport follows from the sum of the above mentioned parts. The error in s_1/s_2 is determined in the same way in the following sub sections.

5.3.2 The error in the bed-level measurements

Standard deviation in the bottom measurements

The bottom level in one cross section is measured in five points. The mean value of the bottom level follows from the following equation, which represents the weighted mean of the five measured points:

$$m = m_1/8 + m_2/4 + m_3/4 + m_4/4 + m_5/8 \tag{5.4}$$

where m is the mean value of the bed level and m_i is the bed level at one point.

The standard deviation in m is, combining equation (5.4) with (5.1):

$$\sigma_m = \sigma_{m_i} \cdot \sqrt{\left(\frac{7}{32}\right)} \tag{5.5}$$

where σ_{mi} is the standard deviation of the bottom measurement in one point and σ_m the standard deviation of the mean bottom level.

σ_{mi} is caused by the error in the reading and the error in placing the square plate on the bottom. This gives: $\sigma_{mi} = 2$ mm.

Using equation (5.5) then gives $\sigma_m = 0.94$ mm.

An error is also caused by the ripples in the cross section. This causes that the mean of the five measurements in a cross section is not the exact value of the average bottom level in that cross section. (See chapter four). This influence is the most important one. The error caused by this phenomenon is assumed to be 4 mm.

This yields in total $\sigma_m = 5$ mm.

Standard deviation of the change in volume between two cross sections

The change in volume between two cross sections follows from equation (5.6):

$$\Delta\Delta V = \{(m_1'-m_1)+(m_2'-m_2)\}.B.\Delta L/2 \tag{5.6}$$

Where $\Delta\Delta V$ is the change of volume between two cross sections; m_i is the mean bottom level of a cross section before running the model, m_i' is the mean bottom level of a cross section after running the model, B is the width of the branch and ΔL is the distance between the two cross sections.

The standard deviation in $\Delta\Delta V$ is, combining equation (5.6) with (5.1):

$$\sigma_{\Delta\Delta V} = \sigma_m.B.\Delta L \tag{5.7}$$

Where σ_m is the standard deviation in the mean bottom level and $\sigma_{\Delta\Delta V}$ is the standard deviation in the change of volume between two cross sections.
It is assumed that the standard deviation in B and ΔL is zero.

ΔL is in both of the branches, 500 mm.
B depends on the branch; $B_1 = 400$ mm and $B_2 = 600$ mm.
σ_m is 5 mm.

Thus for branch 1, $\sigma_{\Delta\Delta V} = 1*10^6$ mm^3 and for branch 2, $\sigma_{\Delta\Delta V} = 1.5*10^6$ mm^3

Standard deviation of the total volume change in one branch

The total volume change in one branch follows from the following equation:

$$\Delta V = \sum_{i=1}^{n-1} \Delta\Delta V_i \tag{5.8}$$

where ΔV is the total volume-change in one branch, $\Delta\Delta V_i$ is the volume change between two cross sections and n is the number of cross sections.

The standard deviation in ΔV is, combining equation (5.8) with equation (5.1):

$$\sigma_{\Delta V} = (n-1)^{1/2} * \sigma_{\Delta\Delta V} \tag{5.9}$$

where $\sigma_{\Delta V}$ is the standard deviation of the total volume change in one branch and $\sigma_{\Delta\Delta V}$ is the standard deviation of the volume change between two cross sections.

For branch 1, n=17 and $\sigma_{\Delta\Delta V} = 1*10^6$ mm^3 => $\sigma_{\Delta V} = 4.13*10^{-3}$ m^3 (5.10)
For branch 2, n=17 and $\sigma_{\Delta\Delta V} = 1.5*10^6$mm^3 => $\sigma_{\Delta V} = 6.18*10^{-3}$ m^3 (5.11)

5.3.3 Sand-trap measurements

The measurement error in the volume of sand in the sand trap is caused by errors made when measuring this volume of sand. Another problem which influences this volume of sand is the fact that sand passes the sand trap. In this section first the error of the measurement of the volume of sand is treated. At the end the influence of the sand passing the sand trap is treated.

The standard deviation of the sand in one bucket

The submerged weight of the sand in one bucket follows from the following equation:

$$W_{ui} = W_m - W_w \tag{5.12}$$

where W_{ui} is the under-water weight of the sand in one bucket, W_m is the measured weight of the bucket with sand and water and W_w is the weight the bucket would have had if it was filled unto the same level, but without sand.

The standard deviation in W_{ui} is, combining equation (5.12) with equation (5.1):

$$\sigma_{W_{u,i}}=\sqrt{(\sigma_{W_m})^2+(\sigma_{W_w})^2} \tag{5.13}$$

σ_{Wm} is caused by the error, made when weighing the bucket on the scale. Since the scale was an old fashioned one, $\sigma_{Wm} = 0.1$ kg.

σ_{Ww} is caused by two phenomena.

- The first part of the error is caused when measuring the water level in the bucket with a point gauge. This error is 0.2 mm. Calculation shows that the influence of this error on the determination of the weight is zero.
- The second part of the error is caused by the fact that the buckets, when new, are hallmarked as being in a perfect state. While using the buckets, however, dents were made in the buckets. A calculated guess is made of the size of a dent: an average dent has a cylinder form, with a radius of 5 cm and a height of 1 cm. This volume, filled with wet sand, gives a weight of 0.1 kg.
  Thus, $\sigma_{Ww} = 0.1$ kg.

Substituting these numbers in equation (5.13) yields $\sigma_{Wui} = 0.14$ kg.

The standard deviation of the volume of sand in one bucket

The volume of sand in one bucket follows from the following equation:

$$V_i=\frac{\sigma_{W_{u,i}}}{\rho(1-\epsilon)} \tag{5.14}$$

where V_i is the volume of sand in one bucket, ρ is the mass density of the submerged sand and ϵ is the void ratio of the sand.

The standard deviation in V_i is, combining equation (5.14) with (5.1):

$$\sigma_{V_i}=\sqrt{\left(\frac{1}{\rho(1-\epsilon)}\right)^2.\sigma^2_{W_{u,i}}+\left(\frac{W_{u,i}}{\rho(1-\epsilon)}\right)^2.\sigma_\epsilon^{\,2}} \tag{5.15}$$

It is assumed here that $\sigma_\rho = 0$, since the influence of σ_ρ on σ_{Vi} is almost zero.

Substituting $\rho = 1650$ kg/m^3, $\epsilon = 0.41$, $W_{ui} = 12$ kg, $\sigma_{Wui} = 0.14$ kg and $\sigma_\epsilon = 0.02$ in equation (5.15) yields $\sigma_{Vi} = 2.9 * 10^{-4}$ m^3.

The standard deviation of the total volume of sand in a sand trap

The total volume of sand in a sand trap is determined by simply adding the volumes of the buckets. This gives the following equation:

$$V_s = \sum_{i=1}^{n} V_i \tag{5.16}$$

where V_s is the total volume of sand in sand trap i, V_i is the volume of sand in one bucket and n is the number of buckets. Using equation (5.1) together with equation (5.16) gives $\sigma_{V_s} = n^{1/2} * \sigma_{Vi} = n^{1/2} * 2.9 * 10^{-4}$ m^3

With this the measurement error of the volume of sand in the sand trap is treated.

The second part of the error in the volume of sand in the sand trap is made by the loss of sand that passes the sand trap; tests have shown (see chapter four) that on average 1% of the sand that reaches the sand trap is passing it. The volume of sand that has passed the sand trap can be related to the number of buckets, using the fact that the average weight of sand in one bucket is 12 kg. This results in equation 5.17:

$$V_{passing} = 0.01n \frac{12}{\rho_u(1-\epsilon)} \tag{5.17}$$

The error caused by this problem is equal to the average amount of sand that passes the sand trap. With $\rho_u = 1650$ kg/m^3 and $\epsilon = 0.41$ this yields $\sigma_{V_{s,passing}} = n * 1.2 * 10^{-4}$ m^3

Using σ_{V_s} and $\sigma_{V_{s,passing}}$ and equation 5.1 gives the standard deviation in V_s, resulting in equation (5.18):

$$\sigma_{V_s} = \sqrt{n(2.9.10^{-4})^2 + n^2(1.2.10^{-4})^2} \tag{5.18}$$

5.3.4 The standard deviation of the total sediment transport per unit of width

The total volume of sand per unit of width that passed the nose in a branch follows from the following equation:

for branch 1: $s_1 = (V_{s1} + \Delta V_1)/B_1$
for branch 2: $s_2 = (V_{s2} + \Delta V_2)/B_2$

The standard deviation in s_i is determined using equation (5.1), (5.10), (5.11) and (5.18). This results in equation (5.19):

$$\sigma_{s_i} = \frac{\sqrt{\sigma^2{}_{V_{si}} + \sigma^2{}_{\Delta V_i}}}{B_i} \tag{5.19}$$

5.3.5 The standard deviation in s_1/s_2

In the previous sections, the standard deviation in the sediment transport for both branches was determined. Now the standard deviation in s_1/s_2 will be determined. This gives, using (5.1):

$$\sigma_{\left(\frac{s_1}{s_2}\right)} = \frac{\sqrt{\sigma_{s_1}{}^2 . s_2{}^2 + \sigma_{s_2}{}^2 . s_1{}^2}}{s_2{}^2} \tag{5.20}$$

Where σ_{s1} and σ_{s2} follow from equation (5.19)

5.4 Results

In this section the result of the former analysis is given for every experiment. In table 5.1 the results are given for the first nose. In table 5.2 the results are given for the second nose. In the tables, sigma means the standard deviation.

exp. nr.	s1/s2	Sigma s1/s2	q1/q2	Sigma q1/q2
1111	0.558	0.053	0.761	0.025
1121	-7.924	1.076	2.925	0.062
1131a	0.220	0.036	0.629	0.024
1131b	0.162	0.061	0.731	0.025
1131c	1.500	0.129	0.982	0.028
1141a	1.500	0.149	1.047	0.029
1141b	1.263	0.107	0.970	0.028
1141c	1.330	0.119	1.005	0.028
1211a	0.207	0.036	0.724	0.025
1211b	0.798	0.064	0.820	0.026
1211c	0.842	0.064	0.779	0.025
1221a	1.940	0.151	1.023	0.029
1221b	1.134	0.074	0.903	0.027
1221c	1.027	0.082	0.891	0.027
1311a	0.221	0.043	0.560	0.023
1321a	2.438	0.259	1.364	0.034
1321b	9.058	2.171	2.211	0.049
1331a	1.656	0.161	1.005	0.028
1331b	0.867	0.077	0.842	0.026
1331c	0.455	0.052	0.753	0.025
1341a	0.350	0.048	0.535	0.023
1411a	0.099	0.079	0.477	0.022

Table 5.1 - Measurement errors first nose

exp. nr.	s1/s2	Sigma s1/s2	q1/q2	Sigma q1/q2
2111a	3.820	0.329	1.160	0.031
2111b	0.530	0.112	0.751	0.025
2111c	0.271	0.114	0.633	0.024
2111d	0.272	0.113	0.537	0.023
2111e	0.145	0.099	0.536	0.023
2121a	27.789	18.276	2.307	0.050
2121b	4.892	0.572	1.259	0.032
2121c	1.094	0.169	0.744	0.025
2121d	0.233	0.126	0.659	0.024
2211a	3.173	0.251	1.188	0.031
2211b	1.128	0.095	0.735	0.025
2211c	0.825	0.108	0.729	0.025
2221a	25.425	6.251	2.231	0.049
2221b	5.908	0.556	1.325	0.033
2221c	1.859	0.232	0.923	0.027
2311a	2.817	0.476	1.453	0.035
2311b	3.815	0.641	1.292	0.033
2311c	2.540	0.574	1.036	0.029

Table 5.2 - Measurement errors second nose

Chapter 6 Data processing

6.1 Experiment numbering

To prevent mixing of the results of the experiments, the experiments are coded. The experimental code was chosen in such a way, that all variables can be recognized. For the experiments several influences are studied, the upstream discharge, the nose type, the position of the tailgates and the type of sand. For a proper coding these four features should be presented in the number of the experiment.
The first number of the experiment code represents the nose type. The symmetrical nose is represented by number one. The nose type closing the first branch is number two and the nose closing branch two is number three. The experiments described in this report were only carried out for the first and the second nose type. For this reason all codes mentioned in this report start with number one or two.
The second figure in the code represents the upstream discharge. In the former section it is described that three different upstream discharges are used. There is a discharge of 30 l/s, represented by a one in the code, a discharge of 40 l/s represented by a two in the code and a discharge of 20 l/s represented by a three in the code.
In the former section it is also described that creating another discharge ratio q_1/q_2 is done by changing the water levels at the end of the branches. Every time this was done the third number in the code was increased by one.
The last number in the code, represents the sand used in the model. The experiments described in this report, are all done for the same type of sand, so all the experimental codes mentioned end with the number one.
For the most experiments a letter is added. This is done for experiments, which were run for several days. An A represents the first day, a B the second day etcetera.

According to this reasoning experiment 1321A contains of the following features: the first nose type was used, the upstream discharge of 20 l/s, the second adjustment of the tail gates was applied and the first type of sand. The A indicates that the first day experiment was running.

6.2 Data processing, the spreadsheet program

When all readings described in chapter four are taken, their number is considerable. To make data processing more comprehensive, standard forms are created. The readings were written on these forms. Examples of the standard forms can be found in the appendix A. For every type of measurement, a standard form is created; three forms for handling the measurements of the bottom levels, a form involving the discharge measurements, a form involving the water level measurements at every stilling basin and a form involving the sand trap measurements were used.

The aim of the experiments is to calculate the sediment transport ratio and the discharge ratio from the measured data. For this purpose a spreadsheet program is used. In appendix A an example of a spreadsheet can be found. For every observation, a spreadsheet was made.

This spreadsheet can be divided into several parts. In figure 6.1 the spreadsheet is presented in a schematized form. In part A the readings of the bottom levels are entered and the bottom levels are related to the same basis level. In B and C the changes in bottom level are calculated. In D the reading of the water levels and the discharges are entered. In E the final sediment and discharge ratios are calculated. In the next paragraphs these calculations are further detailed.

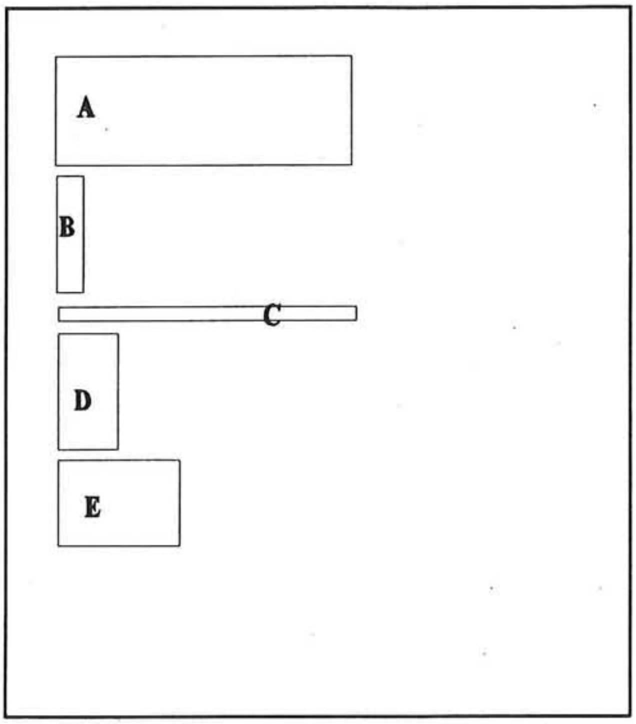


Figure 6.1 - General lay-out of a spreadsheet.

In the first part of the spreadsheet, part A, the readings of the bed levels are taken into account. In the columns from left to right, first the readings of the bed level before the experiment started, are entered. From the readings, the actual bed levels can be calculated. The actual bed levels are calculated by relating all readings to the same reference level. In chapter four, it is explained that the reference level was chosen to be the laboratory floor. In chapter four it is also explained how the relation between the measured reading and the level was found and expressed in a factor. In the spreadsheet, next to the readings this correction factor for every measured point is given. In the following columns the actual bed levels are calculated using this correction factor. In the last column the bed levels are averaged over one cross section.

In part A of the spreadsheet, the readings of the bottom levels after an experiment has been carried out, are also handled. Just as in the former situation, in the columns next to the reading, the correction factor is printed, then the actual bed levels are calculated and in the last column the average bed level for every cross-section can be found.

In part B, the bed-level change during an experiment is calculated. This is done by simply subtracting the average bed level, found at the end of an observation, from the average bed level, found at the beginning of an observation. The Difference in the bed levels between the end and the beginning of an experiment is calculated. In part B, a column expressing the differences in volume of bottom material can be found. This is done by averaging the differences in bed levels in two successive cross sections and multiplying them with the surface area between the two cross sections. In chapter five it is described, that a considerable error is made here.

For the area between cross sections eight and nine a problem arises. Between cross sections eight and nine the bifurcation occurs. This leads to the fact that for cross section nine two average bed levels are present, one for each branch. So, two different bed-level changes have to be compared with the bed level change in cross section eight. To calculate the change in volume at the bifurcation, the average of the bed-level change at both sides of the nose in cross section nine is averaged with the bed-level change in cross section eight. This average bed-level change multiplied by the average width and length of the area between cross section eight and nine, gives the change in volume.

In part C, the bed-level change at the end of the branches is found. At the end of the branches a slope toward the sand trap is present. The length of the slope and the height of the top is used here to calculate the change in volume. As the top of the slope is positioned between the last and the second last cross section, the change in volume between the last and the second last cross section is calculated. The value, calculated here, replaces the one calculated in the former part.

In part D of the spreadsheet the discharges and the water levels can be found. For the discharge measurements, the readings of the still water basins belonging to the respective Rehbock flumes, are written down on the standard form. In chapter four, it is described how the Rehbock flumes were calibrated. Using equation (3.1) the measured water level at the stilling basin, which is related to the Rehbock flume, can be related to the discharge. A table, in which all possible reading of the stilling basins are related to actual discharges, is made. For every reading taken during an observation, the actual discharge is found in this table. The discharges found are inserted here in this part of the spreadsheet.

In the last part of the spreadsheet, the final results are calculated. First the total bottom change for every branch is calculated. The total bed-level change is expressed in [m^3]. This is done by simply adding the volume changes between every cross section, found in part C of the spreadsheet. Next the amount of sand in the sand trap is considered. First the measured amount, in kg, is given, then the volume is calculated, using the void ratio found in chapter four. When the volume of bed level change and the volume of sand, found in the sand trap, is known, the amount of sand, which has passed the bifurcation can be calculated. The calculated values for S_1 and S_2 represent the total amount of sand that passed cross section nine in branch one and two respectively, during the entire duration of an experiment.

Now S_1 and S_2 are found the value for $_1S$ divided by $_2S$ can be calculated. Next in the final results the average discharge, for both branches, is calculated. Dividing the discharge in branch one by the discharge found in branch two is the following step. At last the sand balance is checked. In the last row, first the sum of all the bed level changes and the volume of sand found in the sand traps is given. In the next row the amount of sand fed is calculated. The difference between these two expressed as a percentage of the sand fed ends the spreadsheet.

For every observation all measurementsand part E of the spreadsheet is given in the report of measurements.

6.3 results

When for every experiment this spreadsheet is applied, the results for the sediment transport ratio and for the discharge ratio are calculated. In the next tables the results of the sediment transports and discharges are given:

exp. nr	Q_1 [l/s]	Q_2 [l/s]	S_1 [m^3]	S_2 [m^3]	S_1/S_2	Q_1/Q_2
1111	9.53	18.78	0.0515	0.1375	0.374	0.51
1121	18.45	9.46	0.2427	-0.045	-5.32	1.95
1131a	9.32	22.21	0.0256	0.1769	0.145	0.42
1131b	9.95	20.42	0.0111	0.1029	0.108	0.49
1131c	11.96	18.26	0.0877	0.0878	0.999	0.65
1141a	12.94	18.94	0.0762	0.0762	1.00	0.68
1141b	12.41	19.20	0.0796	0.095	0.841	0.65
1141c	12.72	18.99	0.0784	0.0878	0.894	0.67
1211a	12.56	26.04	0.0251	0.1806	0.139	0.48
1211b	13.66	24.99	0.067	0.1257	0.534	0.55
1211c	13.10	25.21	0.073	0.1299	0.562	0.52
1221a	15.57	22.85	0.1187	0.0923	1.286	0.68
1221b	14.44	24.00	0.0992	0.131	0.758	0.60
1221c	14.38	24.18	0.0764	0.1113	0.687	0.59
1311a	5.09	13.64	0.0222	0.1491	0.149	0.38
1321a	8.83	9.72	0.1045	0.0639	1.635	0.91
1321b	10.88	7.38	0.1571	0.0259	6.074	1.47
1331a	7.39	11.03	0.0855	0.0767	1.114	0.67
1331b	6.61	11.77	0.0626	0.109	0.574	0.56
1331c	6.11	12.19	0.0397	0.132	0.30	0.50
1341a	4.90	13.74	0.0322	0.137	0.235	0.36
1411a	2.45	7.70	0.0053	0.0798	0.066	0.32

exp. nr	Q_1 [l/s]	Q_2 [l/s]	S_1 [m^3]	S_2 [m^3]	S_1/S_2	Q_1/Q_2
2111a	6.48	22.34	0.0851	0.089	0.951	0.29
2111b	4.49	23.90	0.020	0151	0.133	0.19
2111c	3.90	24.65	0.00099	0146	0.068	0.16
2111d	3.36	25.10	0.0104	0147	0.071	0.13
2111e	3.37	25.14	0.0006	0.168	0.036	0.13
2121a	10.23	17.72	0.0663	0.0095	6.973	0.58
2121b	6.79	21.54	0.0746	0.0608	1.227	0.32
2121c	4.43	23.85	0.0289	0.1062	0.272	0.19
2121d	4.00	24.35	0.0077	0.1320	0.058	0.16
2211a	8.29	27.92	0.0825	0.1039	0.795	0.30
2211b	6.04	32.71	0.0544	0.1929	0.282	0.18
2211c	5.93	32.57	0.0334	0.1620	0.206	0.18
2221a	13.65	24.47	0.1659	0.0261	6.352	0.56
2221b	9.50	28.67	0.10898	0.0738	1.478	0.33
2221c	7.18	31.13	0.0403	0.088	0.456	0.23
2311a	5.22	14.38	0.0362	0.0514	0.704	0.36
2311b	4.91	15.20	0.0433	0.0454	0.952	0.32
2311c	4.03	15.57	0.0254	0.0398	0.637	0.26

Chapter 7 Statistical analysis

7.1 Introduction

In this chapter, estimations for M and k occurring in equation (2.22) or (7.1) are calculated, using statistics. Here only the results are given. The theoretical backgrounds of the statistical methods used, are discussed in appendix B.
In this chapter, the notation applied in statistics, is followed. This notation, however creates sometimes conflicts with the notation used in river engineering. This has led to the following notations: estimations of variables are distinguished by a ^. So, $\hat{k}$ is an estimate of k.
In statistics, vectors are denoted by a capital letter to distinguish between one of the values in this vector and the vector itself. So, u_i is the ith value of the vector U. This creates a conflict with the notation used in the river engineering. To distinguish for instance the difference between the total discharge and the discharge per unit of width, a capital letter is used for the total discharge. The same holds for the sediment transport rates. In this report the notation used in river engineering is followed. Thus the difference between a number of a discharge vector and the vector itself, can be found in the context in which they are used.

Using the experimental results, a function, describing the sediment distribution over the two branches has to be found. As described before the most likely function is;

$$\frac{s_1}{s_2}=M\left(\frac{q_1}{q_2}\right)^k \tag{7.1}$$

in which;

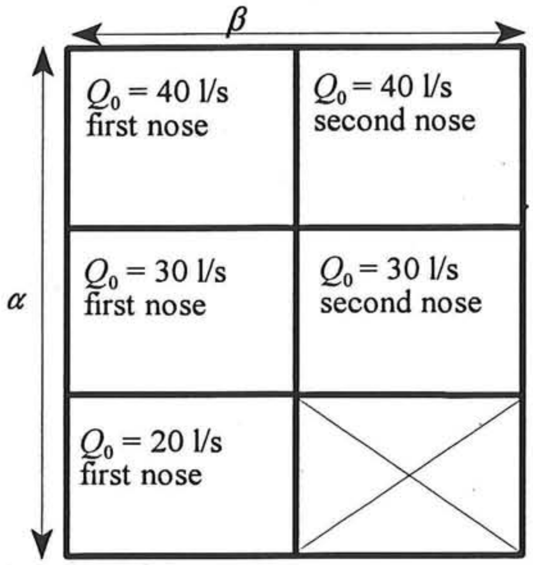
s_1 = sediment transport in branch one,
s_2 = sediment transport in branch two,
q_1 = discharge in branch one,
q_2 = discharge in branch two,
M, k = constants to be estimated.

The sediment transports and the discharges are per unit width at the bifurcation. Since the discharges and sediment transports are obtained from the experiments, only M and k are unknown

First the observations were checked, leading to several problems. In experiment 1121 a negative value for s_2 was found. Since sediment transport cannot have a negative value, something had to be gone wrong. Experiment 1121 was one of the first experiments carried out. Some trouble was faced in creating a proper discharge in both branches; for experiment 1121 the velocity in branch two was too low, so sediment transport did not occur. Around the tip of the nose a scour hole developed and a little sediment from branch two was transferred into branch one, leading to a negative sediment transport in branch two. As for the experiment sediment transport in both branches was assumed, experiment 1121 is neglected in further analysis.

For some experiments, for instance in experiment 2221a, s_2 was very low, though still positive; therefore, a large value for the ratio s_1/s_2 is found. This gives no problem in the analysis.

For experiments with the second nose and an upstream discharge of 20 l/s, only three observations were done. It was decided, that this number of observations is too low to use the results in the analysis.



Q_0 = 40 l/s first nose	Q_0 = 40 l/s second nose
Q_0 = 30 l/s first nose	Q_0 = 30 l/s second nose
Q_0 = 20 l/s first nose	

Figure 7.1 - The experiment matrix.

A matrix of the experiments can be created. In this matrix, the rows represent the discharges and the columns the nose types. Since the data for the second nose and an upstream discharge of 20 l/s are not included in the analysis, a part of this matrix will remain empty. For some statistical applications, this will cause a problem. This problem is known in statistics, as the problem of the empty cell and cannot easily be solved. In this situation, the problem can only be solved, when the experiments for 20 l/s with the second nose are finished. In figure 7.1, the experimental matrix is given, α represents the influence of the upstream discharges and β the influence of the nose types.

Using regression techniques, the coefficient M and the exponent k can be estimated. First a non-linear method, the 'd.u.d'. method, is used, next a linear regression method is applied. For both methods, a cost function is minimized, this is explained in appendix B. The difference between the two methods is the way in which this cost function is minimized. Linear regression methods use derivatives, which have to be determined analytically. Setting these derivatives equal to zero, gives the estimations looked for. The d.u.d. method uses a certain algorithm to approximate the derivatives geometrically. This algorithm is given in appendix B.

7.2 Non-linear regression; d.u.d. method

The d.u.d. method applied to the data found, yields the following results:

Exp. type	$\hat{M}$	$\hat{k}$	$J(\hat{M},\hat{k})/n$
Q= 40 l/s, 1st nose	1.71	4.3	0.02
Q= 30 l/s, 1st nose	1.37	3.96	0.02
Q= 20 l/s, 1st nose	1.23	2.52	0.04
Q= 40 l/s, 2nd nose	2.31	2.99	0.09
Q= 30 l/s, 2nd nose	2.42	2.92	0.14

Table 7.1 - $\hat{M}$- and $\hat{k}$ - values calculated, using the d.u.d. method.

In the above table the values found for $\hat{M}$ and $\hat{k}$ are given. In the last column the values for the sum of squares divided by the number of observations, n, are given. For $J(\hat{M},\hat{k})/n$ equals zero, the line would fit perfectly.

7.3 Linear regression

7.3.1 Introduction

To create a linear model, the logarithm is taken from the equation described earlier .
A mathematical problem arises, when the logarithm of a quantity with a dimension is taken. To overcome this problem, the next transformation is carried out;

$$q=\tilde{q}*\hat{q} \tag{7.2}$$

$$s=\tilde{s}*\hat{s} \tag{7.3}$$

Here $\tilde{q}$ and $\tilde{s}$ carry the magnitude while $\hat{q}$ and $\hat{s}$ carry the dimensions of s and q, respectively.
Now, when taking the quotient of s_1 and s_2 and of q_1 and q_2, the dimensions $\hat{q}$ and $\hat{s}$ vanish. The magnitudes $\tilde{q}$ and $\tilde{s}$ remain.
Further s and q will be used where $\tilde{s}$ and $\tilde{q}$ are meant.

The linear model has the following form:

$$\ln\left(\frac{s_1}{s_2}\right)_i = \ln(M) + k * \ln\left(\frac{q_1}{q_2}\right)_i + u_i \qquad (7.4)$$

The reason, why a linear model is created, is found in the fact that k does not occur in the exponent anymore, so the error found in $\hat{k}$ does not appear in the exponent. For this model confidence intervals can be determined exactly.

To apply the logarithm model, some assumptions have been made. They are explained in appendix B.

7.3.2 Results of linear regression

With a linear model, linear regression analysis can be used to obtain values for $\hat{M}$ and $\hat{k}$. When applying linear regression, also a function representing a sum of squares is minimized. This time the computer program SPSS is used. In the following table, the values found are given. In the table a column R^2 can be found. This R^2 is an indicator for the accuracy of curve fitting, for R^2 equals to one, the curve fits perfectly.

Exp. Type	$\hat{M}$	$\hat{k}$	R^2
Q = 40 l/s, 1st nose	1.99	5.47	0.80
Q = 30 l/s, 1st nose	1.36	4.52	0.87
Q = 20 l/s, 1st nose	1.16	2.69	0.97
Q = 40 l/s, 2nd nose	2.32	3.61	0.99
Q = 30 l/s, 2nd nose	1.73	3.61	0.96

Table 7.2 - Values found for $\hat{M}$ and $\hat{k}$ using linear regression.

The values found with the linear model are different from the values found with the non-linear model.
With SPSS the 95% confidence levels for $\hat{M}$ *and* $\hat{k}$ were calculated, see table 7.3 and 7.4.

Exp. type	lower bound $\hat{M}$	$\hat{M}$	upper bound $\hat{M}$
$Q = 40$ l/s, 1st nose	0.95	1.99	4.16
$Q = 30$ l/s, 1st nose	0.84	1.35	2.20
$Q = 20$ l/s, 1st nose	0.96	1.23	1.60
$Q = 40$ l/s, 2nd nose	1.96	2.32	2.77
$Q = 30$ l/s, 2nd nose	1.25	1.73	2.38

Table 7.3 - The 95% confidence levels for $\hat{M}$

exp. type	lower bound $\hat{k}$	$\hat{k}$	upper bound $\hat{k}$
$Q = 40$ l/s, 1st nose	1.72	5.47	9.23
$Q = 30$ l/s, 1st nose	2.47	4.52	6.56
$Q = 20$ l/s, 1st nose	1.96	2.51	3.05
$Q = 40$ l/s, 2nd nose	2.51	2.93	3.78
$Q = 30$ l/s, 2nd nose	2.95	3.62	4.28

Table 7.4 - The 95% confidence levels for $\hat{k}$.

Next the 'lack of fit' is checked. This is done in the following way; The residuals are the differences between the observations and the values calculated using equation (7.4). Looking at the residuals, two different situations can occur. First, the equation completely describes the relation between the sediment transport and the discharges. For this situation these residuals consist of the measuring errors only. Plots of the residuals versus the discharge ratio show a random pattern.

Secondly, the equation does not completely describe the relation between the sediment ratio and the discharge ratio. The residuals consist of the measurement errors and an extra factor. Now plots of the residuals versus the discharge ratio indicate a relation between the two. In this situation an extra term should be added to the equation described earlier.
In appendix B, graphs are shown in which the residuals versus the discharge ratio are plotted. As can be seen a clear pattern cannot be found. Thus no relation exists between the residuals and the discharge ratio, so an extra term does not need to be added to the equation.

7.4 Analysis of variance

Using the linear model, testing the validity of $\hat{M}$ and $\hat{k}$ can easily be done. The following tests were carried out.

- Is k different for upstream discharges?
- Is k different for the two different types of noses?
- M equals one?

In the previous sections of this chapter, the estimates $\hat{M}$ and $\hat{k}$ are found. Since they are estimations of stochastic variables, the question remains whether their values are influenced by the upstream discharges and different nose types or whether the different values are only different estimations of the same variable. Another question that remains is about the value of M. In chapter two it is stated that M should equal one, when the discharges and the sediment transports are taken per unit of width at the bifurcation. The estimates, $\hat{M}$, found in the former sections gave values a little great than one. In this section tests are carried out to study the influence of the different upstream discharges and different nose types on $\hat{k}$ and to study the value of $\hat{M}$

In appendix B the criteria and the calculations, needed to carry out these tests are explained.

First the influence of the upstream discharges on the value of $\hat{k}$ is looked at. It is concluded that for the first nose, a different upstream discharge gives a different value for $\hat{k}$. As can be seen in table 7.1 and 7.2, a larger upstream discharge leads to a higher value for $\hat{k}$. For the second nose, only two different upstream discharges were used. From these two experiments it could not be concluded that a different upstream discharge leads to a different $\hat{k}$.

Next, for one upstream discharge, the influence of the nose type is tested. For an upstream discharge of 30 l/s, the difference in nose type does not lead to a significant difference in $\hat{k}$. An upstream discharge of 40 l/s does give, however, a different $\hat{k}$ for the two different nose types.

Finally $\hat{M}$ is tested. The test '$\hat{M}$ equals one' is changed, when using the logarithm model into ln($\hat{M}$) equals to zero. This is a standard test. For the first nose, $\hat{M}$ is likely to equal one. For the experiments carried out for the second nose, the value of $\hat{M}$ is not likely to equal one.

In this section, it became clear, that the number of experiments, carried so far, is rather low. When the third nose type is tested and when the experiments using an upstream discharge of 20 l/s and the second nose type are finished, the above stated conclusions can be stated more decisively.

7.5 Multivariate analysis

The next step in analysing the data, is to study the relation between the sediment transport in one branch and the discharge in the other branch. This can be achieved by changing the ratios of the sediment transports and the discharges into a two-dimensional vector. Consequently ln(*M*) also changes into a two-dimensional vector, while *k* becomes a matrix. Now a different equation is found; the estimates $\hat{M}$ and $\hat{k}$ are different from the estimations found in the former analysis. When this is applied, the model gets the following form:

$$\begin{pmatrix} \ln s_1 \\ \ln s_2 \end{pmatrix} = \begin{pmatrix} \ln M_1 \\ \ln M_2 \end{pmatrix} + \begin{pmatrix} k_{11} & k_{12} \\ k_{21} & k_{22} \end{pmatrix} \begin{pmatrix} \ln q_1 \\ \ln q_2 \end{pmatrix} \tag{7.5}$$

In the above model, the relation between the sediment transport in one branch and the discharge in the other one is represented by k_{12} and k_{21}.
As the sediment transports and the discharges are no longer represented by a ratio, dimensions start playing a role. In the analysis up to now the sediment transports s_1 and s_2 have the dimension [m^2], while the discharges q_1 and q_2 have the dimension [dm^2/s]. To get the same dimensions, the dimension of the discharges is changed into m^2. This is done by multiplying the discharges with the experimental time and dividing by 100. Now the quantities do carry a dimension, though they carry the same dimension.

The parameters were calculated for every nose type and every discharge separately. A summary of the results is shown in the table below. These values were calculated using the computer program SPSS. In appendix B it is described how these calculations were carried out.
For the calculated values, the hypothesis 'these values equal zero' are also tested. For the values indicated with *, the hypothesis could not be rejected. A significance level of 5% is chosen.
In the table also the number of observations for every experiment is given.

	Nose 1	Nose 2
$Q_0 = 40$ l/s	$\ln(\hat{M}_1)= 118.7^*$ $\hat{M}_1 = 1.8 * 10^{51}$ $\ln(\hat{M}_2)= -16.41^*$ $\hat{M}_2 = 0.0$ $\hat{k}_{11}= -2.51^*$ $\hat{k}_{21} = -0.87^*$ $\hat{k}_{12} = -14.58^*$ $\hat{k}_{22} = 2.95^*$ 6 observations	$\ln(\hat{M}_1)= -3.22^*$ $\hat{M}_1 = 0.04$ $\ln(\hat{M}_2)= 35.32^*$ $\hat{M}_2 = 2.2 * 10^{15}$ $\hat{k}_{11}= 1.41^*$ $\hat{k}_{21} = -2.98^*$ $\hat{k}_{12} = -1.12^*$ $\hat{k}_{22} = -2.36^*$ 6 observations
$Q_0 = 30$ l/s	$\ln(\hat{M}_1)= -42.25$ $\hat{M}_1 = 0.0$ $\ln(\hat{M}_2)= -11.45$ $\hat{M}_2 = 0.0$ $\hat{k}_{11}= 6.83$ $\hat{k}_{21} = -0.49^*$ $\hat{k}_{12} = -0.87^*$ $\hat{k}_{22} = 1.89$ 7 observations	$\ln(\hat{M}_1)= -85.09$ $\hat{M}_1 = 0.0$ $\ln(\hat{M}_2)= -60.92$ $\hat{M}_2 = 0.0$ $\hat{k}_{11}= 5.11$ $\hat{k}_{21} = 0.55^*$ $\hat{k}_{12} = 7.36$ $\hat{k}_{22} = 8.22$ 9 observations
$Q_0 = 20$ l/s	$\ln(\hat{M}_1)= -10.48*$ $\hat{M}_1 = 0.0$ $\ln(\hat{M}_2)= -17.39$ $\hat{M}_2 = 0.0$ $\hat{k}_{11} = 1.95^*$ $\hat{k}_{21} = -0.07^*$ $\hat{k}_{12} = -0.56^*$ $\hat{k}_{22} = 2.54$ 7 observations	

Table 7.5 - Results from the multivariate analysis. An * indicates a value, which does not differ significantly from zero.

In table(7.5) it can be seen, that for many parameters the hypothesis, the parameter equals zero, is not rejected. This is caused by the fact that the number of estimated parameters nearly equals the number of observations done for one experiment. When more information is available that is when more observations are done for one experiment, the situation improves. This can be seen in the experiment with an upstream discharge of 30 l/s and nose type two. For this experiment nine observations were carried out and the validity has been increased.

To improve the estimate $\hat{k}$, $\hat{M}$ is neglected in the next analysis. In the following table the estimations of the parameters k are given.

	Nose 1	Nose 2
$Q_0 = 40$ l/s	$\hat{k}_{11} = 3.77$ $\hat{k}_{21} = -1.74$ $\hat{k}_{12} = -3.93$ $\hat{k}_{22} = 1.48$ 6 observations	$\hat{k}_{11} = 1.29$ $\hat{k}_{21} = -1.68$ $\hat{k}_{12} = -1.46$ $\hat{k}_{22} = 1.38$ 6 observations
$Q_0 = 30$ l/s	$\hat{k}_{11} = 2.98$ $\hat{k}_{21} = -1.54$ $\hat{k}_{12} = -3.22$ $\hat{k}_{22} = 1.25$ 7 observations	$\hat{k}_{11} = 1.77$ $\hat{k}_{21} = -1.84$ $\hat{k}_{12} = -2.06$ $\hat{k}_{22} = 1.47$ 9 observations
$Q_0 = 20$ l/s	$\hat{k}_{11} = 1.19$ $\hat{k}_{21} = -1.34$ $\hat{k}_{12} = -1.48$ $\hat{k}_{22} = 1.01$ 7 observations	

Table 7.6 - Improved results from the multivariate analysis.

In this situation, the validity of the estimations for the parameters has improved. Again using the 5% significance level, the above-described hypothesis is not rejected for every estimated parameter. As expected, k_{12} and k_{21}, the interactions between the sediment transport in one branch and the discharge in the other branch, appear to be negative.

The total upstream discharge is constant, so, when the discharge in one branch increases, the discharge in the other branch has to decrease. This implies, that a change in discharge distribution has a double effect on the sediment transports.

For instance, when in branch one the discharge increases, the discharge in branch two will decrease. The increase in discharge in branch one causes an increase of the sediment transport in that branch. In equation (7.5) this is represented by a positive $\hat{k}_{11}$. On the other hand the decrease of discharge in branch two causes an extra increase of sediment transport in branch one. This is represented by a negative value for $\hat{k}_{12}$. The same holds for the other branch.

Equivalent to section 7.4, validity tests on the values given in table 7.6 can be executed. First it is tested if $\hat{k}_{12}$ equals $\hat{k}_{21}$. In appendix B the exact calculation is given. For every experiment it is concluded that the hypothesis '$\hat{k}_{12}$ equals $\hat{k}_{21}$' is clearly not rejected. So for every experiment, branch one influences branch two in the same way as branch two influences branch one.
Next the hypothesis '$\hat{k}_{11}$ equals $\hat{k}_{22}$' is tested. Again it is obvious that this hypothesis is not rejected for every experiment.

7.6 Summary

In this chapter the data has been analysed and several aspects have been considered. First the data have been checked and one observation has been neglected. Next, the formula has been checked. It is concluded, that the formula describes the data; no extra term needs to be added. Estimations for the unknown parameters M and k were calculated using a linear regression model and the d.u.d. method. For these estimations the following conclusions could be found:

- for the first nose a different upstream discharge gives a different value for $\hat{k}$;
- for the second nose a different upstream discharge does not have a clear influence on the value for $\hat{k}$;
- for different nose types, using the same upstream discharge, the influence on the value for $\hat{k}$ is not clear, for $Q_0 = 30$ l/s, there is probably no influence, while for $Q_0 = 40$ l/s there probably is;
- for the first nose, the estimate, $\hat{M}$ is likely to equal one and for the second nose likely not;

The hypotheses stated above are somewhat vague. This is caused mainly by the small number of experiments available. When more data would be available, the hypotheses can be stated more decisively. First the experiment with an upstream discharge of 20 l/s, using the second nose should be finished. Also, more observations for one experiment should be carried out.
The effect of missing data became even more troublesome, when the relation between the sediment transport in one branch and the discharge in the other branch was studied. This is explained in appendix B.
Finally the correlation between the discharge in one branch and the sediment transport in the other branch is looked at. As expected, there is a negative correlation between the two.

Chapter 8 Simulations with WENDY

8.1 Introduction

In this chapter a description is given of the simulations of the experimental model, done with the one-dimensional computer simulation-program WENDY. The goal of these simulations is to compare the results from the experiments with those from WENDY. Therefrom more insight is obtained into the behaviour of the experiments. First, one experiment is completely simulated (see section 8.2). Then more experiments are compared, looking only at (Q_1/Q_2). At the end some indications are given, which can be applied while doing experiments in the future.

Simulations were carried out of three experiments:
- with 40 l/s using the first nose: experiment 1211; this experiment took three days;
- with 20 l/s using the first nose: experiment 1331; this experiment took three days;
- with 30 l/s using the second nose: experiment 2111; this experiment took five days;

In this report experiment 1211 is completely treated. From experiments 1331 and 2111 the results are given in the form of the discharge as a function of the time, since this is representative for the experiments.

8.2 Simulation of experiment 1211

8.2.1 Input in WENDY

Experiment 1211 comprises three runs with the first nose and with Q_0=40 l/s. The following values were used in this experiment:

L_0	= 4.55 m	$Q_{1,,t=0}$	= 11.0 l/s
L_1	= 8.60 m	$Q_{2,t=0}$	= 27.5 l/s
L_2	= 8.40 m	$Q_{1,t=end}$	= 13.3 l/s
B_0	= 1.00 m	$Q_{2,t=end}$	= 25.2 l/s
B_1	= 0.40 m	i_0	= 1.12 10^{-3}
B_2	= 0.60 m	i_1	= 0.94 10^{-3}
C	= 30 $m^{1/2}/s$	i_2	= 1.18 10^{-3}
Δ	= 1.65	Δz_1	= 0.75 cm
D_{50}	= 270 10^{-6} m	Δz_2	= -2.25 cm
S_0	= 34.2 kg/h	h_1	= 8.45 cm
Q_0	= 38.5 l/s	h_2	= 8.40 cm

where
L_i is the length of branch i,
B_i is the width of branch i,

C is the Chézy coefficient,
Δ is the relative mass density of the sediment,
D_{50} is the 50% exceeded diameter of the sediment,
S_0 is the upstream sediment transport,
Q_0 is the upstream discharge,
$Q_{i,,t=0}$ is the discharge in branch i at the start of the experiment,
$Q_{i,,t=end}$ is the discharge in branch i at the end of the experiment,
i_i is the slope of branch i,
Δz_i is the bottom jump at the bifurcation in branch i; A positive value means that the bottom jump is upwards,
h_i is the water level at the end of branch i; The zero level of this water level is the bottom level at the begin of branch 0; It is assumed to be constant in the time.

