NBSIR 81-2367

Prediction of the Hydraulic Jump Location Following A Change of Slope in A Partially Filled Drainage Pipe

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Center for Building Technology
Washington, DC 20234

and

Drainage Research Group
Department of Building Technology
Brunel University
U.K.

May 1981

Issued November 1981

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NBSIR 81-2367

PREDICTION OF THE HYDRAULIC JUMP LOCATION FOLLOWING A CHANGE OF SLOPE IN A PARTIALLY FILLED DRAINAGE PIPE

Dr. J. A. Swaffield

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Center for Building Technology
Washington, DC 20234

and

Drainage Research Group
Department of Building Technology
Brunel University
U.K.

May 1981

Issued November 1981

U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, *Secretary*
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

ABSTRACT

The criteria governing the formation of a hydraulic jump in a partially filled fluid conduit downstream of a slope change are presented together with the necessary techniques to enable water surface profiles and jump location to be predicted.

Computer programs designed to model the conditions leading to jump formation under flow and channel scale conditions compatible with current drainage system design are presented.

The results of a wide range of test conditions in terms of jump formation and position downstream of a change in channel slope are presented together with a set of criteria to be used in evaluating whether a jump will occur for a given set of design conditions.

PREFACE

This report is one of a group documenting National Bureau of Standards (NBS) research and analysis efforts in developing water conservation test methods, analysis, economics, and strategies for implementation and acceptance. This work is sponsored by the Department of Housing and Urban Development/Office of Policy Development and Research, Division of Energy Building Technology and Standards, under HUD Interagency Agreement H-48-78.

Report prepared by Dr. J. A. Swaffield, guest research worker at NBS-Stevens Institute of Technology from Brunel University, U.K.

TABLE OF CONTENTS

LIST OF FIGURES

List of Figures (cont.)

LIST OF TABLES

NOTATION

A	Channel cross sectional area
C	Chezy constant
D	Pipe diameter
E	Specific energy
F&M	Sum of hydrostatic force, F, and momentum, M, at any flow section
F_r	Froude number
g	Acceleration due to gravity
h	Flow depth
$\bar{h}$	Centroid depth
h_c	Critical flow depth
h_n	Normal flow depth
L	Jump location distance from pipe entry
m	Hydraulic mean depth
n	Manning coefficient
P	Wetted perimeter
Q	Flow rate
S	Slope of energy grade line
S_o	Channel slope
T	Water surface width in channel
V	Local average velocity
W	Width rectangular channel
Z	Elevation channel above some datum
ρ	Fluid density
θ_1	Approach pipe slope
θ_2	Test pipe slope

1. INTRODUCTION

Early studies of the formation of a hydraulic jump in open channel fluid flow may be traced to the 1820's and to a large extent were responsible for the classification of flow regimes in open channels now employed. The major work on jump formation has been, historically, directed towards the large civil engineering excavated channels with near horizontal bed slopes and straight sided cross sectional shapes. Both experimental and analytical treatments find wide application in such open channel design. Characteristically the presence of a hydraulic jump is responsible for the necessary water surface profile discontinuity that must occur if flow is established in a channel at a velocity compatible with the rapid or supercritical flow regime when the channel slope and roughness characteristics dictate that subcritical, or tranquil, flow regime conditions should prevail. Obviously such a method of increasing flow depth also provides a potent energy dissipation and flow mixing mechanism. These characteristics of the hydraulic jump to some extent explain the interest in this phenomenon in open channel design. Chow [1] quotes a wide range of useful applications of the jump mechanism in open channel erosion and bed uplift by decreasing local velocity and increasing flow depth. Similarly the mixing properties of the jump can be utilized in chemical water purification processes as well as in aeration.

A review of the literature on the topic therefore reveals a strong bias toward large scale applications, with the design criteria being designed with a view to including rather than excluding the hydraulic jump from open channel flow.

In drainage design both scale and motivation are diametrically opposed to the situation described above. The conditions governing the formation of a hydraulic jump translate unchanged with the scale of the system; however in the design of a drainage system the occurrence of a jump is to be avoided if possible. In a partially filled drainage pipe the occurrence of a hydraulic jump could result in a local full bore flow that would interfere with the venting of the system and could lead to back pressure problems upstream. Vertical stacks discharging into shallow gradient drains represent a design condition that could lead to jump formation. Additionally the local full bore flow could deposit suspended material on the crown of the pipe, leading after sometime to a possibility of pipe restriction and blockage. The location of a jump in plumbing systems design is of secondary importance.