The Chézy coefficient is assumed to be constant in the whole test rig and also during the total experiment time. To calculate the Chézy coefficient in every branch, the water depth, the width of every branch and the *k* value according to Nikuradse are needed. The *k* value is assumed to be 0.02 m. The water depths can be taken from the water-level measurements and the bed level measurements during the experiment. Though, it is difficult to obtain a water depth from these measurements, since the bed level is fluctuating strongly due to the dunes in the bed. Therefore the water depths are taken from the design of the experiment. In experiment 1211 the waterdepths were calculated to be 0.1 m in all branches. This gives, with the given widhts of the branches, the following values for the Chézy coefficient, using equation 4.2:

C_0=30.6 $m^{1/2}/s$
C_1=28.8 $m^{1/2}/s$
C_2=29.8 $m^{1/2}/s$

Since the *k* value is an assumed value, these values of the Chézy coefficient are not exact values. Therefore it is assumed that in all branches $C = 30\ m^{1/2}/s$. The WENDY simulations give values for the water depths too. After the simulations it will be checked whether the assumption of the Chézy coefficient was a good one.

The used transport formula was the formula of Engelund-Hansen. This formula was chosen for the following reasons. The ratio between the shear velocity u_* and the fall velocity of the grains were checked. The fall velocity followed from a common graph which relates the fall velocity to the temperature of the water, the shape of the grains and the grain size. This graph gave, with T=25 degrees celsius, $D_{50} = 0.27$ mm and a shape parameter of 0.7, a fall velocity of 0.037 m/s. The shear velocity followed from $u_* = g^{1/2}.u.C^{-1}$. Here u_* is the shear velocity. The lowest velocity was assumed to be 0.30 m/s; the heighest velocity was assumed to be 0.37 m/s. These assumptions followed from the design of the experiments. These velocities gave respective values for the shear velocity of 0.031 m/s and 0.039 m/s.

So the average shear velocity was about the same as the fall velocity. With this result no choice between the Engelund-Hansen formula and the Meyer-Peter and Müller formula could be made. But the Meyer-Peter and Müller formula can only be trusted if D_m>0.4 mm, while the Engelund-Hansen formula can be trusted if D_m>0.19 mm. Therefore the Engelund Hansen formula was chosen.

The relation, found for the sediment distribution at the nose was, for Q_0=40 l/s, using the first nose type:

$$\left(\frac{s_1}{s_2}\right)=1.99\left(\frac{q_1}{q_2}\right)^{5.47} \tag{8.3}$$

In WENDY the nodal point relation has been built in in the following way:

$$\left(\frac{S_1}{S_2}\right)=\left(\frac{B_1}{B_2}\right)^{r}\cdot\left(\frac{Q_1}{Q_2}\right)^{k} \tag{8.4}$$

If in this formula r would be (1-k), in the nodal point relation, equation (4.1), M would be one. Unfortunately, this is not true here, so equation (8.3) has to be rewritten in the form of equation (8.4); rewriting equation (8.3) gives:

$$\left(\frac{S_1}{S_2}\right)=1.99\left(\frac{B_1}{B_2}\right)^{1-5.47}\cdot\left(\frac{Q_1}{Q_2}\right)^{5.47} \tag{8.5}$$

Comparing equation (8.5) with equation (8.4) gives k = 5.47 and

$$1.99\left(\frac{B_1}{B_2}\right)^{1-5.47}=\left(\frac{B_1}{B_2}\right)^{r} \tag{8.6}$$

From equation (8.6) it follows r = -6.19
Thus, in WENDY the values r = -6.19 and k = 5.47 (equation 8.4) have to be entered.

8.2.2 Results

To compare the results from WENDY with the results from the experiments, Q_1 and Q_2 are taken as the representative values, since the error made when measuring Q_1 and Q_2, is small compared to the other measured values. Another reason is that Q_1 and Q_2 are the most frequently measured magnitudes. The bed-level change from WENDY is also compared with the bed-level measurements from the experiment. In appendix C the velocities, sediment transports, average water depths and the water levels of the WENDY simulations of experiment 1211 are given.

In figure 8.1 Q_1 and Q_2 are plotted versus time, both for the WENDY calculations and for the experimental results.

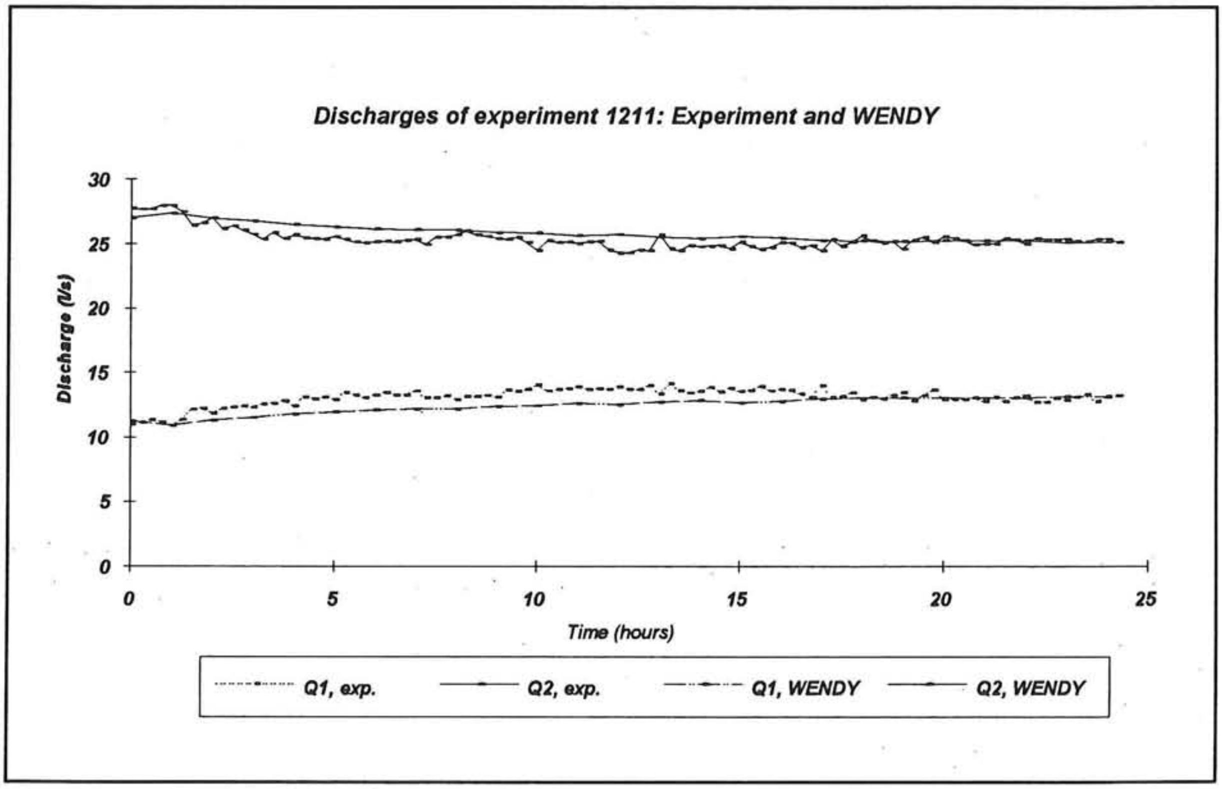


Figure 8.1 - Exp 1211: Discharge vs. Time

In figure 8.1 it can be seen that the discharges in the experiment and from the WENDY simulations are about the same. Therefrom it can be concluded that the simulation of the experiment can be done quite accurately.

In figure 8.2 the bed levels along the length of branches 0, 1 and 2 are plotted for several time points. From $x = 0$ m to 4.55 m, branch 0 is represented; from $x = 4.55$ m to 13.15 m, branch 1 is represented and from $x = 13.15$ m to 21.55 m branch 2 is represented. (x is the distance from the upstream boundary). From figure 8.2 it can be seen that branch 0 was not in its equilibrium situation when the experiment started. By simulating an experiment with WENDY before actualy running it, the correct bottom level of branch 0 can easily be obtained. By doing this, it can be avoided that branch 0 is not in its equilibrium situation, and thus, causing back-water curves which might influence the flow pattern at the nose.

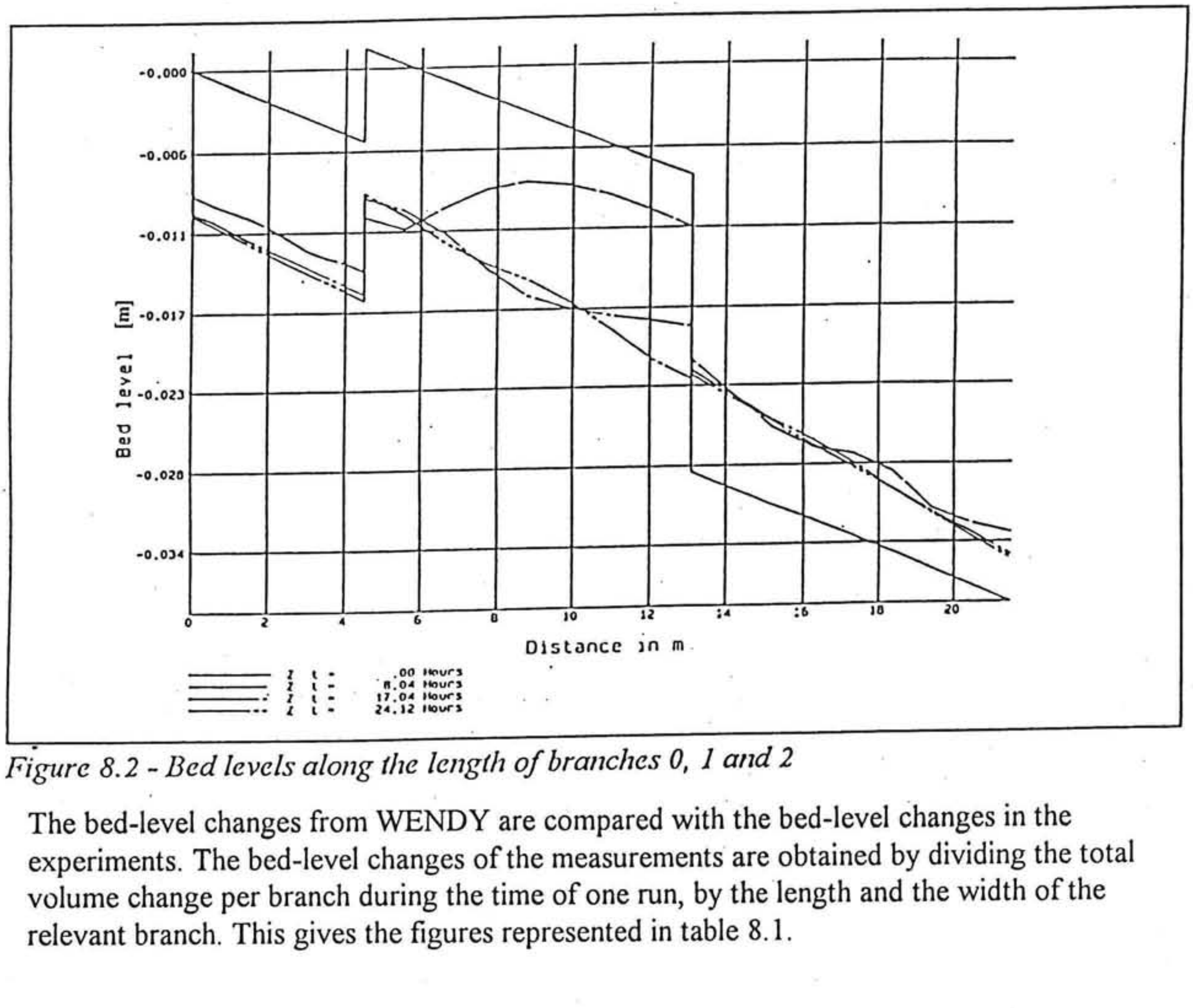


Figure 8.2 - Bed levels along the length of branches 0, 1 and 2

The bed-level changes from WENDY are compared with the bed-level changes in the experiments. The bed-level changes of the measurements are obtained by dividing the total volume change per branch during the time of one run, by the length and the width of the relevant branch. This gives the figures represented in table 8.1.

Time $[h]$	Δz Branch 0 [mm]		Δz Branch1 [mm]		Δz Branch 2 [mm]	
	Experimental	WENDY	Experimental	WENDY	Experimental	WENDY
8	-7.3	-7.6	-19.1	-6	+2.0	+4.5
16	-10.4	-8.9	-19.1	-10.5	+2.9	+3.9
24	-10.3	-9.0	-14.7	-11.5	+5.5	+3.9

Table 8.1 - Δz versus time for every branch

In table 8.1 the bed-level changes are presented. The bed-level change from WENDY follows from figure 8.2, using the average bed levels.

In the WENDY simulations a Chézy coefficient of 30 $m^{1/2}/s$ was used. This value was obtained, using a water depth of 0.1 m. The results of the WENDY simulations gave the water depths. They can be found in appendix C, figure C3. From this figure, the average depths of every branch during the experiment are derived:

$a_0 = 0.11$ m
$a_1 = 0.10$ m
$a_2 = 0.12$ m

This gives the following Chézy coefficients using equation 4.2:

$C_0 = 31.2\ m^{1/2}/s$
$C_1 = 28.8\ m^{1/2}/s$
$C_2 = 30.8\ m^{1/2}/s$

The differences between these values and the assumed value of the Chézy coefficient is small. Therefore it is assumed that the used Chézy coefficient does not need any correction.

The water levels of the WENDY simulations can be compared with the measured water levels. The measured water levels are somewhat difficult to represent, because there was a fluctuation in the water levels during the experiments. That is why the water levels that are represented here are a mean value of four measured values, which are measured every half an hour: The water level at the nose is not mentioned here, since the results of the water level measurement at that point are unreliable, so here the water levels at the begin of branch 0, and at the ends of branches 1 and 2 are represented. The water levels are represented here as a value above the chosen zero level. In table 8.3 the water levels from the WENDY simulation are presented. These water levels can be found in figure C.2 in appendix C.

Location	Water level, t=0 [mm]	Water level, at the end of the experiment [mm]
Branch 0, begin (h_0)	381.0	377.8
Branch 1, end (h_1)	360.9	359.8
Branch 2, end (h_2)	357.5	358.2
h_0-h_1	20.1	18.0
h_0-h_2	23.5	19.6
h_1-h_2	3.4	1.6

Table 8.2 - Measured water levels

Location	Water level, t=0 [mm]	Water level, at the end of the experiment [mm]
Branch 0, begin (h_0)	106.0	103.5
Branch 1, end (h_1)	85.0	85.0
Branch 2, end (h_2)	84.5	84.5
h_0-h_1	21	18.5
h_0-h_2	21.5	19.0
h_1-h_2	0.5	0.5

Table 8.3 - Water levels from the WENDY simulation

The values from table 8.2 and 8.3 are compared with eachother by using the differences between the water levels. As can be seen, the values of h_0-h_1 and h_0-h_2 are almost the same for the measurements and the WENDY simulations. The value of h_1-h_2 should remain the same during the experiment. Though, during the experiment this was difficult to do as can be seen in

table 8.2. In section 8.5 this problem will be treated. Therefore the values of h_1-h_2 from the WENDY simulation and from the experiment differ.
The Chézy coefficient can be derived from the results, by looking at the slope, the depth and at the velocity of the simulation of the experiment. From figure C.1 the flow velocity can be derived. From figure C.2 the slopes can be derived and from figure C.3 the water depths can be derived. Decided is to use the results at the end of the experiment (t = 24 hours), because at the end of the experiment the equilibrium situation is reached, so no influences of back water curves will be there. The Chézy coefficient can be calculated then, using the Chézy equation. The results of this are given in table 8.4.

Branch	u [m/s]	a [m]	i	R [m]	C [$m^{1/2}/s$]
0	0.34	0.113	1.21 E-3	0.092	32.2
1	0.31	0.106	1.51 E-3	0.069	30.3
2	0.35	0.119	1.61 E-3	0.085	29.9

Table 8.4 - Chézy coefficient from the simulation results

From table 8.4 it can be seen that the found Chézy coefficients are comparable with the assumed Chézy coefficient of 30 $m^{1/2}/s$. Therefrom it can be concluded that the results can be trusted.

8.3 Simulation of experiment 1331

8.3.1 Input in WENDY

Experiment 1331 comprises three runs with the first nose and with Q_0=20 l/s. The following values were used and found in this experiment:

L_0 = 4.55 m
L_1 = 8.60 m
L_2 = 8.40 m
B_0 = 1.00 m
B_1 = 0.40 m
B_2 = 0.60 m
C = 30 $m^{1/2}/s$
Δ = 1.65
D_{50} = 270 10^{-6} m
Q_0 = 18.4 l/s

$Q_{1,,t=0}$ = 8.4 l/s
$Q_{2,t=0}$ = 10.0 l/s
$Q_{1,t=end}$ = 5.7 l/s
$Q_{2,t=end}$ = 12.7 l/s
i_0 = 2.17 10^{-3}
i_1 = 1.98 10^{-3}
i_2 = 2.21 10^{-3}
h_1 = 4.16 cm
h_2 = 4.00 cm
S_0 = 30.2 kg/h

The relation, found for the sediment distribution at the nose was, for Q_0=20 l/s, using the first nose type:

$$\left(\frac{S_1}{S_2}\right)=2.30\left(\frac{Q_1}{Q_2}\right)^{2.69} \qquad (8.7)$$

Comparing equation (8.7) with equation (8.4) gives $k = 2.69$ and $r = -2.05$.
Thus, in WENDY the values $r = -2.05$ and $k = 2.69$ (equation 8.4) have to be entered.

8.3.2 Results

From the simulation of experiment 1331 only the results of the discharges are given, since the discharges are the representative values. In figure 8.3 The discharges of branch 1 and branch 2 are plotted versus the time, both for the WENDY calculations and for the experimental results. It can be seen that the shapes of the discharges of the measurements and of the WENDY simulations are quite the same, but the reached equilibrium situation differs some. This can be caused by the fact that the difference in water levels at the end of branches 1 and 2 is not exactly known. This will be treated more in detail in section 8.5.

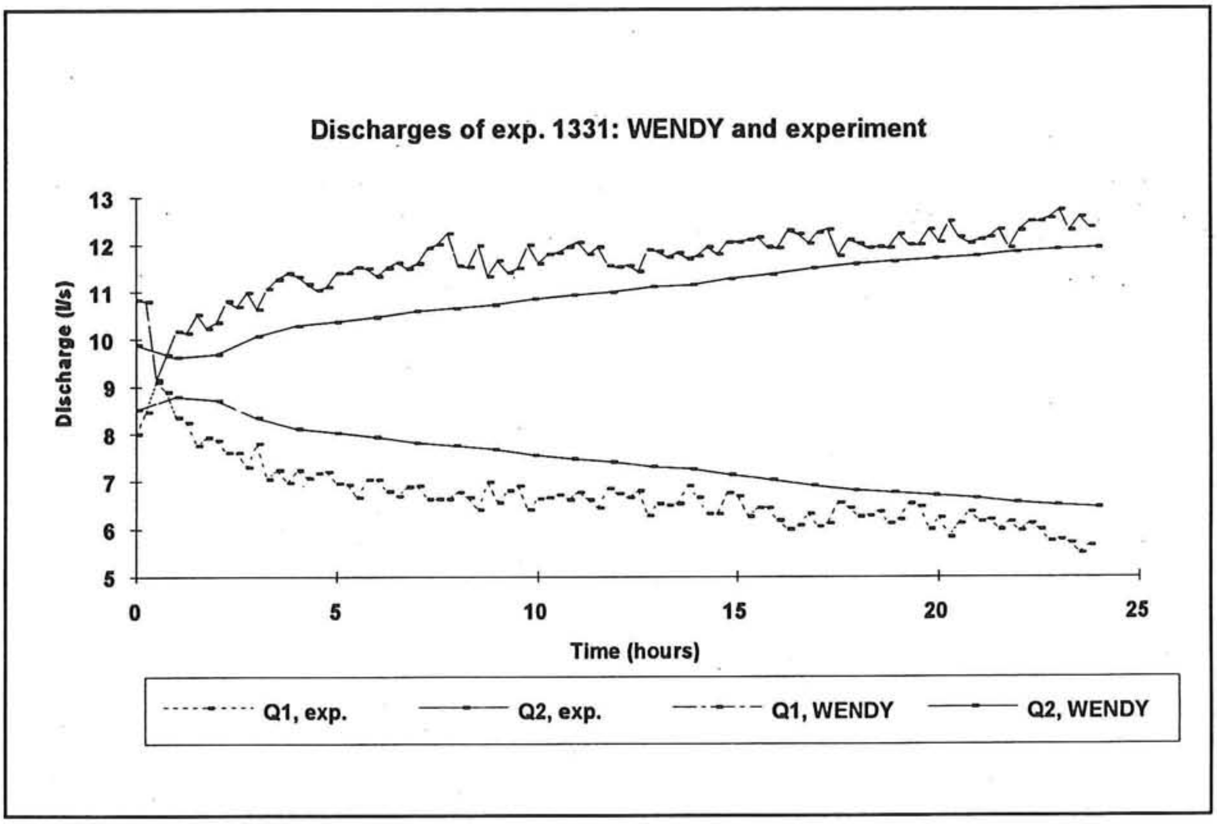


Figure 8.3 - Discharges of exp 1331: WENDY and experiment

8.4 Simulation of experiment 2111

8.4.1 Input in WENDY

Experiment 2111 comprises five runs with the second nose and with Q_0=30 l/s. The following values were used and found in this experiment:

L_0 = 4.55 m
L_1 = 8.60 m
L_2 = 8.40 m
B_0 = 1.00 m
B_1 = 0.40 m
B_2 = 0.60 m
C = 30 $m^{1/2}/s$
Δ = 1.65
D_{50} = 270 10^{-6} m
Q_0 = 28.8 l/s

$Q_{1,,t=0}$ = 8.2 l/s
$Q_{2,t=0}$ = 20.6 l/s
$Q_{1,t=end}$ = 3.4 l/s
$Q_{2,t=end}$ = 25.4 l/s
i_0 = 1.48 10^{-3}
i_1 = 1.26 10^{-3}
i_2 = 1.44 10^{-3}
h_1 = 5.13 cm
h_2 = 5.00 cm
S_0 = 33.7 kg/h

The relation, found for the sediment distribution at the nose was, for Q_0=30 l/s, using the second nose:

$$\left(\frac{S_1}{S_2}\right) = 12.1\left(\frac{Q_1}{Q_2}\right)^{3.61} \tag{8.8}$$

Comparing equation (8.8) with equation (8.4) gives $k = 3.61$ and $r = -6.15$.
Thus, in WENDY the values $r = -6.15$ and $k = 3.61$ (equation 8.4) have to be entered.

8.4.2 Results

Also from the simulation of experiment 2111 only the results of the discharges are given, since the discharges are the representative values. In figure 8.4 the discharges of branch 1 and branch 2 are plotted versus the time, both for the WENDY calculations and for the experimental results. Here it can be seen that the the equilibria reached differ somewhat . A reason for this can be that during the experiments the velocity in branch 1 became so low, that sand transport did not occure anymore. This causes sedimentation in branch 1 and thus a lower discharge in branch 1. In the WENDY calculation it is not taken into account that the velocity can be lower than the critical velocity that causes the first movement of sediment.

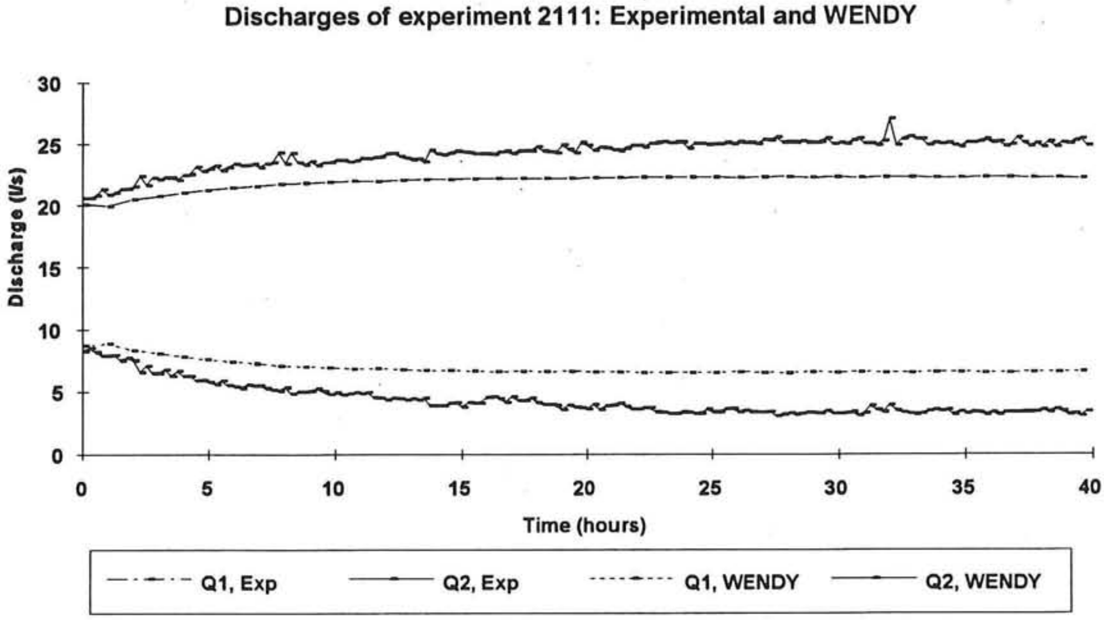


Figure 8.4 - Discharges of exp. 2111: WENDY and experiment

8.5 The influence of the water levels at the ends of branch 1 and 2 on the equilibrium

While running the experiments, it appeared that it was difficult to keep the water levels at the end of branch 1 and 2 at a constant level during the running. This is, among others, important while comparing the results of the experiments with the results of WENDY calculations. Therefore the influence of Δh, which is the difference of the water level at the end of branch 1 and the water level at the end of branch 2, on the equilibrium is tested. A measure of the equilibrium is the ratio of the discharges. This measure is used here to represent the equilibrium situation.

It is very time consuming to test the influence of Δh on Q_1/Q_2 with WENDY, because for every Δh, Q_1/Q_2 should be determined, so for every Δh a simulation with WENDY should be carried out. Therefore this problem is solved analytically. To calculate the equilibrium situation, eight equations with eight unknowns have to be solved:

$$a_1 = Q_1 . S_1^{-1/5} . B_1^{-4/5} . m^{1/5} \tag{8.9}$$

$$a_2 = Q_2 . S_2^{-1/5} . B_2^{-4/5} . m^{1/5} \tag{8.10}$$

$$i_1 = Q_1^{-1} S_1^{3/5} B_1^{2/5} m^{-3/5} C^{-2} \tag{8.11}$$

$$i_2 = Q_2^{-1} S_2^{3/5} B_2^{2/5} m^{-3/5} C^{-2} \tag{8.12}$$

$$i_1 . L_1 = i_2 (L_2 + R) \tag{8.13}$$

$$S_0 = S_1 + S_2 \tag{8.14}$$

$$Q_0 = Q_1 + Q_2 \tag{8.15}$$

$$\left(\frac{S_1}{S_2}\right) = M \left(\frac{Q_1}{Q_2}\right)^k \tag{8.16}$$

Special attention on R in equation 8.13 has to be paid:
It is not possible to put Δh at the end of the branches directly in the equations. That is why a virtual extra length is given to branch 2, named by R, giving a water-level difference at the end of the branch. For every R, the 8 equations can be solved.

Equations (8.9) to (8.12) follow from the combination of the Chezy equation and the transport equation for both branches. It is asumed here, that the hydraulic radius is equal to the depth, since $a << B$. Equation (8.13) follows from the fact that the water levels at the bifurcation are the same for both branches. Equations (8.14) and (8.15) follow from continuity and equation (8.16) is the nodal point relation at the bifurcation.

Solving equations (8.9) to (8.16) gives:

$$\left(\frac{Q_1}{Q_2}\right)=M^{\left(-\frac{3}{3k-5}\right)}.\left(\frac{B_1}{B_2}\right)^{\left(-\frac{2}{3k-5}\right)}.\left(\frac{L_2+R}{L_1}\right)^{\left(\frac{5}{3k-5}\right)} \tag{8.17}$$

q_1 and q_2 then follow from $q_i = Q_i/B_i$ and:

$$q_0=q_1+q_2 \tag{8.18}$$

Using this, Δh can be calculated by:

$$\Delta h=i_2.R \tag{8.19}$$

Thus, a positive Δh is related to the fact that $h_2>h_1$

Solving equations (8.17) and (8.19) gives the following relation between Δh and Q_1 or Q_2, if an upstream discharge of 18.4 l/s and an upstream sediment transport of 30.2 kg/h are used, which was the case in experiment 1331:

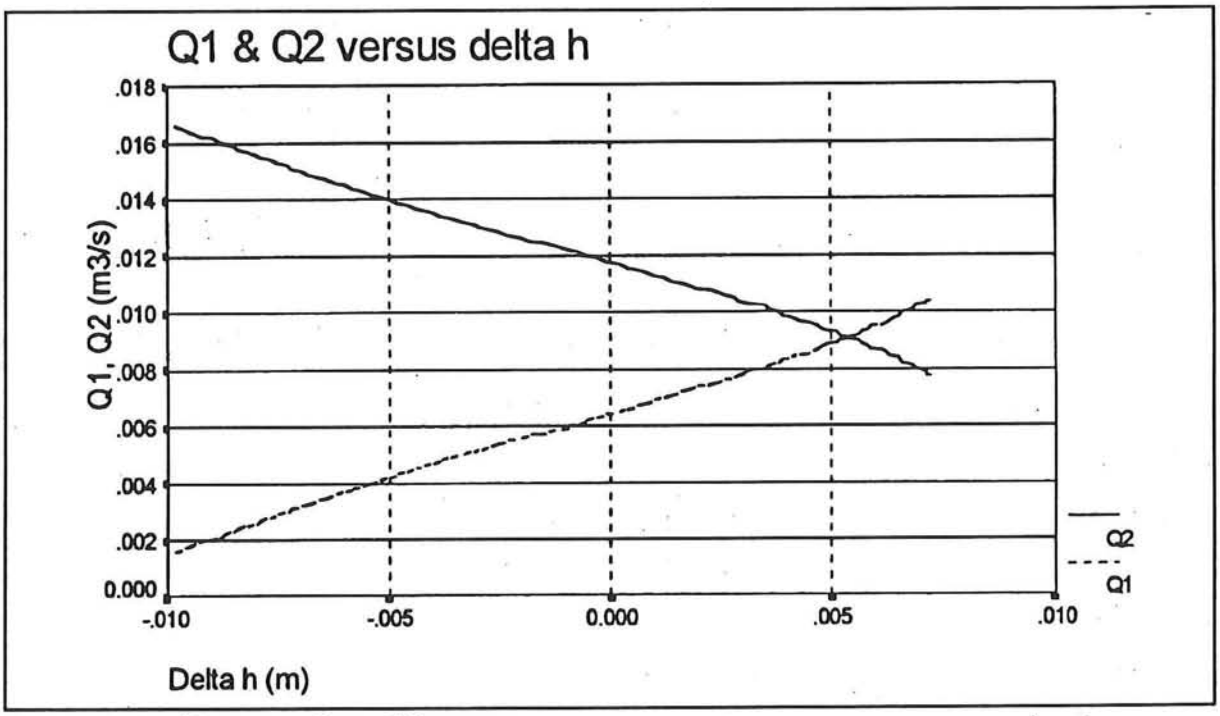


Figure 8.5 - Δh versus Q_1 and Q_2

During a series of three experiments it appeared that Δh at the tail gates had a maximum variation of 5 mm. From figure 8.5 it can be seen that a variation of Δh from -2.5 mm to 2.5 mm gives a variation of Q_1/Q_2 from 0.4 to 0.7, which is considerable. Therefore it is difficult to compare the results of the experiments with WENDY calculations, because the boundary conditions i.e. water levels at the end of the respective branches are not exactly determined.

Therefore it can be concluded that it is very important to keep the water levels at the tail gates at a constant level during the experiments. Special attention should be given to this.

The results of the WENDY simulations gave for experiment 1331 and experiment 2111 somewhat different equilibrium situations than those from the experimental measurements. Here the Δh is calculated, using equation 8.17, for which the Q_1/Q_2 ratio of the simulations is the same as the ratio of the measured discharges. The results of this are given in table 8.5.

Experiment	Experimental Q_1, t=end (l/s)	Experimental Q_2, t=end (l/s)	Δh, input WENDY (mm)	Δh which gives the measured discharges (mm)
1331	5.7	12.7	-1.6	-2.3
2111	3.4	25.4	-1.3	-7.2

Table 8.5 - corrected Δh

In table 8.5 it can be seen that the correction on Δh in experiment 1331 is small; it is only 0.7 mm. This correction falls in the range that Δh fluctuated during the experiment. So it is possible that this influence is the reason for the fact that the WENDY simulations did not give the same equilbrium situation as the measurements from the experiment.
The correcton on Δh in experiment 2111 is big; it is 5.9 mm. This correction does not fall in the range that Δh fluctuated during the experiment. So in experiment 2111 there must be another reason for the fact that the WENDY simulations did not give the same equilbrium situation as the measurements from the experiment. This was mentioned already in section 8.4.

8.6 Conclusions and recommendations

The simulations of the experiments with WENDY lead to the following conclusions and recommendations.

- The results of the simulation and the experimental measurements of experiment 1211 show more or less the same figures for the discharges and the bed levels. The results of the simulation of experiment 1331 and 2111 and their experimental measurements show more difference, looking at their equilibrium situation. This can be caused by a incorrect Δh, in the case of experiment 1331, or by the fact that the velocity in one branch was low, so that no more sediment transport occured, in the case of experiment 2111. In the WENDY calculation this is not taken into account.

- The bottom level of branch 0 should be in an equilibrium state during the total experiment, to avoid that branch 0 is not in its equilibrium situation, which causes back-water curves which influence the flow pattern at the nose. This was, however, not the case. In future experiments this can be avoided by simulating the designed experiment with WENDY. If the bed level of branch 0 is changing, the experiment should be redesigned until bed-level changes do not occur anymore.

- The influence of the difference of the water levels at the end of branch 1 and 2 is considerable. Since it is difficult to adjust Δh while running the experiments, the final equilibrium state will not be one certain state, but will have a certain bandwidth. Therefore it is very important to take good care of the adjustment of the tail gates while running future experiments. A possible sollution for this problem is to take the changing water level into account, and stop adjusting the tail gates. This, however, gives other problems; the downstream boundary conditions of the experiment are changing during the execution of the experiment. This might influence the results.

Chapter 9 Conclusions and recommendations

9.1 Discussion and conclusions

9.1.1 Introduction.

In the former chapters the data obtained after running the experiments have been analysed. In chapter six, the results of the experiments are given. Chapter seven discusses the statistical analysis used to find estimations for the parameters. In chapter eight, some observations are compared with computer calculations. This chapter repeats the conclusions already found in the previous chapters and recommendations for the next experiments are given.

9.1.2 Restricted number of experiments.

This report is based on the first experiments on river bifurcations. The first part of the research was not completed, at the time this report was written. If results for the other nose types and types of sand are available, a qualitatively better analysis can be made of the behaviour of river bifurcations. The number of observations done for one experiment is rather small. When applying statistical analysis this gives rise to certain problems. When more observations are done for one experiment, the bandwidthfor the estimated variables becomes smaller. As the observations are time consuming, for the next experiments an optimum number of tests done for one experiment should be determined. This is described in the following sections.

Although the number of experiments is rather small, the tendency is clear. This can be observed, when looking at the graphs in appendix B. More observations for one experiment will not lead to significant different values for M and k of equation (2.22) from the values found in chapter seven.

9.1.3 Conclusions

For the first nose different values for k are found for different upstream discharges. For the second nose, however, only one value for k is found. When the upstream discharge is held constant at 40 l/s, a different value for k is found for the two different nose types. When constant upstream discharge of 30 l/s is applied, only one value for k is found for the two nose types. The most logical conclusion to be drawn from these results is that more experiments should be carried out.

Using the results in morphological simulations should be done with great care. If, because no other possibilities are available, values for M and$k$ have to be obtained from the results given in this report, it is recommended to use an average of the values found for the experiments carried out for the first nose, as for this nose most observations were done and this shape of the nose is the most logical one occurring in nature. Because of the following reasons, care should be taken when using these results.

First the linkage between the experimental results and the reality is not looked at. It is not known if k remains the same when the test rig is scaled to natural proportions.
Secondly, when this average k is used, it should be notified that this value k will lead to a stable bifurcation.

From chapter eight it is concluded that good simulations of the experiments using a computer program can be done. The results, found in the computer simulations agree well with the experimental results. So, when simulations of real river bifurcations are carried out, good results can be obtained, if a correct nodal point relation is used.

9.2 Continuation of the experiments

9.2.1 Experimental design

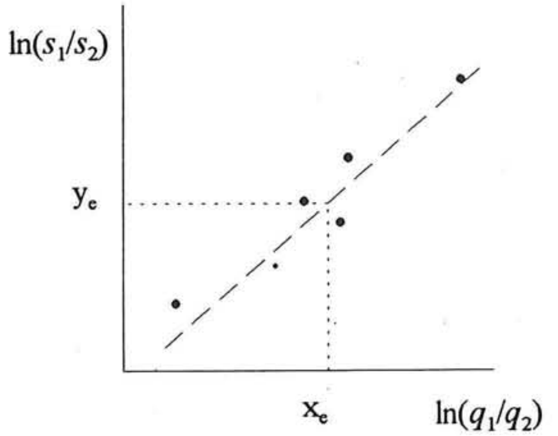


Figure 9.1 - Logarithm of sediment transport ratio versus the logarithm of the discharge ratio.

In the previous chapters it is stated several times, that more experiments are going to be carried out. This report represents more an intermedium stage or even a preliminary stadium then a final situation. Before new experiments are done, the next questions should be looked at.

- Are three different upstream discharges enough or should intermediate discharges, like 25 l/s or 35 l/s, also be used?
- How many observations for one experiment should be carried out?
- In which region of the graph, in which the sediment transport rates versus the discharge rate is plotted, should the observations be obtained?

The last two questions are explained as follows:
In figure 9.1 an example of the results of an arbitrary experiment is presented. The observations are given in a graph, with on the x-axis the logarithm of the discharge ratio and on the y-axis the logarithm of the sediment transport ratio. The equilibrium of this experiment can be found in (x_e, y_e). The most observations are done around this equilibrium and few observations are found at the 'ends' of the line in figure 9.1. The points at the 'edges' of the line are important. More observations done for that region give a more accurate fitted line in figure 9.1. This leads to a

smaller bandwidth of the estimated parameters. A problem arises for the experiments on river bifurcations, as they tend to approach the equilibrium situation therefore, it is hard to get observations, which are not in the region around that equilibrium. It can be done by running an experiment for one day.

In chapter four it is described that before an experiment is going to be carried out, first the equilibrium situation is calculated, and then a disturbance is added to this equilibrium. During the experiment this disturbance is faded away. After one day of running the experiment, the point found in graph 9.1, is not in the region of the equilibrium. So, when running the model for only one day, these points can be created. This way of running the model is rather time consuming, as for one point at least two days are needed, one day for preparing the bed and one day for running the model.

For the following experiments more accuracy, that is more observations for one experiment and observations in the region where they are needed, should be weighed versus the time-consuming character of the observations. So the needed accuracy should be defined and the above discussed phenomenon should be studied more thoroughly. A part of statistical mathematics is known as *experimental design*. This experimental design can be used to answer the above questions. Several books are written about this and related subjects, for instance (Atkinson and Donev,1992)

9.2.2. Comparison with nature

Sofar only the results of the model study are discussed. The purpose of the study is to use the results in computer simulations. For a good understanding of the values found, a comparison with natural bifurcations should be carried out. In the previous chapters it is explained that the local bathometry determines the behaviour of the bifurcation. For the study three different nose types are designed, one symmetrical and two asymmetrical. The two asymmetrical nose types are used to get a clear distinction between the results. A completely different local geometry is found, when the entrance to one of the two branches is narrowed. So the three different nose types should give different results. The question remains whether these nose shapes occur in nature, not only the asymmetric ones but also the symmetrical nose type. Another question is whether the difference in local geometry between stable and unstable bifurcations can be visualized in nature, for instance from aerial photographs.

The comparison between the values found in this report and those that should occur in nature is more difficult. Scaling the test rig dimensions to real river dimensions will create problems, because due to scaling effects the local three-dimensional geometry will be distorted. In the experiments it is found that the upstream discharge influences the value of k. Thus, seasonal fluctuations of the upstream discharge will affect the behaviour of the bifurcation.

9.2.3 Improving the experiments

During an experiment the water levels were measured. The second stilling basin was connected with the test rig using a pitot tube. Probably this pitot tube did not work properly, since the levels measured in the second stilling basin could not alway be trusted.
The sand feeder did not feed a constant amount of sand during an experiment. Also the calibration of the sand feeder has to be checked every time the sand feeder is started.
Without properly measured water levels at the nose, water velocities could not be calculated. Therefore it is recommended to measure the velocities in future experiments. For the experiments ran sofar the water levels at the end of the branches were kept constant. This was done by adjusting the tail gates during an experiment. Since a considereable error is made, it should be reconsidered whether the water levels or the tail gates should be kept constant.

9.2.4 Recommendations

In the sections described above, some recommendations were already given and explained. In section 9.2.1 it is described that the number of observations should be looked at. In section 9.2.2 a comparison with nature is recommended.
For a continuation of the experiments several possibilities occur. However, before the test rig is being rebuilt, changing the dimensions, or other structures are built, it is recommended to finish the experiments already started. Thus, first finish the observations, using the second nose and an upstream discharge of 20 l/s.

The next step could: be finishing the experiments using the third nose type. It is also recommended to carry out experiments with other types of sand. When these experiments are carried out, new test situations can be thought of. The most logical set-up is to originate the next experiments from the experiments described above.

Summarizing the recommendations are:

- Finish the experiments for the second nose.
- Determine the optimum number of observations, as described in section 9.2.1.
- Carry out experiments for the third nose.
- Carry out experiments for different types of sand.
- Compare the results with natural bifurcations.
- Use the computer program Wendy when designing an experiment.
- Some parts of the test rig need to be looked at.
- Reconsider whether the water levels or the tail gates are held constant during an experiment.

Main Symbols

A = surface of cross section.
a = water depth
a_{i} = water depth in branch i
B_{i} = width of branch *i*
C = Chézy coefficient
D_{50} = main grain size diameter
E = expectation of a stochastic variable
F = test quantity
Fr = Froude number
g = acceleration of gravity
h = water level
i = slope of bed level
i = number of branch
$\boldsymbol{J}$ = Jacobian
J = cost function
k = power in nodal point relation (eq. 2.6)
k = bed roughness
L = length of branch
M = coefficient in nodal point relation (eq. 2.7)
m = coefficient in sediment transport formula (eq. 2.12)
n = power in sediment transport formula (eq. 2.12)
n = number of tests done for one experiment
p = number of variables to be estimated; number of rows in β vector
Q = total discharge in branch *i*
Q_0 = total upstream discharge
q_{i} = discharge per unit of width in branch *i*
R = hydraulic radius
R^2 = test quantity
S_{i} = sediment transport rate in branch *i*, determined by nodal point relation
S_{ie} = sediment transport capacity
s = sediment transport per unit width
SS_{res} = residual sum of squares
$SS_{\mathrm{res,H}}$ = residual sum of squares under the hypothesis
SS_{tot} = total sum of squares
T = teststatistic
t = actual value of T
t = time
u = flow velocity in x direction

u = measuring error
U = vector of measuring errors
V = volume of sand
v = flow velocity in y-direction
W = weight of sand
w = flow velocity in z-direction, fall velocity
x = x-axis, longitudinal direction of the river
X = design matrix
y = y-axis, transversal direction of river branch
Y = vector of dependent variables
z = z-axis
z_b = bottom level

α = influence of the different upstream discharges.
β = influence of the different nose types
β_i = parameter to be estimated
ϵ = void ratio of sediment
μ = cell avarage
ρ = mass density of water
ρ_s = mass density of sediment
σ = standard error

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APPENDIX A: MEASURING

In this appendix first the standard forms are shown. These forms are not the ones used, but the improved ones.
Secondly in this appendix the final results for every experiment are given.