In the special case of hospital drainage flow in the UK this has been found to be a particular problem due to the use of the drainage system to transport macerated disposable bed pans manufactured from strengthened paper-mache.

Thus in drainage design the hydraulic jump is to be avoided where possible by design.

The objective of the computer simulation described in this report therefore was to produce a usable computer program that could give guidance on the design condition likely to produce a hydraulic jump. It was intended that the computer program would be tested in the work reported for a range of flow conditions and pipe sizes and slopes typical of drainage design. These values incidentally being far removed from the calculation examples found in the literature for channels carrying flows measured in MG/Day.

However, as mentioned, the basic prediction methods and the flow criteria translate across the scale differentials. One problem however does become obvious and that relates to channel cross section shape. The criteria relating to jump formation are primarily related to flow depth and velocity and hence, for a known flow rate, to channel cross section. Similarly the forces acting involve the calculation of flow centroidal depth. The large body of literature available is almost entirely restricted to simple, straight sided channel shapes, and understandably so. The introduction of circular sections, while not in itself difficult in a numerical computer aided solution, dispenses with any possibility of deriving analytical solutions for jump location, strength or depth change. Douglas et al. [2], for example present a jump location calculation technique for a simple rectangular channel, with a range of simplifying assumptions, that is typical of the analytical treatments available [3, 4].

The technique chosen for this study was based on the assumption of gradually varied flow conditions both upstream and downstream of the hydraulic jump formed in the channel as a result of the slope change. Gradually varied flow implies that the flow parameters change sufficiently slowed for the steady, uniform flow equations, characterized by Chezy and Manning, to be applied to incremental length sections employing the local depth and velocity values.

The criteria determining the formation of the jump are well documented in terms of a force and momentum balance at the jump between the upstream and downstream water surface profiles. This force and momentum balance leads to the concept of conjugate depths and hence to the strength and depth change associated with the jump. The gradually varied flow assumptions allow the water surface profiles to be calculated and hence the jump position may be calculated.

This report presents the theoretical background to a computer model based on the gradually varied flow assumption and the force and momentum equivalence criteria for jump formation. A listing of the Fortran programs written to model the problem is presented together with flow charts and data input descriptions that will allow future use of the developed techniques. Results for a range of flow and pipe and channel design parameters typical of drainage systems are included, both as summary tables produced by the programs and in graphical form to illustrate points and trends of particular interest.

2. THEORETICAL CONSIDERATIONS

2.1 Steady, Uniform Flow in Open Channels

Figure 1 illustrates the force balance equation for steady flow in an open channel or partially filled duct. The common expression of this relationship is known as the Chezy equation where

$$V = C\sqrt{mS_o} \qquad (1)$$

m = hydraulic mean depth A/P, m
S_o = sin θ duct slope
V = mean velocity, m/s
C = Chezy constant.

The value of Chezy coefficient C was found by Manning to be dependent on hydraulic mean depth and duct surface roughness n. The Manning formula is the simplest of the open channel equations:

$$V = \frac{1}{n} m^{2/3} S_o^{1/2}$$

$$Q = \frac{1}{n} A\, m^{2/3} S_o^{1/2} \qquad (2)$$

where Q is the flow rate, m^3/s
A is the flow cross sectional area, m^2

The value of the Manning coefficient, n, varies with pipe or channel material. Chow [1] suggests values in the range 0.009 to 0.018 for materials commonly found in building drainage systems.

Equation 2 determines the flow depth under steady, uniform conditions, only one value of h yielding the values of A and m necessary to satisfy the equation. As this depth is by definition constant downstream, $dh/dx = 0$, it must also be the terminal depth corresponding to the flow terminal velocity at that channel slope.

This depth, h_n, is commonly referred to as the normal depth.

The specific energy of the flow may be defined as

$$E = h + \frac{V^2}{2g} \qquad (3)$$

where h = local flow depth, m
V = local average flow velocity, m/s

For non-uniform velocity distributions a kinetic energy coefficient weighting factor, α, may be introduced as $\alpha V^2/2g$; here, the assumption is made of uniform distribution with $\alpha = 1$.

It may be shown that for a rectangular channel, width W, that there are two possible depths for any particular value of E above a minimum.

$$E = h + \frac{V^2}{2g} = h + \frac{Q^2}{2gA^2}$$

A = hW for rectangular case

$$E = h + \frac{Q^2}{2g(hW)^2}$$

$$h^3 - Eh^2 + Q^2/2gW^2 = 0$$

For a constant specific energy, E, this equation has three roots; two real, one imaginary. Figure 2 illustrates the alternate depths possible for a constant specific energy, generally characterized as rapid and tranquil flow. It will be shown that the boundary between these two alternatives depends on flow rate and cross sectional shape.