FORM 1:

experiment number :
Date :
starting of the pump :
closing the pump :
experimentation time :
total experiment time :
position tail gate 1 :
position tail gate 2 :
water temperature :
D_{50} :

experiment number :
Date :
starting of the pump :
closing the pump :
experimentation time :
total experiment time :
position tail gate 1 :
position tail gate 2 :
water temperature :
D_{50} :

experiment number :
Date :
starting of the pump :
closing the pump :
experimentation time :
total experiment time :
position tail gate 1 :
position tail gate 2 :
water temperature :
D_{50} :

FORM 2A: bed level measurements.

experiment number: date:

time: begin \ end of experiment.

cross sec.	readings (mm)									
	1=left	2	3	4	5=m	6	7	8	9	10=r
01										
02										
03										
04										
05										
06										
07										
08										
9(0.6)										
9(0.4)										
10 (0.4)										
10 (0.6)										
11 (0.4)										
11 (0.6)										
12 (0.4)										
12 (0.6)										

FORM 2B: bed level measurements:

experiment number: date:

time: begin \ end of experiment

cross sec.	readings				
	1 = left	2	3 = middle	4	5 = right
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					

FORM 2C: bed level measurements:

experiment number: date:

time: begin \ end of experiment

cross sec.	reading				
	1 = left	2	3 = middle	4	5 = right
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					

FORM 3: water level measurments:

experiment number: date:

Stilling basin number:

reading 1 (cm)	reading 2 (cm)	reading 3 (cm)	mean (cm)	time

FORM 4: discharge measurements:

experiment number: date:

Rehbock weir:

exp. time	time	level	discharge (l/s)

FORM 5: sand measurements:

experiment number: date:

sand in sand trap nr:
weight bucket, sand and water: : kg
weight bucket and water : kg
weight sand : kg

weight bucket, sand and water: : kg
weight bucket and water : kg
weight sand : kg

weight bucket, sand and water: : kg
weight bucket and water : kg
weight sand : kg

weight bucket, sand and water: : kg
weight bucket and water : kg
weight sand : kg

weight bucket, sand and water: : kg
weight bucket and water : kg
weight sand : kg

weight bucket, sand and water: : kg
weight bucket and water : kg
weight sand : kg

weight bucket, sand and water: : kg
weight bucket and water : kg
weight sand : kg

weight bucket, sand and water: : kg
weight bucket and water : kg
weight sand : kg

total weight sand in sand trap no.. : kg
total volume sand in sand trap no..: m^3

A. 2 Final results for every experiment

In the following part of appendix A, the final results are given for every experiment. The readings of the bed levels, the discharges and the water levels are given in the report of measurements.

The final results consist of the following. For the three branches the volume of bed-level change is given. The amount of sand in the sand traps, as well as the volume of sand in the sand traps are given next. These are followed by the sediment transport rates at the nose, $S_1$and S_2 and there ratio S_1/S_2 and the discharges at the nose. The final results are finished by checking the sand balance. The amount of measured sand and feeded sand are compared to each other.

	FINAL	RESULTS	OF RUN	NO. 1111		
	========	========	========	=========		
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
-0.01766	-0.028081	0.0264399	75.33	105.16	0.0795375	0.1110337
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.0514563	0.1374736	0.3742992	9.525	18.775	0.5073236	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.1712696	0.1605154	0.0107542	6.699762			

	FINAL	RESULTS	OF RUN	NO.1121		
	========	========	========	=======		
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
-0.00275	0.015753	-0.045602	214.93	2	0.2269349	0
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.2426878	-0.045602	-5.321917	18.451818	9.4572727	1.9510718	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.1943362	0.2333837	-0.039048	16.731032			

	FINAL	RESULTS	OF RUN	1131a		
	=========	=========	========	========		
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
-0.0148472	-0.0251198	0.00945893	48.09	158.65	0.0507761	0.1675114
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.02565628	0.17697028	0.1449751	9.3172727	22.21	0.419508	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.18777937	0.20642956	-0.0186502	9.0346492			

FINAL	RESULTS	OF RUN	NO. 1131b			
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
-0.002885	-0.010006	-0.015675	20	112.35	0.0211171	0.1186253
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(m3/s)	(m3/s)		
0.0111109	0.1029505	0.1079247	9.9533333	20.417778	0.4874837	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.1111767	0.1577806	-0.046604	29.53716			

	FINAL	RESULTS	OF RUN	N0.1131c		
	=========	=========	========	========		
DELTA V0 (m3)	DELTA V1 (m3)	DELTA V2 (m3)	SAND TRAP 1 (kg)	SAND TRAP 2 (kg)	VOLUME TRAP 1 (m3)	VOLUME TRAP 2 (m3)
0.02465063	0.00258043	0.02732318	80.64	57.3	0.0851441	0.0605005
S1, AT THE NOSE (m3)	S2, AT THE NOSE (m3)	S1/S2	Q1 AVERAGE (l/s)	Q2 AVERAGE (l/s)	Q1/Q2	
0.08772455	0.08782365	0.99887159	11.956	18.261	0.6547287	
MEASURED SAND (m3)	FEEDED SAND (m3)	DIFFERENCE (m3)	ERROR %			
0.20019882	0.18933666	0.01086216	5.7369554			

	FINAL	RESULTS	OF RUN .	1141a		
	========	========	========	=======		
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
0.0017447	0.02341	0.0069522	50.05	65.58	0.0528455	0.069243
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.0762555	0.0761952	1.0007924	12.940606	18.542727	0.6978804	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.1541953	0.1724739	-0.018279	10.597857			

	FINAL	RESULTS	OF RUN	NO.1141b		
	========	========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
-0.000324	0.0108736	0.0019526	65.05	87.77	0.0686833	0.0926724
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.079557	0.094625	0.840761	12.415625	19.202188	0.6465735	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.1738575	0.1703504	0.0035071	2.0587715			

	FINAL	RESULTS	OF RUN	NO.1141c		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
-0.0057141	-0.0020188	0.00344724	76.2	79.88	0.0804561	0.0843417
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.07843738	0.08778892	0.89347697	12.718485	18.984848	0.6699282	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.16051216	0.18549076	-0.0249786	13.466226			

	FINAL	RESULTS	OF RUN	NO. 1211a		
	==========	==========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
-0.0334274	-0.06462433	0.010764225	84.97	160.83	0.089716	0.16981
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.02509165	0.180577339	0.138952375	12.555882	26.035588	0.4822584	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.172241589	0.191111695	-0.01887011	9.8738628			

	FINAL	RESULTS	OF RUN	NO. 1211b		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
-0.0137071	0.00003099	0.00498536	63.59	114.35	0.0671418	0.120737
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.06717279	0.12572235	0.53429473	13.658125	24.9875	0.5465983	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.17918801	0.16987706	0.00931095	5.4809932			

	FINAL	RESULTS	OF RUN	NO.1211c		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
0.00050608	0.01477386	0.01341139	55.18	110.34	0.0582621	0.116503
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.07303593	0.1299144	0.562185	13.096563	25.207188	0.5195567	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.2034564	0.17566235	0.02779405	15.822431			

	FINAL	RESULTS	OF RUN	NO.1221a		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
-0.0446092	0.02362528	-0.0349671	90.1	120.57	0.0951325	0.1273044
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.11875778	0.0923373	1.2861301	15.575313	22.847813	0.6816982	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.16648586	0.19222931	-0.0257435	13.392053			

	FINAL	RESULTS	OF RUN	1221b		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
0.00638445	0.00905863	-0.0084714	85.34	131.89	0.0901066	0.1392567
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.09916527	0.13078532	0.75822936	14.444063	24.000313	0.6018281	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.23633503	0.18197357	0.05436146	29.873272			

	FINAL	RESULTS	OF RUN	NO.1221c		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
-0.0199953	-0.0048813	-0.0093695	76.96	114.25	0.0812586	0.1206314
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.07637728	0.11126188	0.68646406	14.379063	24.18	0.5946676	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.16764384	0.17734534	-0.0097015	5.4704001			

	FINAL	RESULTS	OF RUN	1311a		
	========	========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
0.000036	-0.016187	-0.005743	36.32	146.68	0.0383486	0.1548728
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.0221621	0.1491302	0.1486092	5.0870968	13.639032	0.3729808	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.1713283	0.1477549	0.0235734	15.954383			

	FINAL	RESULTS	OF RUN	NO.1321a		
	=========	=========	========	========	===	
DELTA V0 (m3)	DELTA V1 (m3)	DELTA V2 (m3)	SAND TRAP 1 (kg)	SAND TRAP 2 (kg)	VOLUME TRAP 1 (m3)	VOLUME TRAP 2 (m3)
-0.0205359	-0.0642291	0.03758767	159.78	24.91	0.1687045	0.0263013
S1, AT THE NOSE (m3)	S2, AT THE NOSE (m3)	S1/S2	Q1 AVERAGE (l/s)	Q2 AVERAGE (l/s)	Q1/Q2	
0.10447537	0.06388902	1.63526336	8.8366667	9.721	0.9090286	
MEASURED SAND (m3)	FEEDED SAND (m3)	DIFFER-ENCE (m3)	ERROR %			
0.1478285	0.15901321	-0.0111847	7.0338269			

	FINAL	RESULTS	OF RUN	NO.1321b		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
-0.006031	-0.0210763	0.019334	168.78	6.19	0.1782072	0.0065357
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.15713088	0.02586974	6.07392517	10.879667	7.3816667	1.4738767	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.17696963	0.16024587	0.01672376	10.43631			

	FINAL	RESULTS	OF RUN	NO.1331a		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
-0.0073407	0.04722394	-0.0851963	36.24	153.34	0.0382642	0.1619048
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.08548811	0.07670845	1.11445495	7.3925	11.025	0.6705215	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.15485586	0.1589902	-0.0041343	2.6003781			

	FINAL	RESULTS	OF RUN	NO.1331b		
	=========	=========	========	========	===	
DELTA V0 (m3)	DELTA V1 (m3)	DELTA V2 (m3)	SAND TRAP 1 (kg)	SAND TRAP 2 (kg)	VOLUME TRAP 1 (m3)	VOLUME TRAP 2 (m3)
-0.0171475	0.00164528	-0.0083626	57.71	111.16	0.0609334	0.1173688
S1, AT THE NOSE (m3)	S2, AT THE NOSE (m3)	S1/S2	Q1 AVERAGE (l/s)	Q2 AVERAGE (l/s)	Q1/Q2	
0.06257866	0.10900621	0.57408343	6.614375	11.769375	0.5619988	
MEASURED SAND (m3)	FEEDED SAND (m3)	DIFFER-ENCE (m3)	ERROR %			
0.1544374	0.15883242	-0.004395	2.7670796			

	FINAL	RESULTS	OF RUN	NO.1331c		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
0.01255756	-0.0062631	-0.0016788	43.5	126.6	0.0459297	0.1336712
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.03966658	0.13199236	0.30052178	6.1159375	12.193125	0.501589	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.1842165	0.15883242	0.02538408	15.981672			

	FINAL	RESULTS	OF RUN	NO.1341a		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
0.00524268	0.02614813	-0.0062228	5.82	135.58	0.0061451	0.1431528
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.0322932	0.13692999	0.23583734	4.9026667	13.741667	0.3567738	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.17446587	0.16369732	0.01076855	6.5783298			

	FINAL	RESULTS	OF RUN	NO.1411a		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
0.00516576	-0.0322681	-0.0144032	35.56	89.19	0.0375462	0.0941717
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.00527807	0.07976852	0.06616732	2.448125	7.7009375	0.3178996	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.09021234	0.0916705	-0.0014582	1.5906545			

	FINAL	RESULTS	OF RUN	NO.2111a		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
0.00472828	0.07727881	-0.0148797	7.38	98.73	0.0077922	0.1042445
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.08507102	0.08936487	0.95195154	6.484375	22.340938	0.2902463	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.17916417	0.17724016	0.00192402	1.0855416			

	FINAL	RESULTS	OF RUN	NO.2111b		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
0.00960995	0.01689504	0.00507164	3	137.74	0.0031676	0.1454334
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.0200626	0.15050507	0.13330182	4.4929915	23.904274	0.1879577	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.18017762	0.17150746	0.00867015	5.0552639			

	FINAL	RESULTS	OF RUN	NO.2111c		
	=========	=========	========	========	===	
DELTA V0 (m3)	DELTA V1 (m3)	DELTA V2 (m3)	SAND TRAP 1 (kg)	SAND TRAP 2 (kg)	VOLUME TRAP 1 (m3)	VOLUME TRAP 2 (m3)
-0.0052762	0.00549457	-0.0169431	4.14	154.02	0.0043712	0.1626227
S1, AT THE NOSE (m3)	S2, AT THE NOSE (m3)	S1/S2	Q1 AVERAGE (l/s)	Q2 AVERAGE (l/s)	Q1/Q2	
0.00986581	0.14567964	0.06772263	3.8971875	24.653125	0.1580809	
MEASURED SAND (m3)	FEEDED SAND (m3)	DIFFER-ENCE (m3)	ERROR %			
0.15026929	0.17587272	-0.0256034	14.557932			

	FINAL	RESULTS	OF RUN	NO.2111d		
	=========	=========	========	========	===	
DELTA V0	DELTA V1	DELTA V2	SAND	SAND	VOLUME	VOLUME
			TRAP 1	TRAP 2	TRAP 1	TRAP 2
(m3)	(m3)	(m3)	(kg)	(kg)	(m3)	(m3)
-0.0123831	0.0085725	-0.0112243	1.75	149.49	0.0018477	0.1578397
S1, AT	S2, AT	S1/S2	Q1	Q2	Q1/Q2	
THE NOSE	THE NOSE		AVERAGE	AVERAGE		
(m3)	(m3)		(l/s)	(l/s)		
0.01042024	0.14661542	0.07107193	3.3678125	25.100313	0.1341741	
MEASURED	FEEDED	DIFFER-	ERROR			
SAND	SAND	ENCE	%			
(m3)	(m3)	(m3)				
0.14465261	0.17487345	-0.0302208	17.281547			

	FINAL	RESULTS	OF RUN	NO.2111e		
	=========	=========	========	========	===	
DELTA V0 (m3)	DELTA V1 (m3)	DELTA V2 (m3)	SAND TRAP 1 (kg)	SAND TRAP 2 (kg)	VOLUME TRAP 1 (m3)	VOLUME TRAP 2 (m3)
0.00048567	0.00047852	-0.0038246	5.35	163.16	0.0056488	0.1722733
S1, AT THE NOSE (m3)	S2, AT THE NOSE (m3)	S1/S2	Q1 AVERAGE (l/s)	Q2 AVERAGE (l/s)	Q1/Q2	
0.00612734	0.16844867	0.03637513	3.3734375	25.13875	0.1341927	
MEASURED SAND (m3)	FEEDED SAND (m3)	DIFFERENCE (m3)	ERROR %			
0.17506168	0.16177766	0.01328402	8.2112827			

APPENDIX B Statistical background

B.1 The d.u.d. method.

In chapter seven the estimates, $\hat{M}$ and $\hat{k}$ are calculated, using the d.u.d. method.
Estimating k and M can be done, using the 'Least-Squares Method'. This method gives an $\hat{M}$ and a $\hat{k}$ for which the difference between the measured ratio s_1/s_2 and the analytical function $M(q_1/q_2)^k$ is minimized:

$$J=\sum_{i=1}^{i=n}\left(M\left(\frac{q_1}{q_2}\right)_i^k-\left(\frac{s_1}{s_2}\right)_i\right)^2 \tag{b.1}$$

J = cost function

J should be minimized. As the measurements are discrete, a summation is used instead of an integral.

For finding $\hat{M}$ and $\hat{k}$, the derivatives are taken and set equal to zero:

$$\frac{\partial J}{\partial M}=0 \text{ and } \frac{\partial J}{\partial k}=0 \tag{b.2}$$

This yields a set of two functions with two unknown quantities, which can be solved. The problem is to deal with the derivative, $\partial J/\partial k$, as k occurs in the exponent of the function J. Therefore, the d.u.d. (Does not Use Derivatives) method is used.
The d.u.d. method (Ralston and Jennrich 1978), uses an algorithm to find the minimum in the cost function (b.1). This algorithm starts with three different points. Each point represents an $\hat{M}$-, a $\hat{k}$ and a J- value. The J-value is the sum of squares for the specific $\hat{M}$- and $\hat{k}$- value. By comparing the different J- values, better estimations, $\hat{M}$ and $\hat{k}$, can be obtained. 'Better' means: the new $\hat{M}$-, and $\hat{k}$- value have a lower J- value, so they fit better. This process will be repeated until no significant change in J occurs. The exact algorithm is given below.

step 1. $\Theta = [\hat{M}, \hat{k}]$

$p = 2$; number of elements in Θ vector.

$f(\Theta) = M(q_1/q_2)^k$.

$Y = s_1/s_2$.

n = number of experiments per nose.

step 2. Compute $J(\Theta) = \Sigma[Y_i - f_i(\Theta)]^2$ for three, $(p + 1)$, different values of $\hat{M}$ and $\hat{k}$ These vectors will be numbered so that $J(\Theta_1) \geq J(\Theta_2) \geq J(\Theta_3)$.

step 3. Compute $\Delta\Theta$ and ΔF.

$\Delta\Theta = [(\Theta_1 - \Theta_3)(\Theta_2 - \Theta_3)]$.

$\Delta F = [(f(\Theta_1) - f(\Theta_3)) (f(\Theta_2) - f(\Theta_3))]$

step 4. Compute α.

$\alpha = (\Delta F'\Delta F)^{-1}\Delta F'(Y - f(\Theta_3))$.

In which $\Delta F'$ is the transposed matrix of ΔF and ΔF^{-1} is the inverse of matrix ΔF.

step 5. Compute Θ_{new}.

$\Theta_{new} = \Theta_3 + \alpha\Delta\Theta$.

step 6. Compute $f(\Theta_{new})$.

step 7. Compute $J(\Theta_{new})$.

step 8. Erase Θ_1 and $f(\Theta_1)$ and renumber the remaining vectors.

step 9. Return to step 3.

This process can be repeated until any significant decrease of $J(\Theta)$ does not occur anymore. The Θ vector with the lowest $J(\Theta)$-value represents the best estimations of the *M*- and the *k*- value.

B.2 Statistical theory

B.2.1 Linear regression

In chapter seven the equation describing the relation between the sediment transports and the discharges was transferred into a linear function. In this appendix more attention is paid to the underlying theory of linear regression and how it is applied.

When model studies in general are carried out, certain parameters have to be estimated. If a linear model is assumed, the following equations can be used to describe the phenomenon to be studied:

$$\begin{aligned} y_1 &= \beta_0+\beta_1 x_{1,1}+\dots+\beta_{p-1}x_{1,p-1}+u_1 \\ y_2 &= \beta_0+\beta_1 x_{2,1}+\dots+\beta_{p-1}x_{2,p-1}+u_1 \\ &\;\;\vdots \\ y_n &= \beta_0+\beta_1 x_{n,1}+\dots+\beta_{p-1}x_{n,p-1}+u_n \end{aligned} \tag{b.3}$$

in which n is the number of observations done for one experiment and p is the number of parameters to be estimated. In the model a constant β_0 is inserted. This constant is known in statistics as the intercept. The other β_i are the variables to be estimated.
The set of equations can be summarized in a matrix notation:

$$Y=X\beta+u \tag{b.4}$$

in which Y is the dependent variable. In the study on river bifurcations, Y is the vector representing the logarithms of the measured sediment transport ratios, $\ln(s_1/s_2)$.

The X, in equation (b.4), is known as the *regression matrix*, the *design matrix* or just the X *matrix*. This matrix represents the *independent variables* or *response variables*. In this situation, the logarithm of the measured discharge ratio, $\ln(q_1/q_2)$, can be found in the design matrix.
The number of rows of the design matrix equals the number of observations, n. The number of columns equals the number of parameters to be estimated, p. So the design matrix is a $n\times p$ matrix. Since the number of observations is usually larger than the number of parameters to be estimated, $n>p$, the design matrix is not a square matrix.
The presence of an intercept affects the design matrix. Because of the intercept, the first row of the design matrix is filled with constants of the value one.

The vector β, in equation (b.4), is the *parameter vector*. This vector represents the unknown parameters, which have to be estimated in this regression analysis.
In this situation the parameter vector consists of the intercept, $\ln(\hat{M})$ and $\hat{k}$.

The vector u consists of the measuring errors.

This results into the following matrices:

$$Y = \begin{pmatrix} y_1 \\ y_2 \\ \cdot \\ \cdot \\ \cdot \\ y_n \end{pmatrix} = \begin{pmatrix} \ln(\frac{s_1}{s_2})_1 \\ \ln(\frac{s_1}{s_2})_2 \\ \cdot \\ \cdot \\ \ln(\frac{s_1}{s_2})_n \end{pmatrix} \qquad \text{(b.5)}$$

$$X = \begin{pmatrix} x_{10} & x_{11} & x_{12} & \cdot\cdot & x_{1,p-1} \\ x_{20} & x_{21} & x_{22} & \cdot\cdot & x_{2,p-1} \\ & & \cdot\,\cdot & & \\ & & \cdot\,\cdot & & \\ x_{n0} & x_{n1} & x_{n2} & \cdot\cdot & x_{n,p-1} \end{pmatrix} = \begin{pmatrix} 1 & \ln(\frac{q_1}{q_2})_1 \\ 1 & \ln(\frac{q_1}{q_2})_2 \\ & \cdot\,\cdot \\ & \cdot\,\cdot \\ 1 & \ln(\frac{q_1}{q_2})_n \end{pmatrix} \qquad \text{(b.6)}$$

$$\beta = \begin{pmatrix} \beta_0 \\ \beta_1 \\ . \\ . \\ \beta_{p-1} \end{pmatrix} = \begin{pmatrix} \ln(M) \\ k \end{pmatrix} \qquad (b.7)$$

B.2.2 Assumptions

To apply linear regression, several assumptions have to be made. These assumptions are known in statistics as the Gauss-Markov conditions. These conditions involve the measurement errors.
The first Gauss-Markov condition is: the expectation of the measuring error u_i should equal zero.

$$E(u_i) = 0 \qquad (b.8)$$

This condition excludes the situation in which the measuring error shows a certain trend, for instance, when a straight line is fitted where a quadratic function should be used.

The second condition: the variance, V, of the measuring error should be constant:

$$V(U_i) = E(U_i - E(U_i))^2 = \sigma^2 \qquad (b.9)$$

When this condition is fulfilled, the residuals do not increase or decrease with increasing or decreasing measured variables.

The third assumption excludes the situation in which a correlation, C, exists between measurement errors:

$$C(u_i, u_j) = E((u_i - E(u_i))(u_j - E(u_j))) = 0 \qquad (b.10)$$

A plot can be made with, on the x-axis, the logarithm of the discharge ratio and, on the y-axis, the logarithm of the sediment ratio. In this plot the measurement errors in the discharges can be derived from the horizontal distance between a point found in an experiment and the regression

line. The measurement errors in the sediment ratio can be found from the vertical distance between a measuring point and the regression line. There is a measurement error in the discharge measurement as well as in the sediment measurement, so the real measurement error represented in the plot is a combination of these two.
As stated in chapter five, the measurement error in the discharges is very small compared to the measurement error in the sediment transports. When the measurement errors in the discharges are neglected, the measurement errors are represented by the residuals, the vertical distances between the measuring points and the regression line.

In table B.1, the measurement errors found in chapter five, are compared with the residuals. In order to get a correct comparison, the values given in the column residual are obtained in the following manner:

$$S = \frac{SS_{res}}{n-p} \tag{b.11}$$

in which :

S^2 = estimation of standard error σ^2
SS_{res} = residual sum of squares
n = number of observations done for one experiment
p = number of parameters to be estimated

This will be explained later on.

Experiment	measurement error	S^2
Q_0 = 40 l/s, first nose type	0.09	0.14
Q_0 = 30 l/s, first nose type	0.14	0.15
Q_0 = 20 l/s, first nose type	0.14	0.07
Q_0 = 40 l/s, second nose type	0.13	0.02
Q_0 = 30 l/s, second nose type	0.36	0.15

Table B.1 - Measurement error in sediment transport ratio versus the residuals.

B.2.3. Analysis of variance

In chapter seven it is described that the values for $\hat{M}$ and $\hat{k}$ are tested. In this part of appendix B, this test is described. To carry out the tests, the tested variables are assumed to have a normal distribution. First a new model, an anova model, is defined. The computer program SPSS is used again. In this section of appendix B the background of the analysis is discussed. In section B.3, the output of SPSS is shown and explained.

First a new statistical model, the 'anova' model is defined. The term anova model, which stands for *ANalysis Of Variance model*, should not be mixed up with the term *ANOVA table*. An ANOVA table is given in the output of SPSS and gives the sum of squares and the degrees of freedom. An anova model is a reshaped version of the studied statistical model.
The purpose of an anova model is to study the influences of variables, which were changed during the experiment. In statistics these variables are called factors. In the study on river bifurcations, the upstream discharges and the nose types are the two factors. A factor is used as a label or indicator to separate the observations into groups. A simple anova model has the following shape:

$$E(Y_{ij}) = \mu + \alpha_i \tag{b.12}$$

In equation (b.12) it is expressed that the expectation of Y, equals an overall average μ and a deviation caused by the factor, α.

In equation (b.12) there is only one factor, α. In statistics this is known as *one way classification*. In the situation of the river bifurcation, there were two factors, the nose type and the upstream discharge, so there is a two-way classification.
This way of modelling causes the data to be classified in groups. These groups are called cells. In chapter seven, it is explained how the data could be divided into cells. For the three upstream discharges and two noses six cells are created. For the last cell only few data were available.

When α represents the influence of the upstream discharges and β the influence of the nose types, the next equation can be found:

$$E(Y_{ijk}) = \mu + \alpha_i + \beta_j \tag{b.13}$$

in which the index refers to the different groups indicated by α, index j refers to the groups indicated by β and index k refers to the number of observations.
Or, when using matrices:

$$\begin{pmatrix} y_{1,1,1} \\ \cdot \\ \cdot \\ y_{1,1,n} \\ y_{1,2,1} \\ \cdot \\ \cdot \\ y_{1,2,n} \\ \cdot \\ \cdot \\ \cdot \\ y_{3,2,n} \end{pmatrix} = \begin{pmatrix} 1&1&0&0&1&0 \\ 1&1&0&0&0&1 \\ 1&0&1&0&1&0 \\ 1&0&1&0&0&1 \\ 1&0&0&1&1&0 \\ 1&0&0&1&0&1 \end{pmatrix} \begin{pmatrix} \mu \\ \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \beta_1 \\ \beta_2 \end{pmatrix} \tag{b.14}$$

In the above equations the overall mean μ and the effects α and β can be found; α represents the three upstream discharges and β the two nose types. The advantage of this alternative way of parameterizing can easily be shown. The effects of several factors can clearly be distinguished. There is, however, also a disadvantage. Using this alternative way of parameterizing, the number of independent equations is less then the number of unknown variables. In the design matrix, this can be shown; the sum of the second, third and the fourth column equals the first column. The sum of the fifth and the sixth column also equals the first column. To solve this problem extra equations are inserted. This is done by expressing the factors according to a certain reference level. This reference level is usualy the first factor, α_1 and β_1 , or the last α_3 and β_2 in the equation (b.14).

For instance, when the reference is chosen to be 'the first', this means that α_1 and β_1 equal zero. The averaged Y in the first cell equals μ; $E(Y_{11}) = \mu + \alpha_1 + \beta_1 = \mu$. For the cell-averaged Y, for the cell with the same β and with another α, the value for α_2 can be added to μ: $E(Y_{12}) = \mu + \alpha_2$

In section 7.4 the analysis of variance is discussed. In this part of the appendix some theoretical background is given.
To test the found estimations, first a hypothesis is stated. For instance the first test given in chapter seven is:' $\hat{k}$ is equal for different upstream discharges using the first nose', or, $\hat{k}_{20} = \hat{k}_{30} = \hat{k}_{40}$. For every hypothesis a test parameter T is defined;

$$T=\left(\frac{SS_{res,H}-SS_{res}}{SS_{res}}\right)*\frac{n-p}{q} \tag{b.15}$$

in which

SS_{res} = residual sum of squares, that is the sum of squares, left when a line has been fit,.
$SS_{res,H}$ = residual sum of squares, when using the hypothesis,
n = the number of experiments,
p = the number of parameters,
q = the decrease in number of parameters to be estimated.

To calculate SS_{res} and $SS_{res,H}$, in equation (b.15), SPSS has been used. In section B.3 the input and output of SPSS are discussed. The result of the calculations is given below.

T has an F-distribution, with q and n-p as its degrees of freedom. The following notation is used: the capital letter T refers to the variable defined in equation (b15), being F (Fisher-) distributed, the small letter t refers to an actual value for T.
The hypothesis is assumed to be rejected, when $t \geq F_\alpha(q,n\text{-}p)$, in which α indicates the level of significance. In statistical handbooks, tables, which give the values for the F-distribution, can be found. The values for SS_{res} and $SS_{res,H}$ are calculated by the computer program SPSS.

In table B.2 the results of equation (b.15) are given. In this table, a letter is referring to the tested hypotheses. The *A* refers to the hypothesis: 'k is equal for different upstream discharges, using the first nose', $\hat{k}_{20} = \hat{k}_{30} = \hat{k}_{40}$. *B* refers to the hypothesis; '$\hat{k}$ is equal for different upstream discharges, using the second nose', $\hat{k}_{30} = \hat{k}_{40}$. The letters *C* and *D* stand for '$\hat{k}$ is equal for the two nose types' where for *C* the upstream discharge is 30 l/s and for *D* the upstream discharge is 40 l/s.

	A	B	C	D
$SS_{res,H}$	2.96	1.41	1.97	1.09
SS_{res}	1.66	1.15	1.81	0.64
n	20	15	16	12
p	6	4	4	4
q	2	1	1	1
t	5.63	2.49	1.06	5.63
$F_\alpha(q,n-p)$	3.74	4.84	4.75	5.32

Table B.2 - Calculations of t

Testing for every Q_0, whether $\hat{M}$ in the formula equals one, means that in the logarithm model, 'ln($\hat{M}$) equals zero', is tested. This test is standard given in the output of SPSS.
For testing whether a variable β equals zero, equation b15 can be rewritten:

$$T = \frac{\hat{\beta}_j^2}{S^2[(X'X)^{-1}]_{jj}} \tag{b.16}$$

in which $S^2[X^tX]^{-1}$ equals the variance of $\hat{\beta}_j$. Again T has an F(1, n-p) distribution. In SPSS another simplification can be made:

$$T = \frac{\hat{\beta}_j}{S\sqrt{[(X'X)^{-1}]_{jj}}} = \frac{\hat{\beta}_j}{SE(\hat{\beta}_j)} \tag{b.17}$$

in which SE($\hat{\beta}_j$) is the standard error of $\hat{\beta}_j$. Both $\hat{\beta}_j$ and SE($\hat{\beta}_j$) can be found in the output, as can be seen in figure B1. T defined in equation (b.17) ,has a Student(n-p) distribution.

Results:

Q_0=40 l/s, first nose: T= 2.599; Sig T = 0.0601
=> M is possibly one.

Q_0=30 l/s, first nose: T= 1.625; Sig T = 0.1652
=>M is possibly one.

Q_0=20 l/s, first nose: T= 1.489; Sig T = 0.2106
=>M is possibly one.

Q_0=30 l/s, second nose: T= 4.583; Sig T = 0.0025
=>M is not one.

Q_0=40 l/s, second nose: T= 13.51; Sig T = 0.0002
=>M is not one.

B.2.4. Multivariate analysis

The last analysis carried out in chapter seven, is the multivariate analysis. Multivariate analysis is an analysis in more than one dimension. In this situation the ratio of the sediment transports and that of the discharges is split in two, so a two-dimensional system is created.

The most simple way to calculate the estimates $\hat{M}$ and $\hat{k}$ is to use linear regression. For every combination of upstream discharges and nose types the following equation can be inserted:

$$\begin{aligned} \ln s_1 &= \ln M + k_{11} \ln q_1 + k_{12} \ln q_2 \\ \ln s_2 &= \ln M + k_{21} \ln q_1 + k_{22} \ln q_2 \end{aligned} \tag{b.18}$$

The results are discussed in chapter seven.For the multivariate option, again the analysis of variances is tested. For this situation also equation (b.15) holds, for calculating T. The significance of T, sig T, has an $F_\alpha(1, n\text{-}p)$ distribution.

	Q_0= 40 l/s first nose	Q_0= 30 l/s first nose	Q_0= 20 l/s first nose	Q_0= 40 l/s second nose	Q_0= 30 l/s second nose
$SS_{\mathrm{res,H}}$	0.6	1.845	0.458	0.479	3.33
SS_{res}	0.418	1.51	0.442	0.458	3.28
n-p	8	10	10	8	14
q	1	1	1	1	1
t	3.48	2.2	0.36	0.37	0.21
$F_\alpha(1, n\text{-}p)$	5.32	4.96	4.96	5.32	4.6

Table B.3 - Results for testing $\hat{k}_{12}$ *equals* $\hat{k}_{21}$

For the significance level α, a level of 5% is taken. It can be seen in table B.3 that $F_\alpha(1, n\text{-}p)$ is (much) larger than t, for every experiment. So the hypothesis '$\hat{k}_{12}$ equals $\hat{k}_{21}$' is clearly accepted.

	Q_0= 40 l/s first nose	Q_0= 30 l/s first nose	Q_0= 20 l/s first nose	Q_0= 40 l/s second nose	Q_0= 30 l/s second nose
$SS_{\text{res,H}}$	0.617	1.863	0.467	0.462	3.37
SS_{res}	0.419	1.51	0.442	0.458	3.28
$n\text{-}p$	8	10	10	8	14
q	1	1	1	1	1
t	3.78	2.34	0.57	0.07	0.38
$F_\alpha(1, n\text{-}p)$	5.32	4.96	4.96	5.32	4.6

Table B.4 - Results of testing $\hat{k}_{11}$ equals $\hat{k}_{22}$

Again a significance level of 5% is taken. The hypothesis' $\hat{k}_{11}$ equals $\hat{k}_{22}$' is accepted, as for every experiment $F_\alpha(1, n\text{-}p)$ is larger than t.

B.3 COMPUTER PROGRAM SPSS

B.3.1. Linear regression

To solve equation (b.1), several computer programs are available. Here the program SPSS is used. Although SPSS stands for Statistical Package for the Social Sciences, it can be used very well for technical applications

To calculate the estimated values of the parameters, $\hat{\beta}$, SPSS uses the least-squares-method. In the general situation the next equation has to be minimized:

$$S=\sum_{i=1}^{n}(y_i-\hat{\beta}_0x_{i,0}-\hat{\beta}_1x_{i,1}-\dots-\hat{\beta}_{p-1}x_{i,p-1})^2 \qquad (b.19)$$

This equation can be rewritten in a matrix notation:

$$S = (y-X\hat{\beta})'(y-X\hat{\beta}) = \|y-X\hat{\beta}\|^2 \qquad (b.20)$$

The required input, consists of the dependent variable ln (s_1/s_2) and the independent variable $\ln(q_1/q_2)$, for each measured point. If this is done for the experiment with an upstream discharge of 30 l/s and the first nose, the following output is created:

```
     **** MULTIPLE REGRESSION ****


------------------ Variables in the Equation ------------------

Variable          B      SE B      Beta         T  Sig T

LNDIS      4.516251   .796615   .930257    5.669  .0024
(Constant)  .306199   .188486              1.625  .1652
```

Figure B.1 - Part of SPSS output; parameter estimates

In the output the following can be found: in the first column, the variables used in the regression analysis are printed. 'LNDIS' is the variable *k*, 'Constant' is the intercept ln(M). In the column B the estimated values for the parameters, belonging to the respective variables are given. The first number in this column represents the estimate $\hat{k}$, the second number represents the value of the intercept ln ($\hat{M}$). The third column represents the standard errors of the estimated parameters. In the fifth and the sixth column, the validity of the estimated parameter is tested. The fifth column is named *T*, which stands for Test statistics. The expression for *T* and Sig *T* are described above. Here it is tested, whether the discussed variable equals zero or not. The first number in the last column represents the value P(T>5.669). As can be seen the value for $\hat{k}$ does not equal zero, since the value for Sig *T* is low. In 0.24% of the cases the value for *T* is exceeded. This means that the value for *T* is large, so $\hat{k}$ does not equal zero. For the estimate ln($\hat{M}$) the same reasoning can be applied. Sig *T* is rather large, this means that in 16.5% of the cases the value for *T* is exceeded, so ln($\hat{M}$) can equal zero.

Another part of the same output is the ANOVA table. ANOVA stands for *ANalysis Of VAriance*. In the output of SPSS the next figure can be found:

```
Analysis of Variance
              DF    Sum of Squares    Mean Square
Regression     1       4.75530          4.75530
Residual       5        .73976           .14795

F =     32.14101      Signif F =  .0024
```

Figure B.2 - Part of SPSS output; ANOVA table

The first column is named DF, which stands for *Degrees of Freedom*. The first figure, represents the number of independent variables. For a model without an intercept, the number of independent variables equals the number of estimated parameters, p. When a model with an intercept is used, the number of independent variables equals p-1.
For the 'river bifurcation model', there is only one independent variable, namely k. The last number in the first column represents the number of observations, n, minus the number of parameters, p. For the experiment, of 30 l/s and the second nose, seven observations were carried out. Thus for this situation, $n - p$ equals 5.
In the second column the sums of squares are given. The last figure is the *Residual Sum of Squares.* This is the value of the cost function S (equation B.19), after the least squares method is applied.
The first number is the *Regressional Sum of Squares.*

The third column, named *mean square,* is the second column divided by the first column.

The in chapter seven mentioned quantity R^2 is also given in the output. This R^2 can also be calculated, using the ANOVA table:

$$R^2 = \frac{SS_{Regression}}{SS_{Regression} + SS_{Residual}} = \frac{4.76}{4.76 + 0.74} = 0.87 \qquad \text{(b.21)}$$

For R^2 equals one, there is no residual sum of squares, so the estimated parameters then fit perfectly.

B.3.2 Analysis of variance

In section B.2.3 the background of the analysis of variance is given. This section discusses the input and output of SPSS. The input consists of three different variables. Except for the dependent variable $\ln(s_1/s_2)$ and the independent variable $\ln(q_1/q_2)$, another variable, is used. This new variable is a kind of indicator or a label, to indicate the different groups of observations. An indicator to distinguish the separate groups is known as *factor*. This factor is a variable, which has the value one for all observations done in the first group, the value two for all observations done for the second group etcetera.

For all data, in this river bifurcation study, the groups are formed by the different upstream discharges and the different nose types.
For all data, one factor for the five different groups can be created. Another option is two different factors. One factor to indicate the three different upstream discharges and one to indicate the different nose types, see figure (7.1).

In this example the value of $\hat{k}$ is tested for the first nose. So, one factor, flow, indicating the three different groups for the three different upstream discharges, is created.

To relate the independent variable in a correct way to the different groups, the independent variable is split in three variables. These 'new' variables, named flow1, flow2 and flow3, represent, for the related group, the independent variable $\ln(q_1/q_2)$. The rest of this variable consists of constants of the value zero. If N is the number of observations done in one group, then:

$$flow1=\begin{pmatrix} \ln(\frac{q_1}{q_2})_{i=1} \\ . \\ \ln(\frac{q_1}{q_2})_{i=N} \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \quad flow2=\begin{pmatrix} 0 \\ 0 \\ \ln(\frac{q_1}{q_2})_{i=1} \\ . \\ \ln(\frac{q_1}{q_2})_{i=N} \\ 0 \\ 0 \end{pmatrix} \quad flow3=\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ \ln(\frac{q_1}{q_2})_{i=1} \\ . \\ \ln(\frac{q_1}{q_2})_{i=N} \end{pmatrix} \qquad \text{(b.22)}$$

The input of the independent variable consists of these new variables, named flow1, flow2 and flow3. When this is done, the next can be found in the output:

```
* * * * * * A n a l y s I s   o f  V a r I a n c e -- design  1 * * * * * *

Tests of Significance for LNSRATIO using UNIQUE sums of squares
Source of Variation        SS    DF    MS       F    Sig of F
WITHIN+RESIDUAL          1.66    14   .12
REGRESSION              16.50     3  5.50   46.44      .000
FLOW                      .34     2   .17    1.45      .268

(Model)                 17.01     5  3.40   28.73      .000
(Total)                 18.67    19   .98
```

Figure B.3 - Part of SPSS output; ANOVA table.

In the part of the output printed above, the following can be found. In the second column the sum of squares can be found. The first figure, which is named *within + residual,* represents the residual sum of squares, SS_{res}. This SS_{res} is the summation of the squares of the difference between the measured and the calculated y:

$$SS_{res} = \sum_{j=1}^{n} \sum_{i=1}^{p} (y_{i,j} - (\hat{\mu} + \hat{\alpha}_i + \hat{\beta}_i x_{i,j}))^2 \qquad \text{(b.23)}$$

in which p is the number of cells.
In equation (b.23) the square of the differences between the observed and the calculated y is given. The last figure given in the second column, is the total sum of square SS_{tot}. This *Sstot* is defined in the following way:

$$SS_{tot} = \sum_{j=1}^{N} \sum_{i=i}^{3} (y_{i,j} - \bar{y}..))^2 \qquad \text{(b.24)}$$

in which N is the number of observations in one cell and $\bar{y}$ is the overall mean:

$$\bar{y}.. = \frac{1}{n} \sum_{i=1}^{n} y_{i,j} \qquad \text{(b.25)}$$

The sum of squares caused by the model itself is the total sum of squares minus the residual sum of squares: $SS_{\text{model}} = SS_{\text{tot}} - SS_{\text{res}}$.

In the third column the degrees of freedom are given. The first figure in this column represents the value for *n-p*, the number of observations minus the number of parameters to be estimated. For the effect regression, the number of degrees of freedom is three, which equals the number of regression lines to be estimated, one for every upstream discharge.

For the effect flow, two degrees of freedom are given. This is the number of cells, created by this factor, minus one. This is according to the fact described earlier in this appendix, that the first cell or the last cell acts as a rference for the other cells. This number of degrees of freedom equals *q* in the expression for *T*, equation (b.15).
The fourth column is named *mean sum squares, MS*. The mean squares can be found by dividing the sum of squares, the second column, by the degrees of freedom, the third column.

The fifth and sixth column represent the tests parameters These test parameters are the same as the test parameters used in the linear regression. The values of *F* can be found by dividing the mean sum of squares by the mean residual sum of squares. For the effect regression the following is found:

$$F = \frac{5.50}{0.12} = 46.44 \qquad \text{(b.26)}$$

Here it is tested whether the slopes of the three regression lines are identical. The tested hypothesis is; $\beta_1 = \beta_2 = \beta_3$
The high value for *F* and the low value for *sigF* causes the hypothesis to be rejected. This means that the three different regression lines have different slopes.

To calculate the value for the test parameter *T*, $SS_{\text{res,H}}$ has still to be calculated. The value for $SS_{\text{res,H}}$ represents the value for the sum of squares, when the hypothesis is applied. This is done when instead of the three variables flow1 trough flow3, $\ln(q_1/q_2)$ is used as independent variable. The following output is created:

```
* * * * * * A n a l y s I s   o f   V a r I a n c e -- design  1 * * * * * *

Tests of Significance for LNSRATIO using UNIQUE sums of squares
Source of Variation        SS    DF      MS       F     Sig of F
WITHIN+RESIDUAL          2.96    16     .19
REGRESSION              15.19     1   15.19   82.05     .000
FLOW                      .17     2     .09     .46     .639

(Model)                 15.71     3    5.24   28.28     .000
(Total)                 18.67    19     .98
```

Figure B.4 - Part of SPSS output; ANOVA table under the hypothesis.

In the first column the sum of squares can be found again, the first figure represents the value for $SS_{res,H}$. Now T can be calculated.
In section 7.4 it can be found that T has the value 5.48. For the other hypothesis carried out in chapter seven, the same reasoning is followed

B.3.3 Multivariate analysis

The input file for SPSS, used in section B.2.3, consists of five variables. The first variable is a column that represents the values for $\ln(s_1)$ in the first rows and consists of the values for $\ln(s_2)$. The second and third columns represent the values for $\ln(q_1)$ and $\ln(q_2)$, respectively, for the first rows and consist of constants of the value zero for the other rows. Column four and five are the opposites of column two and three; the first rows represent the value zero and the other rows consist of $\ln(q_1)$ and $\ln(q_2)$.
Using the option 'linear regression' in SPSS, the values for $\hat{k}$, for SS_{res} and for n-p can be found. To calculate $SS_{res,H}$ the input file is changed. This change consists of the junction of the third and the fourth column. After executing linear regression, there is now only one value for $\hat{k}_{12}$ and $\hat{k}_{21}$ calculated. Furthermore, the value for $SS_{res,H}$ can be found in the output.