From equation 3 and Figure 2 it may also be seen that the flow specific energy has a minimum value below which the given flow conditions cannot exist. In a channel of arbitrary cross sectional shape this value may be determined as follows:

$$E = h + \frac{Q^2}{2gA^2}$$

$$\frac{dE}{dh} = 0 = 1 - \frac{Q^2}{gA^3}\frac{da}{dh} \tag{4}$$

From Figure 2

$$dA = T\ dh \tag{5}$$

where T is the surface width at any depth, h.

From equations (4) and (5) the minimum value of E will occur at a depth value, h_c, that satisfies the expression

$$1 - Q^2T/gA^3 = 0 \qquad (6)$$

This value of h is referred to as the flow critical depth h_c.

If the normal flow depth h_n exceeds h_c then the terminal flow would be termed subcritical, or tranquil flow. If h_n is less than h_c then the flow is termed rapid or supercritical.

It should be stressed that h_c is independent of pipe slope and pipe surface roughness; while the normal depth is dependent on both. Thus the same volume flow rate in any particular pipe may be rapid or tranquil depending on pipe slope, and similarly the same flow rate in a series of constant diameter pipes will be tranquil or rapid depending on roughness.

Pipes or channels in which rapid flow is normal are termed steep; pipes or channels in which tranquil flow is normal are termed of mild slope. It will be shown that hydraulic jumps may only be established in mild slope channels.

2.2 Gradually Varied Flow in Open Channels

Gradually varied flow is steady non-uniform flow of a special type. The flow parameters are assumed to change slowly, if at all, in the flow direction. The basic assumption in the treatment of this type of flow is that the local head loss at any section is given by the Manning expession, equation 2, for the local flow depth and rate under assumed steady, uniform flow conditions.

Based on the assumptions above and figure 3, the depth profile may be expressed as follows:

$$\frac{d}{dL}\left\{\frac{V^2}{2g} + (Z_o - S_oL) + h\right\} = -\left\{\frac{nQ}{Am^{2/3}}\right\}^2 \qquad (7)$$

where $(Z_o - S_oL)$ is the elevation at distance L along the channel, measured in the downstream direction; S_o is sin θ, channel bed slope,

$$\text{hence } -\frac{V}{g}\frac{dv}{dL} + S_o - \frac{dh}{dL} = \frac{nQ}{Am^{2/3}}^2 \qquad (8)$$

and as, Q = VA

$$\frac{dV}{dL}A + V\frac{dA}{dL} = 0$$

and $\frac{dA}{dh}$ = T from equation 5 it follows that

$$\frac{dV}{dL} = -\frac{V}{A}\frac{dA}{dL} = -\frac{VT}{A}\frac{dh}{dL} = -\frac{QT}{A^2}\frac{dh}{dL}$$

and substituting in equation (8) yields

$$\frac{Q^2T}{gA^3}\frac{dh}{dL} + S_o - \frac{dh}{dL} = \left\{ \frac{n\ Q}{A\ m^{2/3}} \right\}^2 \tag{9}$$

$$dL = \left\{ \frac{1 - Q^2T/g\ A^3}{S_o - (nQ/Am^{2/3})^2} \right\} dh$$

$$L = \int_{h_o}^{h_1} \frac{1 - Q^2T/gA^3}{S_o - (nQ/Am^{2/3})^2}\, dh \tag{10}$$

where L is the distance between two known depths h_o, h_1.

Figure 4 illustrates this numerical integration, which may be conveniently achieved by Simpson's rule.

The numerator and denominator of the function to be integrated in equation 10 may be recognized as the equations determining the critical and normal flow depths in an open channel.

When the term $(1 - Q^2T/gA^3)$ is zero the flow is at critical depth, i.e., there is no change in L for a change in h.

When the term $S_o - (nQ/Am^{2/3})^2$ is zero uniform flow depth is achieved, i.e., there is no change in h for a change in L.

For uniform cross section channels with constant roughness, n, and slope, S_o, the expression (10) becomes solely a function of flow depth h.

In order to numerically evaluate (10) it is necessary to define boundary conditions from which the integration may proceed. It should be stressed that the integration may be carried out either upstream or downstream from a known depth point. This ability is central to the use of this technique to determine the position of a profile discontinuity, such as an hydraulic jump.

Figure 5 illustrates the control depths used in the prediction of the water surface profiles in the case being investigated, namely the change in slope of an open channel.

It is assumed in figure 5 that suitable conditions exist for the formation of a hydraulic jump in the pipe downstream of the slope change. In order to predict the water surface profiles therefore three control depths are required as follows:

1) Downstream boundary at C. It may be assumed that the downstream boundary is formed by the condition that critical flow depth forms at a free discharge. Experimental work (3) has shown that the depth at such a discharge is slightly less than critical and that the critical depth occurs slightly upstream, around 0.7 pipe diameters, however this assumption is sufficient if the channel considered is long.

   Naturally if the normal flow depth is less than critical then the flow depth is unaffected by the presence of the discharge point and normal depth is maintained up to the exit at C. In this condition the flow is termed supercritical and the local wave speed is less than the flow velocity. For this reason information concerning the presence of the open discharge cannot be transmitted upstream, hence the maintenance of normal depth.

   Calculation of the water surface profile upstream from C show that normal flow depth is approached very rapidly, perhaps within 10-15 pipe diameters. For this reason a simplification that is considered justified would be to assume normal flow depth, above critical, in the whole pipe section B to C. This simplification has a bearing on the calculated position of the hydraulic jump as will be discussed later.

2) The upstream boundary at B. The upstream boundary is dependent on the exit conditions from the steep pipe AB, figure 5. If the specific energy at B in pipe AB is known, together with the flow rate, Q, then it is possible to predict the depth at B in pipe BC. Alternatively the flow rate and specific energy at B could be used as input information to the calculation, dispensing with the pipe length AB water profile integration.

3) The entry condition at A. The entry condition at A determines the flow profile in AB. Critical depth at the entry point A may be used, the normal depth in the steep pipe AB will be less than this value and the profile will take on the shape shown in figure 5, approaching normal depth at some point along AB.

   Alternatively the pipe length AB may be assumed long enough for terminal flow conditions to be achieved at B. This despenses with the calculation of the water surface profile in AB as equation (2) may be used to determine normal supercritical depth at B and equation (3) determines the appropriate specific energy provided the channel depth-area relationship is known.

   The choice of the depth increment value dh in the numerical integration is based, in this treatment, on the difference between the control depth for that section and the "target" depth. For example in section C to B the control depth is the critical depth at C while the target is the normal flow depth reached at some point between C and B. The depth cannot exceed this target. Hence an appropriate increment site may be calculated by

$$dh = (h_n - h_c)/N, \text{ C to B} \tag{11}$$

where N is some reasonable number in the range 10 to 30, depending on the desired accuracy and computation time.

Similarly for the section B to C

$$dh = (h_c - h_B)/N \tag{12}$$

For the steep slope A to B the increment would be

$$dh = (h_A - h_B)/N \tag{13}$$

where h_B is the normal depth expected for that particular channel and flow conditions.

2.3 Hydraulic Jump

The hydraulic jump is an important example of local nonuniform flow. In drainage design it is to be avoided as the local depth increase may be sufficient to produce full bore flow and associated back pressure problems. However, in the wider engineering context the inclusion of a hydraulic jump is often beneficial as a means of rapidly dissipating flow energy, with consequent reduction in channel erosion problems, the design of power plant turbine tail races being an example.

There is a considerable body of experimental and analytical literature available on the formation and characteristics of the hydraulic jump. The majority of this work is related directly to large civil engineering applications and is also confined to channels of straight sided cross sectional shape, from rectangular to trapezoidal. This is understandable as such channel shapes would be the naturally excavated design. Although laboratory models usually employ rectangular glass sided open channels to study, for example, jump formation downstream of a sluice gate, no references were found to the case of jump formation downstream of a slope change in small diameter partially filled pipes, namely the building drainage case.

The flow process leading to the formation of a hydraulic jump may be explained as follows: Assume that flow is established in a mild slope channel at a depth below critical for that channel and flow rate. As the normal flow depth is greater than critical, i.e., definition of mild slope, the effect of cumulative friction losses in the channel will be to increase the depth, with a consequent decrease in local average velocity. This depth change should continue until normal flow depth is achieved at some downstream point. This cannot happen via a gradually varied flow process as the theoretical water surface slope would have to be vertical as the depth passed through the critical value. Hence a discontinuity, or jump, in the depth profile is required to transfer the flow from supercritical conditions upstream of the jump to subcritical downstream. It is important to note therefore that such a discontinuity can only occur from a depth below critical to a depth above critical.