B.4 Graphs and plots

In the next graphs the found regression lines are given.

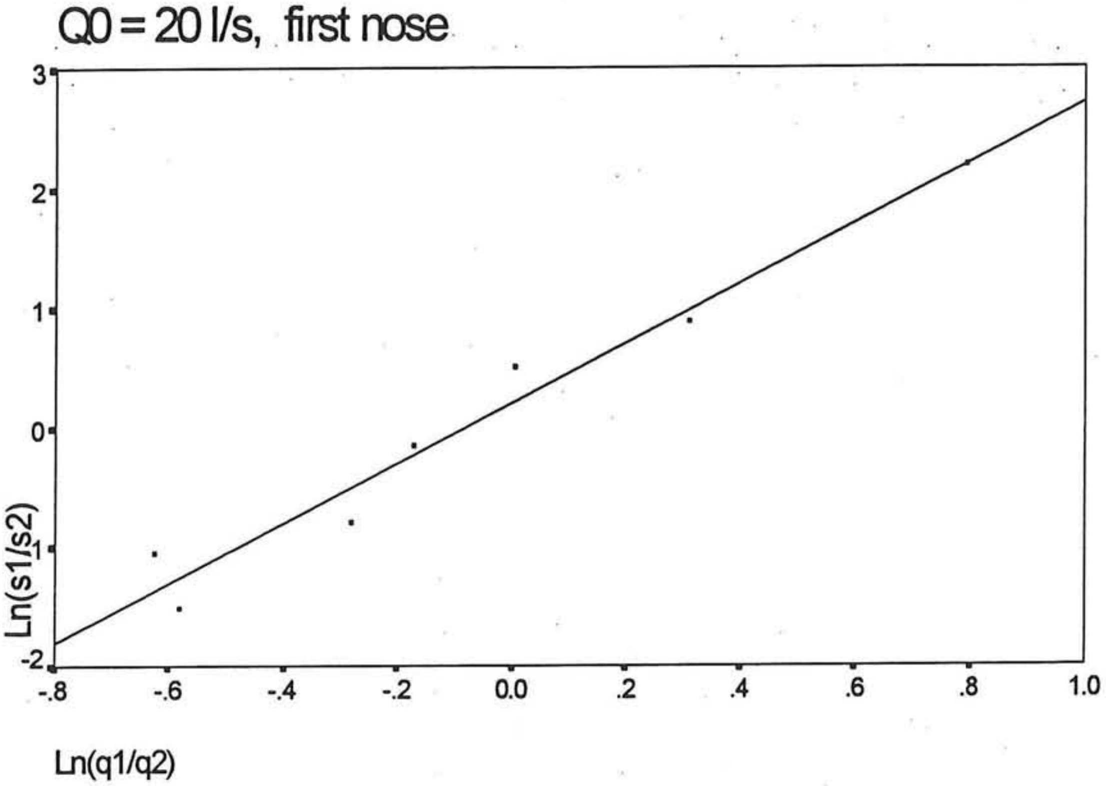

Figure B.5 - Regression line for the experiment with upstream discharge of 20 l/s and the first nose type

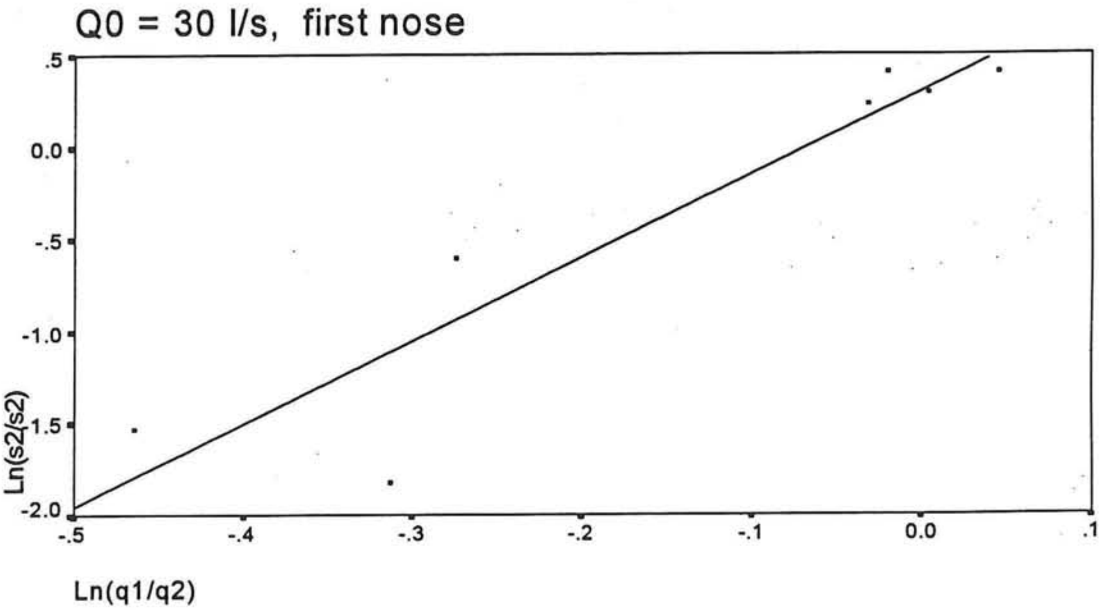

Figure B.6 - Regression line for the experiment with upstream discharge of 30 l/s and the first nose type

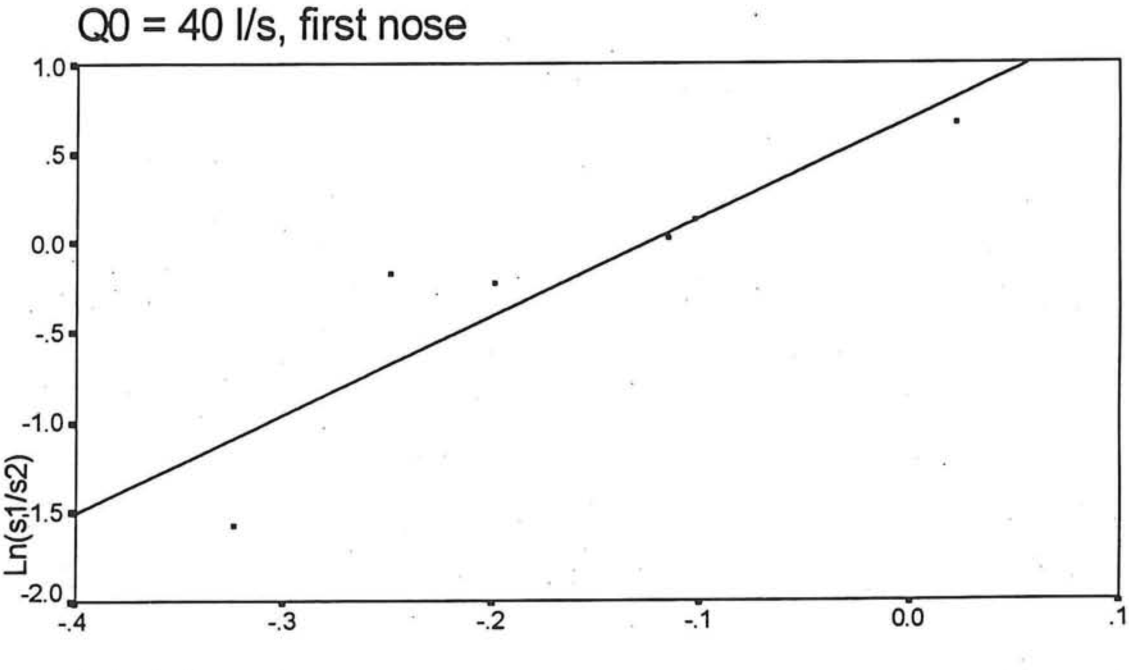

Figure B.7 - Regression line for the experiment with upstream discharge of 40 l/s and the first nose type

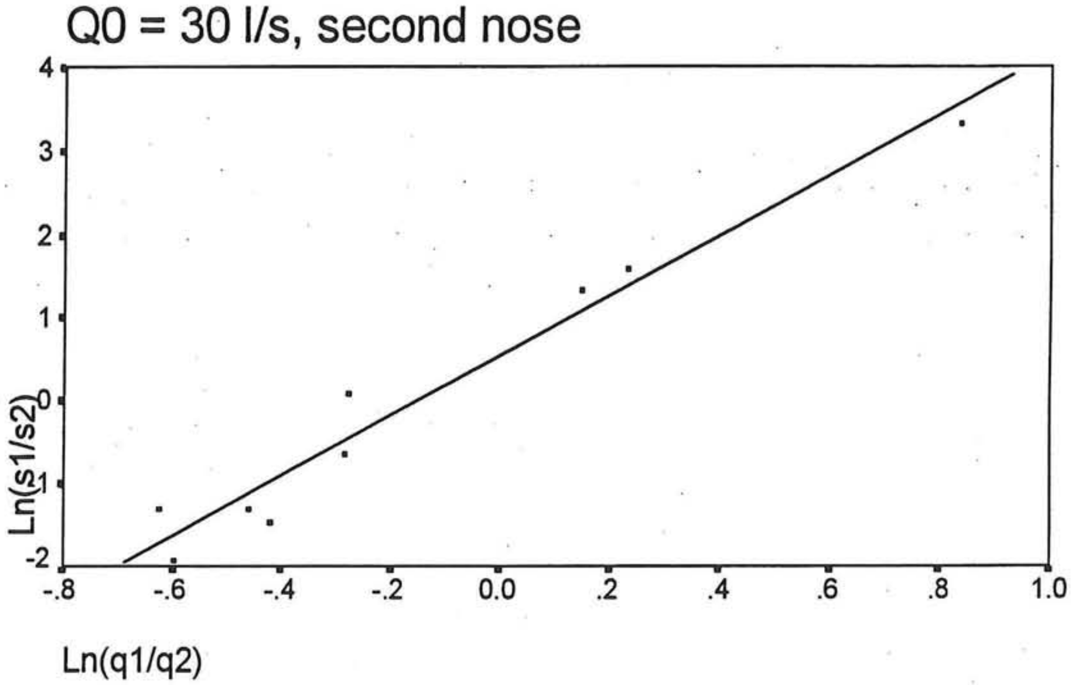

Figure B.8 - Regression line for the experiment with upstream discharge of 30 l/s and the second nose type

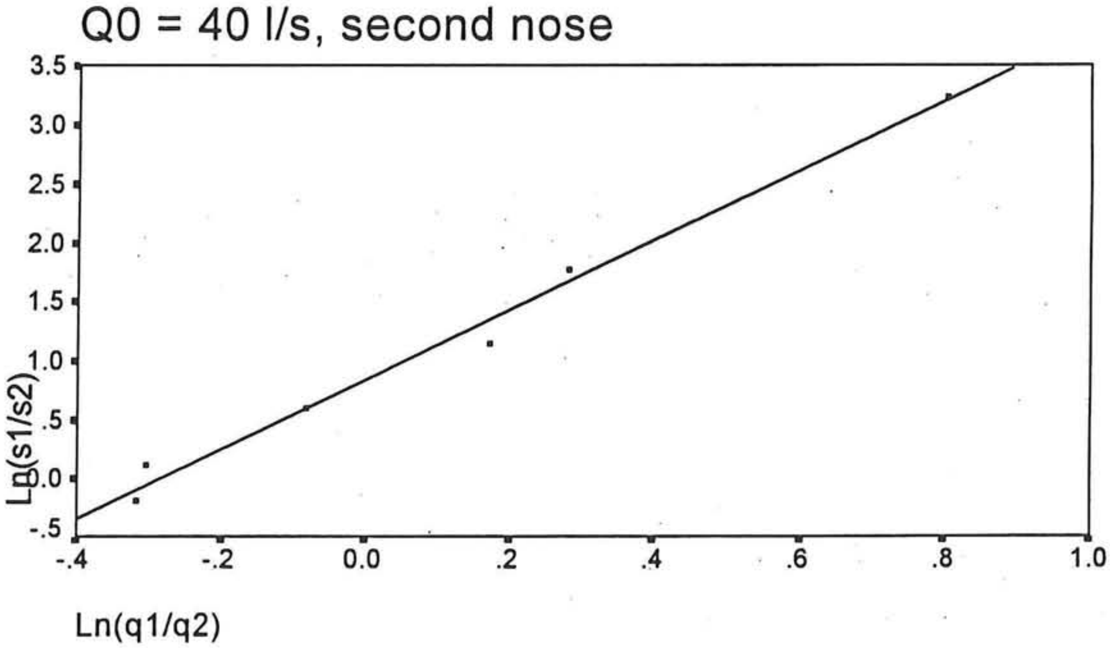

Figure B.9 - Regression line for the experiment with upstream discharge of 40 l/s and the second nose type

In the following graphs, the residuals are plotted versus the discharge ratio. On the y-axis, the residuals can be found and on the x-axis, the discharge ratio.

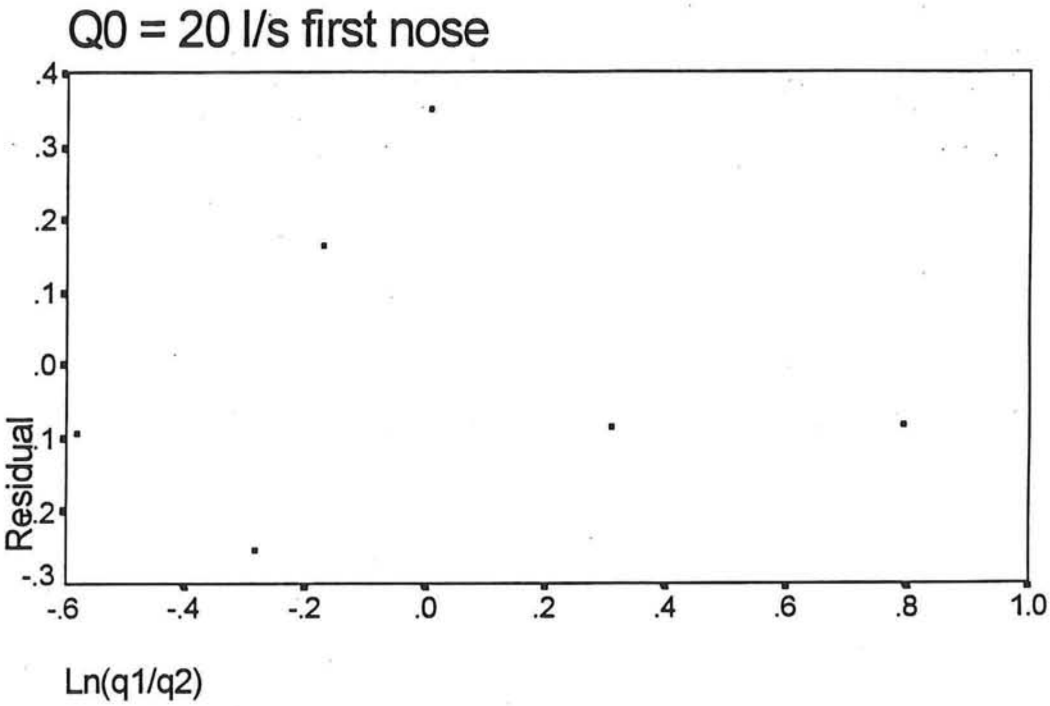

Figure B.10 - The residuals versus the discharge ratio

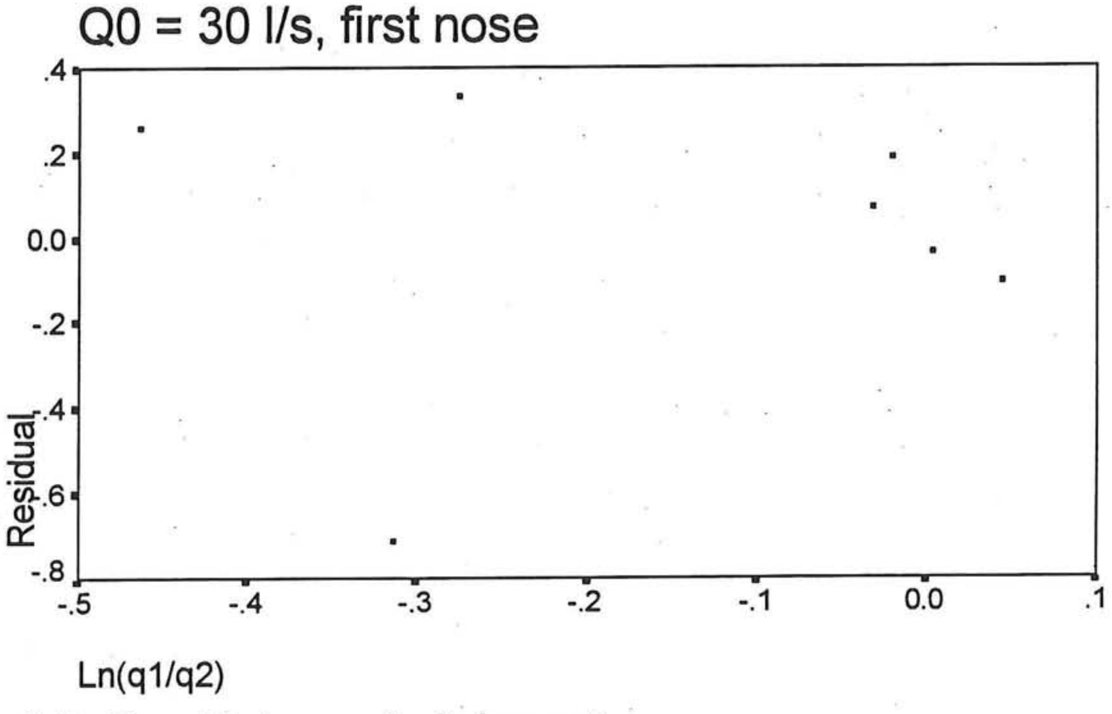

Figure B.11 - The residuals versus the discharge ratio

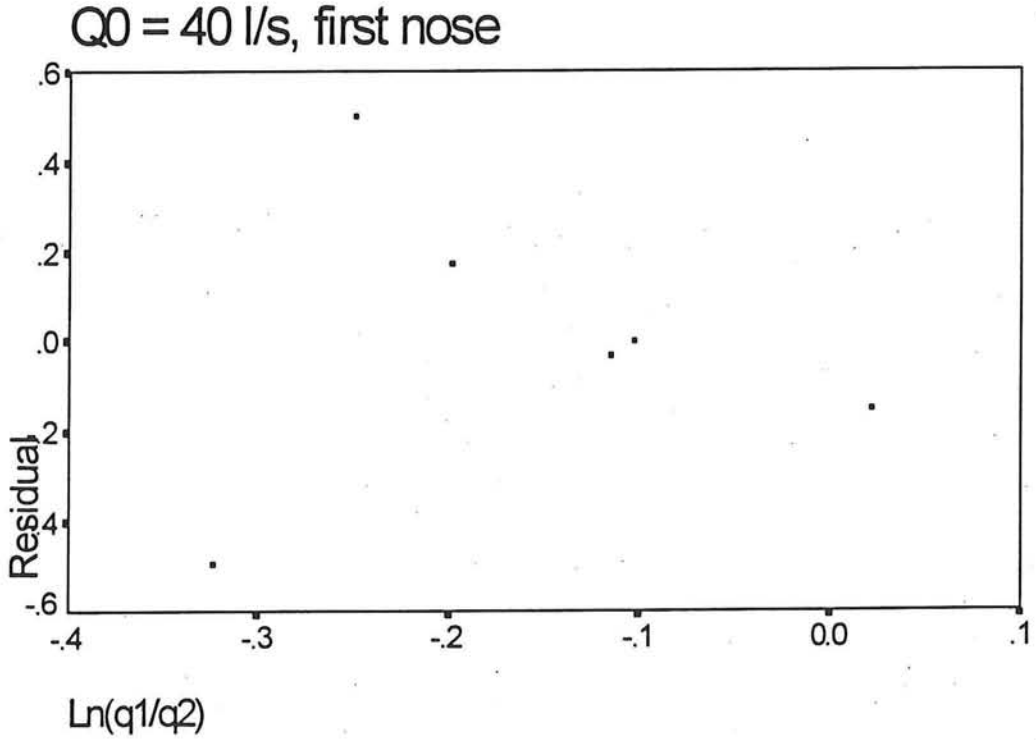

Figure B.12 - The residuals versus the discharge ratio

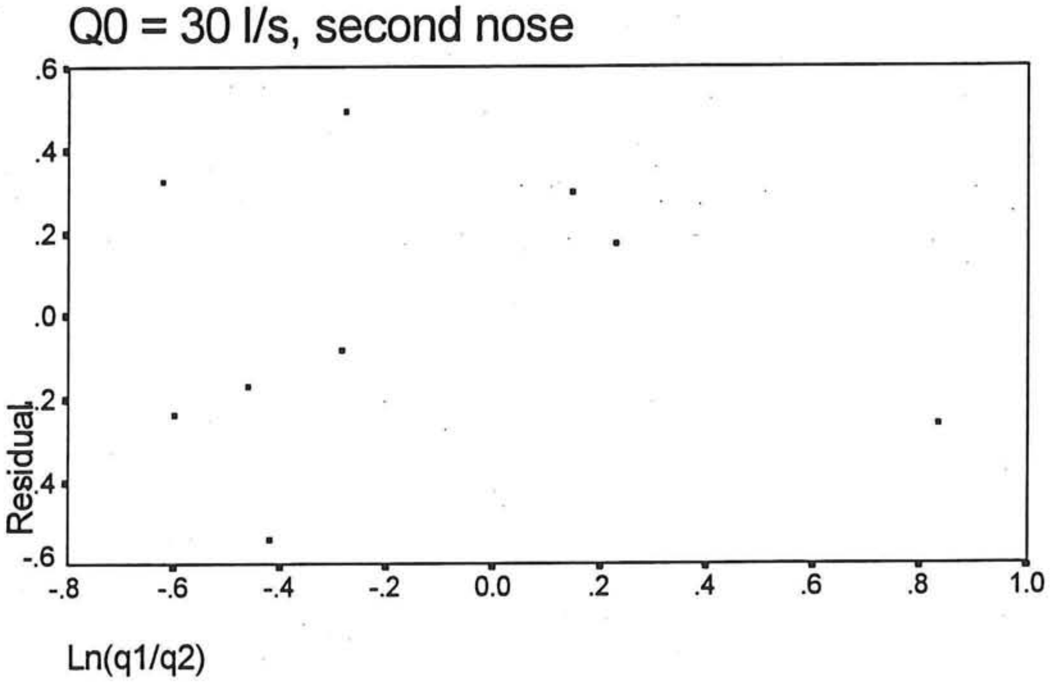

Figure B.13 - The residuals versus the discharge ratio

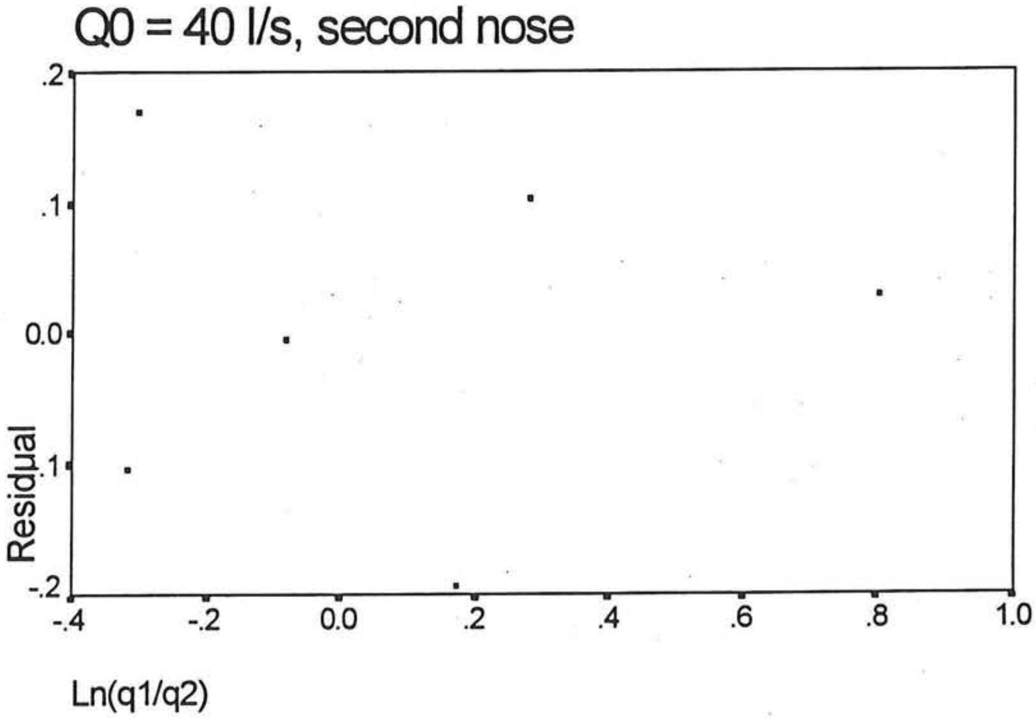

Figure B.14 - The residuals versus the discharge ratio

Appendix C WENDY

C.1 Input file in WENDY

In WENDY, a shell is used to enter the physical data and the boundary conditions. Since the dimensions of the test rig are small, the data of the bed levels at the start of the simulation have to be put in in the text file that is made by the shell. The nodal point relation also has to be entered in this text file. That is why the text file of the simulation of experiment 1211 is showed here. The name of this text file is '1211.dat':

```
'SPLITSING                                    '
'PRINT   '  1  2  3 /
'NUMBERS '   3    1    0    3   28   31   28   31    1
           0    0    5   18    2    6   11    0
'BRANCH  '    1    10
              .00       .50     1.00      1.50      2.00
             2.50      3.00     3.50      4.00      4.50
'BRANCH  '    2    9
              .00      1.08     2.15      3.23      4.30
             5.38      6.45     7.53      8.60
'BRANCH  '    3    9
              .00      1.05     2.10      3.15      4.20
             5.25      6.30     7.35      8.40
'NODE    '    1    3    1    -2    -3    3    5.47   -6.19
'BOUND   '    1    -1    3    5
'PAR-QH  '   2       .00    .100000E-02    .360000E+04
      .00   2    0/
'PAR-S   '   5       .00    .115741E-04    .360000E+04  .00
'BOUND   '   2    2    3    6
'PAR-QH  '   1       .00    .100000E-01    .360000E+04
      .00   1    0/
'BOUND   '   3    3    3    6
'PAR-QH  '   3       .00    .100000E-01    .360000E+04
      .00   1    0/
'CROSS'   1    2
             .00       1.00      1.00
            1.00       1.00      1.00
'CROSS'   2    2
            -5.55E-4   1.00      1.00
            1.00       1.00      1.00
'CROSS'   3    2
            -1.11E-3   1.00      1.00
            1.00       1.00      1.00
'CROSS'   4    2
            -1.67E-3   1.00      1.00
```

```
              1.00       1.00       1.00
'CROSS'     5    2
              -2.22E-3 1.00       1.00
              1.00       1.00       1.00
'CROSS'     6    2
              -2.78E-3 1.00       1.00
              1.00       1.00       1.00
'CROSS'     7    2
              -3.33E-3 1.00       1.00
              1.00       1.00       1.00
'CROSS'     8    2
              -3.89E-3   1.00       1.00
              1.00       1.00       1.00
'CROSS'     9    2
              -4.44E-3 1.00       1.00
              1.00       1.00       1.00
'CROSS'     10    2
              -5.00E-3 1.00       1.00
              1.00       1.00       1.00
'CROSS'     11    2
              1.37E-3   .40        .40
              1.00       .40        .40
'CROSS'     12    2
              2.43E-4   .40        .40
              1.00       .40        .40
'CROSS'     13    2
              -8.9E-4   .40        .40
              1.00       .40        .40
'CROSS'     14    2
              -2.02E-3    .40        .40
              1.00       .40        .40
'CROSS'     15    2
              -3.14E-3 .40        .40
              1.00       .40        .40
'CROSS'     16    2
              -4.27E-3 .40        .40
               .99      .40        .40
'CROSS'     17    2
              -5.40E-3 .40        .40
               .99      .40        .40
'CROSS'     18    2
              -6.53E-3 .40        .40
               .99      .40        .40
'CROSS'     19    2
              -7.66E-3 .40        .40
```

```
            .99      .40      .40
'CROSS'    20    2
          -0.0287    .60      .60
           1.00      .60      .60
'CROSS'    21    2
          -0.0299    .60      .60
           1.00      .60      .60
'CROSS'    22    2
          -.0311     .60      .60
           1.00      .60      .60
'CROSS'    23    2
          -.0322     .60      .60
           1.00      .60      .60
'CROSS'    24    2
          -.0334     .60      .60
           1.00      .60      .60
'CROSS'    25    2
          -.0346     .60      .60
            .99      .60      .60
'CROSS'    26    2
          -.0358     .60      .60
            .99      .60      .60
'CROSS'    27    2
          -.0370     .60      .60
            .99      .60      .60
'CROSS'    28    2
          -.0382     .60      .60
            .99      .60      .60
'CS-BRANCH'     1
'CS-H'    1    1     .00     1.00     1.00
'CS-H'    2    2     .00     1.00     1.00
'CS-H'    3    3     .00     1.00     1.00
'CS-H'    4    4     .00     1.00     1.00
'CS-H'    5    5     .00     1.00     1.00
'CS-H'    6    6     .00     1.00     1.00
'CS-H'    7    7     .00     1.00     1.00
'CS-H'    8    8     .00     1.00     1.00
'CS-H'    9    9     .00     1.00     1.00
'CS-H'   10   10     .00     1.00     1.00
'CS-BRANCH'     2
'CS-H'    1   11     .00      .40      .40
'CS-H'    2   12     .00      .40      .40
'CS-H'    3   13     .00      .40      .40
'CS-H'    4   14     .00      .40      .40
'CS-H'    5   15     .00      .40      .40
```

```
'CS-H'   6  16   .00   .40   .40
'CS-H'   7  17   .00   .40   .40
'CS-H'   8  18   .00   .40   .40
'CS-H'   9  19   .00   .40   .40
'CS-BRANCH'   3
'CS-H'   1  20   .00   .60   .60
'CS-H'   2  21   .00   .60   .60
'CS-H'   3  22   .00   .60   .60
'CS-H'   4  23   .00   .60   .60
'CS-H'   5  24   .00   .60   .60
'CS-H'   6  25   .00   .60   .60
'CS-H'   7  26   .00   .60   .60
'CS-H'   8  27   .00   .60   .60
'CS-H'   9  28   .00   .60   .60
```

C.2 Description of WENDY

The mathematical computer model WENDY was developed by DELFT HYDRAULICS. The present computer model WENDY is a package consisting of five application programs:

- Water flow (WAFLOW option)
- Water flow with density effects (SAFLOW option)
- Water flow and sediment transport (SEFLOW option)
- Water flow and suspended sediment transport (SUSFLOW option)
- Water flow and measured water level data (NETFIL option)

Considering the subject of this report only the SEFLOW option has been used. An important characteristic of the WENDY program is that it is a one-dimensional model. In the context of this study on bifurcations in rivers, WENDY therefore needs additional information on the sediment distribution over the downstream branches, in order to represent this three-dimensional penomenon in a one-dimensional model. The extra information (i.e. an internal boundary condition) is given by the nodal-point relation (see chapter two).

The momentum equation and the mass balances for water and sediment are solved numerically by finite-difference methods. The difference equations are expressed on a non-uniform staggered grid.

C.3 Graphs of the calculations

In chapter eight a description of the simulations of experiment 1211 with WENDY is given. The most important results were given in chapter eight already. Here graphs are given of the sediment transport, the flow velocity, the average water depth and the water levels of experiment 1211.

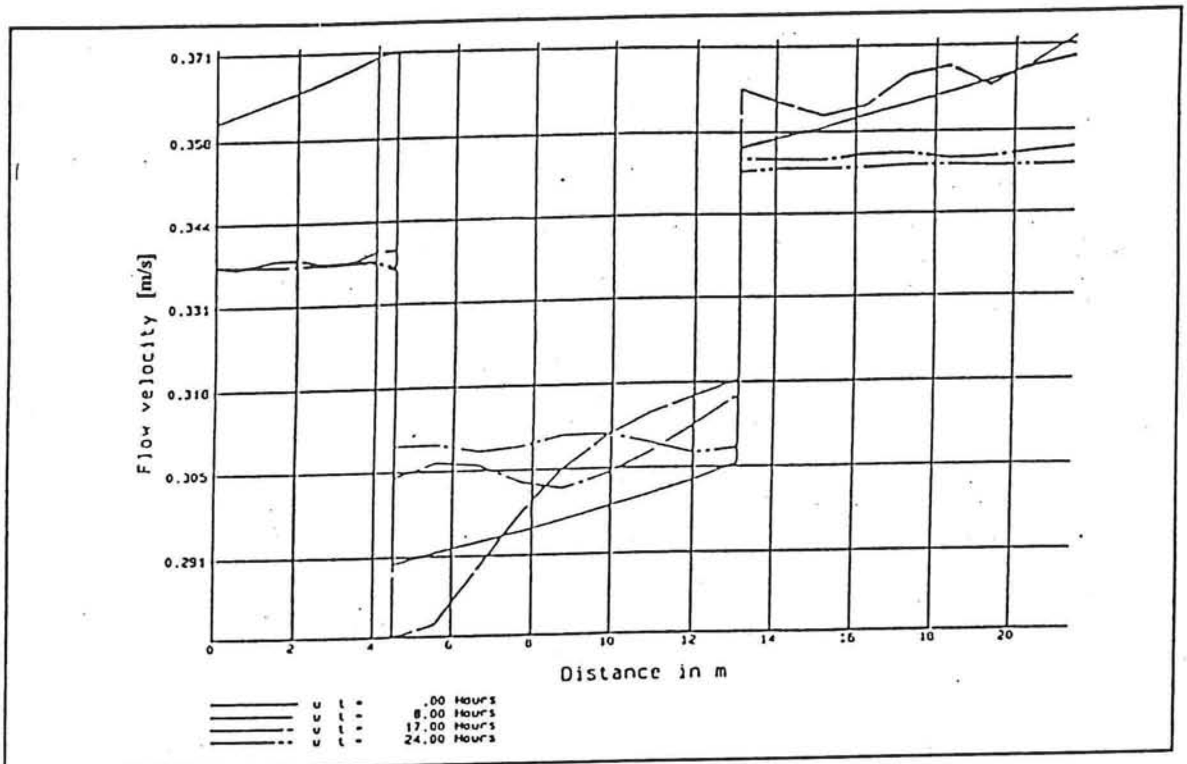

Figure C.1 - Flow velocity of experiment 1211

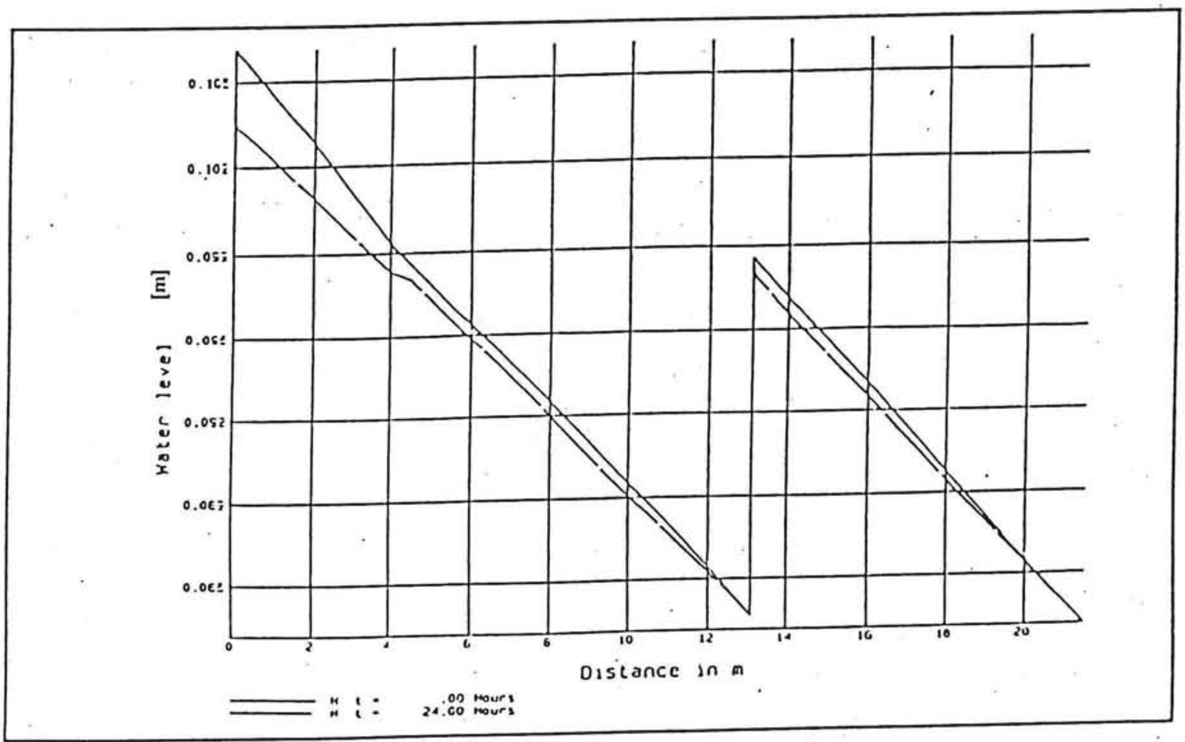

Figure C.2 - Water levels of experiment 1211

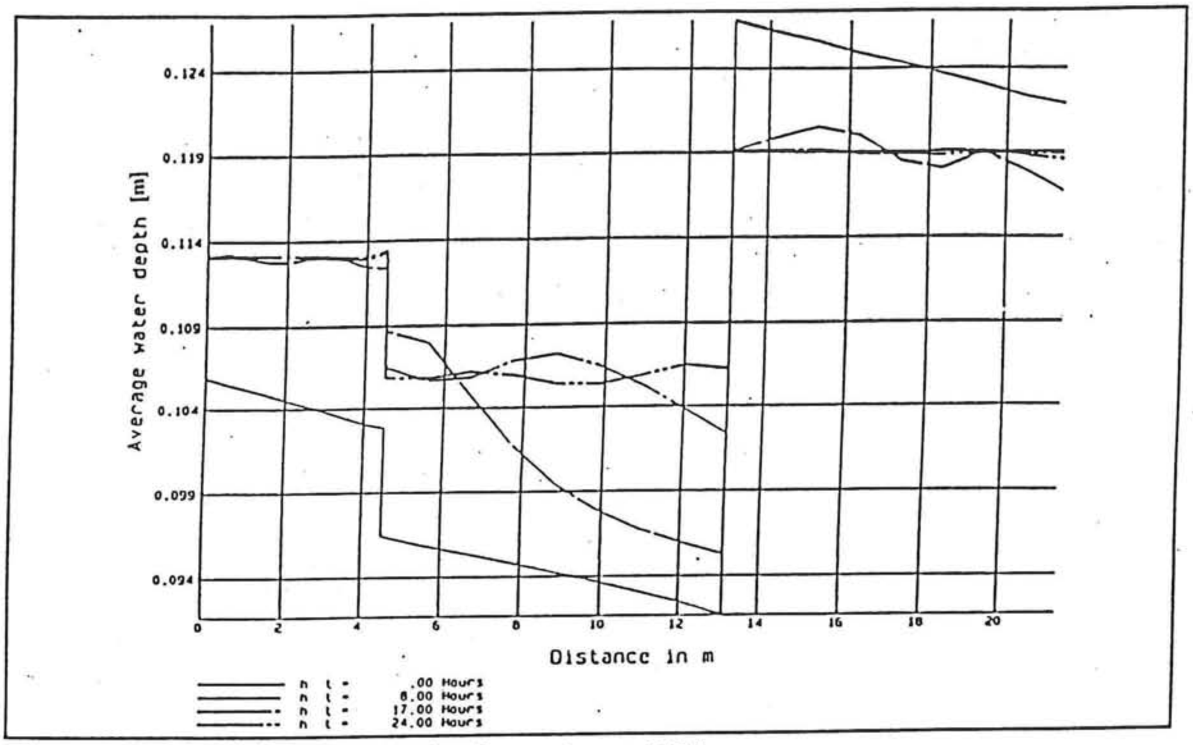

Figure C.3 - Average water depth of experiment 1211

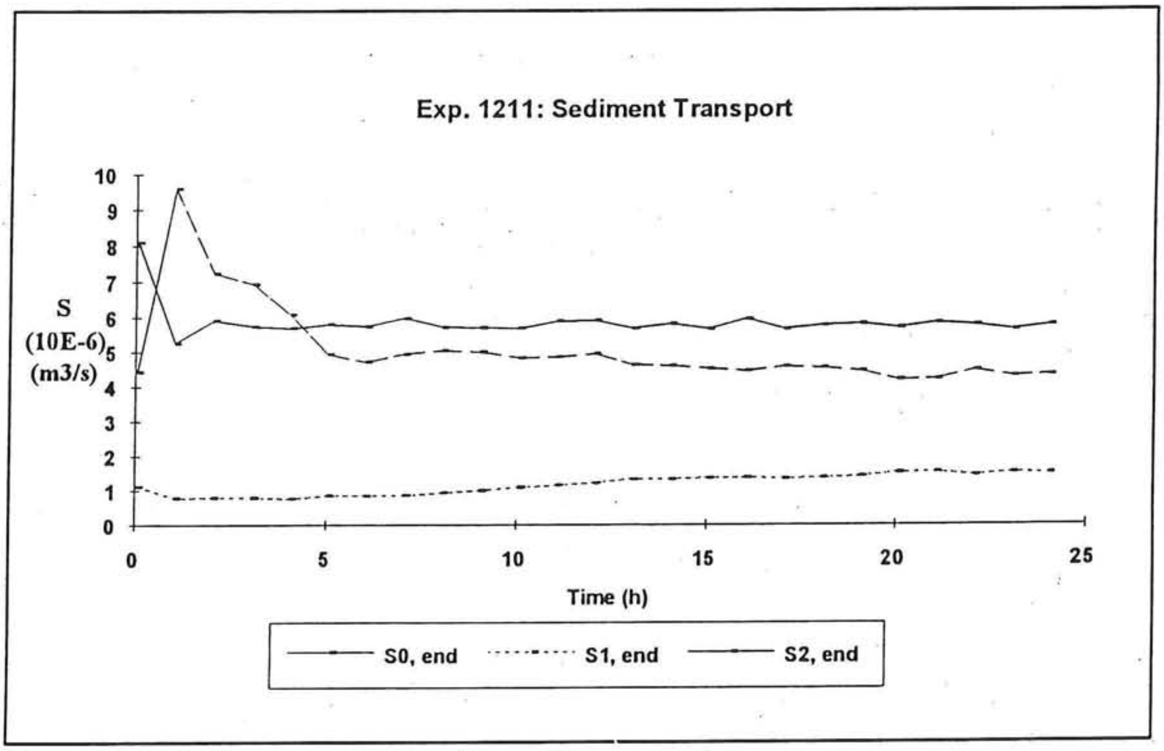

Figure C.4 - Sediment transports of exp. 1211

Introduction

This report of measurements belongs to MSc. thesis of Roosjen and Zwanenburg, called; Research on bifurcations in rivers. A part of this research consisted of running experiments on a test rig. The readings taken during these experiments are presented in this report. Information about their meaning, the measurement methods, the measurements errors etc. can be found in the main report.

On the next pages, the reference factors for the bed-level measurements are given. The reference level is chosen to be the concrete floor of the test rig in the middle of cross section one. For every inaccuracy a factor is given. The 'pin' factor and a 'plank' factor originate from the different measuring devices used to measure the bed-level. For the upstream branch, branch 0, an other measuring device was used, resulting in the 'plank' factor. At the ends of branch one and two, a heigher wall crest is present. This resulted in a 'pin' factor, as a longer pin was needed to reach the bed. To be able to reach the bed after the reference level was measured, the zero level was moved. Finally inaccuracy in the wall crest resulted in a wall factor. These factors were given per cross section.

After finishing some experiments, the reference levels have been changed. For every measured point one 'adjust factor' is given. The 'old' reference levels have been from experiment number 1111 to number 1221c. The 'new' adjust factors have been used from experiment number 1311a to 2111e.