In the steady flow case, namely flow conditions constant with time, the position of this jump may be determined by a consideration of the forces acting on the fluid at the jump position and the water surface profiles upstream and downstream of the jump, figure 6.

Referring to figure 6 and assuming both a near horizontal channel, so that the fluid weight component may be ignored, and steady flow conditions, application of the momentum equation yields:

$$F_{h1} - F_{h2} = \rho\, Q(V_2 - V_1)$$

where F_h are the hydrostatic forces at 1 and 2

$$\text{hence } \rho_g A_1 \overline{h}_1 - \rho_g A_2 \overline{h}_2 = \rho A_2 V_2^2 - \rho A_1 V_1^2 \tag{14}$$

where A is the flow cross sectional area and h is the centroid depth, as illustrated in figure 7.

Rearranging (14) yields:

$$(\rho g A\overline{h} + \rho_g A\overline{h} + \rho A V^2)_2$$

or

$$(F+M)_1 = (F+M)_2 \tag{15}$$

where M is the momentum term ρAV^2

This analysis assumes that the jump length may be ignored, this allows the exclusion of local frictional effects over the pipe section containing the jump. This point will be returned to in the discussion of the prediction model.

It will be seen that both F and M depend on the flow depth and on the relationship between depth and area and hence centroid position.

The complexity of this expression (15) depends entirely therefore on the form of the depth to area relationship and on the local water surface profiles either side of the jump. The (F+M) term is sometimes referred to as the specific force (1); however this not entirely satisfactory due to the momentum content, and thereafter it is referred to as the (F & M) term.

Thus the position of the jump may be predicted provided that the flow depth profiles upstream and downstream are known. A knowledge of local depth plus the steady flow assumption allows all the terms in equation (15) to be calculated and allows the (F & M) values applicable to each point on either water surface profiles upstream and downstream of the jump to be plotted as shown in figure 8.

The intersection of the two (F & M) curves fixes the jump position. The two corresponding depths on the upstream and downstream water surface profiles are the conjugate depths for the jump and allow the energy loss to be calculated across the jump.

$$\Delta E = \{h + \frac{V^2}{2g}\}_2 - \{h + \frac{V^2}{2g}\}_1 \tag{16}$$

The formation of a hydraulic jump downstream of a slope change is not inevitable however. Figure 9 illustrates five conditions that should be considered in evaluating the possibility of jump formation.

a) If the flow normal depth, dependent on both pipe slope and roughness, is less than the critical depth, that is independent of slope or roughness, then no jump will form.

b) If the flow normal depth is greater than the critical depth and the (F & M) term at pipe entry is greater than the normal depth (F & M) value, then a jump will form as shown in figure 9. Its position may be determined as described previously.

c) If the pipe is insufficiently large in cross sectional area to maintain a free water surface, i.e., open channel flow, then full bore flow will be established in the pipe. This case is not treated here beyond its identification by comparing the normal depth calculated to the available pipe diameter.

d) A more interesting case occurs if the (F & M) value at pipe entry, i.e., at the slope change, is less than the (F & M) value appropriate to the downstream normal flow depth. In this case the jump effectively forms in the steep pipe, or it may be regarded as drowned at pipe entry. Analysis of this case requires the introduction of the mass component down the steep slope appropriate to the water mass contained between the sections 1 and 2 in figure 6. This introduces the physical length of the jump, obviously a simple treatment regards the jump as concentrated in one location; however in practice it can have lengths several times its downstream depth. Chow [1] presents an analysis based on empirical jump length measurements for rectangular channels, however no data is available for partially filled pipes and for the purposes of this study this case is merely identified by a comparison of the (F & M) term values as mentioned above.

e) A trivial case is formed when the length of pipe available downstream of the slope change is short. Here no jump will form if the length is less than that necessary for the flow depth to increase to the theoretical jump conjugate depth value appropriate to the upstream water surface profile. This case is not illustrated in figure 9.

Figure 10 illustrates the tests associated with these boundary conditions. It will be seen that (F & M) curve vs. slope has a minimum value, hence for particular pairs of values of θ_1, and θ_2 the (F & M) terms may change in their relative magnitudes.

Figure 11 summarizes these tests into a format that will be employed later in the generation of tables to indicate jump formation possibility.

2.4 Loss Coefficients for Slope Transitions in Open Channel Flow

No data could be obtained on the loss coefficients for slope transitions in open channel flow. For this reason the results presented assume no loss at the test pipe entry. The computer program as written has been designed to include such a loss coefficient, in the range 0 to 1, should such data become available from a future experimental program. The effect of such a loss would be to increase the flow depth at pipe entry, with a consequent decrease in the (F & M) term at pipe entry. In turn this would have the effect of generally moving the jump location upstream towards pipe entry. At the lower approach pipe slopes this effect could result in the jump appearing to become drowned at pipe entry. Experimental work is required to verify the model and the predicted effects of the loss coefficient discussed above.

3. CALCULATION TECHNIQUES AND PRESENTATION OF RESULTS

3.1 Determination of Normal and Critical Depths

The bisection method was used to solve the equation defining both critical flow depth

$$X = 1 - Q^2T/gA^3$$

and normal flow depth

$$Y = S_o - (n\,Q/Am^{2/3})^2$$

It may be assumed that both X and Y have zero values for some value of depth h in the range $0 < h < D$ for pipe case or $0 < h < W$ for the square section case. The process is described below:

The initial interval is bisected and a trial value of h = D/2 or W/2, depending on geometry, is used to evaluate X, Y above. If the resulting values are positive then the sought after root is less than the trial value just used.

A new trial value is obtained by bisecting the interval 0 to D/2 or W/2 and X and Y recalculated. If the values obtained remain positive, a further reduction in trial value is obtained by bisection.

If the values of X, Y are negative then the desired root is larger than the trial value and an increased h value is obtained by bisection between the upper limit, in this case D or W, and the trial value just employed. This process may be repeated until the required root is obtained.

Due to the need to include the area depth relationship the solution process must be iterative. The computation time depends largely on the complexity of the area-depth function.

3.2 Numerical Integration for Surface Profiles

The integration of the position vs depth profile

$$L = \int_{h_1}^{h_2} \frac{1 - QT^2/gA^3}{S_o - (nQ/Am^{2/3})^2}\, dh$$

is achieved by means of Simpson's Rule. Let the integral $X = \int_{h_0}^{h_1} F(h)\, dh$, then if the interval h_1-h_0 is divided into 2 equal increments, the value of X is given by

$$X = \frac{1}{3} dh \; [(F(h_o) + 4F(h_o+dh) + F(h_o+2dh)]$$

As the integration moves on the length traversed may be accumulated as L = L + X at the completion of each integration.

3.3 Determination of Jump Position

The water surface profiles and the associated (F & M) curves for the flow upstream and downstream of the jump are illustrated by figure 8. The jump position is determined in the following manner within the computer program; figure 12 illustrates:

1) Choose a small increment Δx less than the smallest ΔL on either of the water surface profiles. Note ΔL varies along each profile as shown in figure 4.

2) For the water surface profile downstream of the jump, i.e. that calculated by integration back from the critical depth at pipe discharge, determine the calculated profile points on either side of the Δx value, measured from pipe entry, points G, H figure 12.

3) Calculate the (F & M) value at position Δx on the downstream profile, point J.

4) For the profile calculated by integration downstream from pipe entry determine whether the corresponding (F & M) values at the known profile points on either side of Δx are bracketing the trial (F & M) value from step 3, points K, M. If this is the case the curves intersect in this increment, if both are greater than the trial value then the curves have not intersected up to this interval.

5) If the curves have not intersected, increase the search position from x to x + Δx and repeat steps 2 through 4.

6) If the curves have intersected then the intersection point can be obtained by solving the two straight line equations representing the water surface profiles between the two pairs of known points bracketing the intersection position. This is illustrated by points UV, and XY in figure 12.

   The technique uses the simplifying assumption that the water depth downstream of the jump is at the normal flow level, hence (F & M) for C to B becomes a known constant. This simplification was extensively used in the results presented (in figure 12 the resulting downstream depth was H then became the constant normal depth value).

3.4 Presentation of Results

The parameters governing the flow and the location of the hydraulic jump are numerous. The selected test cases, analyzed by program HYDJUMP run on the NBS CBT Perkin Elmer 732 computer, are summarized below:

1.1) Pipe diameters: 0.075, 0.10, 0.15 m.
1.2) Manning coefficient 0.015.
1.3) Test pipe slopes at all pipe diameters: 1/40, 1/80, 1/100, 1/200 (Additionally slopes 1/150, 1/300, 1/400, 1/600 were run for the 0.15 m diameter pipe only).
1.4) Approach pipe slopes 2°, 4°, 6°, 10°, 20°, 30°, 45°, 60°, 75° and 90°.
1.5) Additionally for the 0.15 m pipe at 1/300 slope, the effect of Manning coefficient values of 0.009, 0.012, 0.015 and 0.018 on jump position for the whole range of approach slopes was carried out at one flow rate.