On the following pages for every experiment the following is given. First the bed-level readings before the start of an experiment, are given. These readings are indicated as 'first measurements'. These are followed by the 'last measurements', which are the readings after an experiment was carried out. Then the discharges and water levels are presented.

For the water levels also adjust factors are present. Since the measurement devices have been changed, for different tests different adjust factors occur. The factors are given in the next table

	stilling basin no. 1 (mm)	stilling basin no. 2 (mm)	stilling basin no. 3 (mm)	stilling basin no. 4 (mm)
Experiment no. 1111 to 1211a	288.5	279.8	290.5	161.0
Experiment no. 1211a to 1331a	170.2	175.44	155.83	169.87
Experiment no. 1331a to 2111e	172.1	177.8	156.3	170.1

reference factors used from exp. 1111 to exp. 1221

MEAN LEVEL [mm]	PIN FACTOR [mm]	PLANK FACTOR [mm]	ZERO MOVE [mm]	WALL FACTOR Ref. TO Sec. 1 (mm)
88.525	0	14.6	123.2	0
132.575	0	14.6	123.2	-1.9
135.3	0	14.6	123.2	-0.7
133.225	0	14.6	123.2	-1.6
135.0625	0	14.6	123.2	-1.5
128.5	0	14.6	123.2	0.5
138.475	0	14.6	123.2	-0.8
125.9125	0	14.6	123.2	1.3
122.35	0	14.6	123.2	3.1
126.225	0	14.6	123.2	-3.4
136.825	0	14.6	123.2	-7
133.825	0	14.6	123.2	-3.4
139.05	0	9	123.2	-3.8
138.575	0	9	123.2	-4.5
136	0	9	123.2	-3.9
136.55	0	9	123.2	-4.9
134.5	0	9	123.2	-1.4
130.1	0	9	123.2	0.2
133.15	0	9	123.2	-1.3
129.125	0	9	123.2	1
128.25	0	9	123.2	1.2
127.425	0	9	123.2	2.1
196.55	150.5	9	123.2	79.2
197	150.5	9	123.2	81.3
194.775	150.5	9	123.2	81.9
0	150.5	9	123.2	83.9
127.45	0	14.6	123.2	3.1
132.4	0	14.6	123.2	-3.4
137.6	0	14.6	123.2	-7
130.525	0	14.6	123.2	-3.4
129.075	0	9	123.2	-6.4
127.35	0	9	123.2	-7.7
126	0	9	123.2	-6.6
127.6	0	9	123.2	-10
124.35	0	9	123.2	-8.8
121.3	0	9	123.2	-8.3
123.375	0	9	123.2	-8.1
108.45	0	9	123.2	-6.7
181.375	150.5	9	123.2	85.5
176.05	150.5	9	123.2	85.3
178.725	150.5	9	123.2	83.6
180.85	150.5	9	123.2	79.4
0	150.5	9	123.2	79.3

reference factors used from exp. 1311a to exp. 2111e

cross section	FACTOR POINT 1 (mm)	FACTOR POINT 2 (mm)	FACTOR POINT 3 (mm)	FACTOR POINT 4 (mm)	FACTOR POINT 5 (mm)
1	238.37	238.13	238.07	238.00	239.87
2	238.47	238.47	238.40	238.40	238.07
3	238.77	238.77	238.07	238.13	238.00
4	238.13	238.23	237.93	238.26	238.53
5	241.06	240.90	241.00	240.90	240.70
6	241.23	241.06	240.53	240.06	240.43
7	240.20	239.70	239.47	238.53	239.03
8	237.06	237.60	237.70	237.40	237.10
9(0.8)	239.00	239.17	238.50	239.36	239.43
10(0.7)	242.26	243.33	243.30	242.53	243.00
11(0.625)	241.87	243.37	242.93	242.47	243.27
12(0.6)	243.97	244.07	244.07	244.07	244.60
13	249.50	249.77	250.03	248.97	248.37
14	251.60	251.23	251.00	250.67	250.43
15	249.90	249.80	249.80	249.67	249.47
16	250.50	250.43	250.77	249.60	249.30
17	247.87	247.87	247.63	247.47	247.07
18	246.57	246.37	246.07	245.53	247.07
19	245.90	245.77	245.70	245.37	245.23
20	245.27	245.00	244.50	243.93	243.40
21	242.30	242.33	242.13	241.77	241.77
22	242.20	243.00	243.73	244.53	245.13
23	310.18	309.95	310.25	309.95	309.75
24	310.52	310.32	309.98	309.65	309.28
25	309.78	309.38	308.92	308.38	307.95
26	308.88	308.35	307.42	306.35	305.55
9(0.2)	238.50	238.03	238.17	238.10	238.20
10(0.35)	240.73	241.07	240.40	241.53	241.53
11(0.44)	243.47	243.73	243.73	244.06	244.50
12(0.415)	244.93	244.20	244.67	244.03	244.23
27	250.00	249.83	249.93	250.00	250.10
28	252.03	252.07	252.07	252.10	252.47
29	251.37	251.33	251.40	251.37	251.57
30	253.00	253.10	253.17	253.20	253.30
31	252.03	251.63	251.40	251.10	250.73
32	251.83	251.80	251.63	251.47	251.40
33	250.50	250.53	250.67	250.83	250.77
34	250.70	250.50	250.37	249.97	250.07
35	303.08	302.95	302.95	302.92	303.05
36	303.75	303.92	304.25	304.55	304.95
37	305.62	305.82	306.08	306.42	306.58
38	307.15	307.32	307.32	307.68	307.75
39	309.05	308.95	308.75	308.68	308.78

reference factors used from exp. 1311a to exp. 2111e

FACTOR POINT 6 (mm)	FACTOR POINT 7 (mm)	FACTOR POINT 8 (mm)	FACTOR POINT 9 (mm)	FACTOR POINT 10 (mm)
237.97	237.67	237.87	237.93	240.17
238.13	238.63	238.47	238.57	238.97
238.30	238.57	238.70	238.57	238.73
238.63	238.63	239.06	239.43	239.53
240.96	241.40	241.73	242.10	242.20
238.46	238.83	239.20	237.77	239.27
239.36	238.76	238.80	238.97	238.50
237.33	237.23	237.03	237.40	236.70

EXPERIMEN 1111
Data first measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	41.2	70.8	80.4	74.1	64
2	90.1	83.4	81.2	86	81.4
3	79.6	84.7	96.7	79	74.5
4	86	74.6	75.9	96.9	92
5	81.4	93.6	86.4	97	103.6
6	99.8	90.8	87.3	86.6	98.5
7	57.2	87.8	86.2	92.3	47.9
8	78.7	78.1	87.8	70.2	59.6
9	73.2	86.5	70.6		
10	90.1	85	91		
11	81.9	89.8	93.8		
12	96.9	100.9	88.8		
13	77.6	73.2	74.7		
14	78	77.3	79.5		
15	75.3	52.5	72.8		
16	65	65	62.6		
17	64	64.7	62.9		
18	57.9	53.2	55		
19	68.5	62.9	60.5		
20	56.4	61	48		
21	52.7	52.6	54.2		
22	57.7	73.8	53.8		
23	135	137.5	136.6		
24	137	137	140.2		
25	29	43.6	62		
26	0	0	0		
9	79.6	68.2	58.6		
10	80.3	78.2	74.5		
11	79.9	81	85.6		
12	53.3	94.3	102.6		
27	83.9	91.9	92		
28	78.7	100.2	110		
29	75.5	105.6	98		
30	92.1	89.6	93.9		
31	54	72.3	64.6		
32	88.9	87.4	86.2		
33	84.5	83.3	82.7		
34	62.4	71.9	67.9		
35	136.9	142	133.9		
36	151.9	148.1	147.6		
37	152.3	159.6	156		
38	174.2	178.5	135.2		
39	0	0	0		

EXPERIMEN 1111
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	11.8	27.9	44.9	11.8	0.1
2	39.7	63.9	94.4	41.2	44
3	69.9	80.8	90.9	94.8	87
4	70.9	88.7	85.4	94.5	69.9
5	87.8	88.9	100.9	93.7	69.8
6	80.8	90.8	91.9	72.8	76.7
7	88.1	91	78.3	102.3	75.7
8	61.7	88	90.2	90.9	77.4
9	89.6	79.7	41		
10	90.3	74	56		
11	100.1	97	74.7		
12	105.8	103	74.8		
13	105.5	80.1	49.6		
14	84.9	77.8	70.8		
15	89.2	79	31.8		
16	68.5	86.5	29.9		
17	67	72.8	77.9		
18	61	73.5	64.6		
19	44.9	56.3	87.5		
20	46.7	58	70.2		
21	28.2	52.5	82.7		
22	33.9	68.8	85		
23	136	132.5	139.6		
24	108.2	133.5	146.8		
25	104	123.4	138.9		
26	0	0	0		
9	39.2	94	90.1		
10	98.3	99	59.6		
11	75	92	95.3		
12	83.3	93.5	92.3		
27	80	75.9	69.2		
28	70.4	74.5	76.4		
29	75.9	80.5	84.2		
30	77.3	76.3	76.3		
31	88.5	78.6	66.9		
32	73.2	67.3	77.5		
33	77.9	73.2	77.3		
34	65.5	75.7	56		
35	133	113.5	118.6		
36	133.7	125.5	119.5		
37	145.5	119.9	107.3		
38	131	130	120.5		
39	0	0	0		

DATA OF RUN NO. 1111

DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)	STILLING BASIN NO.	STILLING BASIN READING (mm)
0	7.3	21.4	28.7	1	35.4
1	9	20.9	29.9	2	
2	9.4	19.7	29.1	3	23.4
3	10.4	19.3	29.7	4	158.4
4	9.91	17.16	27.07		
5	10.15	17.38	27.53		
6	10.02	17.18	27.2		
7	10.02	17.18	27.2		

EXPERIMEN 1211
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	146.5	149.1	154	141.9	141.7
2	138.2	142.5	144	144.5	135.4
3	140.3	141.7	141.1	137.2	134.8
4	136.8	139.7	140.3	135.1	131.6
5	140.3	141.7	141.7	139.9	139.8
6	139.3	144.4	144.1	142.9	138.9
7	148.8	149.2	152	145.9	150.8
8	138.3	141.6	144.6	137.8	136.9
9	141.3	143.2	129.1		
10	176.6	166.3	161		
11	171.1	176.9	169.1		
12	162	177.1	171.7		
13	156.4	159	148.8		
14	152.3	150.3	151.4		
15	145.8	140.1	149		
16	143.9	147.9	142.1		
17	139.9	139.5	138.9		
18	133.9	142.5	149.6		
19	136	139.3	141.2		
20	134.6	131.6	136.8		
21	128.8	133.9	131		
22	122.6	130.4	127.6		
23	186.9	193.3	195		
24	191.2	195.7	201.6		
25	215	201.2	203.2		
26	0	0	0		
9	134.2	132.1	141.7		
10	130	121	132		
11	124.3	116.7	126		
12	111.8	110.9	173.6		
27	103.2	98.4	104		
28	91.6	88.6	95.5		
29	91.7	83	84.1		
30	90.5	85.1	82.7		
31	87.5	76	71.3		
32	77.8	71.2	75		
33	72.5	69.6	76		
34	77.1	72.3	70.7		
35	133.1	128.7	127		
36	141	138.6	138.7		
37	141.4	145.6	155.9		
38	141.7	146.2	150.5		
39	141.3	142.3	146.7		

EXPERIMEN 1211
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	71.2	169.6	176.3	77	84.2
2	108.2	175.3	203	125.1	76.3
3	153.5	166.9	158.2	148.7	126.8
4	164.8	145	130	150.3	157.9
5	170.1	143.7	162.1	142.5	149.9
6	168.3	133.9	136.6	135.1	155
7	159.8	149.9	146.1	154.8	138.7
8	128	139.2	143.7	141.3	134.3
9	98.7	92.5	-10		
10	172.1	114.1	-6		
11	174	168.2	49.3		
12	136.8	173.2	151.8		
13	147.7	155.5	145.9		
14	152.1	146.6	165.8		
15	150	137.8	140.9		
16	145.7	139.7	154.7		
17	158.3	129.3	144.8		
18	134.6	150.4	147.9		
19	139.6	148.9	136.4		
20	122.8	140	138.3		
21	122.9	145	159.8		
22	110.7	153.8	151.5		
23	190.8	209.3	200.9		
24	197.6	209.1	191.4		
25	202.8	195.7	191.8		
26	0	0	0		
9	10.6	82.5	147.1		
10	28.8	106.7	89.2		
11	75.4	121.7	88.6		
12	113	123.7	82.8		
27	108	90.6	102.5		
28	77.5	90.9	106.6		
29	95.5	98.9	107.2		
30	66.2	87.9	104.5		
31	101.5	115.7	86		
32	117.8	78.8	69		
33	71.9	97.8	112.9		
34	54	70	86.8		
35	159.5	159.1	134.5		
36	167.3	159.5	133.8		
37	166.8	153	126.9		
38	124.7	132.9	153.5		
39	0	0	0		

DATA OF RUN NO. 1121

DISCHARGE MEASUREMENTS				WATER LEVEL STILLING BASIN NO.	MEASUREME STILLING BASIN READING (mm)
TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)		
0	18.57	8.16	26.73	1	63
1	18.36	9.82	28.18	2	-
2	19.1	9.09	28.19	3	46.1
3	18.44	9.09	27.53	4	178.5
4	18.44	9.09	27.53		
5	18.44	9.09	27.53		
6	18.12	9.39	27.51		
7	17.74	9.55	27.29		
8	17.74	9.55	27.29		
9	18.91	10.9	29.81		
10	19.11	10.3	29.41		

EXPERIMEN1311A
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	123.2	131.5	132.8	133.1	128.8
2	131.2	132.1	128.2	133.2	134.8
3	134	130.7	130.4	129	125.1
4	133.1	131.4	127.3	130.9	133.2
5	129	127.2	127.2	129	134.6
6	129.3	126.8	124.2	126.5	129.1
7	127.6	124.6	125.1	125.8	128
8	128.8	122.9	122.5	123.9	123
9	123.6	120.5	123.2		
10	130.8	127.5	128.5		
11	124.3	123.8	126.3		
12	124.6	117.7	122.7		
13	127.2	126	126.2		
14	119.6	121.5	122.2		
15	119.7	119.8	121		
16	119.6	118.9	118		
17	116.5	112.5	114.3		
18	115.7	112.2	115.7		
19	109.7	111.7	115.3		
20	112.8	109.9	112.2		
21	109	108.8	107.1		
22	108.8	107.4	110.2		
23	184.1	181.8	180.5		
24	189.1	180.2	178		
25	176.9	174.5	178.5		
26	0	0	0		
9	122.3	121.5	121.4		
10	127	129.8	128.3		
11	135.2	134.1	136.1		
12	141.5	135.3	133.5		
27	144.2	144.4	144.8		
28	141.8	140.2	139.5		
29	138	136.9	135.9		
30	141	141.5	140.2		
31	140.4	139.2	139.6		
32	138.7	137	136.7		
33	136.8	135.8	136.5		
34	125.4	126.2	126.9		
35	191.2	189.3	187.2		
36	184.2	185.7	186.1		
37	193.4	189.8	182.4		
38	189.5	190.3	190.2		
39	0	0	0		

EXPERIMEN1311A
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	81.9	156.1	133.6	156	136.3
2	123.8	130.9	139.5	140.4	135.6
3	137.7	142.8	126.8	117.5	133.4
4	116.2	117	132	136.6	121.2
5	112.9	131	146.8	136.6	129
6	126.9	139	123.9	101.6	126.8
7	133	116.8	121.9	123.2	133
8	110	130.4	127.1	101.5	120.6
9	133.9	127	118.4	110.9	51.2
10	135.5	115.8	108.5	108.6	106.1
11	119.3	122.5	123.8	112.8	118.4
12	108.6	105.5	122.3	118.8	92.3
13	110.1	123.4	130.3	125.1	106.1
14	136.1	137.2	121.4	118	87.6
15	146	135	112.8	110.8	80
16	119.6	116.5	122.1	110.3	126
17	116.8	113.8	112.5	121.6	121.6
18	106	114.8	108	112.9	111.9
19	81.9	100.5	100.6	120.2	126.1
20	100.9	103.5	113.1	119	122.7
21	94.8	104.6	111.1	119.5	101.2
22	62.1	93.1	112.1	111.6	127.3
23	163.7	147.6	179.9	181.1	180
24	181.9	189.4	183.5	193.5	201.3
25	187.8	195	184.2	199.7	199.5
26	0	0	0	0	0
9	46.5	111.5	132.3	130.1	135
10	104.5	127	120.7	143.6	150.3
11	129.2	130.1	140.3	129.1	128
12	128.2	145.1	127	141.1	129.6
27	140.9	142.4	139.9	133.2	126.3
28	147.5	148.1	142	131.7	131.3
29	129.7	127.1	123.9	130.5	137
30	139.1	132.2	138.9	137	130.7
31	151	137.1	118.4	110.3	99.5
32	129.3	142.9	129.5	129.3	120.8
33	118.9	122.8	137.1	126	111.9
34	115.8	127.5	116.6	119.4	105.3
35	198.3	195.2	187.1	181.4	163.6
36	199.1	192	181.1	168.3	164
37	197.7	192.8	177.9	169.9	158.5
38	199.7	173	191.5	163.7	164.1
39	0	0	0	0	0

DATA OF RUN NO. 1131a

DISCHARGE MEASUREMENTS				WATER LEVEL STILLING	
TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)	BASIN NO.	MEASUREME STILLING BASIN READING (mm)
0	10.56	24.14	34.7	1	69.6
0.17	11.04	27.6	38.64	2	0
0.5	9.71	25.19	34.9	3	42.8
1	8.29	22.58	30.87	4	176.8
2	7.91	23.05	30.96		
3	9.07	22.67	31.74		
4	9.4	22.12	31.52		
5	9.4	21.8	31.2		
6	9.52	21.33	30.85		
7	9.1	22.12	31.22		
8	9.52	21.45	30.97		
9	10.01	21.7	31.71		
10	9.71	21.35	31.06		

EXPERIMEN1131B
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	100.4	107.3	110.2	97.7	114.5
2	110.9	153.2	147.3	120.4	116.2
3	132.4	151.2	142.8	153.6	125.3
4	152.2	143	132.5	142	138
5	152.8	158.5	134.6	141.1	147.4
6	154.9	146	133	134.4	134.1
7	180	148.2	145.6	136	137.9
8	151.6	152.5	134.6	144.2	136.9
9	156.5	133.95	96.65		
10	82.2	152.9	160.2		
11	152.1	145.3	126.5		
12	171.8	127.1	122		
13	155	126.4	103.2		
14	159	129.1	115.4		
15	144.3	138.5	79.6		
16	132.3	115.8	121.7		
17	127.3	109.6	126.7		
18	86.9	116.8	129		
19	118.4	105	147.7		
20	113.9	98.9	130		
21	88.8	124.9	129.4		
22	94.7	115.5	144.8		
23	188.8	188.3	196		
24	189.9	187.8	191.7		
25	184.9	184.4	187.1		
26	0	0	0		
9	82.45	132.7	178.1		
10	128	123.7	135.9		
11	127.5	147.4	141.2		
12	166.5	158.9	122.4		
27	160.8	143.9	118.7		
28	149.2	139.2	134.1		
29	131.7	145.4	142.1		
30	139.1	134.5	130.2		
31	144.3	150.2	123.4		
32	130.5	142.4	133.5		
33	146.2	132.6	126.3		
34	136.1	133.4	131.8		
35	181.3	180.5	181.2		
36	183.5	187.9	192.8		
37	191.8	192.4	193.5		
38	183.8	184.3	186.2		
39	0	0	0		

EXPERIMEN1131b
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	68.1	83.2	83.5	72.1	98.6
2	98.2	138.4	143.3	143.8	93
3	107.2	126.9	138.2	132	114
4	122.9	123.2	131.4	134.8	146.3
5	121.8	128.1	115.9	134.5	119.3
6	127.3	131.7	118.8	133.8	120.4
7	128.2	125.6	133	113.9	116.9
8	121.7	138.6	118.1	140.8	124.3
9	131.9	128.1	66.5		
10	132.1	103.7	102.1		
11	136	132.3	109.9		
12	140	141.5	105.6		
13	134.6	127.3	92		
14	150.5	121.8	129.2		
15	164.9	122.3	90.4		
16	136.4	133.8	97.5		
17	86.4	127.5	118.9		
18	115.1	120.6	145.1		
19	87.5	121.9	116.2		
20	98.6	124.5	123.3		
21	72.1	109.7	136.5		
22	52.9	105.8	126.6		
23	181.9	187	210.6		
24	171.1	191.6	200.3		
25	187.3	188.9	191.9		
26	0	0	0		
9	63.5	127.6	133.1		
10	69.6	133	151.7		
11	100	145.6	130		
12	151.1	141.5	125		
27	133.6	132.4	123.5		
28	134.6	149.9	127.4		
29	126.1	139.2	148		
30	152.2	142.7	133.5		
31	139.2	124.1	126.2		
32	122.3	129.6	112.4		
33	105.1	124.7	152.5		
34	130.5	139.3	125.2		
35	208.2	178.7	158.8		
36	204	192.7	161		
37	197.9	193	171.2		
38	235.9	214.5	204.9		
39	0	0	0		

DATA OF RUN NO. 1131 B

DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0	10.24	20.47	30.71
1	9.99	20.5	30.49
2	10.02	20.42	30.44
3	10.33	19.82	30.15
4	9.86	20.1	29.96
5	9.71	19.7	29.41
6	9.86	20.71	30.57
7	9.86	20.92	30.78
8	9.71	21.12	30.83

WATER LEVEL MEASUREMENTS

STILLING BASIN NO.	READING BEGIN (mm)
1	68
2	68
3	42.8
4	176.9

STILLING BASIN NO.	READING END (mm)
1	67.5
2	67.5
3	42.8
4	176.9

EXPERIMENT1131C
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	68.1	83.2	83.5	72.1	98.6
2	98.2	138.4	143.3	143.8	93
3	107.2	126.9	138.2	132	114
4	122.9	123.2	131.4	134.8	146.3
5	121.8	128.1	115.9	134.5	119.3
6	127.3	131.7	118.8	133.8	120.4
7	128.2	125.6	133	113.9	116.9
8	121.7	138.6	118.1	140.8	124.3
9	131.9	128.1	66.5		
10	132.1	103.7	102.1		
11	136	132.3	109.9		
12	140	141.5	105.6		
13	134.6	127.3	92		
14	150.5	121.8	129.2		
15	164.9	122.3	90.4		
16	136.4	133.8	97.5		
17	86.4	127.5	118.9		
18	115.1	120.6	145.1		
19	87.5	121.9	116.2		
20	98.6	124.5	123.3		
21	72.1	109.7	136.5		
22	52.9	105.8	126.6		
23	181.9	187	210.6		
24	171.1	191.6	200.3		
25	187.3	188.9	191.9		
26	0	0	0		
9	63.5	127.6	133.1		
10	69.6	133	151.7		
11	100	145.6	130		
12	151.1	141.5	125		
27	133.6	132.4	123.5		
28	134.6	149.9	127.4		
29	126.1	139.2	148		
30	152.2	142.7	133.5		
31	139.2	124.1	126.2		
32	122.3	129.6	112.4		
33	105.1	124.7	152.5		
34	130.5	139.3	125.2		
35	208.2	178.7	158.8		
36	204	192.7	161		
37	197.9	193	171.2		
38	235.9	214.5	204.9		
39	0	0	0		

EXPERIMENT1131C
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	71.3	90.7	107.4	78.5	88.5
2	109.2	146.9	116.4	154.3	103.7
3	134.3	139.5	134.3	129.5	139.1
4	164.6	119.3	126.4	124.3	123.5
5	152.2	155.2	126.5	120.2	130.5
6	157.4	120	145.6	136	117.9
7	116.7	133	128.2	138.8	142.2
8	123.4	140	131.1	149.1	135
9	140.45	131.55	79.65		
10	158.3	112.9	87.3		
11	137.7	145.2	113.1		
12	134.9	130.8	110		
13	157.6	140.4	92.2		
14	152.2	127.9	128.3		
15	152	144.6	110.2		
16	136.7	129.7	117.3		
17	115.4	129.5	145.2		
18	117.2	145.9	131.2		
19	103.9	136.2	156.9		
20	87.8	134.1	145.3		
21	99	118.6	155.4		
22	89.9	114.8	155.6		
23	168.4	205.2	191.4		
24	198.4	173.2	163.9		
25	164.2	169.6	207.8		
26	0	0	0		
9	82.1	119.6	155.3		
10	92	129.1	125.5		
11	108	121.1	141.9		
12	117.8	122	124.1		
27	128.8	122.9	146		
28	109.5	137.7	152		
29	142.8	117.9	134		
30	129	151.9	123.2		
31	148.4	137.4	146.4		
32	133.7	140	134.5		
33	152.4	141.1	126.7		
34	129.2	136.6	111.1		
35	198.7	188.2	175.7		
36	206.9	176.9	176.5		
37	189.9	183	162.7		
38	183.6	178.7	179.9		
39	0	0	0		

DATA OF RUN NO. 1131C
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DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0	10.97	19.49	30.46
1	11.26	18.85	30.11
2	11.26	18.81	30.07
3	11.59	18.42	30.01
4	12.2	17.84	30.04
5	12.2	17.75	29.95
6	12.46	18.07	30.53
7	12.33	17.99	30.32
8	12.36	18.04	30.4
9	12.93	17.35	30.28

DATA OF RUN NO. 1131C

WATER LEVEL MEASUREMENTS

TIME (h)	STILLING BASIN NO. 1 (mm)	STILLING BASIN NO. 2 (mm)	STILLING BASIN NO. 3 (mm)	STILLING BASIN NO. 4 (mm)
0	70.2	73.1	48	172.9
3	71.2	96.5	48.4	174.6
4	69.5	68.1	47.5	174.8
5	71.1	69.8	47.6	173.7
8	70	69.8	46.9	172.5
9	71.4	71.7	48.1	175.7

EXPERIMEN1141A
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	71.5	84	91	97.8	91.1
2	101	145.6	124.7	150.4	118.2
3	133.1	134.4	143	129.6	135.3
4	161.7	130.2	130.5	130	122.7
5	152.8	153.3	131.7	115.3	127.1
6	151.1	122	135.7	122.1	117.3
7	120.5	135.4	145.8	139	146.9
8	123	124.3	126.9	126.6	128.7
9	126.6	121.8	119.2		
10	130.7	124.6	125		
11	138.5	135.9	137		
12	135.5	133.1	133.6		
13	144.5	138.3	135.1		
14	141	138	137.3		
15	140.8	134.2	134.8		
16	138.9	135.5	136.3		
17	137.7	133	134.3		
18	131.2	128.5	132.2		
19	134	132.1	134.4		
20	130.9	127	131.6		
21	130.3	126.4	129.9		
22	127.6	127	128.1		
23	194.1	196.6	198.9		
24	196.7	197	197.3		
25	192	196.5	194.1		
26	0	0	0		
9	124	127.3	131.2		
10	130.5	133	133.1		
11	137.8	136.7	139.2		
12	134.8	125.9	135.5		
27	127.6	130.2	128.3		
28	126.5	127	128.9		
29	124.9	126.5	126.1		
30	129.1	127.3	126.7		
31	122.6	124.2	126.4		
32	123.5	119.1	123.5		
33	123	123.4	123.7		
34	108.3	105.6	114.3		
35	180.2	180.8	183.7		
36	176.9	174.2	178.9		
37	176.9	178.5	181		
38	182.3	177.5	186.1		
39	0	0	0		

EXPERIMEN1141A
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	69.6	79	94.3	103.1	102.1
2	125.6	141.2	142	154	122
3	163.4	139	130.2	117	132.1
4	124	135.2	150	140.9	148
5	138	137	150	140	126.2
6	123	128.3	128.4	129.6	136
7	145	142	125.4	129.2	124.5
8	129.5	152	139.3	122.1	117.3
9	137.4	110.8	136.2	145.4	89.2
10	150.6	150	130	121.5	112.2
11	126.1	144.9	112.7	126	124
12	164.9	144	127	131.4	110.2
13	152.8	161.3	134.4	126.6	96.7
14	140.2	168.6	154.1	118.6	111.1
15	144.6	137.3	145.3	127.7	116.8
16	141.9	155.5	133.2	116.1	126.1
17	105.7	105.6	146.9	125.2	128.9
18	146.9	149.4	126.3	131	101.5
19	103.5	123.2	128.2	141.9	160
20	118	142.3	131.1	136	135.2
21	66	103	136.9	142.5	151.3
22	87.1	102.5	133.8	150.5	165.5
23	183.9	197.5	204.7	214.6	225.2
24	167.9	203.2	197.1	205.5	225.7
25	185.7	186.2	194.8	195.5	195.7
26	0	0	0	0	0
9	76.2	107.3	125.8	136	158.7
10	85.5	109.7	121.8	152.1	150.9
11	126.7	130.6	137.8	131.5	131.9
12	129.1	143.3	146.3	134.6	115.7
27	136.5	154.5	135.2	134.9	109.9
28	133.4	139.9	134.5	132	124.5
29	133.3	140.2	137.9	137.3	150.6
30	136.6	144	147	133.5	129.7
31	153.5	129.5	121.2	144.8	126.5
32	111.4	120	141.8	133.2	148.6
33	152.3	148.2	136.7	120.3	126
34	126.7	117.1	136.9	153.8	129.1
35	217.1	200	188.9	160.8	164.8
36	219.6	205.3	191.6	178.5	150.9
37	203.7	202.5	194.8	174.1	166.8
38	200.8	181.1	185.9	184.1	186.1
39	0	0	0	0	0

EXPERIMEN1141A
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	90.5	84.6	82	86.9	85.8
2	111	147.2	130.8	119	81.6
3	146	127	128	122.1	130
4	150	118	134.3	129	123.3
5	134	134	141	134.3	128.3
6	127	142	136.4	137.3	140.3
7	123.2	126.8	138.5	142.6	151.8
8	135.6	120.3	141	134.1	109.3

DATA OF RUN NO. 1141A

DISCHARGE MEASUREMENTS

TIME (h)	Q1 (m3/s)	Q2 (m3/s)	TOTAL Q (m3/s)
0.15	12.95	18.78	31.73
0.3	13.85	17.99	31.84
0.45	13.09	18.34	31.43
1	13.64	17.92	31.56
1.15	13.78	17.68	31.46
1.3	13.61	18.42	32.03
1.45	13.75	17.96	31.71
2	13.82	17.99	31.81
2.15	13.4	18.46	31.86
2.3	13.19	18.07	31.26
2.45	12.98	18.27	31.25
3	12.91	18.94	31.85
3.15	13.05	18.46	31.51
3.3	12.78	18.5	31.28
3.45	13.3	18.4	31.7
4	12.4	19.09	31.49
4.15	13.5	17.96	31.46
4.3	12.95	18.5	31.45
4.45	12.81	18.7	31.51
5	12.64	18.82	31.46
5.15	13.02	18.7	31.72
5.3	12.6	19.14	31.74
5.45	12.27	18.9	31.17
6	12.47	18.7	31.17
6.15	12.57	18.7	31.27
6.3	12.64	18.74	31.38
6.45	12.59	18.63	31.22
7	12.74	18.82	31.56
7.15	12.13	19.02	31.15
7.3	12.81	18.74	31.55
7.45	12.64	18.5	31.14
8	12	19.25	31.25
8.15	12.16	18.82	30.98

DATA OF RUN NO. 1141A

WATER LEVEL MEASUREMENTS

TIME (h)	READING BASIN NO. 1 (mm)	READING BASIN NO. 2 (mm)	READING BASIN NO. 3 (mm)	READING BASIN NO. 4 (mm)
0.5	75.97	77.97	52.53	179.63
1	73.4	77.47	53.3	181.63
1.5	75	76.6	52.6	181.23
2	75.33	75.97	53.8	178.8
2.5	74.7	75.5	53.5	179.03
3	71.93	76.03	51.63	181.97
3.5	76.17	76.17	51.77	182.2
4	75.07	76.3	52.93	182.43
4.5	73.93	76	51.13	180.3
5	75.1	76.3	51.57	180.6
5.5	77.37	77.57	53.4	184.2
6	76.9	77.9	53.96	184.83
6.5	77.4	77.73	53.1	184.13
7	75.8	78.2	52.73	183.07
7.5	78.17	78.17	52.23	182.33
8	77.03	78.23	53.23	181.5

EXPERIMEN1141B
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	69.6	79	94.3	103.1	102.1
2	125.6	141.2	142	154	122
3	163.4	139	130.2	117	132.1
4	124	135.2	150	140.9	148
5	138	137	150	140	126.2
6	123	128.3	128.4	129.6	136
7	145	142	125.4	129.2	124.5
8	129.5	152	139.3	122.1	117.3
9	137.4	110.8	136.2	145.4	89.2
10	150.6	150	130	121.5	112.2
11	126.1	144.9	112.7	126	124
12	164.9	144	127	131.4	110.2
13	152.8	161.3	134.4	126.6	96.7
14	140.2	168.6	154.1	118.6	111.1
15	144.6	137.3	145.3	127.7	116.8
16	141.9	155.5	133.2	116.1	126.1
17	105.7	105.6	146.9	125.2	128.9
18	146.9	149.4	126.3	131	101.5
19	103.5	123.2	128.2	141.9	160
20	118	142.3	131.1	136	135.2
21	66	103	136.9	142.5	151.3
22	87.1	102.5	133.8	150.5	165.5
23	183.9	197.5	204.7	214.6	225.2
24	167.9	203.2	197.1	205.5	225.7
25	185.7	186.2	194.8	195.5	195.7
26	0	0	0	0	0
9	76.2	107.3	125.8	136	158.7
10	85.5	109.7	121.8	152.1	150.9
11	126.7	130.6	137.8	131.5	131.9
12	129.1	143.3	146.3	134.6	115.7
27	136.5	154.5	135.2	134.9	109.9
28	133.4	139.9	134.5	132	124.5
29	133.3	140.2	137.9	137.3	150.6
30	136.6	144	147	133.5	129.7
31	153.5	129.5	121.2	144.8	126.5
32	111.4	120	141.8	133.2	148.6
33	152.3	148.2	136.7	120.3	126
34	126.7	117.1	136.9	153.8	129.1
35	217.1	200	188.9	160.8	164.8
36	219.6	205.3	191.6	178.5	150.9
37	203.7	202.5	194.8	174.1	166.8
38	200.8	181.1	185.9	184.1	186.1
39	0	0	0	0	0

EXPERIMEN1141B
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	90.5	84.6	82	86.9	85.8
2	111	147.2	130.8	119	81.6
3	146	127	128	122.1	130
4	150	118	134.3	129	123.3
5	134	134	141	134.3	128.3
6	127	142	136.4	137.3	140.3
7	123.2	126.8	138.5	142.6	151.8
8	135.6	120.3	141	134.1	109.3

EXPERIMEN1141B
DATA   last measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	72.9	75	90	101.8	98.2
2	98	107	121.9	124.4	124.2
3	122.5	126.7	123.7	129.7	143.2
4	122.6	118	121.9	145.5	142
5	118	120	136.8	134	120
6	151.9	157.5	124.3	141.2	140.7
7	147	124.8	145.7	142	139.9
8	134.7	139.3	126	126	135
9	128.9	135.9	150.5	138	65
10	124.9	121	145.7	148.6	130.4
11	159.9	147.3	139.6	137.6	141.9
12	150.2	140.8	127.6	117.2	85.7
13	168.5	154.1	143.4	108.2	102.1
14	176.6	178.1	120.9	105.6	102.3
15	146.4	132.5	130.9	144.9	108.1
16	138.1	131.2	147.6	138	133
17	130.7	134	125.3	130	129.8
18	125.6	134.3	124.9	133.4	138.2
19	133.7	156.4	130.5	116	95.4
20	117.6	117.3	131.2	133.8	168.3
21	82.9	128.5	133.6	141.4	142.4
22	103.2	117.6	126.6	148.4	153.3
23	180.7	190.2	205.8	210	198.7
24	162.6	183.9	194.2	194	211.2
25	181.1	190.9	183.3	193.1	204
26	0	0	0	0	0
9	69.6	93.6	117.8	130.5	152
10	101.5	131.8	124.2	131	150.5
11	129	136	126.4	122	133.6
12	137.9	136.1	123.3	133.6	127.1
27	143	143	136.8	144.6	129.2
28	126.4	128.2	137.3	134.8	153.6
29	153.7	158.7	137.9	144.6	140.2
30	147.8	152.3	162.4	135.6	146.1
31	138.3	142.2	146.3	135.4	127.5
32	129.4	126.1	133.5	148.9	152.3
33	152.5	148.7	136	141.3	126.1
34	134.8	135.8	134.9	144.8	118.5
35	219	191.8	202.1	172.4	158.4
36	212	184.4	196.2	179.7	175.3
37	206.1	206.4	200.6	181.7	173.7
38	195.2	176.4	198.6	198.2	204.4
39	0	0	0	0	0

EXPERIMEN1141B
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	102.1	91.9	89.8	82.5	90
2	141	138	134.9	140.8	110
3	139	119.2	132.8	140	152.5
4	142.5	142	147	139.4	136.8
5	141.5	133.5	151.1	152	140
6	122.8	122.8	130.9	134	132.7
7	105.7	137.2	131	140.2	125.2
8	135.5	140	126.4	137	135.5

DATA OF RUN NO. 1141B
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DISCHARGE MEASUREMENT

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	13.22	18.82	32.04
0.3	12.74	18.86	31.6
0.45	12.91	19.02	31.93
1	12.67	18.7	31.37
1.15	12.67	19.17	31.84
1.3	12.64	19.14	31.78
1.45	12.37	19.45	31.82
2	12.54	19.33	31.87
2.15	12.3	19.21	31.51
2.3	12.33	19.29	31.62
2.45	12.27	19.29	31.56
3	12.23	19.62	31.85
3.15	12.27	19.37	31.64
3.3	12.6	18.78	31.38
3.45	12.67	18.78	31.45
4	12.27	18.86	31.13
4.15	12.23	19.1	31.33
4.3	12.81	19.25	32.06
4.45	12.6	19.21	31.81
5	12.2	19.1	31.3
5.15	12.3	19.21	31.51
5.3	11.96	19.45	31.41
5.45	12.64	18.82	31.46
6	12.4	19.14	31.54
6.15	12	19.25	31.25
6.3	11.96	19.62	31.58
6.45	12.27	19.49	31.76
7	12.27	19.49	31.76
7.15	11.93	19.9	31.83
7.3	12.54	19.29	31.83
7.45	12.16	19.21	31.37
8	12.33	19.25	31.58

DATA OF RUN NO. 1141B

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	77.4	57.1	50.9	181.7
1	78.6	71.6	55.4	183.8
1.5	78.3	74.8	54.1	183.6
2	77.8	76.4	54.3	182.5
2.5	77.4	76.2	52.2	182.9
3	76.3	76.3	53.8	182.4
3.5	77.7	75.9	51.7	182.9
4	78.2	75.6	52.2	183.1
4.5	77.3	75.3	54.7	182.7
5	77.1	75.1	53.1	182.3
5.5	77.8	75.4	54.8	182.6
6	77.5	75.1	53.7	184.5
6.5	77.6	74.8	53.7	180.7
7	76.2	74.4	51.7	182.4
7.5	76.4	74.2	53.8	181.7
8	77.9	74.2	54	182.9

EXPERIMENT1141C
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	72.9	75	90	101.8	98.2
2	98	107	121.9	124.4	124.2
3	122.5	126.7	123.7	129.7	143.2
4	122.6	118	121.9	145.5	142
5	118	120	136.8	134	120
6	151.9	157.5	124.3	141.2	140.7
7	147	124.8	145.7	142	139.9
8	134.7	139.3	126	126	135
9	128.9	135.9	150.5	138	65
10	124.9	121	145.7	148.6	130.4
11	159.9	147.3	139.6	137.6	141.9
12	150.2	140.8	127.6	117.2	85.7
13	168.5	154.1	143.4	108.2	102.1
14	176.6	178.1	120.9	105.6	102.3
15	146.4	132.5	130.9	144.9	108.1
16	138.1	131.2	147.6	138	133
17	130.7	134	125.3	130	129.8
18	125.6	134.3	124.9	133.4	138.2
19	133.7	156.4	130.5	116	95.4
20	117.6	117.3	131.2	133.8	168.3
21	82.9	128.5	133.6	141.4	142.4
22	103.2	117.6	126.6	148.4	153.3
23	180.7	190.2	205.8	210	198.7
24	162.6	183.9	194.2	194	211.2
25	181.1	190.9	183.3	193.1	204
26	0	0	0	0	0
9	69.6	93.6	117.8	130.5	152
10	101.5	131.8	124.2	131	150.5
11	129	136	126.4	122	133.6
12	137.9	136.1	123.3	133.6	127.1
27	143	143	136.8	144.6	129.2
28	126.4	128.2	137.3	134.8	153.6
29	153.7	158.7	137.9	144.6	140.2
30	147.8	152.3	162.4	135.6	146.1
31	138.3	142.2	146.3	135.4	127.5
32	129.4	126.1	133.5	148.9	152.3
33	152.5	148.7	136	141.3	126.1
34	134.8	135.8	134.9	144.8	118.5
35	219	191.8	202.1	172.4	158.4
36	212	184.4	196.2	179.7	175.3
37	206.1	206.4	200.6	181.7	173.7
38	195.2	176.4	198.6	198.2	204.4
39	0	0	0	0	0

EXPERIMEN1141C
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	102.1	91.9	89.8	82.5	90
2	141	138	134.9	140.8	110
3	139	119.2	132.8	140	152.5
4	142.5	142	147	139.4	136.8
5	141.5	133.5	151.1	152	140
6	122.8	122.8	130.9	134	132.7
7	105.7	137.2	131	140.2	125.2
8	135.5	140	126.4	137	135.5

EXPERIMENT1141C
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	81.9	79.1	76.3	90.1	78.6
2	106	158.3	170.7	150.3	96.6
3	134.2	129.2	141.3	140.2	135.1
4	130.5	132.7	159.8	146.1	147.8
5	119.3	120.6	130.8	135	151.1
6	133.8	131.7	121.5	146.4	143.1
7	147.4	138.4	129.6	126.5	121.1
8	132	123.2	132	135.1	134.8
9	145.1	140	145.3	116	70.2
10	149.3	151.3	123.5	112.8	115
11	136.9	150.9	145.5	132	122.8
12	142.2	117.4	150.4	135.5	114
13	150	134.9	145.4	126.8	113.1
14	181	139.7	164.5	116.1	109.6
15	170.2	138.6	143.7	128	103.2
16	147.2	148.9	158.7	128.2	127.8
17	134.5	127.5	140	138.3	139.4
18	103.8	118	124.9	144.1	148
19	83.2	127.3	143.2	140.5	146.5
20	149	144	119.3	120	105.7
21	157.2	149.5	119.6	124	78.4
22	148.3	123.7	133.7	101.4	113.1
23	180.8	165.5	197.8	192.9	225.7
24	192.9	180	198.6	192.1	193.7
25	190.9	194.1	204.2	187.1	202.5
26	0	0	0	0	0
9	67.9	96.4	126.3	148.2	150.7
10	99.5	112.3	120.8	141	132.4
11	118.7	137.8	140.7	138.1	121
12	162.5	156.9	148.8	129.1	130.7
27	126.9	122.3	136	124.5	131.1
28	140.9	133.4	128.7	160.4	158.7
29	150.4	150.4	151.1	141.4	146
30	134.4	128.7	127.5	136	128.9
31	161.4	133.8	154.8	129.7	121.8
32	140.8	141.9	153.8	141.4	114.2
33	128.5	135.2	138.9	135.9	135.9
34	152.6	134.5	120.7	139.4	125
35	210.7	200.8	188.5	191.6	185.6
36	220.6	204.6	179.1	180.4	172.8
37	207.2	199	184.1	172.2	163.6
38	202.2	182.7	184	192.9	190.7
39	0	0	0	0	0

EXPERIMEN1141C
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	91.8	86.2	87.5	85.3	89.7
2	116.1	119.9	138.9	126.2	97.8
3	145.5	155	137.3	133	140.8
4	132	127.7	123.7	121.2	118.4
5	134.9	133	138.5	133.7	160.8
6	114.5	116.2	116	137.4	139.1
7	124	134.5	142.8	136	136.8
8	103.3	115.9	104.7	102.4	138.7