2.1) Rectangular channels, width 0.075, 0.10, 0.15 m.
2.2) Manning coefficient 0.015 only.
2.3) Test pipe slopes 1/40, 1/80, 1/100, 1/200.
2.4) Approach pipe slopes 2°, 4°, 6°, 10°, 20°, 30°, 45°, 60°, 75° and 90°.

The full results are presented in tabular form in a series of appendices.

In addition plotted data is presented to illustrate the main points in the discussion of the results.

The results indicated the need to determine the boundary conditions in terms of normal and critical flow depths, pipe diameter and (F & M) values. This led to an additional program HYDSUM, capable of calculating normal and critical depths as well as (F & M) values. Tables based on this program's output are included as a method of determining whether a jump will form in the test pipe.

The two main programs, HYDJUMP and HYDSUM are included in an appendix together with flow charts and input data instructions.

3.5 Selection of Input Data

The choice of input test conditions was governed by the range of values likely to be found in drainage systems. The pipe diameters chosen, 0.075, 0.10 and 0.15 conform to this criteria as do the pipe gradients used for all test cases, 1/40, 1/80, 1/100, 1/200. The choice of pipe roughness or Manning coefficient was more difficult, however values in the range 0.009 to 0.018 are recommended in many texts, i.e. Jaeger [3] and Chow [1].

As previously discussed, the losses at the change of slope that produce the conditions conducive to hydraulic jump formation have been ignored in this treatment. No available data on open channel transition loss coefficients for partially filled pipes or channels could be obtained. The program is capable of dealing with transition losses however via an input data control variable provided the loss can be expressed as a factor, 0 to 1.0, of the specific energy of the flow at pipe entry.

4. DISCUSSION

The position of the hydraulic jump in a mild slope channel following a change in bed slope is determined by the equivalence of the hydrostatic force plus momentum terms outlined in equations 14 and 15 and figures 6 and 8. If, as a starting assumption, the flow downstream of the jump is assumed to be uniform and at normal depth, then the jump position appears to be entirely dependent on the rate of change of the (F & M) term with respect to distance along the channel. This is demonstrated in figure 12, and the following analysis.

The results for jump location therefore may be discussed in terms of the parameters governing this gradient, d(F & M)/dL.

From equation 14, that the (F & M) term at any location may be expressed as

$$(F \& M) = \rho g A\bar{h} + \rho A V^2$$

$$F \& M = \rho g A\bar{h} + \rho \frac{Q^2}{A} \tag{17}$$

$$\frac{d(F \& M)}{dL} = \rho g A \frac{d\bar{h}}{dL} + \rho g h \frac{dA}{dL} - \rho \frac{Q^2}{A^2} \frac{dA}{dL} \tag{18}$$

The form of equation (17) indicates that (F & M) will initially decrease as depth and hence area A increase, however at some depth value the hydrostatic force term will predominate and the (F & M) value will increase. It therefore follows that there would theoretically be two intersection points for the two (F & M) curves in figure 12, however the intersection closest to the pipe entry is the valid solution and the technique described in figure 12 will ensure that this is the solution produced. The form of equation (18) confirms this point, d(F & M)/dL being initially negative due to the predominance of the momentum term.

As the rate of decrease of (F & M) is dependent on both depth and rate of change of depth, it is necessary to incorporate the Manning equation to represent local friction losses at the equivalent steady, uniform flow conditions. This appears in the denominator of equation (10) and may be used to explain the movement of the jump position.

$$\frac{\Delta h}{\Delta L} = \frac{S_o - (n\,Q/Am^{2/3})^2}{1 - Q^2T/gA^3} \tag{19}$$

Changes in S_o, Q, and n that result in an increase in the value of $\Delta h/\Delta L$ will indicate an increase in d(F & M)/dL, however this does not automatically imply that the jump position will move upstream.

Figures 13 and 14 illustrate the dependence of flow normal and critical depths and (F & M) values on flow rate and pipe slope for the 0.15 m diameter pipe case. It will be seen that as Q increases or S_o decreases, the values of normal depth and (F & M) increase. This effectively reduces the necessary drop from the (F & M) value associated with the water surface profile at pipe entry upstream of the jump, figure 12, and would imply, for a constant d(F & M)/dL, a jump location movement towards pipe entry.