DATA OF RUN NO. 1141C
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DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	12.67	18.78	31.45
0.3	12.98	18.86	31.84
0.45	12.98	18.86	31.84
1	12.98	18.74	31.72
1.15	12.76	19.11	31.87
1.3	12.63	19.15	31.78
1.45	12.91	18.94	31.85
2	12.88	18.94	31.82
2.15	12.57	19.17	31.74
2.3	12.57	19.17	31.74
2.45	12.4	18.9	31.3
3	12.5	19.1	31.6
3.15	12.43	19.25	31.68
3.3	12.84	19.06	31.9
3.45	13.02	18.86	31.88
4	12.71	18.66	31.37
4.15	12.91	18.74	31.65
4.3	12.67	18.78	31.45
4.45	12.95	18.38	31.33
5	12.71	18.82	31.53
5.15	12.1	19.29	31.39
5.3	12.6	18.78	31.38
5.45	12.67	18.82	31.49
6	12.91	18.46	31.37
6.15	12.78	18.74	31.52
6.3	12.23	19.45	31.68
6.45	12.87	19.25	32.12
7	12.6	19.37	31.97
7.15	12.6	19.1	31.7
7.3	12.88	18.94	31.82
7.45	12.88	19.37	32.25
8	12.78	19.37	32.15
8.15	12.74	19.29	32.03

DATA OF RUN NO. 1141C

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0	79.3	79.1	55.4	183.9
0.5	78.2	79.33	55.63	183.5
1	76.53	79.23	55.1	182.17
1.5	76.4	79.1	54.7	183.07
2	78.23	79.13	54.4	182.77
2.5	78.3	78.7	54.03	184.27
3	78.53	78.93	55.2	181.77
3.5	78.27	79.33	52.83	183.8
4	76.77	78.93	52.73	182.53
4.5	77.57	79.03	53.8	183.07
5	78	79.36	53.7	183.1
5.5	77.8	77.8	54.6	184
6	77.93	78.1	54.93	183.23
6.5	78.1	79.03	54.43	183.9
7	77.3	79.3	53.36	182.27
7.5	76.63	78.9	53.23	183.5
8	77.1	78.2	53.1	182.87

EXPERIMENT 1211A
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	127.8	127.5	126.9	128	128.7
2	134.3	134.6	136.1	137.7	136
3	132.5	132.8	135.7	134.1	133.6
4	132.9	133.5	135.1	133.8	134.1
5	131.1	133.8	133.4	131.1	131.8
6	129.5	130.7	129.7	129.5	129.5
7	129.6	130.5	127.9	126.6	129
8	126.7	127	126.7	124.9	126.4
9	128	127.5	126	123.8	125.9
10	129.9	130.8	128.6	127.7	127.3
11	127.2	128.1	128.2	129	126.3
12	119.2	120.9	120.8	118.7	120.3
13	118.7	117.5	118.1	118	116.9
14	120.6	119.8	119	119.9	119
15	118	119.1	119.8	117.7	120
16	119.8	120	119.4	120.6	119.4
17	115.6	117.3	113.8	115.8	115.1
18	115.3	114.1	114.2	113.4	114.9
19	115.6	114	115.5	115.9	116.4
20	114.9	113.8	114	112.2	114.7
21	112.3	114.8	113	113.5	114.3
22	109.1	109.2	110.1	110.1	111.9
23	182.9	182.4	181.4	184.7	186.2
24	178.3	177	178.2	178.6	182.3
25	176.2	177.3	176.9	176.3	178.9
26	0	0	0	0	0
9	128.7	130.1	128.5	127.8	128
10	144.8	143	140.5	140.5	139.5
11	144.2	139.2	139.5	140.9	144.8
12	146.5	147.2	147	145	144.9
27	159.5	162.3	160.9	159.2	160
28	159.2	160.1	159.5	160.5	160.9
29	160.1	160	160.9	159	159.9
30	160.5	160.5	160.8	160.5	160.5
31	160.4	161.5	160.9	159.1	158.8
32	158.1	157.5	158.3	156.5	156.9
33	155.5	157.4	156.5	157.6	157
34	154.1	154.9	154.5	155.5	155
35	215.5	212.9	210.5	211.9	212
36	214.9	214.4	212.3	211.4	209.2
37	215.9	214.4	213.9	212.5	213.9
38	216.9	215.9	214.9	216.5	219.2
39	0	0	0	0	0

EXPERIMEN1211A
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	127.1	125.4	129.1	129.8	131.3
2	135	135.6	133.1	132.5	136.3
3	133.7	131.6	132.5	132.6	133.6
4	133.5	132.5	133.4	132.5	132.6
5	131.7	132.1	132	133.5	131.9
6	128.4	128.1	128.5	129.7	127.7
7	128.7	128	129	129.8	128.8
8	125	126.2	125.9	126.1	126.7

EXPERIMENT 1211A
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	99	96.4	70.2	80.7	79.2
2	129.2	121.1	142.8	127.2	112.2
3	137.1	137.5	135.1	124.4	136.2
4	125.6	131.2	133.6	134.7	137.6
5	118.6	109	138	141.4	136.6
6	107.2	106.8	142	132.2	131.1
7	139.6	132.6	123.4	121.3	113.9
8	94.5	127.6	132.1	123	128.8
9	114.4	111	131.4	105.8	68
10	139.6	142.2	119.6	111	112.4
11	131	136	132.5	127	99
12	130	137.9	133.5	113.7	134.1
13	142.9	148.8	138.7	119	61.3
14	162.3	147.7	120.6	116.9	88.2
15	127.9	133	111.8	127.4	121.7
16	134.3	128	135.5	123.8	101.4
17	102.9	123.4	125	118.9	119.7
18	95.9	98	123.2	101.2	122.6
19	89.5	99.5	113.2	139.4	132.9
20	93.2	92.3	103.3	144.7	138.2
21	105.1	103	114.6	123	138.8
22	76	82.9	117.6	134.8	143.4
23	161.9	174.6	190.1	196.9	201.9
24	157.3	178.7	176	195.2	204.7
25	161.2	173.5	202.1	184	177.6
26	0	0	0	0	0
9	68	84.4	120.9	126	131.4
10	76.1	111.9	146	144	155.5
11	115	135.8	142	129.8	129.4
12	143.3	140.8	132.5	130.4	130
27	135.2	137.5	134.8	130	153.8
28	140.4	136	140.5	139.9	131.7
29	145.3	150.9	148.3	143.5	121.7
30	139	141.5	145.2	126.2	130.1
31	132.5	135.5	135.7	135	128.6
32	144	147.8	111	128.7	122.4
33	137.9	125.3	129	132.6	132
34	132.9	134.5	133.7	131.9	121.2
35	208.7	203	194.8	178.7	165.9
36	201	215	209.6	175.1	162
37	185.9	187.9	200	190.2	169.9
38	212.8	198.9	186.3	181.2	166
39	0	0	0	0	0

EXPERIMEN1211A
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	68.6	67.1	75.8	86.5	102.9
2	107.3	104.2	123.9	103.4	99.9
3	145.7	145.9	132.5	131.1	101.1
4	133.5	130.9	141	141.1	128.2
5	121.4	147.9	137	120.7	121
6	109.9	128.6	118.3	122	144.7
7	123.6	129	104.6	128.3	128.8
8	110.9	130.3	127.3	115.1	111.4

DATA OF RUN NO. 1211a

DISCHARGE	MEASUREMENT		
TIME	Q1	Q2	TOTAL Q
(h)	(l/s)	(l/s)	(l/s)
0.15	10.98	27.76	38.74
0.3	11.14	27.67	38.81
0.45	11.3	27.71	39.01
1	11.14	27.99	39.13
1.15	10.91	27.99	38.9
1.3	11.37	27.48	38.85
1.45	12.16	26.44	38.6
2	12.23	26.62	38.85
2.15	11.83	27.03	38.86
2.3	12.2	26.17	38.37
2.45	12.3	26.39	38.69
3	12.4	26.08	38.48
3.15	12.3	25.77	38.07
3.3	12.57	25.37	37.94
3.45	12.64	25.9	38.54
4	12.84	25.41	38.25
4.15	12.4	25.72	38.12
4.3	13.12	25.5	38.62
4.45	12.96	25.45	38.41
5	13.1	25.4	38.5
5.15	12.95	25.6	38.55
5.3	13.48	25.37	38.85
5.45	13.29	25.19	38.48
6	13.05	25.1	38.15
6.15	13.29	25.19	38.48
6.3	13.47	25.23	38.7
6.45	13.26	25.19	38.45
7	13.26	25.32	38.58
7.15	13.57	25.37	38.94
7.3	13.05	24.97	38.02
7.45	13.05	25.54	38.59
8	13.19	25.54	38.73
8.15	12.95	25.72	38.67
8.3	13.15	26.03	39.18

DATA OF RUN NO. 1211a

WATER LEVEL MEASUREMENTS

TIME	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0	208.6		204.2	188.8
0.5	211.2	176.7	203.5	189.3
1	211.1	188.2	202.7	189.5
1.5	211.8	192.3	201.6	191.1
2	211.9	194.4	202.7	191
2.5	209.4	194.5	202.3	190.2
3	209.2	194.3	200.5	191.5
3.5	209.9	193.7	202.5	190.9
4	210.5	193.1	201.3	188.3
4.5	210.4	192.9	203.1	189.1
5	208.7	192.9	202.1	192.4
5.5	209	192.4	200.3	191.8
6	209.1	191.7	203.4	192.4
6.5	207.6	191.4	202.3	191.5
7	209	191.1	202.3	190.7
7.5	208.9	191.4	203	195.7
8	208.1	191.6	202.3	191

EXPERIMENT1211B
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	99	96.4	70.2	80.7	79.2
2	129.2	121.1	142.8	127.2	112.2
3	137.1	137.5	135.1	124.4	136.2
4	125.6	131.2	133.6	134.7	137.6
5	118.6	109	138	141.4	136.6
6	107.2	106.8	142	132.2	131.1
7	139.6	132.6	123.4	121.3	113.9
8	94.5	127.6	132.1	123	128.8
9	114.4	111	131.4	105.8	68
10	139.6	142.2	119.6	111	112.4
11	131	136	132.5	127	99
12	130	137.9	133.5	113.7	134.1
13	142.9	148.8	138.7	119	61.3
14	162.3	147.7	120.6	116.9	88.2
15	127.9	133	111.8	127.4	121.7
16	134.3	128	135.5	123.8	101.4
17	102.9	123.4	125	118.9	119.7
18	95.9	98	123.2	101.2	122.6
19	89.5	99.5	113.2	139.4	132.9
20	93.2	92.3	103.3	144.7	138.2
21	105.1	103	114.6	123	138.8
22	76	82.9	117.6	134.8	143.4
23	161.9	174.6	190.1	196.9	201.9
24	157.3	178.7	176	195.2	204.7
25	161.2	173.5	202.1	184	177.6
26	0	0	0	0	0
9	68	84.4	120.9	126	131.4
10	76.1	111.9	146	144	155.5
11	115	135.8	142	129.8	129.4
12	143.3	140.8	132.5	130.4	130
27	135.2	137.5	134.8	130	153.8
28	140.4	136	140.5	139.9	131.7
29	145.3	150.9	148.3	143.5	121.7
30	139	141.5	145.2	126.2	130.1
31	132.5	135.5	135.7	135	128.6
32	144	147.8	111	128.7	122.4
33	137.9	125.3	129	132.6	132
34	132.9	134.5	133.7	131.9	121.2
35	208.7	203	194.8	178.7	165.9
36	201	215	209.6	175.1	162
37	185.9	187.9	200	190.2	169.9
38	212.8	198.9	186.3	181.2	166
39	0	0	0	0	0

EXPERIMEN1211B
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	68.6	67.1	75.8	86.5	102.9
2	107.3	104.2	123.9	103.4	99.9
3	145.7	145.9	132.5	131.1	101.1
4	133.5	130.9	141	141.1	128.2
5	121.4	147.9	137	120.7	121
6	109.9	128.6	118.3	122	144.7
7	123.6	129	104.6	128.3	128.8
8	110.9	130.3	127.3	115.1	111.4

EXPERIMENT1211b
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	72.8	90.9	73.2	78.5	70
2	126.4	154.2	160.1	132.9	98.1
3	152.2	146	125.1	123.8	110.1
4	128.7	107.3	119.8	141.3	120
5	134.5	134.3	135.5	112.4	112.6
6	115.4	130.2	132.6	131.8	127.1
7	120	117.5	113.9	124	98.8
8	118	124.4	127.2	133.6	129.3
9	138.2	109.8	129.1	109.1	87.3
10	127.2	130.2	126.7	117.2	89.1
11	131.4	122.2	114.9	111.7	112.2
12	131.6	118.4	131.8	127.5	117.2
13	134.6	132	132	120.6	98
14	130.9	122.8	150	109.5	96.5
15	172.8	153.5	117.5	106.9	96.5
16	119.5	151.4	116	106.3	116.5
17	110	119.2	135.5	128.7	114.6
18	104.4	112.1	109.8	135.1	140
19	111.4	117.4	106.7	124.2	145.9
20	83.4	123.1	125.4	134.6	121.5
21	59.4	89	122.6	138	144.1
22	58.5	96.8	115.5	132.1	147.7
23	165.4	170.3	183.3	202.8	199.4
24	174.6	185.7	177.6	176.9	188
25	155.6	162.8	193.8	180.1	194.7
26	0	0	0	0	0
9	85.1	111.6	132.4	143.1	142
10	90.2	111.1	119.2	156	162.5
11	128.5	139.4	136.6	141.2	129
12	143.9	138.4	111.2	129	131.1
27	138.2	128.1	126.3	136.6	124.6
28	129.7	138.4	118.5	127.7	141.2
29	140.5	152.1	146.2	125.9	147.3
30	140.8	137.8	131.9	131.9	122.8
31	154.1	151.3	139.2	124.6	139.3
32	139.9	134.6	132.5	133.6	143.4
33	121.4	139.5	124.9	145.4	142.6
34	139.1	147	135	126.8	110.5
35	222.1	198.3	180.2	169.5	147.7
36	162.2	195.9	198.2	189.7	189.1
37	213.2	185.9	190.9	163.9	169.3
38	195.2	195.4	179.8	192.4	181.9
39	0	0	0	0	0

EXPERIMEN1211b
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	55.4	52.1	59.7	66.2	88.5
2	95.2	86	87.8	102.3	100.6
3	125	130.3	127.3	116.5	90.3
4	118.7	110.3	92.4	106.6	114.6
5	119	124.2	131.6	128.7	120
6	116.6	129	133.8	130.8	141.2
7	108.7	131.2	142	138.2	125.3
8	131.2	145	129	106.8	105

DATA OF RUN NO. 1211b
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DISCHARGE MEASUREMENT

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	13.15	25.72	38.87
0.3	13.22	25.63	38.85
0.45	13.09	25.45	38.54
1	13.64	25.37	39.01
1.15	13.54	25.54	39.08
1.3	13.68	25.14	38.82
1.45	14.03	24.53	38.56
2	13.57	25.32	38.89
2.15	13.68	25.14	38.82
2.3	13.75	25.19	38.94
2.45	13.92	25.06	38.98
3	13.71	25.19	38.9
3.15	13.75	25.23	38.98
3.3	13.71	24.57	38.28
3.45	13.92	24.31	38.23
4	13.71	24.35	38.06
4.15	13.68	24.57	38.25
4.3	13.99	24.48	38.47
4.45	13.36	25.78	39.14
5	14.14	24.66	38.8
5.15	13.61	24.48	38.09
5.3	13.43	24.92	38.35
5.45	13.54	24.84	38.38
6	13.89	24.88	38.77
6.15	13.5	24.92	38.42
6.3	13.82	24.66	38.48
6.45	13.54	25.19	38.73
7	13.61	24.88	38.49
7.15	13.96	24.61	38.57
7.3	13.57	24.75	38.32
7.45	13.71	25.14	38.85
8	13.64	25.1	38.74

DATA OF RUN NO. 1211b

WATER LEVEL MEASUREMENTS

TIME	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	208.9		203.1	190.5
1	207.8	238.1	201.6	189.9
1.5	208.3	236.5	201.3	190
2	208.8	235.2	206	189.2
2.5	207.1	234.8	203.5	190.6
3	207.2	231.8	203.2	189.9
3.5	208.2	231.2	201.7	189.9
4	208	230.2	204.9	191.4
4.5	207.7	229.2	202.2	189.7
5	208.6	228.5	203.3	189.6
5.5	208.9	227.1	202.6	189.3
6	207.2	226.8	203.1	190.1
6.5	208	225.6	204.4	190.5
7	207.8	225.5	203.2	190.3
7.5	208.8	224.9	203.5	190
8	202.3	224.5	203.4	187.7

EXPERIMENT1211C
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	72.8	90.9	73.2	78.5	70
2	126.4	154.2	160.1	132.9	98.1
3	152.2	146	125.1	123.8	110.1
4	128.7	107.3	119.8	141.3	120
5	134.5	134.3	135.5	112.4	112.6
6	115.4	130.2	132.6	131.8	127.1
7	120	117.5	113.9	124	98.8
8	118	124.4	127.2	133.6	129.3
9	138.2	109.8	129.1	109.1	87.3
10	127.2	130.2	126.7	117.2	89.1
11	131.4	122.2	114.9	111.7	112.2
12	131.6	118.4	131.8	127.5	117.2
13	134.6	132	132	120.6	98
14	130.9	122.8	150	109.5	96.5
15	172.8	153.5	117.5	106.9	96.5
16	119.5	151.4	116	106.3	116.5
17	110	119.2	135.5	128.7	114.6
18	104.4	112.1	109.8	135.1	140
19	111.4	117.4	106.7	124.2	145.9
20	83.4	123.1	125.4	134.6	121.5
21	59.4	89	122.6	138	144.1
22	58.5	96.8	115.5	132.1	147.7
23	165.4	170.3	183.3	202.8	199.4
24	174.6	185.7	177.6	176.9	188
25	155.6	162.8	193.8	180.1	194.7
26	0	0	0	0	0
9	85.1	111.6	132.4	143.1	142
10	90.2	111.1	119.2	156	162.5
11	128.5	139.4	136.6	141.2	129
12	143.9	138.4	111.2	129	131.1
27	138.2	128.1	126.3	136.6	124.6
28	129.7	138.4	118.5	127.7	141.2
29	140.5	152.1	146.2	125.9	147.3
30	140.8	137.8	131.9	131.9	122.8
31	154.1	151.3	139.2	124.6	139.3
32	139.9	134.6	132.5	133.6	143.4
33	121.4	139.5	124.9	145.4	142.6
34	139.1	147	135	126.8	110.5
35	222.1	198.3	180.2	169.5	147.7
36	162.2	195.9	198.2	189.7	189.1
37	213.2	185.9	190.9	163.9	169.3
38	195.2	195.4	179.8	192.4	181.9
39	0	0	0	0	0

EXPERIMEN1211C
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	55.4	52.1	59.7	66.2	88.5
2	95.2	86	87.8	102.3	100.6
3	125	130.3	127.3	116.5	90.3
4	118.7	110.3	92.4	106.6	114.6
5	119	124.2	131.6	128.7	120
6	116.6	129	133.8	130.8	141.2
7	108.7	131.2	142	138.2	125.3
8	131.2	145	129	106.8	105

EXPERIMENT1211C
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	65.6	97.2	74.8	70	58.2
2	91.1	131	138.2	126	126.7
3	141.5	128.8	106.8	97.3	96.9
4	140.8	135.5	125.9	115	139.9
5	119	130.5	141	141.4	103.1
6	140.2	145.3	135.4	131.1	117.9
7	108.2	121	138.1	136	120.2
8	114.5	112.1	115	110.2	128.1
9	139.1	118.1	117.5	121	80.2
10	98	122.9	116.6	116.1	108.4
11	112.4	119	123.6	123.5	123.9
12	141.2	136	122.1	104.1	81.7
13	157.3	139.4	137	114.5	91.3
14	168.8	145.3	122	116.5	91.4
15	157.1	150.1	128.7	116.5	95.5
16	135.2	117	111.1	118.4	120.2
17	124.9	125.9	140	108.7	118.5
18	109.2	120.8	137.7	114.6	120.8
19	94.3	103.9	129.5	118.5	128.5
20	86.7	119.5	106.4	112.5	120
21	93.2	110.2	105.4	137.3	149.6
22	182.3	188.5	105.4	139.7	163.7
23	180.5	167.7	175.4	203	210.5
24	171.3	156.6	193.9	193	185.7
25	168.3	184.6	193.6	191.2	179.4
26	0	0	0	0	0
9	86.9	124	126.6	131	151.7
10	99.9	129.6	135.2	148.4	158
11	144.6	150	133.1	134.1	128.1
12	131.9	130	138.9	148.6	151.6
27	130.5	124.5	139	138.9	140.1
28	131.8	140	141.3	135.8	134
29	142.5	151	145.5	117.4	157.1
30	133.5	137.3	146.4	140	139.9
31	131	132.9	129.5	150.3	162.2
32	144.8	154.5	139.3	145.9	124.1
33	126.4	142.8	136.5	139	134.3
34	126.8	130.9	128.9	140.9	137.8
35	211.5	203	199.5	180	154.8
36	222.2	206	200.7	183.9	181.2
37	204.4	201	185.8	186	175.5
38	200.5	182	187	197.5	196.8
39	0	0	0	0	0

EXPERIMEN1211C
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	51	46.4	51.3	60.8	92.2
2	98	104.6	141.1	139.5	116.6
3	139.7	124.8	124.6	133.9	138.9
4	129.6	134.4	129.2	120.7	125
5	102.2	126	102.6	107	108.3
6	115	88.5	124	134.1	136.1
7	132	121.5	115.2	113.3	120.1
8	126.8	136.6	121	101	119.4

DATA OF RUN NO. 1211c
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DISCHARGE MEASUREMENT

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	13.33	24.75	38.08
0.3	13.09	24.92	38.01
0.45	13.99	24.48	38.47
1	13.09	25.37	38.46
1.15	13.15	24.88	38.03
1.3	13.47	25.19	38.66
1.45	12.95	25.68	38.63
2	13.12	25.28	38.4
2.15	12.98	25.1	38.08
2.3	13.29	25.23	38.52
2.45	13.47	24.62	38.09
3	12.81	25.32	38.13
3.15	13.22	25.54	38.76
3.3	13.64	25.14	38.78
3.45	12.91	25.63	38.54
4	12.91	25.45	38.36
4.15	12.93	25.32	38.25
4.3	13.04	24.95	37.99
4.45	12.76	25.01	37.77
5	13.1	25.01	38.11
5.15	12.79	25.45	38.24
5.3	13.03	25.35	38.38
5.45	13.21	25.01	38.22
6	12.73	25.45	38.18
6.15	12.73	25.36	38.09
6.3	13	25.36	38.36
6.45	12.87	25.4	38.27
7	13.07	25.23	38.3
7.15	13.31	25.18	38.49
7.3	12.76	25.4	38.16
7.45	13.15	25.4	38.55
8	13.19	25.17	38.36

DATA OF RUN NO. 1211c

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	207.5	219.8	203	190.1
1	206.9	219.5	204.2	188.3
1.5	207.8	219.1	203.1	189.9
2	207.5	218.6	201.9	190.2
2.5	208.7	218.2	203.1	190
3	208	217.7	201.9	189.2
3.5	208.3	217.2	202.5	190.2
4	207.3	215.6	202.8	198.8
4.5	208.4	215.4	203.3	191.2
5	207.8	214.8	202.5	188.3
5.5	208.6	214.4	202.4	189.7
6	207.8	214.1	202	189.6
6.5	206.9	213.4	203.6	187.4
7	207.8	213.3	202.4	189.8

EXPERIMENT1221A
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	131.8	129.1	125.9	127.3	137.6
2	135	135.3	132	127.6	127.8
3	131.4	130.5	129.6	130.3	133.2
4	132.5	129.1	131.3	131.9	130.8
5	130	129.5	131	131.6	131.8
6	131.4	128.5	130.2	127.5	121.5
7	130.4	128.3	129.4	128.1	122.7
8	125.9	126.4	126	122.8	122.2
9	125.5	122.9	118.4		
10	133.6	130.7	128.5		
11	137.5	137.2	134.4		
12	136.2	130.2	115.2		
13	142.3	141.6	137.9		
14	143.4	142.5	139.2		
15	140.8	140	135.6		
16	140.3	140.6	132.8		
17	137.2	137.3	132.9		
18	134.9	135.8	133.4		
19	136.4	135	134.1		
20	135	132.5	132.7		
21	134	133.2	131.4		
22	130.9	131.2	128.7		
23	205.2	201.9	198.2		
24	201	197.8	194.9		
25	203.3	201.7	200.1		
26	0	0	0		
9	120.5	122.1	126.2		
10	128.9	127.7	129.1		
11	127.6	128.2	130		
12	121.3	121.5	121.7		
27	126.3	127.3	127.5		
28	128.9	127.8	127.4		
29	125	125.5	125.3		
30	129.1	127.7	127.6		
31	127	128.9	126.7		
32	127	123.9	127.3		
33	127.3	125.6	126.2		
34	124.3	122.5	122.8		
35	182.7	182	182		
36	183	181.8	178.9		
37	184.4	183.5	180.7		
38	186.4	183.2	184.3		
39	0	0	0		

EXPERIMENT1221A
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	92.8	94.9	87.1	89.5	85.1
2	99.8	128	132.1	97.9	114.6
3	102	103.5	115.9	119.2	102
4	128	129.9	115.1	93.2	128.9
5	113.9	117.1	111.2	132	131.4
6	114.3	127.3	118.5	123	122.2
7	113.9	110.9	129	105.6	129.4
8	120.9	115.2	118.8	120.5	121.6
9	125.6	117.1	138.5	116.7	29
10	97.1	144	115.5	93	94
11	142.2	133	127.3	134.2	94.4
12	158.2	139.8	128.7	125.9	100.7
13	150.1	151.8	126.9	116.9	94.3
14	163.9	146.2	135	106.8	104.6
15	163.6	151.9	122.4	120	117.1
16	146.1	145.1	145	131.4	126.1
17	118.5	122.8	122.5	127.9	121
18	110	112.1	119.6	141.9	136.8
19	100.5	112.9	132.6	145.6	141.3
20	104.7	105.2	137.9	137.6	142.7
21	79.2	92.3	125.4	123.5	134.2
22	89.5	113.7	105.3	134.2	160.4
23	179.5	189.3	183.1	179.5	195.9
24	154.5	185	206.1	212.5	209.5
25	180.4	162.9	185.2	200.3	199
26	0	0	0	0	0
9	27.8	84.9	120.5	147.3	157.9
10	99.8	131.1	144	157	142.2
11	127.5	145.1	143.6	131.5	118.1
12	125.8	133.4	128.6	135.6	136
27	131.6	134.4	134.6	138.8	149.1
28	124.2	143.5	154.3	126.5	144.9
29	140.8	133.7	133.7	129.5	118.5
30	143.1	143.9	142.5	143.7	122.4
31	144.4	149.9	134	118.7	143
32	128.1	131.8	125.6	126.9	127.1
33	117.6	118.9	145.2	125.2	122.2
34	119.5	134.1	134.2	138	142.4
35	212.8	189.5	184.9	175.5	146.6
36	213.9	194.7	171.2	176.4	159
37	197.3	200.8	190.7	175.7	162.8
38	221.2	202.1	191.7	170.6	160
39	0	0	0	0	0

EXPERIMEN1221A
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	67	71.2	80	85.2	105.9
2	118	115.2	97.9	126.1	102.9
3	89.2	124.4	121	118.3	121.3
4	115	135.7	132.6	140.5	135
5	143	120.6	124.6	113.8	129
6	121.6	128	114.7	135.5	125.5
7	137	130	118.8	110.5	125.2
8	116.5	132.6	139.3	136	123.8

DATA OF RUN NO. 1221a
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DISCHARGE E MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	16.59	21.7	38.29
0.3	16.63	22.21	38.84
0.45	15.95	22.33	38.28
1	15.84	22.38	38.22
1.15	16.93	21.75	38.68
1.3	15.66	22.46	38.12
1.45	15.99	22.59	38.58
2	16.18	22.5	38.68
2.15	16.21	21.91	38.12
2.3	16.1	22.12	38.22
2.45	15.58	22.84	38.42
3	15.4	23.27	38.67
3.15	15.51	23.23	38.74
3.3	15.18	23.27	38.45
3.45	15.66	22.97	38.63
4	15.66	22.84	38.5
4.15	15.51	22.89	38.4
4.3	15.58	23.1	38.68
4.45	15.81	22.84	38.65
5	15.07	23.27	38.34
5.15	15.18	23.27	38.45
5.3	15.44	23.06	38.5
5.45	15.33	23.06	38.39
6	15.33	22.89	38.22
6.15	15.29	23.14	38.43
6.3	14.64	23.4	38.04
6.45	15.04	23.23	38.27
7	15.07	23.23	38.3
7.15	14.81	23.49	38.3
7.3	15.03	23.18	38.21
7.45	15.03	23.4	38.43
8	15.18	23.31	38.49

DATA OF RUN NO. 1221a

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	207.8	205.4	203.9	188.5
1	208.1	199.3	202.8	185
1.5	209	197.3	201.8	187.1
2	208.9	197.1	204.1	187.1
2.5	208.9	196.4	202.7	190
3	208.6	196.7	204.8	188.3
3.5	209.1	196.3	203.3	186.7
4	209.6	197	203.4	188.3
4.5	209.5	196.9	204	189.4
5	209.9	196.9	204.5	189.2
5.5	209.5	196.8	200.8	185.7
6	209.2	196.6	202.7	187.7
6.5	209.4	196.2	201.7	189.1
7	208.6	196.1	201.8	186.8
7.5	207.9	196.7	204.2	188.2
8	208.4	196.5	203.2	188.8

EXPERIMENT1221B
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	92.8	94.9	87.1	89.5	85.1
2	99.8	128	132.1	97.9	114.6
3	102	103.5	115.9	119.2	102
4	128	129.9	115.1	93.2	128.9
5	113.9	117.1	111.2	132	131.4
6	114.3	127.3	118.5	123	122.2
7	113.9	110.9	129	105.6	129.4
8	120.9	115.2	118.8	120.5	121.6
9	125.6	117.1	138.5	116.7	29
10	97.1	144	115.5	93	94
11	142.2	133	127.3	134.2	94.4
12	158.2	139.8	128.7	125.9	100.7
13	150.1	151.8	126.9	116.9	94.3
14	163.9	146.2	135	106.8	104.6
15	163.6	151.9	122.4	120	117.1
16	146.1	145.1	145	131.4	126.1
17	118.5	122.8	122.5	127.9	121
18	110	112.1	119.6	141.9	136.8
19	100.5	112.9	132.6	145.6	141.3
20	104.7	105.2	137.9	137.6	142.7
21	79.2	92.3	125.4	123.5	134.2
22	89.5	113.7	105.3	134.2	160.4
23	179.5	189.3	183.1	179.5	195.9
24	154.5	185	206.1	212.5	209.5
25	180.4	162.9	185.2	200.3	199
26	0	0	0	0	0
9	27.8	84.9	120.5	147.3	157.9
10	99.8	131.1	144	157	142.2
11	127.5	145.1	143.6	131.5	118.1
12	125.8	133.4	128.6	135.6	136
27	131.6	134.4	134.6	138.8	149.1
28	124.2	143.5	154.3	126.5	144.9
29	140.8	133.7	133.7	129.5	118.5
30	143.1	143.9	142.5	143.7	122.4
31	144.4	149.9	134	118.7	143
32	128.1	131.8	125.6	126.9	127.1
33	117.6	118.9	145.2	125.2	122.2
34	119.5	134.1	134.2	138	142.4
35	212.8	189.5	184.9	175.5	146.6
36	213.9	194.7	171.2	176.4	159
37	197.3	200.8	190.7	175.7	162.8
38	221.2	202.1	191.7	170.6	160
39	0	0	0	0	0

EXPERIMEN1221B
DATA first measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	67	71.2	80	85.2	105.9
2	118	115.2	97.9	126.1	102.9
3	89.2	124.4	121	118.3	121.3
4	115	135.7	132.6	140.5	135
5	143	120.6	124.6	113.8	129
6	121.6	128	114.7	135.5	125.5
7	137	130	118.8	110.5	125.2
8	116.5	132.6	139.3	136	123.8

EXPERIMENT1221B
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 1 [mm]	MEASURED LEVEL POINT 2 [mm]	MEASURED LEVEL POINT 3 [mm]	MEASURED LEVEL POINT 4 [mm]	MEASURED LEVEL POINT 5 [mm]
1	60	87.4	83.9	71.2	75
2	102.8	121	139.9	110	109
3	136.4	122.3	117.3	92	119
4	146.5	119.7	115.5	124.6	126
5	113.5	133.3	117.1	134.5	155.8
6	128	125.2	131.1	117	110
7	103	123.4	121.5	144.6	146.7
8	115.6	110.5	121.2	130	118.8
9	147	119	109	107.8	69.8
10	127	132	128.1	121	110.3
11	139.2	134	105.2	108.3	107.4
12	144	187.1	115	129.9	113.4
13	138.5	158	143.1	108	78.4
14	166.5	141.6	100	98.5	108
15	153.5	122.5	137.5	113	182.5
16	139.5	121.5	130	122.9	151
17	113.3	125	120	131.5	121.2
18	121.3	117	125	152	154.5
19	103	102.1	130.2	135.5	150
20	91	116	121.4	141.9	152.5
21	82	99	118.2	130.9	125.5
22	80.5	96	102.8	135.5	152.7
23	178	194	201.8	188.8	201.5
24	171	167	199.2	198.2	198.7
25	201	168.8	177	197	193.5
26	0	0	0	0	0
9	98.8	92.8	121.5	158.5	155.5
10	88.9	105.5	112.9	151	159.9
11	129.5	126.5	126.5	139.2	137.9
12	123.1	111.2	122.8	133.4	127.5
27	142	136.1	140.5	134	126.2
28	139.6	143	149	137.9	125.7
29	129.6	127.2	133.7	141.5	129
30	154.9	153.5	155.4	119	128.6
31	133	120.2	136.5	146.1	142
32	145.2	155.1	131	135.2	130
33	138.1	137.5	152	156.4	153.5
34	139	128.1	132.5	134.8	131
35	214.4	204	194.2	187	180
36	215.5	215.9	195.7	180.5	160
37	185	198.9	208	193.9	165
38	208.9	214	194.8	170.9	159.5
39	0	0	0	0	0

EXPERIMEN1221B
DATA last measurements

CROSS SECTION	MEASURED LEVEL POINT 6 [mm]	MEASURED LEVEL POINT 7 [mm]	MEASURED LEVEL POINT 8 [mm]	MEASURED LEVEL POINT 9 [mm]	MEASURED LEVEL POINT 10 [mm]
1	52.3	49	46	66	82.2
2	90	108	123	129.8	109
3	125.9	111.5	137.2	126.5	128.3
4	139.5	137.2	132	118.9	128.5
5	137.9	135	104.5	105.9	118
6	135.5	126.2	128.1	112.6	113.8
7	131.1	111	123.1	110	121.7
8	132.1	122	150	117.8	121

DATA OF RUN NO. 1221b
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DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	14.96	23.14	38.1
0.3	15.18	23.53	38.71
0.45	14.71	23.87	38.58
1	14.93	23.66	38.59
1.15	15.07	23.7	38.77
1.3	14.67	24	38.67
1.45	15.33	23.01	38.34
2	15	23.66	38.66
2.15	14.71	24	38.71
2.3	14.71	23.92	38.63
2.45	14.42	24.27	38.69
3	14.53	24.31	38.84
3.15	14.46	24.39	38.85
3.3	14.42	24.27	38.69
3.45	14.6	23.83	38.43
4	14.82	23.57	38.39
4.15	14.57	23.92	38.49
4.3	14.49	23.75	38.24
4.45	14.49	24.6	39.09
5	14.35	24.14	38.49
5.15	14.39	24.27	38.66
5.3	13.88	24.09	37.97
5.45	13.81	24.97	38.78
6	14.35	24.04	38.39
6.15	14.02	24.22	38.24
6.3	14.02	24.22	38.24
6.45	14.02	24.22	38.24
7	14.02	24.26	38.28
7.15	14.02	23.96	37.98
7.3	13.67	24	37.67
7.45	13.67	24.09	37.76
8	13.92	24.13	38.05

DATA OF RUN NO. 1221b

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	208.1	216.6	204.7	188.5
1	208.1	208.5	203.9	187.6
1.5	208.3	202.2	201.5	188.9
2	208.8	199.7	202.9	187.6
2.5	208.6	199.2	202.3	189.5
3	209.1	198.1	203.4	188.8
3.5	208.5	197.1	202.2	187.9
4	207.4	196.3	202.2	188
4.5	207.7	195.3	203.6	189.6
5	208.6	195	201.1	187
5.5	208.1	194.6	201.9	185
6	208.5	194.2	202.6	185.43
6.5	208.5	194.3	202.9	185.5
7	208.4	194.5	202.9	187.3
7.5	208.5	194.6	203	187
8	208.5	194.6	202.9	187.2

EXPERIMENT1221C
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	60	87.4	83.9	71.2	75
2	102.8	121	139.9	110	109
3	136.4	122.3	117.3	92	119
4	146.5	119.7	115.5	124.6	126
5	113.5	133.3	117.1	134.5	155.8
6	128	125.2	131.1	117	110
7	103	123.4	121.5	144.6	146.7
8	115.6	110.5	121.2	130	118.8
9	147	119	109	107.8	69.8
10	127	132	128.1	121	110.3
11	139.2	134	105.2	108.3	107.4
12	144	187.1	115	129.9	113.4
13	138.5	158	143.1	108	78.4
14	166.5	141.6	100	98.5	108
15	153.5	122.5	137.5	113	182.5
16	139.5	121.5	130	122.9	151
17	113.3	125	120	131.5	121.2
18	121.3	117	125	152	154.5
19	103	102.1	130.2	135.5	150
20	91	116	121.4	141.9	152.5
21	82	99	118.2	130.9	125.5
22	80.5	96	102.8	135.5	152.7
23	178	194	201.8	198.8	201.5
24	171	167	199.2	198.2	198.7
25	201	168.8	177	197	193.5
26	0	0	0	0	0
9	98.8	92.8	121.5	158.5	155.5
10	88.9	105.5	112.9	151	159.9
11	129.5	126.5	126.5	139.2	137.9
12	123.1	111.2	122.8	133.4	127.5
27	142	136.1	140.5	134	126.2
28	139.6	143	149	137.9	125.7
29	129.6	127.2	133.7	141.5	129
30	154.9	153.5	155.4	119	128.6
31	133	120.2	136.5	146.1	142
32	145.2	155.1	131	135.2	130
33	138.1	137.5	152	156.4	153.5
34	139	128.1	132.5	134.8	131
35	214.4	204	194.2	187	180
36	215.5	215.9	195.7	180.5	160
37	185	198.9	208	193.9	165
38	208.9	214	194.8	170.9	159.5
39	0	0	0	0	0

EXPERIMEN1221C
DATA first measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	52.3	49	46	66	82.2
2	90	108	123	129.8	109
3	125.9	111.5	137.2	126.5	128.3
4	139.4	137.2	132	118.9	128.5
5	137.9	135	104.5	105.9	118
6	135.5	126.2	128.1	112.6	113.8
7	131.1	111	123.1	110	121.7
8	132.1	122	150	117.8	121

EXPERIMENT1221C
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	69.2	64.8	72.6	88.5	77.5
2	115.2	143.7	151.6	146	122
3	133.5	129.5	109	121.7	124
4	128	114.6	116	111.2	113.5
5	114.5	110	126	128	108
6	120.5	108.6	111.4	123.6	128.2
7	129	126.5	112.5	119.1	103
8	102	104.5	97	140	132.8
9	104	114.2	103.2	110.4	61.2
10	139.2	141.2	127.9	120.8	108
11	153.5	134.6	130	130	124.9
12	160.1	145.4	137.2	113.8	88.8
13	148.3	136	119	112	60.5
14	172	146.5	126	104.9	86.2
15	137.4	136.6	127.5	110	87.5
16	123	120.6	115.3	135.8	105.6
17	119	121.5	113.5	114	137
18	105	102.6	128.8	129	129.3
19	106.5	86.8	132	131.5	137.5
20	83.8	106.9	127	139.1	142
21	95.9	108	111	127.1	158.2
22	103.9	103	117.2	138.3	143
23	179.6	180.2	181	200.5	206.3
24	167	187	164	197.5	219
25	182	177	176.8	195.5	184
26	0	0	0	0	0
9	48.9	100	120.6	150	162.4
10	77	95.3	135	133	152
11	145.8	136	128.1	134.3	121.1
12	119.2	115	123.4	138.2	121.3
27	136.5	143.4	131.5	137.5	141
28	120.4	132	152.1	159.9	154.5
29	152.3	136.8	139	133	124.8
30	143	137.2	143	158.6	148.5
31	147.5	146	147.1	149	138
32	148.8	147.5	130.8	132.9	140
33	128	133.1	132.9	129.5	125
34	127	125.1	136.2	127.8	114.6
35	211.8	175	183.8	170.3	169
36	197	210	186	188.9	147
37	212.5	207	204.3	176	163.8
38	209	178.5	159	174	163.5
39	0	0	0	0	0

EXPERIMEN1221C
DATA last measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	66	56.1	50	54	79.5
2	98.5	79	92.6	99	102
3	127.9	111.8	114.5	103	53.8
4	121	133	113.5	120	110.5
5	135.4	132.6	122.8	111	118.8
6	103.5	107.6	114.2	134.1	127
7	100	112.8	125	136.1	151.2
8	117.2	131.6	128.2	111.7	130.5

DATA OF RUN NO. 1221c

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DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	14.35	24.52	38.87
0.3	14.35	24.35	38.7
0.45	14.31	24.53	38.84
1	14.35	24.13	38.48
1.15	14.24	23.91	38.15
1.3	14.13	23.87	38
1.45	14.2	23.96	38.16
2	14.24	23.91	38.15
2.15	14.56	24.26	38.82
2.3	14.56	24.3	38.86
2.45	14.6	24.09	38.69
3	14.63	24.13	38.76
3.15	14.6	23.91	38.51
3.3	14.7	24.13	38.83
3.45	14.5	24.3	38.8
4	14.63	24.3	38.93
4.15	14.5	24.44	38.94
4.3	14.5	24.3	38.8
4.45	14.5	24.35	38.85
5	14.56	24.26	38.82
5.15	14.56	24.26	38.82
5.3	14.6	24.22	38.82
5.45	14.42	24.13	38.55
6	14.1	24.09	38.19
6.15	14.13	24.04	38.17
6.3	14.13	24.3	38.43
6.45	14.2	24.3	38.5
7	14.1	24.09	38.19
7.15	14.1	24.09	38.19
7.3	14.2	24.13	38.33
7.45	14.2	24.13	38.33
8	14.38	24.03	38.41

DATA OF RUN NO. 1221c

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0	207.9		202.9	187.2
0.5	208.1	201.5	203	187.6
1	208	200.5	202.4	188
1.5	208.4	200.7	201.5	188.7
2	208.5	198.2	201.9	189.1
2.5	208	198.2	201.9	189.7
3	208.1	198	202.6	189.1
3.5	207.9	197.7	202.2	189
4	208.1	197.6	202.9	189
4.5	207.7	196.1	203.1	189
5	207.5	196	203.3	188.9
5.5	207.6	195.6	203	189.1
6	207.5	195.8	203	189
6.5	207.5	195.1	202.3	189.1
7	207.4	195.3	202.5	189.3
7.5	207.5	195.1	202.3	189.2
8	207.5	194.9	202.1	189.6

EXPERIMEN1311A
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	123.2	131.5	132.8	133.1	128.8
2	131.2	132.1	128.2	133.2	134.8
3	134	130.7	130.4	129	125.1
4	133.1	131.4	127.3	130.9	133.2
5	129	127.2	127.2	129	134.6
6	129.3	126.8	124.2	126.5	129.1
7	127.6	124.6	125.1	125.8	128
8	128.8	122.9	122.5	123.9	123
9	123.6	120.5	123.2		
10	130.8	127.5	128.5		
11	124.3	123.8	126.3		
12	124.6	117.7	122.7		
13	127.2	126	126.2		
14	119.6	121.5	122.2		
15	119.7	119.8	121		
16	119.6	118.9	118		
17	116.5	112.5	114.3		
18	115.7	112.2	115.7		
19	109.7	111.7	115.3		
20	112.8	109.9	112.2		
21	109	108.8	107.1		
22	108.8	107.4	110.2		
23	184.1	181.8	180.5		
24	189.1	180.2	178		
25	176.9	174.5	178.5		
26	0	0	0		
9	122.3	121.5	121.4		
10	127	129.8	128.3		
11	135.2	134.1	136.1		
12	141.5	135.3	133.5		
27	144.2	144.4	144.8		
28	141.8	140.2	139.5		
29	138	136.9	135.9		
30	141	141.5	140.2		
31	140.4	139.2	139.6		
32	138.7	137	136.7		
33	136.8	135.8	136.5		
34	125.4	126.2	126.9		
35	191.2	189.3	187.2		
36	184.2	185.7	186.1		
37	193.4	189.8	182.4		
38	189.5	190.3	190.2		
39	0	0	0		

EXPERIMEN1311A
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	81.9	156.1	133.6	156	136.3
2	123.8	130.9	139.5	140.4	135.6
3	137.7	142.8	126.8	117.5	133.4
4	116.2	117	132	136.6	121.2
5	112.9	131	146.8	136.6	129
6	126.9	139	123.9	101.6	126.8
7	133	116.8	121.9	123.2	133
8	110	130.4	127.1	101.5	120.6
9	133.9	127	118.4	110.9	51.2
10	135.5	115.8	108.5	108.6	106.1
11	119.3	122.5	123.8	112.8	118.4
12	108.6	105.5	122.3	118.8	92.3
13	110.1	123.4	130.3	125.1	106.1
14	136.1	137.2	121.4	118	87.6
15	146	135	112.8	110.8	80
16	119.6	116.5	122.1	110.3	126
17	116.8	113.8	112.5	121.6	121.6
18	106	114.8	108	112.9	111.9
19	81.9	100.5	100.6	120.2	126.1
20	100.9	103.5	113.1	119	122.7
21	94.8	104.6	111.1	119.5	101.2
22	62.1	93.1	112.1	111.6	127.3
23	163.7	147.6	179.9	181.1	180
24	181.9	189.4	183.5	193.5	201.3
25	187.8	195	184.2	199.7	199.5
26	0	0	0	0	0
9	46.5	111.5	132.3	130.1	135
10	104.5	127	120.7	143.6	150.3
11	129.2	130.1	140.3	129.1	128
12	128.2	145.1	127	141.1	129.6
27	140.9	142.4	139.9	133.2	126.3
28	147.5	148.1	142	131.7	131.3
29	129.7	127.1	123.9	130.5	137
30	139.1	132.2	138.9	137	130.7
31	151	137.1	118.4	110.3	99.5
32	129.3	142.9	129.5	129.3	120.8
33	118.9	122.8	137.1	126	111.9
34	115.8	127.5	116.6	119.4	105.3
35	198.3	195.2	187.1	181.4	163.6
36	199.1	192	181.1	168.3	164
37	197.7	192.8	177.9	169.9	158.5
38	199.7	173	191.5	163.7	164.1
39	0	0	0	0	0

EXPERIMEN1311A
DATA last measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	109.3	136.3	170	148	97.4
2	134.2	140.5	148.4	139.1	144.7
3	139.6	138	133.5	146	138.2
4	128.7	121.7	133	142.5	129.5
5	134	130.4	128	128.9	105.7
6	116.5	125.5	112.5	118.7	140.7
7	136.6	145.8	116	126	113
8	121.2	118.2	114.8	112	118.3

DATA OF RUN NO. 1311a
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DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	5.87	13.18	19.05
0.3	5.26	13.63	18.89
0.45	5.02	13.84	18.86
1	5.31	13.63	18.94
1.15	5.21	13.52	18.73
1.3	5.02	13.77	18.79
1.45	5.24	13.56	18.8
2	5.24	13.56	18.8
2.15	4.94	13.8	18.74
2.3	5.26	13.42	18.68
2.45	5.07	13.52	18.59
3	5.19	13.56	18.75
3.15	4.87	13.73	18.6
3.3	4.97	13.98	18.95
3.45	5.21	13.66	18.87
4	4.8	13.88	18.68
4.15	4.97	13.52	18.49
4.3	4.8	13.52	18.32
4.45	4.82	13.49	18.31
5	4.82	13.52	18.34
5.15	4.82	13.63	18.45
5.3	4.85	14.02	18.87
5.45	4.87	13.91	18.78
6	4.87	13.84	18.71
6.15	5.34	13.52	18.86
6.3	5.31	13.52	18.83
6.45	5.26	13.63	18.89
7	5.31	13.56	18.87
7.15	5.02	13.49	18.51
7.3	5.02	13.84	18.86
7.45	5.14	13.56	18.7

DATA OF RUN NO. 1311a

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	167.7	177	141.8	131.4
1	165.8	170.4	147.5	131.3
1.5	165.9	168.3	144.1	133.3
2	164.1	167	148	133.1
2.5	165.1	165.3	145.3	132.1
3	165.3	164.6	146.3	131.8
3.5	165.1	163.6	145.6	132.3
4	165	162.9	147.96	135
4.5	163.8	162.5	144.3	133.6
5	163.9	161.4	145.7	132.9
5.5	163.9	161.2	144.8	132.8
6	163.8	161.1	144.9	133.4
6.5	163.9	161.2	146.6	133.4
7	163.9	159.4	147.1	133.7
7.5	164.3	159	147.5	134
8	164.2	158.9	148	134.5

EXPERIMEN1321A
DATA first measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	109.3	136.3	170	148	97.4
2	134.2	140.5	148.4	139.1	144.7
3	139.6	138	133.5	146	138.2
4	128.7	121.7	133	142.5	129.5
5	134	130.4	128	128.9	105.7
6	116.5	125.5	112.5	118.7	140.7
7	136.6	145.8	116	126	113
8	121.2	118.2	114.8	112	118.3

EXPERIMENT1321A
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	81.9	156.1	133.6	156	136.3
2	123.8	130.9	139.5	140.4	135.6
3	137.7	142.8	126.8	117.5	133.4
4	116.2	117	132	136.6	121.2
5	112.9	131	146.8	136.6	129
6	126.9	139	123.9	101.6	126.8
7	133	116.8	121.9	123.2	133
8	110	130.4	127.1	101.5	120.6
9	133.9	127	118.4	110.9	51.2
10	135.5	115.8	108.5	108.6	106.1
11	119.3	122.5	123.8	112.8	118.4
12	108.6	105.5	122.3	118.8	92.3
13	110.1	123.4	130.3	125.1	106.1
14	136.1	137.2	121.4	118	87.6
15	146	135	112.8	110.8	80
16	119.6	116.5	122.1	110.3	126
17	116.8	113.8	112.5	121.6	121.6
18	106	114.8	108	112.9	111.9
19	81.9	100.5	100.6	120.2	126.1
20	100.9	103.5	113.1	119	122.7
21	94.8	104.6	111.1	119.5	101.2
22	62.1	93.1	112.1	111.6	127.3
23	163.7	147.6	179.9	181.1	180
24	181.9	189.4	183.5	193.5	201.3
25	187.8	195	184.2	199.7	199.5
26	0	0	0	0	0
9	46.5	111.5	132.3	130.1	135
10	104.5	127	120.7	143.6	150.3
11	129.2	130.1	140.3	129.1	128
12	128.2	145.1	127	141.1	129.6
27	140.9	142.4	139.9	133.2	126.3
28	147.5	148.1	142	131.7	131.3
29	129.7	127.1	123.9	130.5	137
30	139.1	132.2	138.9	137	130.7
31	151	137.1	118.4	110.3	99.5
32	129.3	142.9	129.5	129.3	120.8
33	118.9	122.8	137.1	126	111.9
34	115.8	127.5	116.6	119.4	105.3
35	198.3	195.2	187.1	181.4	163.6
36	199.1	192	181.1	168.3	164
37	197.7	192.8	177.9	169.9	158.5
38	199.7	173	191.5	163.7	164.1
39	0	0	0	0	0

EXPERIMENT1321
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	96.4	113	132.3	116.6	96.5
2	97.7	105.3	113.4	107.4	118.5
3	89.8	107.8	110.7	102.4	117.7
4	89.7	99.2	103.8	120.3	133.8
5	122.7	96.8	116.4	114.8	124.8
6	125.5	104.8	100.4	120.3	101.2
7	120.1	133.7	139	138.6	120.7
8	142.8	129.7	124.4	117.3	113.4
9	129.5	132.7	146	116.5	60.4
10	135.3	148	133.3	124.8	104.9
11	113.1	117.8	117.3	132.8	150.9
12	128.4	148	126	120.5	100.9
13	147	143	133.4	109.4	91.1
14	139	142.1	132.3	131.9	109
15	132.1	141.3	128.4	120.7	114.1
16	126.4	137.6	125	123.5	120.7
17	115.7	132.2	125	107.7	126.2
18	111.9	121	121.6	138.5	131.1
19	100	97.5	114.1	129.1	140.1
20	73.7	100	110	134.8	122
21	88.9	109	96	120.4	125.7
22	99.3	108.1	98.9	123.7	124.5
23	150	169.3	198.5	201.7	181.6
24	152	169.6	182.5	197.2	207.2
25	164.4	158.3	184	194.5	189
26	0	0	0	0	0
9	63.6	92.9	92.9	98.2	101.2
10	98.8	114	106.2	104.7	92.6
11	105	114.1	108.3	100.7	99.2
12	91.8	96.2	117.3	120.9	114.5
27	71.8	76.7	114.8	125.6	125
28	88	110.1	116.8	125.6	96.9
29	109	115.1	116.2	121	129.1
30	100	108.5	122.9	106.2	120.5
31	120.5	122.2	109.1	117.2	115.5
32	103.9	122.5	106.7	84.5	64
33	90	96.7	103.7	119	120.6
34	91.8	93.9	110.5	117.4	111.9
35	187.7	162.6	166.5	146.2	126.9
36	189	183.7	152.7	131.3	120.3
37	176.6	172.3	160.1	145.2	132.5
38	162.8	157.5	166.6	156.2	162.4
39	0	0	0	0	0

EXPERIMEN1321
DATA last measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	110.9	129.6	167.9	167.7	120.5
2	146.2	160.9	154.2	152.3	140.8
3	134.3	155.8	148.8	149.1	159
4	134.1	135	131.6	153.7	160.6
5	121.1	128.9	143.3	139.8	144.9
6	108.7	124.6	138.7	134.9	126.6
7	119.6	116.5	138.9	106.4	108.7
8	118.7	110	104.6	94.2	86.6

DATA OF RUN NO. 1321a
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DISCHARGE MEASUREMENT

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	6.61	11.85	18.46
0.3	7.16	11.42	18.58
0.45	7.52	11.19	18.71
1	7.07	11.49	18.56
1.15	7.6	10.77	18.37
1.3	7.21	11.32	18.53
1.45	7.46	11.19	18.65
2	8.09	10.64	18.73
2.15	8.09	10.74	18.83
2.3	7.8	10.9	18.7
2.45	8.23	10.29	18.52
3	8.3	10.39	18.69
3.15	8.77	9.73	18.5
3.3	8.68	10.01	18.69
3.45	8.86	9.67	18.53
4	9.06	9.3	18.36
4.15	8.89	9.39	18.28
4.3	9.1	9.51	18.61
4.45	9.37	9.36	18.73
5	9.49	9.27	18.76
5.15	9.76	8.92	18.68
5.3	10.13	8.3	18.43
5.45	9.76	8.68	18.44
6	10.1	8.12	18.22
6.15	10.36	7.92	18.28
6.3	9.99	8.46	18.45
6.45	10.66	7.94	18.6
7	10.43	8.29	18.72
7.15	10.37	8.14	18.51
7.3	10.18	8.43	18.61

DATA OF RUN NO. 1321a

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	162.1	195.2	151.9	121
1	162.8	174	151.3	122.5
1.5	161.7	161.3	147.9	119.8
2	165.1	153.4	152	124.1
2.5	161.7	150.6	152	127.1
3	164	149.9	150.3	126.8
3.5	161.8	149.1	150	124.6
4	160	148.4	149.3	125.4
4.5	162.1	148.4	151.2	126.2
5	162.2	148.7	151	123.9
5.5	159.2	148.1	150	126.7
6	160.1	148.2	152	123.1
6.5	160.6	148.5	152.4	126.6
7	157.8	147	152.4	123.1
7.5	157.1	147.2	150.9	124.6

EXPERIMENT1321B
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	96.4	113	132.3	116.6	96.5
2	97.7	105.3	113.4	107.4	118.5
3	89.8	107.8	110.7	102.4	117.7
4	89.7	99.2	103.8	120.3	133.8
5	122.7	96.8	116.4	114.8	124.8
6	125.5	104.8	100.4	120.3	101.2
7	120.1	133.7	139	138.6	120.7
8	142.8	129.7	124.4	117.3	113.4
9	129.5	132.7	146	116.5	60.4
10	135.3	148	133.3	124.8	104.9
11	113.1	117.8	117.3	132.8	150.9
12	128.4	148	126	120.5	100.9
13	147	143	133.4	109.4	91.1
14	139	142.1	132.3	131.9	109
15	132.1	141.3	128.4	120.7	114.1
16	126.4	137.6	125	123.5	120.7
17	115.7	132.2	125	107.7	126.2
18	111.9	121	121.6	138.5	131.1
19	100	97.5	114.1	129.1	140.1
20	73.7	100	110	134.8	122
21	88.9	109	96	120.4	125.7
22	99.3	108.1	98.9	123.7	124.5
23	150	169.3	198.5	201.7	181.6
24	152	169.6	182.5	197.2	207.2
25	164.4	158.3	184	194.5	189
26	0	0	0	0	0
9	63.6	92.9	92.9	98.2	101.2
10	98.8	114	106.2	104.7	92.6
11	105	114.1	108.3	100.7	99.2
12	91.8	96.2	117.3	120.9	114.5
27	71.8	76.7	114.8	125.6	125
28	88	110.1	116.8	125.6	96.9
29	109	115.1	116.2	121	129.1
30	100	108.5	122.9	106.2	120.5
31	120.5	122.2	109.1	0	115.5
32	103.9	122.5	106.7	84.5	64
33	90	96.7	103.7	119	120.6
34	91.8	93.9	110.5	117.4	111.9
35	187.7	162.6	166.5	146.2	126.9
36	189	183.7	152.7	131.3	120.3
37	176.6	172.3	160.1	145.2	132.5
38	162.8	157.5	166.6	156.2	162.4
39	0	0	0	0	0

EXPERIMEN1321B
DATA first measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	110.9	129.6	167.9	167.7	120.5
2	146.2	160.9	154.2	152.3	140.8
3	134.3	155.8	148.8	149.1	159
4	134.1	135	131.6	153.7	160.6
5	121.1	128.9	143.3	139.8	144.9
6	108.7	124.6	138.7	134.9	126.6
7	119.6	116.5	138.9	106.4	108.7
8	118.7	110	104.6	94.2	86.6

EXPERIMENT1321B
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	109	147.3	162.6	124.8	117.3
2	127.2	141	117	112.2	116.3
3	132.5	126	129.4	120	134
4	107	130.5	126.2	140	122
5	114.1	123.4	98.4	140.1	149.4
6	136	115.1	111.3	130.5	115.2
7	107.6	128.6	128.7	131.3	105
8	117.3	125	123.2	122.4	110.3
9	135.2	139.5	130	70.1	90.7
10	148.5	147.3	135.4	109.5	70.4
11	145.8	141.7	128.9	120.8	115.7
12	139.5	135.9	136.3	110.2	104.3
13	147.5	139.2	135.3	120.1	125.9
14	145.5	147	134.7	134.9	107.6
15	144.2	160.2	131.9	138.5	121.9
16	122.2	142.8	126.3	122.5	143
17	119.5	122	135.5	136.2	124.1
18	112	122.4	132.7	114.9	142
19	106.9	99.4	132.5	141.9	129.6
20	108.9	111.3	126.7	125.6	138.8
21	93.6	100.7	124.6	137.5	138.2
22	106.1	108.7	106.1	140.7	131.9
23	175.1	173.1	173	207	197.8
24	160.2	168.9	190.7	185.9	203.3
25	169.5	195	189.5	183.9	173.8
26	0	0	0	0	0
9	20.9	54	91.5	127.1	108.5
10	66.4	92.5	100.4	103.2	111.1
11	97.9	98.2	98.8	105.6	102.5
12	106.2	92.4	89.9	96	96.3
27	119.6	118.8	100.9	113.5	112.3
28	105.3	93.9	100	106.1	104.5
29	76.3	91.9	98.9	111.8	116.8
30	102.6	68.1	75.9	116.2	123.9
31	115	105.1	107.1	93	78.6
32	99.5	103	99.9	88.3	92
33	107.1	109.5	107.9	101.9	84.6
34	86.2	91.3	88.8	103.3	124
35	159.5	169	173.7	158.5	131.1
36	172.1	155.5	152.8	133.9	117.5
37	159.6	148	153.9	124.1	124.6
38	138.7	162.8	160.4	135.1	130.6
39	0	0	0	0	0

EXPERIMEN1321B
DATA last measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	89	117.9	154.8	147.6	117.1
2	128.5	136.2	132	122.7	134.9
3	111.2	111.3	111.7	122	117.5
4	118.5	125.2	116	115	114.8
5	130.9	115.6	114.2	116.6	120.5
6	124.1	127.5	121.1	119.8	128.6
7	124.8	132.1	128.7	132.3	120.1
8	126.2	88	122	120.1	118

DATA OF RUN NO. 1321b
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DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	10.05	8.14	18.19
0.3	10.62	7.74	18.36
0.45	10.43	7.99	18.42
1	10.46	7.79	18.25
1.15	10.18	8.14	18.32
1.3	10.62	7.91	18.53
1.45	10.27	7.74	18.01
2	10.94	7.57	18.51
2.15	10.62	7.74	18.36
2.3	10.53	7.62	18.15
2.45	10.56	7.62	18.18
3	10.94	7.51	18.45
3.15	10.66	7.62	18.28
3.3	11.14	7.15	18.29
3.45	11.14	7.23	18.37
4	10.78	7.57	18.35
4.15	10.98	7.26	18.24
4.3	10.78	7.43	18.21
4.45	11.11	7.06	18.17
5	11.33	6.76	18.09
5.15	11.53	6.66	18.19
5.3	11.11	7.04	18.15
5.45	11.04	7.06	18.1
6	11.07	7.31	18.38
6.15	10.72	7.54	18.26
6.3	11.3	6.98	18.28
6.45	11.11	6.98	18.09
7	11.27	6.87	18.14
7.15	11.6	6.71	18.31
7.3	11.5	6.71	18.21

DATA OF RUN NO. 1321b

WATER LEVEL MEASUREMENTS

TIME	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	159.7	135.9	125.8	152.3
1	161.7	142.7	124.2	153
1.5	164.6	145.9	122.6	153.4
2	162.4	147.2	127.2	152.2
2.5	161.4	147.4	125.6	152.4
3	160.9	147.6	125.6	152.3
3.5	161.4	147.5	122.3	152.3
4	161.7	147.6	127.5	152.9
4.5	160.4	147.1	125.5	152.6
5	158.7	147	124.5	151.1
5.5	158.2	146.2	122.6	152.1
6	157.9	146	125.5	153.5
6.5	159.2	146.3	126.8	152.9
7	158.8	146.1	119.4	151.9
7.5	159.9	146.4	126.1	150.9

EXPERIMENT1331A
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	109	147.3	162.6	124.8	117.3
2	127.2	141	117	112.2	116.3
3	132.5	126	129.4	120	134
4	107	130.5	126.2	140	122
5	114.1	123.4	98.4	140.9	149.4
6	136	115.1	111.3	130.5	115.2
7	107.6	128.6	128.7	131.3	105
8	117.3	125	123.2	122.4	110.3
9	135.2	139.5	130	70.1	90.7
10	148.5	147.3	135.4	109.5	70.4
11	145.8	141.7	128.9	120.8	115.7
12	139.5	135.9	136.3	110.2	104.3
13	147.5	139.2	135.3	120.1	125.9
14	145.5	147	134.7	134.9	107.6
15	144.2	160.2	131.9	138.5	121.9
16	122.2	142.8	126.3	122.5	143
17	119.5	122	135.5	136.2	124.1
18	112	122.4	132.7	114.9	142
19	106.9	99.4	132.5	141.9	129.6
20	108.9	111.3	126.7	125.6	138.8
21	93.6	100.7	124.6	137.5	138.2
22	106.1	108.7	106.1	140.7	131.9
23	175.1	173.1	173	207	197.8
24	160.2	168.9	190.7	185.9	203.3
25	169.5	195	189.5	183.9	173.8
26	0	0	0	0	0
9	20.9	54	91.5	127.1	108.5
10	66.4	92.5	100.4	103.2	111.1
11	97.9	98.2	98.8	105.6	102.5
12	106.2	92.4	89.9	96	96.3
27	119.6	118.8	100.9	113.5	112.3
28	105.3	93.9	100	106.1	104.5
29	76.3	91.9	98.9	111.8	116.8
30	102.6	68.1	75.9	116.2	123.9
31	115	105.1	107.1	93	78.6
32	99.5	103	99.9	88.3	92
33	107.1	109.5	107.9	101.9	84.6
34	86.2	91.3	88.8	103.3	124
35	159.5	169	173.7	158.5	131.1
36	172.1	155.5	152.8	133.9	117.5
37	159.6	148	153.9	124.1	124.6
38	138.7	162.8	160.4	135.1	130.6
39	0	0	0	0	0

EXPERIMEN1331A
DATA first measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	89	117.9	154.8	147.6	117.1
2	128.5	136.2	132	122.7	134.9
3	111.2	111.3	111.7	122	117.5
4	118.5	125.2	116	115	114.8
5	130.9	115.6	114.2	116.6	120.5
6	124.1	127.5	121.1	119.8	128.6
7	124.8	132.1	128.7	132.3	120.1
8	126.2	88	122	120.1	118

EXPERIMENT1331a
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	118.5	151.3	150.1	132.4	132.7
2	125	145.4	138.5	135.6	127.7
3	141.8	142.8	124.7	120.3	114.6
4	129.6	131.9	141.9	130.4	115.6
5	101.6	115.8	85.7	105.5	132.1
6	126.1	129.2	140.1	118.7	121.7
7	120.3	115.8	128.9	131.6	121.9
8	109.5	114.4	105.2	102	119.3
9	112.3	92.2	103.1	111.8	73.7
10	105.2	107.1	116.9	105.2	110.2
11	121.3	115	81.2	111.5	102.5
12	117.6	113.7	113.6	108.3	101.6
13	134.5	120.7	114.4	122.2	87.4
14	123.7	137.3	126.5	112.8	92.5
15	120.7	130.1	102.3	100.5	96.9
16	111.3	118.2	116.9	110.1	84.7
17	109.9	108.5	110.9	105	123
18	97	115.8	113.3	99.8	109.1
19	84.8	99.7	97.2	95.2	118.6
20	76	98.5	110.6	102.7	123.2
21	93.7	99.8	98.7	106.2	116.9
22	90.5	92.6	112.6	106.8	111.9
23	143.7	159.4	172.8	188.5	183.7
24	159.2	167.8	174.1	160	192.3
25	160.4	141.9	169.3	171.6	174.9
26	0	0	0	0	0
9	54.7	101.8	131.6	135.5	144.2
10	98.9	115.5	113.8	132.8	134.9
11	115.8	117.8	115.7	119.6	118.7
12	121.2	118.4	128	112.5	104.1
27	117.8	126.4	135.9	115.1	110.2
28	121.3	110	139.2	127.2	130.4
29	136.4	120	122.5	104.6	102.5
30	114	115	117.5	102.4	115.1
31	117.3	117.2	120.7	127.2	118.4
32	106.2	95	119.9	103.5	111.8
33	110	110	107	98.9	118.2
34	108.8	109.7	112.4	108.8	119
35	156.8	160.4	163.3	152.9	180
36	161.6	174.7	173.7	154.9	142.9
37	184.2	159.5	154	168.6	163.9
38	165	162.9	168	153.5	151.6
39	0	0	0	0	0

EXPERIMEN1331a
DATA last measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	110.9	98.5	88.6	121.9	97.3
2	121.2	95	116.4	113	112.7
3	137.4	105.6	130.1	118.4	96.1
4	120.1	124.8	120	117.2	115.5
5	119.8	131.7	135.2	127.3	127
6	100	81.3	111.1	119.2	117.3
7	132.6	131.4	115	96.7	112.4
8	118.5	117.7	119	117.4	117.7

DATA OF RUN NO. 1331a
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DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	8	10.84	18.84
0.3	8.47	10.8	19.27
0.45	9.1	9.15	18.25
1	8.89	9.67	18.56
1.15	8.35	10.17	18.52
1.3	8.24	10.14	18.38
1.45	7.75	10.52	18.27
2	7.92	10.23	18.15
2.15	7.86	10.36	18.22
2.3	7.6	10.8	18.4
2.45	7.6	10.68	18.28
3	7.29	10.99	18.28
3.15	7.79	10.64	18.43
3.3	7.05	11.06	18.11
3.45	7.23	11.26	18.49
4	6.98	11.39	18.37
4.15	7.23	11.32	18.55
4.3	7.07	11.16	18.23
4.45	7.18	11.03	18.21
5	7.2	11.1	18.3
5.15	6.95	11.4	18.35
5.3	6.93	11.39	18.32
5.45	6.66	11.53	18.19
6	7.04	11.49	18.53
6.15	7.04	11.33	18.37
6.3	6.79	11.5	18.29
6.45	6.68	11.62	18.3
7	6.88	11.48	18.36
7.15	6.9	11.59	18.49
7.3	6.63	11.92	18.55
7.45	6.63	12	18.63
8	6.63	12.24	18.87

DATA OF RUN NO. 1331a

WATER LEVEL MEASUREMENTS

TIME	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	158.5	156.2	131	130.5
1	157.5	147	133	128.4
1.5	155.7	143.8	139.2	129.4
2	155.5	142.5	134.1	129.4
2.5	153.7	141.7	135.2	126.9
3	155.3	141.9	135.6	127
3.5	155.8	141.5	133.2	127.5
4	155.8	142	137.7	125.5
4.5	153.7	141.4	136.1	126.6
5	155.4	141.8	137.2	127.2
5.5	153.3	141.4	136.7	127.1
6	154.4	141.4	138.1	128.5
6.5	153.3	141.2	136.9	125.9
7	153.6	141.1	137.5	125.4
7.5	152.8	140.7	137.2	125.1

EXPERIMENT1331B
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	118.5	151.3	150.1	132.4	132.7
2	125	145.4	138.5	135.6	127.7
3	141.8	142.8	124.7	120.3	114.6
4	129.6	131.9	141.9	130.4	115.6
5	101.6	115.8	85.7	105.5	132.1
6	126.1	129.2	140.1	118.7	121.7
7	120.3	115.8	128.9	131.6	121.9
8	109.5	114.4	105.2	102	119.3
9	112.3	92.2	103.1	111.8	73.7
10	105.2	107.1	116.9	105.2	110.2
11	121.3	115	81.2	111.5	102.5
12	117.6	113.7	113.6	108.3	101.6
13	134.5	120.7	114.4	122.2	87.4
14	123.7	137.3	126.5	112.8	92.5
15	120.7	130.1	102.3	100.5	96.9
16	111.3	118.2	116.9	110.1	84.7
17	109.9	108.5	110.9	105	123
18	97	115.8	113.3	99.8	109.1
19	84.8	99.7	97.2	95.2	118.6
20	76	98.5	110.6	102.7	123.2
21	93.7	99.8	98.7	106.2	116.9
22	90.5	92.6	112.6	106.8	111.9
23	143.7	159.4	172.8	188.5	183.7
24	159.2	167.8	174.1	160	192.3
25	160.4	141.9	169.3	171.6	174.9
26	0	0	0	0	0
9	54.7	101.8	131.6	135.5	144.2
10	98.9	115.5	113.8	132.8	134.9
11	115.8	117.8	115.7	119.6	118.7
12	121.2	118.4	128	112.5	104.1
27	117.8	126.4	135.9	115.1	110.2
28	121.3	110	139.2	127.2	130.4
29	136.4	120	122.5	104.6	102.5
30	114	115	117.5	102.4	115.1
31	117.3	117.2	120.7	127.2	118.4
32	106.2	95	119.9	103.5	111.8
33	110	110	107	98.9	118.2
34	108.8	109.7	112.4	108.8	119
35	156.8	160.4	163.3	152.9	180
36	161.6	174.7	173.7	154.9	142.9
37	184.2	159.5	154	168.6	163.9
38	165	162.9	168	153.5	151.6
39	0	0	0	0	0

EXPERIMEN1331B
DATA first measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	110.9	98.5	88.6	121.9	97.3
2	121.2	95	116.4	113	112.7
3	137.4	105.6	130.1	118.4	96.1
4	120.1	124.8	120	117.2	115.5
5	119.8	131.7	135.2	127.3	127
6	100	81.3	111.1	119.2	117.3
7	132.6	131.4	115	96.7	112.4
8	118.5	117.7	119	117.4	117.7

EXPERIMENT1331B
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	111.8	111.6	122.2	129	130.8
2	113	120.2	138.9	126.4	126.9
3	130	123.4	129.6	109.1	115.8
4	144.1	148.2	128.5	125.6	108.8
5	131.8	132.1	128.7	98.9	102.1
6	123.1	136.5	124.9	128.2	130.4
7	113	126	112	92.3	130.5
8	98.9	104.2	130	101.1	111.1
9	120.8	108.3	111	111.2	44.3
10	96.2	106	96.6	133.2	132
11	124.9	107.1	109.3	105.1	104
12	116.4	109.3	104.8	110	88.2
13	126.4	118.8	107.3	121.4	93.3
14	125	135.5	130.6	87.5	91.4
15	142.3	117.9	115.8	88	71.4
16	90.6	104.8	115.4	123.8	127.6
17	96.1	110.8	101.4	104.5	103.9
18	108.7	103.5	112.8	73.9	112.8
19	100	112.2	106	105	114.5
20	69.8	108.9	86	109	113.4
21	67.2	99.6	95.7	115.6	119.2
22	58.6	63.9	112.8	115.2	134.3
23	165.5	168.1	150.7	167.6	179.2
24	153.7	168.5	178.1	166	153.1
25	150	163	167.9	150.5	164.6
26	0	0	0	0	0
9	49.8	98.7	108.9	125	141.1
10	87.8	109	102	116.7	118.4
11	103.3	115.8	121.5	121.6	111.2
12	123.9	113.2	115.9	115	101.7
27	123.4	128.6	133.9	134.9	124.8
28	96.4	110.7	128.6	131.7	118.2
29	123.6	129.2	108.2	126.4	135.2
30	130.6	121.1	119.2	125.2	113.7
31	130.2	113.1	104.5	109.6	100.7
32	122.5	115.7	118.6	115.6	117
33	116.9	118.9	122.1	113.5	115.9
34	103.7	85.6	107.2	124.1	115.2
35	184.1	172.7	166.3	159.6	134.7
36	186	170.2	156.3	162.1	160.5
37	170.3	183.7	176.1	157.8	136.2
38	162.3	149.4	157.4	168.2	168.4
39	0	0	0	0	0

EXPERIMEN1331B
DATA last measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	100.4	97.7	82.1	82.2	98.5
2	113.5	108.7	116.2	118	84.1
3	90	98.2	110.3	116.2	104.4
4	121	117.7	116.8	99.8	101
5	113	120.5	119.7	114.1	102.2
6	120.8	116.5	99.6	113.3	113.5
7	119.2	105.6	123.3	122.1	116.2
8	116.7	120	106.3	110.9	113.3

DATA OF RUN NO. 1331b
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DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	6.77	11.55	18.32
0.3	6.66	11.52	18.18
0.45	6.4	11.98	18.38
1	6.99	11.32	18.31
1.15	6.56	11.65	18.21
1.3	6.8	11.39	18.19
1.45	6.91	11.49	18.4
2	6.4	11.99	18.39
2.15	6.64	11.59	18.23
2.3	6.66	11.79	18.45
2.45	6.72	11.82	18.54
3	6.61	11.95	18.56
3.15	6.77	12.05	18.82
3.3	6.61	11.79	18.4
3.45	6.45	11.95	18.4
4	6.85	11.55	18.4
4.15	6.74	11.52	18.26
4.3	6.66	11.55	18.21
4.45	6.8	11.42	18.22
5	6.29	11.89	18.18
5.15	6.53	11.85	18.38
5.3	6.5	11.72	18.22
5.45	6.53	11.82	18.35
6	6.91	11.69	18.6
6.15	6.66	11.75	18.41
6.3	6.32	11.95	18.27
6.45	6.32	11.79	18.11
7	6.75	12.05	18.8
7.15	6.69	12.05	18.74
7.3	6.26	12.09	18.35
7.45	6.45	12.15	18.6
8	6.45	11.95	18.4

DATA OF RUN NO. 1331b

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	155.2	153.4	137.2	122.2
1	155.8	146.5	138.8	125.6
1.5	155.6	144.2	137.3	124.2
2	156.2	143.5	137.3	123
2.5	155.3	143.5	137.2	124.9
3	155	143	138.5	122.8
3.5	154.1	143.2	136.3	123.9
4	155.3	142.4	136.2	124.3
4.5	154.6	141.5	135.8	126.2
5	155.7	142.2	137.3	123.8
5.5	153.2	142.1	137.4	123.6
6	154	141.9	137	125.9
6.5	155.5	139.8	131.8	126.7
7	155.9	141.1	136.8	127.6
7.5	156.8	141.8	136.9	127.2
8	154.4	141.9	140	126.8

EXPERIMENT1331C
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	111.8	111.6	122.2	129	130.8
2	113	120.2	138.9	126.4	126.9
3	130	123.4	129.6	109.1	115.8
4	144.1	148.2	128.5	125.6	108.8
5	131.8	132.1	128.7	98.9	102.1
6	123.1	136.5	124.9	128.2	130.4
7	113	126	112	92.3	130.5
8	98.9	104.2	130	101.1	111.1
9	120.8	108.3	111	111.2	44.3
10	96.2	106	96.6	133.2	132
11	124.9	107.1	109.3	105.1	104
12	116.4	109.3	104.8	110	88.2
13	126.4	118.8	107.3	121.4	93.3
14	125	135.5	130.6	87.5	91.4
15	142.3	117.9	115.8	88	71.4
16	90.6	104.8	115.4	123.8	127.6
17	96.1	110.8	101.4	104.5	103.9
18	108.7	103.5	112.8	73.9	112.8
19	100	112.2	106	105	114.5
20	69.8	108.9	86	109	113.4
21	67.2	99.6	95.7	115.6	119.2
22	58.6	63.9	112.8	115.2	134.3
23	165.5	168.1	150.7	167.6	179.2
24	153.7	168.5	178.1	166	153.1
25	150	163	167.9	150.5	164.6
26	0	0	0	0	0
9	49.8	98.7	108.9	125	141.1
10	87.8	109	102	116.7	118.4
11	103.3	115.8	121.5	121.6	111.2
12	123.9	113.2	115.9	115	101.7
27	123.4	128.6	133.9	134.9	124.8
28	96.4	110.7	128.6	131.7	118.2
29	123.6	129.2	108.2	126.4	135.2
30	130.6	121.1	119.2	125.2	113.7
31	130.2	113.1	104.5	109.6	100.7
32	122.5	115.7	118.6	115.6	117
33	116.9	118.9	122.1	113.5	115.9
34	103.7	85.6	107.2	124.1	115.2
35	184.1	172.7	166.3	159.6	134.7
36	186	170.2	156.3	162.1	160.5
37	170.3	183.7	176.1	157.8	136.2
38	162.3	149.4	157.4	168.2	168.4
39	0	0	0	0	0

EXPERIMEN1331C
DATA first measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	100.4	97.7	82.1	82.2	98.5
2	113.5	108.7	116.2	118	84.1
3	90	98.2	110.3	116.2	104.4
4	121	117.7	116.8	99.8	101
5	113	120.5	119.7	114.1	102.2
6	120.8	116.5	99.6	113.3	113.5
7	119.2	105.6	123.3	122.1	116.2
8	116.7	120	106.3	110.9	113.3

EXPERIMENT1331C
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	98	97.1	115	127.3	96.1
2	99.6	109.1	105.6	107	105.2
3	79.4	79.7	95.8	115	134
4	82.2	87.5	95	125.1	136.3
5	110	91.1	100.2	110.8	136
6	108.2	115.5	111.9	109	113.8
7	108.1	95	117.3	129	132.1
8	103.9	121	95.8	111	103.7
9	99	113	119	120	78
10	108	102.2	98	116.1	92.2
11	129.2	114.4	114	92	102.1
12	122	123.5	95	99.6	55.2
13	144.4	131.3	119.2	109.5	77
14	125.2	126.8	99.1	99.8	109
15	125.8	133	86.6	106.8	90.5
16	114.8	122.1	125.5	97	93.3
17	105.5	104.3	97.8	119.5	111.3
18	97.8	89.2	115.9	107	102.1
19	120.1	111.3	108.7	79.6	87.8
20	90.2	75.3	94.6	121.4	120.2
21	82.2	105.5	99	116.2	106.4
22	78.7	91.9	102.5	110.2	118.3
23	121.1	159	156.2	169.5	188.5
24	145.9	151.5	165	171.5	173.4
25	160.8	164.2	160.3	161.4	169.6
26	0	0	0	0	0
9	79.1	99	125.9	112.2	119
10	108.2	113	122.1	124.6	124.3
11	99.1	115.2	118	117	118
12	80	106	121	117.8	106.1
27	126.8	129.8	119.4	121	127.1
28	123.5	119	117.5	109.1	115
29	121	123.1	108	110	120.5
30	111	116.2	112	105	104.5
31	125.6	119	113.3	104	101
32	113	121.8	112.8	109.1	98
33	119	103.8	104.4	112.3	97.2
34	101.8	102.6	115.9	114.8	108
35	178.7	172.3	167.8	151	148
36	181.3	172.6	169.2	151.1	147.8
37	171.4	170.4	178	143.2	144.5
38	178	159	150.7	163	164.5
39	0	0	0	0	0

EXPERIMEN1331C
DATA last measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	105.7	118.6	147.6	142	126.2
2	127.5	133	151	149.5	128.3
3	122.8	139.5	136	142.6	144.5
4	130.2	113	141.7	141	146.8
5	127.7	131	142.6	128.8	131.5
6	130	137.1	123.7	122.5	129.3
7	100	121	121.5	121.1	142
8	104.7	125.6	129	109.2	115.2

DATA OF RUN NO. 1331c

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DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	6.18	11.92	18.1
0.3	6	12.29	18.29
0.45	6.08	12.22	18.3
1	6.32	12.02	18.34
1.15	6.05	12.25	18.3
1.3	6.13	12.32	18.45
1.45	6.56	11.75	18.31
2	6.45	12.09	18.54
2.15	6.26	12.02	18.28
2.3	6.29	11.92	18.21
2.45	6.37	11.95	18.32
3	6.13	11.92	18.05
3.15	6.21	12.22	18.43
3.3	6.53	11.99	18.52
3.45	6.48	11.99	18.47
4	6	12.32	18.32
4.15	6.24	12.05	18.29
4.3	5.84	12.49	18.33
4.45	6.13	12.15	18.28
5	6.37	12.02	18.39
5.15	6.16	12.09	18.25
5.3	6.21	12.15	18.36
5.45	6	12.32	18.32
6	6.16	11.92	18.08
6.15	5.97	12.29	18.26
6.3	6.13	12.49	18.62
6.45	6	12.49	18.49
7	5.77	12.56	18.33
7.15	5.79	12.73	18.52
7.3	5.72	12.29	18.01
7.45	5.51	12.59	18.1
8	5.67	12.36	18.03

DATA OF RUN NO. 1331c

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	155.7	137.6	135	122
1	154	139	133.8	121.6
1.5	153.8	140.2	134.5	124.8
2	154.3	140.1	135	122.9
2.5	152.8	139.6	136	123.7
3	153.8	136.7	134.9	123.8
3.5	152.7	139.8	135.8	124.5
4	150.3	139.3	136.9	122.9
4.5	150.3	138.6	135.5	122.8
5	149.9	138.7	135.1	123.8
5.5	151.7	138.7	137.1	122.7
6	151.8	138.8	134.5	124.9
6.5	153.7	138.9	138.9	124.9
7	152	139.1	136.7	125.1
7.5	150.9	138.9	137	124.6

EXPERIMENT1341A
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	98	97.1	115	127.3	96.1
2	99.6	109.1	105.6	107	105.2
3	79.4	79.7	95.8	115	134
4	82.2	87.5	95	125.1	136.3
5	110	91.1	100.2	110.8	136
6	108.2	115.5	111.9	109	113.8
7	108.1	95	117.3	129	132.1
8	103.9	121	95.8	111	103.7
9	99	113	119	120	78
10	108	102.2	98	116.1	92.2
11	129.2	114.4	114	92	102.1
12	122	123.5	95	99.6	55.2
13	144.4	131.3	119.2	109.5	77
14	125.2	126.8	99.1	99.8	109
15	125.8	133	86.6	106.8	90.5
16	114.8	122.1	125.5	97	93.3
17	105.5	104.3	97.8	119.5	111.3
18	97.8	89.2	115.9	107	102.1
19	120.1	111.3	108.7	79.6	87.8
20	90.2	75.3	94.6	121.4	120.2
21	82.2	105.5	99	116.2	106.4
22	78.7	91.9	102.5	110.2	118.3
23	121.1	159	156.2	169.5	188.5
24	145.9	151.5	165	171.5	173.4
25	160.8	164.2	160.3	161.4	169.6
26	0	0	0	0	0
9	79.1	99	125.9	112.2	119
10	108.2	113	122.1	124.6	124.3
11	99.1	115.2	118	117	118
12	80	106	121	117.8	106.1
27	126.8	129.8	119.4	121	127.1
28	123.5	119	117.5	109.1	115
29	121	123.1	108	110	120.5
30	111	116.2	112	105	104.5
31	125.6	119	113.3	104	101
32	113	121.8	112.8	109.1	98
33	119	103.8	104.4	112.3	97.2
34	101.8	102.6	115.9	114.8	108
35	178.7	172.3	167.8	151	148
36	181.3	172.6	169.2	151.1	147.8
37	171.4	170.4	178	143.2	144.5
38	178	159	150.7	163	164.5
39	0	0	0	0	0

EXPERIMEN1341A
DATA first measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	105.7	118.6	147.6	142	126.2
2	127.5	133	151	149.5	128.3
3	122.8	139.5	136	142.6	144.5
4	130.2	113	141.7	141	146.8
5	127.7	131	142.6	128.8	131.5
6	130	137.1	123.7	122.5	129.3
7	100	121	121.5	121.1	142
8	104.7	125.6	129	109.2	115.2

EXPERIMENT1341a
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	102	129.5	148.5	136.2	141.4
2	130.5	132	129.5	111.4	116.2
3	144.3	142.5	118.3	121	135.5
4	127.6	138.6	140.6	131.8	113.6
5	117.9	122.6	134	135.1	126.2
6	127.1	114.8	111.9	105	126
7	105	108.4	111.1	123	120.7
8	115.4	106.4	99.6	111.1	105.6
9	96.1	110.5	100.8	102.1	30
10	125.2	104.6	99.1	111	95.4
11	96.6	105.7	90.4	133	131.4
12	175	119.6	103.2	94.2	66.7
13	122.5	127.5	106.8	115.1	80
14	122.5	129	127.7	95.7	92.9
15	142.3	118.4	101.3	104.3	83.9
16	106	101	107.1	101.9	95.7
17	100.9	98.6	92.8	112.9	106.7
18	81.1	105	110	101.2	117.5
19	90.6	89.9	99.6	103.4	117.2
20	100.8	101.5	91.9	96.3	106.4
21	84.9	82.6	95.7	105.8	96.9
22	66	65.6	103.9	107.8	123.1
23	154.3	165.5	166.9	151.2	175
24	137	171.6	163.2	166.8	176.7
25	149.5	149.6	172.7	175	177.5
26	0	0	0	0	0
9	29.5	104.6	137.6	132.5	129
10	90.7	119.6	125.5	138.8	141.5
11	101	113.3	117.5	138.2	133.3
12	128.7	131.8	138.8	109.8	119.7
27	132.7	138.4	134.4	131.5	130.7
28	125.3	128.6	119.3	123.2	127
29	130.8	121.1	139.7	118.6	132.4
30	148.4	137.6	118.7	131	140.5
31	137.5	105.5	130.5	114.2	113.7
32	124.6	122.8	101.5	129.8	132.5
33	127.2	129	131.6	129.6	116.2
34	126.2	129.6	109.2	111.7	110
35	171.9	183.7	181.9	163.8	165.9
36	169	167.8	142.2	166.7	164.7
37	185.6	164.6	172	172.1	169.8
38	172.6	180.9	155.9	145.6	144.6
39	0	0	0	0	0

EXPERIMEN1341a
DATA last measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	130.3	110.3	86.5	117.6	110.5
2	128.5	120	113	121.1	125
3	125.6	115.5	127.6	128	117.8
4	121	114.4	119.7	115.8	112.2
5	114	137	126.2	110	120.4
6	124.3	129	115.1	111	102.8
7	112.9	130	135	113.7	106.6
8	102.4	121	108.1	132.1	130

DATA OF RUN NO. 1341A

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DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	5.31	13.63	18.94
0.3	5.22	13.56	18.78
0.45	5.49	13.25	18.74
1	5.34	13.49	18.83
1.15	5.36	13.61	18.97
1.3	5.12	13.25	18.37
1.45	5.24	13.39	18.63
2	4.95	13.84	18.79
2.15	5.07	13.21	18.28
2.3	5.11	13.45	18.56
2.45	5.14	13.73	18.87
3	5.11	13.66	18.77
3.15	5.03	13.8	18.83
3.3	5.39	13.42	18.81
3.45	4.82	14.05	18.87
4	4.94	13.8	18.74
4.15	4.68	14.02	18.7
4.3	4.44	14.37	18.81
4.45	4.73	14.05	18.78
5	4.35	13.84	18.19
5.15	4.87	13.49	18.36
5.3	4.87	13.45	18.32
5.45	4.8	13.88	18.68
6	4.58	14.12	18.7
6.15	4.58	14.12	18.7
6.3	4.7	13.84	18.54
6.45	4.65	13.95	18.6
7	4.7	14.37	19.07
7.15	4.28	13.66	17.94
7.3	4.21	13.95	18.16

DATA OF RUN NO. 1341A

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	154.4	148.8	138	128.9
1	151.8	148.8	138.1	127.1
1.5	152	147.7	138.7	127.5
2	151.9	148.3	138	127.8
2.5	152.9	148	137.2	128.1
3	154.2	148	137.5	125.9
3.5	152.9	147.7	137.7	125.7
4	153.7	147.4	137.9	125.1
4.5	153.1	147.1	138.1	127.8
5	152.7	147	136.3	128.1
5.5	152.2	146.7	137.6	127.8
6	153.3	146.6	136.9	127.8
6.5	153.1	146.5	136.4	129.3
7	154.4	146.3	139.5	128.1
7.5	153.2	146.1	137.7	127.4

EXPERIMENT1411a
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	102	129.5	148.5	136.2	141.4
2	130.5	132	129.5	111.4	116.2
3	144.3	142.5	118.3	121	135.5
4	127.6	138.6	140.6	131.8	113.6
5	117.9	122.6	134	135.1	126.2
6	127.1	114.8	111.9	105	126
7	105	108.4	111.1	123	120.7
8	115.4	106.4	99.6	111.1	105.6
9	96.1	110.5	100.8	102.1	30
10	125.2	104.6	99.1	111	95.4
11	96.6	105.7	90.4	133	131.4
12	175	119.6	103.2	94.2	66.7
13	122.5	127.5	106.8	115.1	80
14	122.5	129	127.7	95.7	92.9
15	142.3	118.4	101.3	104.3	83.9
16	106	101	107.1	101.9	95.7
17	100.9	98.6	92.8	112.9	106.7
18	81.1	105	110	101.2	117.5
19	90.6	89.9	99.6	103.4	117.2
20	100.8	101.5	91.9	96.3	106.4
21	84.9	82.6	95.7	105.8	96.9
22	66	65.6	103.9	107.8	123.1
23	154.3	165.5	166.9	151.2	175
24	137	171.6	163.2	166.8	176.7
25	149.5	149.6	172.7	175	177.5
26	0	0	0	0	0
9	29.5	104.6	137.6	132.5	129
10	90.7	119.6	125.5	138.8	141.5
11	101	113.3	117.5	138.2	133.3
12	128.7	131.8	138.8	109.8	119.7
27	132.7	138.4	134.4	131.5	130.7
28	125.3	128.6	119.3	123.2	127
29	130.8	121.1	139.7	118.6	132.4
30	148.4	137.6	118.7	131	140.5
31	137.5	105.5	130.5	114.2	113.7
32	124.6	122.8	101.5	129.8	132.5
33	127.2	129	131.6	129.6	116.2
34	126.2	129.6	109.2	111.7	110
35	171.9	183.7	181.9	163.8	165.9
36	169	167.8	142.2	166.7	164.7
37	185.6	164.6	172	172.1	169.8
38	172.6	180.9	155.9	145.6	144.6
39	0	0	0	0	0

EXPERIMEN1411a
DATA first measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	130.3	110.3	86.5	117.6	110.5
2	128.5	120	113	121.1	125
3	125.6	115.5	127.6	128	117.8
4	121	114.4	119.7	115.8	112.2
5	114	137	126.2	110	120.4
6	124.3	129	115.1	111	102.8
7	112.9	130	135	113.7	106.6
8	102.4	121	108.1	132.1	130

EXPERIMENT1411a
DATA last experiments

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	94.8	119.6	149.8	138.6	141.5
2	132.7	127.5	128.4	125	139
3	138	106	101.9	126.2	123.4
4	122.8	132	130.5	126.5	124.8
5	130	120.5	125.6	114.6	121
6	116.4	122.2	123.6	122.8	105
7	86.9	113.2	123.4	114.3	125.5
8	112.6	106.4	116.7	106.1	107
9	111	105.7	116.3	102.8	90
10	126.5	114.9	121.5	99.3	107.6
11	105.5	116.6	117.7	108.3	101.1
12	117	119.6	110.2	101.3	80.1
13	110.4	120.6	100	112	112.5
14	114.1	112.7	96.2	106.4	112.3
15	120.7	113	107.6	88.5	77.8
16	118.4	114	91	114.9	111.9
17	118.7	109.3	115.8	100	81.3
18	88.2	78.5	92	78.5	111.4
19	94.4	88.5	97.9	109.6	101.2
20	75.4	85.1	99.8	79.5	109.8
21	80.2	79.8	80.3	103.2	101.4
22	77.5	65.5	81	100	94.9
23	150.5	151.1	172.3	173	159.4
24	138.3	139.7	165.5	179.2	160
25	181	154	155.2	172.1	135
26	0	0	0	0	0
9	67.3	108	101.3	124.5	127.6
10	106.8	117.3	115.5	113.6	115.6
11	115.9	113.1	104.5	117.8	113.6
12	106.2	115.2	112.5	113.8	111.1
27	131.3	129.8	126.3	115.4	119.8
28	110	109.5	128	131.5	125
29	111.6	113.4	124.1	105.5	99
30	127	118.8	125.6	105	87.5
31	100	107.6	104.5	120.5	111.3
32	116.3	119.4	104	101	102.5
33	98.5	105.4	124.9	113.9	104.7
34	116.7	104.4	89	112	111.4
35	165.3	146.4	168	166	164.2
36	170.6	162.9	154.4	169	164.8
37	163.5	165.9	149.8	151.4	129.6
38	154.6	159.6	129	129.7	157
39	0	0	0	0	0

EXPERIMEN1411a
DATA last experiments

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	140.4	134	141.4	145.7	109.2
2	135.2	140.1	129.5	131.2	126.9
3	135.7	136.3	117.6	139.7	110.1
4	117.4	131.3	127.2	125	119
5	122.1	121.9	125.6	122.6	110.4
6	116.3	129.7	130.8	127.4	103.2
7	109.8	115.7	109.2	121.7	122.5
8	103.2	116.2	112.3	103.6	109

DATA OF RUN NO. 1411a

DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	2.04	8.19	10.23
0.3	1.99	8.17	10.16
0.45	2.29	7.88	10.17
1	2.18	7.94	10.12
1.15	2.18	8.02	10.2
1.3	2.07	8.23	10.3
1.45	2.02	8.08	10.1
2	2.2	8.11	10.31
2.15	2.09	8.14	10.23
2.3	2.2	8.02	10.22
2.45	2.18	8.14	10.32
3	2.26	7.97	10.23
3.15	2.31	7.88	10.19
3.3	2.26	7.93	10.19
3.45	2.35	7.68	10.03
4	2.37	7.74	10.11
4.15	2.2	7.88	10.08
4.3	2.62	7.51	10.13
4.45	2.58	7.48	10.06
5	2.58	7.43	10.01
5.15	2.62	7.37	9.99
5.3	2.83	7.37	10.2
5.45	2.68	7.29	9.97
6	2.75	7.31	10.06
6.15	2.77	7.29	10.06
6.3	2.81	7.34	10.15
6.45	2.85	7.2	10.05
7	2.73	7.42	10.15
7.15	2.72	7.26	9.98
7.3	2.72	7.48	10.2
7.45	2.77	7.45	10.22
8	3.12	7.23	10.35

DATA OF RUN NO. 1411a

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	142.6	N	119.5	94.8
1	139.2	O	117	94.6
1.5	141	T	117.8	97.3
2	139.9		117.4	94.9
2.5	140.5	M	116.9	92.8
3	139	E	117.6	94.7
3.5	140.6	A	117.5	95.9
4	138.6	S	118.2	94
4.5	140	U	116.9	95.2
5	139.8	R	117.9	96.6
5.5	140.7	E	117.6	94.9
6	138.9	D	117.3	94.5
6.5	138.8		118.2	95
7	141.3		116.4	96.6
7.5	139.5		116.2	96
8	140.7		117.8	97.9

EXPERIMENT2111a
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	142.7	140.6	141.5	139	143.1
2	147.3	145.5	148.3	144.6	146.7
3	146.1	146.7	146.3	145	143.7
4	146.3	144.5	145	145.2	145.4
5	145.1	144.3	143.6	144.2	145.1
6	144	141.2	142.2	142.3	139.9
7	140.8	140.6	140	140.3	140
8	136.2	139.1	141.3	137.3	135.6
9	136	135	139.1		
10	136.6	139.9	140		
11	140.5	140	139		
12	141.9	138.5	135.9		
13	142.5	140	137.9		
14	133.8	132.3	133.6		
15	128.2	126.4	126.9		
16	126.8	127.4	129.1		
17	123.9	123.3	123.5		
18	120.4	120.3	121.2		
19	122.3	121.1	121		
20	117.7	118.4	116.9		
21	117.5	117.8	116.3		
22	113.6	115.8	115.6		
23	186.4	188.2	187.6		
24	185.7	187	188.1		
25	184.1	186	184.7		
26	0	0	0		
9	140.1	137.3	139		
10	135.1	136.4	134.5		
11	131.9	134.3	138.2		
12	135.5	136.7	138.1		
27	136.6	136.9	130.6		
28	147.8	146.5	148.6		
29	143.9	146.8	146.1		
30	149.6	148.7	144.7		
31	145	144.2	141.9		
32	135.8	141.9	141.8		
33	142.3	143.2	140.9		
34	140.9	144.6	139.9		
35	201.9	200.9	198.4		
36	193.1	195.3	189.8		
37	199	199.1	197.8		
38	199.2	203.8	205		
39	0	0	0		

EXPERIMENT2111a
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	150	140.6	132.9	123	125
2	155.5	150	149	151.8	133.9
3	151.2	174.6	186.3	155.8	136.1
4	152.3	150.1	147.7	138.2	150
5	146.1	153.8	155.4	147.3	150.1
6	125.1	142.1	160	154.8	155.9
7	165.6	138.2	130.5	138	131.2
8	138.3	138	139.4	149.9	142.3
9	135.3	136.2	147	135.6	57.6
10	154.8	143.1	145.4	120	67.5
11	164.5	156.1	154.1	104	93.4
12	140.5	140.4	104.9	108	102.5
13	147.2	145.3	106.5	101.3	92.2
14	144.4	146	132	116	124.9
15	135	140.4	104.7	93	120.2
16	131	115.6	120.5	121.5	126.3
17	120.5	120.4	125.7	108.6	120.2
18	104.4	130.5	131.5	133.5	127.1
19	92	109.9	124.7	140.2	148.9
20	102.5	117.4	127.4	125.5	145.6
21	92.5	117.6	123	116.5	138.7
22	89.7	89.8	108.2	145	126.1
23	161.2	173.1	187.5	199.1	200
24	162.1	172.4	199.1	199.5	211
25	138.7	144	193.4	192.2	187.2
26	0	0	0	0	0
9	105.5	111.1	125.5	143.7	154.3
10	175	166.5	171.1	168.5	149.7
11	160.6	180	178.4	190	188.3
12	143.5	178.2	183.2	186.5	180.6
27	181.2	172	185	186	182.2
28	190.1	193.8	178.8	161.2	170.1
29	177	188.3	179.5	183.5	152.9
30	179.7	189.9	179.1	180	160
31	181.8	171.5	175	177.3	163
32	177	157.8	166.3	179.4	168.1
33	166.9	175.2	165.8	168.5	168.7
34	188.5	178.8	171.2	150.4	151.2
35	223.4	217.3	199.5	217.7	203.3
36	242.6	224	217.2	206.5	196.7
37	202.2	213	200.5	196.5	174.1
38	200.7	212.4	186.2	181.5	187
39	0	0	0	0	0

EXPERIMEN2111a
DATA last measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	118.8	132	119	115.8	140.2
2	133.3	164.8	141.8	132.6	148.5
3	113.2	142	175	161.7	143.8
4	140.1	150.9	150.3	141	141.2
5	140	149.8	136	152.6	154.6
6	159.7	134.1	155	143.5	133.5
7	140	136.4	144.2	146.3	155.2
8	151	151.8	123.2	122.5	129.5

DATA OF RUN NO. 2111a
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DISCHARGE MEASUREMENTS

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	8.27	20.6	28.87
0.3	8.5	20.6	29.1
0.45	8.18	20.79	28.97
1	7.89	21.29	29.18
1.15	7.86	20.87	28.73
1.3	7.92	21	28.92
1.45	7.52	21.29	28.81
2	7.72	21.33	29.05
2.15	7.49	21.5	28.99
2.3	6.56	22.38	28.94
2.45	7.1	21.66	28.76
3	6.48	22.25	28.73
3.15	6.5	22.12	28.62
3.3	6.77	22.29	29.06
3.45	6.26	22.29	28.55
4	6.64	22.08	28.72
4.15	6.23	22.46	28.69
4.3	6.26	22.55	28.81
4.45	5.89	23.14	29.03
5	5.92	22.76	28.68
5.15	5.77	22.97	28.74
5.3	5.61	23.23	28.84
5.45	5.87	22.84	28.71
6	5.49	23.1	28.59
6.15	5.44	23.36	28.8
6.3	5.29	23.23	28.52
6.45	5.56	23.27	28.83
7	5.46	23.36	28.82
7.15	5.51	23.1	28.61
7.3	5.31	23.4	28.71
7.45	5.16	23.49	28.65
8	5.07	24.31	29.38

DATA OF RUN NO. 2111a

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	202.2	189.7	197.2	183.9
1	202.1	189.9	199.3	183.8
1.5	203	190.5	196.6	183.5
2	204.3	191	197.9	183.7
2.5	205.5	192.3	198	183.2
3	204.4	190.8	198	183.4
3.5	203.8	190	198.7	184.2
4	204.3	193.2	198.4	184
4.5	204.2	192.4	198.3	184.2
5	203.8	191.7	197.1	182.7
5.5	206.1	192.1	200.3	183.3
6	200.3	192.1	199.7	183.3
6.5	205.8	193.9	199.6	183.2
7	206.2	193.5	199.6	184.6
7.5	204.9	191.2	198.5	184.5
8	205.3	194.2	198.5	184.2

EXPERIMENT2111B
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	150	140.6	132.9	123	125
2	155.5	150	149	151.8	133.9
3	151.2	174.6	186.3	155.8	136.1
4	152.3	150.1	147.7	138.2	150
5	146.1	153.8	155.4	147.3	150.1
6	125.1	142.1	160	154.8	155.9
7	165.6	138.2	130.5	138	131.2
8	138.3	138	139.4	149.9	142.3
9	135.3	136.2	147	135.6	57.6
10	154.8	143.1	145.4	120	67.5
11	164.5	156.1	154.1	104	93.4
12	140.5	140.4	104.9	108	102.5
13	147.2	145.3	106.5	101.3	92.2
14	144.4	146	132	116	124.9
15	135	140.4	104.7	93	120.2
16	131	115.6	120.5	121.5	126.3
17	120.5	120.4	125.7	108.6	120.2
18	104.4	130.5	131.5	133.5	127.1
19	92	109.9	124.7	140.2	148.9
20	102.5	117.4	127.4	125.5	145.6
21	92.5	117.6	123	116.5	138.7
22	89.7	89.8	108.2	145	126.1
23	161.2	173.1	187.5	199.1	200
24	162.1	172.4	199.1	199.5	211
25	138.7	144	193.4	192.2	187.2
26	0	0	0	0	0
9	105.5	111.1	125.5	143.7	154.3
10	175	166.5	171.1	168.5	149.7
11	160.6	180	178.4	190	188.3
12	143.5	178.2	183.2	186.5	180.6
27	181.2	172	185	186	182.2
28	190.1	193.8	178.8	161.2	170.1
29	177	188.3	179.5	183.5	152.9
30	179.7	189.9	179.1	180	160
31	181.8	171.5	175	177.3	163
32	177	157.8	166.3	179.4	168.1
33	166.9	175.2	165.8	168.5	168.7
34	188.5	178.8	171.2	150.4	151.2
35	223.4	217.3	199.5	217.7	203.3
36	242.6	224	217.2	206.5	196.7
37	202.2	213	200.5	196.5	174.1
38	200.7	212.4	186.2	181.5	187
39	0	0	0	0	0

EXPERIMEN2111B
DATA first measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	118.8	132	119	115.8	140.2
2	133.3	164.8	141.8	132.6	148.5
3	113.2	142	175	161.7	143.8
4	140.1	150.9	150.3	141	141.2
5	140	149.8	136	152.6	154.6
6	159.7	134.1	155	143.5	133.5
7	140	136.4	144.2	146.3	155.2
8	151	151.8	123.2	122.5	129.5

EXPERIMENT2111B
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	159.8	109.1	124.7	109.4	113.2
2	140.5	151	142.8	144.6	120.4
3	137.5	145	149.1	131.7	145.9
4	135.8	151	150.3	161.9	165
5	147	128	145.3	137.7	149.5
6	132.9	148.1	150.3	158.8	144.6
7	115.6	154	152.6	143.2	143.5
8	158.5	145.7	152	150.1	124.6
9	151.5	146.5	144.1	156	67.2
10	151.8	156.7	137.6	118.3	101.7
11	169	134.2	134.5	134.2	95.6
12	159.4	138.2	135.1	130.5	102.1
13	152.2	125.7	138.7	115.6	72.5
14	140.4	151.7	119	128.3	112.8
15	141.2	150.7	148	119.4	75.6
16	147.9	136.2	104.5	125.9	106.5
17	97.3	130.5	135	133	127.6
18	93	103	144.8	108.2	122
19	105.8	95.3	121.8	148.4	142.9
20	93.3	104	124.4	106.8	129
21	94.6	117.4	121.7	138.4	143.5
22	97.2	107.4	115.3	120.8	146.5
23	160.6	172.9	193	207.6	208
24	152.1	175.1	200.6	206.2	226.8
25	184.8	176.3	179.1	208.1	197.1
26	0	0	0	0	0
9	61.8	85.5	120	141	149
10	162.7	184.3	173.6	176	176.1
11	185.6	187.7	190.9	178.7	172.4
12	158.1	183.6	197.4	195.1	196.8
27	179.1	178	174.8	189.9	208.2
28	163.5	166.4	190.7	197.1	185.5
29	195.6	191.7	165.4	174	184.6
30	191.7	182.8	183.2	186.3	165.4
31	190	188.3	165.7	161	153.9
32	165.1	170	173.6	157.7	175
33	172.6	173	167.9	181.3	172.4
34	167	158	177.7	182.3	187.6
35	225.7	223.2	235.4	225	210.3
36	246.6	214.5	227.8	226.9	210
37	220.1	231.8	227.8	217.2	220.8
38	221.5	223.4	218.5	214.6	222.5
39	0	0	0	0	0

EXPERIMEN2111B
DATA last measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	108.8	108.2	151.3	128.2	140.1
2	134.1	145	174.7	155.5	153.1
3	168.2	158.9	159	168.8	155
4	166.6	167.1	151.4	157.6	130
5	173.1	158	152.5	151.7	154.7
6	144.2	137.9	155.3	139.8	157.1
7	144.4	146.9	168.2	169.5	161.6
8	149	153.2	144.1	125.8	132.2

DATA OF RUN NO. 2111b
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DISCHARGE MEASUREMENT

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	5.36	23.4	28.76
0.3	4.82	24.27	29.09
0.45	4.99	23.49	28.48
1	4.99	23.31	28.3
1.15	5.09	23.57	28.66
1.3	5.24	23.23	28.47
1.45	5.04	23.44	28.48
2	4.8	23.49	28.29
2.15	4.94	23.66	28.6
2.3	4.73	23.66	28.39
2.45	4.85	23.53	28.38
3	4.94	23.62	28.56
3.15	4.89	23.83	28.72
3.3	4.97	23.79	28.76
3.45	4.54	23.87	28.41
4	4.51	23.95	28.46
4.15	4.37	24.18	28.55
4.3	4.49	24.27	28.76
4.45			0
5	4.35	23.83	28.18
5.15	4.45	23.7	28.15
5.3	4.38	23.79	28.17
5.45	4.49	23.53	28.02
6	3.87	24.53	28.4
6.15	3.87	24.24	28.11
6.3	3.84	24.09	27.93
6.45	4.07	24.27	28.34
7	4.16	24.44	28.6
7.15	3.76	24.35	28.11
7.3	4.16	24.31	28.47
7.45	4.09	24.18	28.27
8	4.09	24.18	28.27

DATA OF RUN NO. 2111b

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	204.9	193.1	198.1	182.8
1	204.7	193.2	196.7	183.3
1.5	206.4	193	195.6	184.8
2	203.6	194	196.4	182.6
2.5	204.4	192.6	197.1	181.9
3	205.6	193.7	198.7	182.9
3.5	207	195.4	199.4	182.2
4	205.2	192.7	195.1	184.1
4.5	205.5	194.4	198.3	183.5
5	203.9	193.8	196.2	184.1
5.5	206.6	194.3	198.6	184.2
6	205.5	192.4	196.8	183.2
6.5	206.3	194.4	197.2	184.3
7	204.4	193.7	196.6	184.3
7.5	206.8	192.8	196.7	184.1
8	207.3	193.8	197.2	183.9

EXPERIMENT2111C
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	159.8	109.1	124.7	109.4	113.2
2	140.5	151	142.8	144.6	120.4
3	137.5	145	149.1	131.7	145.9
4	135.8	151	150.3	161.9	165
5	147	128	145.3	137.7	149.5
6	132.9	148.1	150.3	158.8	144.6
7	115.6	154	152.6	143.2	143.5
8	158.5	145.7	152	150.1	124.6
9	151.5	146.5	144.1	156	67.2
10	151.8	156.7	137.6	118.3	101.7
11	169	134.2	134.5	134.2	95.6
12	159.4	138.2	135.1	130.5	102.1
13	152.2	125.7	138.7	115.6	72.5
14	140.4	151.7	119	128.3	112.8
15	141.2	150.7	148	119.4	75.6
16	147.9	136.2	104.5	125.9	106.5
17	97.3	130.5	135	133	127.6
18	93	103	144.8	108.2	122
19	105.8	95.3	121.8	148.4	142.9
20	93.3	104	124.4	106.8	129
21	94.6	117.4	121.7	138.4	143.5
22	97.2	107.4	115.3	120.8	146.5
23	160.6	172.9	193	207.6	208
24	152.1	175.1	200.6	206.2	226.8
25	184.8	176.3	179.1	208.1	197.1
26	0	0	0	0	0
9	61.8	85.5	120	141	149
10	162.7	184.3	173.6	176	176.1
11	185.6	187.7	190.9	178.7	172.4
12	158.1	183.6	197.4	195.1	196.8
27	179.1	178	174.8	189.9	208.2
28	163.5	166.4	190.7	197.1	185.5
29	195.6	191.7	165.4	174	184.6
30	191.7	182.8	183.2	186.3	165.4
31	190	188.3	165.7	161	153.9
32	165.1	170	173.6	157.7	175
33	172.6	173	167.9	181.3	172.4
34	167	158	177.7	182.3	187.6
35	225.7	223.2	235.4	225	210.3
36	246.6	214.5	227.8	226.9	210
37	220.1	231.8	227.8	217.2	220.8
38	221.5	223.4	218.5	214.6	222.5
39	0	0	0	0	0

EXPERIMEN2111C
DATA first measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	108.8	108.2	151.3	128.2	140.1
2	134.1	145	174.7	155.5	153.1
3	168.2	158.9	159	168.8	155
4	166.6	167.1	151.4	157.6	130
5	173.1	158	152.5	151.7	154.7
6	144.2	137.9	155.3	139.8	157.1
7	144.4	146.9	168.2	169.5	161.6
8	149	153.2	144.1	125.8	132.2

EXPERIMENT2111C
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	162.2	138.5	98.2	97.5	98.9
2	156.4	174.4	166.1	135.7	99.2
3	151.2	123.2	160.5	140	140.5
4	147.5	137	141.4	160.4	164.6
5	144.1	153.3	162.5	136.4	136
6	146.1	151.7	144.6	137.6	145.5
7	153	140.3	148.7	154.5	145
8	145.5	135.5	137	141.7	148.8
9	143.2	130.6	122.8	144.5	81.4
10	149.3	142	131.5	126.4	187
11	155.5	139.9	123	110.9	97.2
12	143.5	143.6	106.4	96.3	85
13	135	141.3	132.8	98	80.5
14	164.5	132.3	103.2	125.3	117.8
15	115.5	135	111	114.9	94.1
16	121.4	102.5	131.2	129.9	119.3
17	122.9	126.9	117.5	138.8	136.2
18	104.6	109.8	117.8	105	123.6
19	101.4	90	126	128.1	133.9
20	87.8	106.3	125.1	134	145
21	84.2	61.9	117.1	135.7	146.5
22	96.2	91.8	112.7	138.5	133.2
23	151.8	165.7	200.2	209	179.6
24	167.5	193.1	181.6	201.3	188
25	152	167.8	198.5	192.3	212.3
26	0	0	0	0	0
9	80.8	93.6	120.7	130	142.8
10	165.2	184	182.7	183.9	186.5
11	182.3	185.4	178.3	193.3	191
12	155.3	190	195.9	182.3	188.7
27	181.5	154.3	182.6	184	178.2
28	193.8	197.7	184.9	180.3	174.2
29	178.9	188.6	186.8	183.9	190
30	181	163.5	184.8	178	177
31	201.5	197	185.4	179	171.6
32	171.4	170.2	163.6	179.3	182.1
33	169.4	170.1	186.1	165	165.9
34	165.3	163.6	170.2	168.5	171.7
35	242.8	252.8	227.4	208.5	207.7
36	222.3	233.9	217.8	216.2	187.7
37	243.9	225.9	231.4	240.6	216.2
38	236	233.2	239.7	227.1	209
39	0	0	0	0	0

EXPERIMEN2111C
DATA last measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	106.2	114	149.5	140.3	135.5
2	127.5	168	172.3	162.1	144.2
3	141	155.1	144.2	146.9	140.8
4	168.7	150.5	141.5	136.2	151
5	153.5	154.5	156	154.6	156.4
6	154.3	131.8	167	161.1	150.8
7	165.1	151.8	152.8	148.2	156.7
8	135.6	150.5	139.9	147	147.2

DATA OF RUN NO. 2111c

DISCHARGE MEASUREMENT

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	4.54	24.22	28.76
0.3	4.61	24.14	28.75
0.45	4.47	24.35	28.82
1	4.14	24.44	28.58
1.15	4.63	24.18	28.81
1.3	4.28	24.44	28.72
1.45	4.28	24.48	28.76
2	4.51	24.44	28.95
2.15	4.16	24.79	28.95
2.3	4	24.44	28.44
2.45	3.98	24.35	28.33
3	3.92	24.27	28.19
3.15	3.56	24.92	28.48
3.3	3.94	24.57	28.51
3.45	3.76	24.27	28.03
4	3.72	25.1	28.82
4.15	3.61	24.84	28.45
4.3	3.98	24.48	28.46
4.45	3.54	24.75	28.29
5	3.85	24.7	28.55
5.15	3.96	24.53	28.49
5.3	4.09	24.44	28.53
5.45	3.83	24.66	28.49
6	3.61	24.84	28.45
6.15	3.61	24.88	28.49
6.3	3.74	24.75	28.49
6.45	3.72	25.01	28.73
7	3.39	25.1	28.49
7.15	3.35	25.18	28.53
7.3	3.26	25.06	28.32
7.45	3.26	25.14	28.4
8	3.41	25.14	28.55

DATA OF RUN NO. 2111c

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	208.5	196.2	199.6	184.6
1	207.3	195.9	198.6	184.1
1.5	209	195.2	198.9	184.6
2	208.9	195.6	200.5	185
2.5	207.3	194.8	199	183.8
3	204.5	194.7	197.8	183.4
3.5	206.9	194.9	197.5	184.4
4	207.2	194.9	199.3	183.8
4.5	206.6	195.5	197.8	185.1
5	207.4	194.2	197.5	184.5
5.5	207.4	195.8	197.5	184.8
6	206.5	195	195.5	184.3
6.5	206.1	193.9	197.8	184.6
7	207.2	194.6	197.6	184.7
7.5	206.9	194.2	197.5	183.8
8	206.9	193.9	197.3	183.8

EXPERIMENT2111d
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	162.2	138.5	98.2	97.5	98.9
2	156.4	174.4	166.1	135.7	99.2
3	151.2	123.2	160.5	140	140.5
4	147.5	137	141.4	160.4	164.6
5	144.1	153.3	162.5	136.4	136
6	146.1	151.7	144.6	137.6	145.5
7	153	140.3	148.7	154.5	145
8	145.5	135.5	137	141.7	148.8
9	143.2	130.6	122.8	144.5	81.4
10	149.3	142	131.5	126.4	187
11	155.5	139.9	123	110.9	97.2
12	143.5	143.6	106.4	96.3	85
13	135	141.3	132.8	98	80.5
14	164.5	132.3	103.2	125.3	117.8
15	115.5	135	111	114.9	94.1
16	121.4	102.5	131.2	129.9	119.3
17	122.9	126.9	117.5	138.8	136.2
18	104.6	109.8	117.8	105	123.6
19	101.4	90	126	128.1	133.9
20	87.8	106.3	125.1	134	145
21	84.2	61.9	117.1	135.7	146.5
22	96.2	91.8	112.7	138.5	133.2
23	151.8	165.7	200.2	209	179.6
24	167.5	193.1	181.6	201.3	188
25	152	167.8	198.5	192.3	212.3
26	0	0	0	0	0
9	80.8	93.6	120.7	130	142.8
10	165.2	184	182.7	183.9	186.5
11	182.3	185.4	178.3	193.3	191
12	155.3	190	195.9	182.3	188.7
27	181.5	154.3	182.6	184	178.2
28	193.8	197.7	184.9	180.3	174.2
29	178.9	188.6	186.8	183.9	190
30	181	163.5	184.8	178	177
31	201.5	197	185.4	179	171.6
32	171.4	170.2	163.6	179.3	182.1
33	169.4	170.1	186.1	165	165.9
34	165.3	163.6	170.2	168.5	171.7
35	242.8	252.8	227.4	208.5	207.7
36	222.3	233.9	217.8	216.2	187.7
37	243.9	225.9	231.4	240.6	216.2
38	236	233.2	239.7	227.1	209
39	0	0	0	0	0

EXPERIMEN2111d
DATA first measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	106.2	114	149.5	140.3	135.5
2	127.5	168	172.3	162.1	144.2
3	141	155.1	144.2	146.9	140.8
4	168.7	150.5	141.5	136.2	151
5	153.5	154.5	156	154.6	156.4
6	154.3	131.8	167	161.1	150.8
7	165.1	151.8	152.8	148.2	156.7
8	135.6	150.5	139.9	147	147.2

EXPERIMENT2111d
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	149.7	128	119	90.9	98
2	139.6	156.2	152.9	149.7	122.6
3	156.8	149	151.2	148.9	137.3
4	160.2	158.5	153.7	163	157.2
5	147.7	145.8	164.5	154.8	142.3
6	139.8	134.8	140	144.3	137.2
7	138.5	136.9	151.4	139.6	150.9
8	145.2	147.1	136.3	121.5	129.2
9	149.2	136.9	133.8	133.4	155.2
10	143.5	135.8	129.2	140.5	127.3
11	149.7	133.3	122.3	105.6	87.2
12	124.7	116.1	96.9	126.2	115.7
13	132.1	115.4	102.7	116	107
14	148.5	146.7	118.3	128.2	102
15	152.5	148.3	139.1	98.9	76
16	100.1	114.3	119.4	120.7	125
17	106.5	107	110.5	128.8	155.1
18	88.3	119.2	114	118.6	108.2
19	86.6	92.8	102	116.4	138.8
20	91.8	105.8	112.9	138.7	145.1
21	93.6	100.3	110.7	117	130.1
22	70.7	97.5	129.9	138.9	143.6
23	162.3	169.8	195	198.6	198.5
24	148.2	166.4	179	192.2	196
25	155.5	181.5	201.8	200	183.1
26	0	0	0	0	0
9	49.6	68.1	95.5	127	138.6
10	146.9	171.1	191	190.9	187.5
11	176.8	181.4	198.9	201.9	184.8
12	167.3	177.6	191.7	180.6	195.2
27	184.8	186.1	194.2	191.6	185.6
28	173.9	193.2	184	177.7	192.8
29	179.7	193	193.2	185	175.9
30	185.8	181.4	184.2	179.6	173.9
31	184.2	191.3	180.8	180.8	175.7
32	190.7	182.8	171.4	199.3	179.8
33	175.1	185.3	182.1	180.5	161.9
34	208.9	189.1	171.6	177.4	155
35	220.6	217.8	241.5	226.8	222.1
36	217.9	244.7	230.9	223.5	202.6
37	243	235.2	223.8	218.6	213.7
38	226.2	223.1	220.1	226.7	236.1
39	0	0	0	0	0

EXPERIMEN2111d
DATA last measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	101.8	103.6	131.9	135	141.2
2	127	155.9	162.8	148.6	139.2
3	154.2	153.1	140.9	123.6	137.9
4	147.5	151.7	141.1	101.5	136.2
5	137.9	147	158.6	144	163.2
6	149.2	158.4	164.8	160.6	136.9
7	136.6	152.1	158.4	137.7	144.3
8	144.2	139.6	142	153.1	155.6
	100.4	52.5			
	139.8	109			

DATA OF RUN NO. 2111d
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DISCHARGE MEASUREMENT

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	3.35	24.62	27.97
0.3	3.29	25.01	28.3
0.45	3.29	25.01	28.3
1	3.61	24.93	28.54
1.15	3.39	24.97	28.36
1.3	3.37	24.97	28.34
1.45	3.61	25.1	28.71
2	3.63	24.97	28.6
2.15	3.37	25.14	28.51
2.3	3.52	25.06	28.58
2.45	3.39	25.1	28.49
3	3.35	24.97	28.32
3.15	3.35	25.32	28.67
3.3	3.43	25.28	28.71
3.45	3.04	25.54	28.58
4	3.2	25.1	28.3
4.15	3.31	25.14	28.45
4.3	3.18	25.1	28.28
4.45	3.26	25.23	28.49
5	3.33	25.1	28.43
5.15	3.31	25.06	28.37
5.3	3.26	25.14	28.4
5.45	3.5	25.46	28.96
6	3.26	24.98	28.24
6.15	3.28	25.06	28.34
6.3	3.31	24.98	28.29
6.45	3.37	25.28	28.65
7	3.08	25.46	28.54
7.15	3.31	25.01	28.32
7.3	3.87	25.01	28.88
7.45	3.54	24.88	28.42
8	3.41	25.23	28.64

DATA OF RUN NO. 2111d

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	205.6	193	196.5	184
1	205.7	193.9	198.5	185.3
1.5	206.4	192.7	196.2	185.5
2	207.2	194.5	196.3	185
2.5	206.9	194.5	196.9	185.3
3	206.3	194.7	195.2	185.2
3.5	205.1	192.7	198.8	184.9
4	204.4	192.8	196.8	184.3
4.5	206.4	192.2	197.8	185.4
5	204.9	193.3	196.2	185
5.5	204.4	191.9	195.5	185.6
6	206.1	194.6	197.7	195.8
6.5	206.1	194.7	197.5	195.3
7	206.1	194.5	197.3	185.4
7.5	207.2	195.7	197.7	186.7
8	207.4	193.9	197.2	185.9

EXPERIMENT2111e
DATA first measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	149.7	128	119	90.9	98
2	139.6	156.2	152.9	149.7	122.6
3	156.8	149	151.2	148.9	137.3
4	160.2	158.5	153.7	163	157.2
5	147.7	145.8	164.5	154.8	142.3
6	139.8	134.8	140	144.3	137.2
7	138.5	136.9	151.4	139.6	150.9
8	145.2	147.1	136.3	121.5	129.2
9	149.2	136.9	133.8	133.4	155.2
10	143.5	135.8	129.2	140.5	127.3
11	149.7	133.3	122.3	105.6	87.2
12	124.7	116.1	96.9	126.2	115.7
13	132.1	115.4	102.7	116	107
14	148.5	146.7	118.3	128.2	102
15	152.5	148.3	139.1	98.9	76
16	100.1	114.3	119.4	120.7	125
17	106.5	107	110.5	128.8	155.1
18	88.3	119.2	114	118.6	108.2
19	86.6	92.8	102	116.4	138.8
20	91.8	105.8	112.9	138.7	145.1
21	93.6	100.3	110.7	117	130.1
22	70.7	97.5	129.9	138.9	143.6
23	162.3	169.8	195	198.6	198.5
24	148.2	166.4	179	192.2	196
25	155.5	181.5	201.8	200	183.1
26	0	0	0	0	0
9	49.6	68.1	95.5	127	138.6
10	146.9	171.1	191	190.9	187.5
11	176.8	181.4	198.9	201.9	184.8
12	167.3	177.6	191.7	180.6	195.2
27	184.8	186.1	194.2	191.6	185.6
28	173.9	193.2	184	177.7	192.8
29	179.7	193	193.2	185	175.9
30	185.8	181.4	184.2	179.6	173.9
31	184.2	191.3	180.8	180.8	175.7
32	190.7	182.8	171.4	199.3	179.8
33	175.1	185.3	182.1	180.5	161.9
34	208.9	189.1	171.6	177.4	155
35	220.6	217.8	241.5	226.8	222.1
36	217.9	244.7	230.9	223.5	202.6
37	243	235.2	223.8	218.6	213.7
38	226.2	223.1	220.1	226.7	236.1
39	0	0	0	0	0

EXPERIMEN2111e
DATA first measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	101.8	103.6	131.9	135	141.2
2	127	155.9	162.8	148.6	139.2
3	154.2	153.1	140.9	123.6	137.9
4	147.5	151.7	141.1	101.5	136.2
5	137.9	147	158.6	144	163.2
6	149.2	158.4	164.8	160.6	136.9
7	136.6	152.1	158.4	137.7	144.3
8	144.2	139.6	142	153.1	155.6
	100.4	52.5			
	139.8	109			

EXPERIMENT2111e
DATA last measurements

CROSS SECTION	MEASURED READING POINT 1 [mm]	MEASURED READING POINT 2 [mm]	MEASURED READING POINT 3 [mm]	MEASURED READING POINT 4 [mm]	MEASURED READING POINT 5 [mm]
1	145	130	119.2	106	96.8
2	150.6	165.7	172.7	152.4	117.5
3	157.7	133.4	139.6	141.4	129
4	150.6	154.7	158.5	161.6	166.4
5	147.8	145.7	154.1	162	152.5
6	156.8	136.4	149.4	155	139.8
7	132.4	166.4	147.6	149.7	143.1
8	147.3	148.9	136.2	125	130.1
9	141.6	128.2	135	134.1	141.1
10	142	147.9	127.4	132.8	100.6
11	154.9	133.2	108.5	104	89.6
12	149.2	126.8	87.9	118.6	96.6
13	129.9	133.9	137.5	111.1	103.3
14	155.1	132.4	141.1	118.3	109.7
15	146.9	138	149.5	104.4	79.9
16	158.6	129.9	115.4	131.2	80.7
17	118.5	124.3	128	101.1	113
18	93.9	115.9	114.6	117.8	128.2
19	84	79.4	106.5	132.7	139
20	60.1	90.7	121.8	130.7	134.5
21	72.9	96.7	99.5	132.4	148.6
22	79	88.4	122.9	143.5	128.6
23	164.3	191.4	182.3	209.2	188.1
24	166.6	173.9	187.8	188.6	206
25	134.1	161	193.2	182.9	198.3
26	0	0	0	0	0
9	67.3	90.6	117	130.9	128.6
10	161.9	174.1	181.6	176.4	183.8
11	187.7	180.7	195.4	196.6	182.1
12	174.1	186.5	181.3	190.6	188.2
27	164.9	185.1	178.9	192.6	174.3
28	167.7	199	190.7	190.6	172.6
29	196.6	204	191.4	180.6	158.3
30	197.3	192.8	186.4	182	173.6
31	190.2	174.1	175.5	188	182.9
32	166	170.1	176.1	174.4	181.8
33	191.1	179.7	183.3	171	154
34	176.2	178.3	183.2	180	179.3
35	249.2	234.6	229.7	220.6	232.6
36	252	224.4	236.3	230.5	225
37	235.4	232.3	234	214.9	224.7
38	229.6	236.6	230.7	235.4	238
39	0	0	0	0	0

EXPERIMEN2111e
DATA last measurements

CROSS SECTION	MEASURED READING POINT 6 [mm]	MEASURED READING POINT 7 [mm]	MEASURED READING POINT 8 [mm]	MEASURED READING POINT 9 [mm]	MEASURED READING POINT 10 [mm]
1	103.6	90.6	117.3	116.4	120
2	104.6	138	163.5	139.9	126.4
3	160.5	172.7	150.3	131	125
4	179.6	148.8	124.5	140	136.9
5	150	140.4	165.5	140.8	114.5
6	129.6	148.7	152.6	144.6	140
7	141.2	136.4	118.8	154.4	139.8
8	159.5	142.3	151.4	144.5	139.8
	125.7	42			
	107.9	91.5			

DATA OF RUN NO. 2111e
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DISCHARGE MEASUREMENT

TIME (h)	Q1 (l/s)	Q2 (l/s)	TOTAL Q (l/s)
0.15	3.94	27.02	30.96
0.3	3.52	24.88	28.4
0.45	3.35	25.41	28.76
1	3.26	25.59	28.85
1.15	3.16	25.41	28.57
1.3	3.29	25.41	28.7
1.45	3.46	24.84	28.3
2	3.54	25.06	28.6
2.15	3.46	24.97	28.43
2.3	3.54	25.06	28.6
2.45	3.18	24.88	28.06
3	3.43	24.75	28.18
3.15	3.29	25.06	28.35
3.3	3.37	25.06	28.43
3.45	3.33	25.2	28.53
4	3.16	25.37	28.53
4.15	3.33	25.1	28.43
4.3	3.2	25.19	28.39
4.45	3.33	24.79	28.12
5	3.35	24.92	28.27
5.15	3.33	25.5	28.83
5.3	3.37	25.06	28.43
5.45	3.39	24.79	28.18
6	3.43	25.01	28.44
6.15	3.56	24.75	28.31
6.3	3.37	25.14	28.51
6.45	3.61	24.75	28.36
7	3.46	25.06	28.52
7.15	3.18	24.97	28.15
7.3	3.29	25.23	28.52
7.45	3.04	25.41	28.45
8	3.43	24.8	28.23

DATA OF RUN NO. 2111e

WATER LEVEL MEASUREMENTS

TIME (h)	READING STILLING BASIN NO. 1 (mm)	READING STILLING BASIN NO. 2 (mm)	READING STILLING BASIN NO. 3 (mm)	READING STILLING BASIN NO. 4 (mm)
0.5	208.4	195.5	196.6	181.7
1	207.7	194.3	198.2	181.5
1.5	207.3	194.3	197.6	184.3
2	207.8	195.7	198.2	184.6
2.5	207.9	193.2	197.3	184.4
3	206.4	192.9	195.2	184.5
3.5	205.7	194	198	183.3
4	206.6	194.6	199.1	183.1
4.5	205.9	193.5	197.2	183.4
5	205.9	194.3	198.6	185.8
5.5	205.8	194.4	195.8	185.3
6	208.4	195.9	198	185.6
6.5	208.4	195.7	197.9	186.5
7	207.8	195.6	196.8	186.3
7.5	207.3	195.4	200.1	185.7
8	206.7	194.5	196.6	187.1