Consider the jump location movement illustrated in figure 15. For constant Q, D, n and test pipe slope, $S_o = \sin\theta_2$, the value of $\Delta h/\Delta L$ will be constant, equation (19). Similarly for constant Q, D, n and S_o the value of normal depth in the test pipe, figure 13, will also be constant, providing a constant target (F & M) value.

However as the approach pipe slope, θ_1, increases the value of the entry conditions to the test pipe change, the entry depth decreases and the entry velocity rises. Thus as θ_1 increases the entry value of (F & M) at L=0 increases, this effect for constant flow rate is illustrated in figure 14.

Therefore the intersection point between the (F & M) curves associated with the water surface profiles upstream and downstream of the jump would be expected to move downstream as the approach pipe slope increased. This effect is illustrated in figure 15 for each of the test pipe slopes considered. Figure 16 confirms this result for the rectangular section channel.

Inherent in the definition of the hydraulic jump location is the criterion that the depth upstream of the jump is below critical and that downstream is above critical. This implies that the Froude Number (upstream of the jump), defined as

$$F_r = V/\sqrt{gh} \tag{20}$$

is greater than unity upstream and less than unity downstream. This results in the inability of jump position information to be transmitted upstream as the wave speed is less than the local flow velocity. As a result of this the depth downstream of the jump may be thought of as the sole determinant of jump position for similar flow situations. This effect is illustrated in figure 15 and 16.

Consider the case of constant approach pipe slope θ_1 and constant flow rate Q, i.e. vertical lines drawn in the L - sin θ_1 plane. In this situation the (F & M) value at pipe inlet remains constant, however as the test pipe slope, θ_2 decreases the normal flow depth increases and with it the target (F & M) value, figures 13 and 14. Thus the downstream flow depth controls the jump position, the jump moving towards the pipe inlet as the test pipe becomes less steep. Jaeger [3] quotes this depth effect as the sole determinant of jump position in the case of hydraulic jump formation upstream of an obstruction to the flow.

As indicated in figure 15 jump location may be expressed by an equation of the form

$$L = L_x - C^K \sin(\theta-\theta_o)^{0.25} \tag{21}$$

It was felt that such an empirical formula had little value in this situation due to the complexity of the boundary conditions already described and the ability of the computer simulation to predict jump positions for a wide range of flow conditions in a relatively short time. It would appear from the available literature, although primarily directed to large civil engineering applications, that this conclusion is shared by most investigators, as no similar relationship was found. In every case it was recommended that jump position be calculated by the gradually varied flow analysis presented for each set of flow conditions.

The downstream depth also controls jump position as indicated by the results presented in figures 17 and 18. Here for constant $S_o = \sin \theta_1 = 1/200$ and constant D and n the jump location moves upstream as the flow rate decreases from 8 to 1 ℓ/s. Reference to figure 14 at any value of $\sin \theta_1$ indicates that the differential between (F & M) at L = 0, i.e. pipe entry value, and the (F & M) value appropriate to normal depth in the test pipe, decreases as the flow rate decreases. Hence, with reference to figure 12, the intersection position would be expected to move upstream, as confirmed for both circular and rectangular cross section channels by figures 17 and 18.

It will be noted that none of the jump position curves pass through the origin. This is to be expected as theoretically the jump location would tend to L = 0 as approach pipe slope θ_1 approaches the test pipe slope θ_2. In addition to this effect some of the curves, namely those representing shallow test pipe slopes, intersect the $\sin \theta_1$ axis at approach pipe slopes greater than this minimum. This is due to the drowning of the jumps at pipe entry, as illustrated in figure 9, Case 4, caused by a reversal of the differential between (F & M) at pipe entry and the (F & M) value associated with the normal depth flow in the test pipe. As mentioned previously the jump moves upstream into the approach pipe and a calculation of its position requires a knowledge of jump length and approach pipe slope. No theoretical calculation technique for jump length, i.e. the distance between control sections 1 and 2 in figure 6, is available, the data on this variable being entirely empirical and generally applicable only to straight sided channel shapes.

Tabulated results for the full range of test cases represented by figure 15 to 18 for pipe diameters and channel widths 0.075 to 0.15 m are presented in Appendices 1 to 6. Tables 1 and 2 present typical examples for the 0.1 m diameter pipe and channel cases. These results for the smaller dimensioned channels, 0.075 and 0.10 m diameter and width confirm the discussion presented above. Figures 19 and 20 are representative of these results.

Referring to figures 19 and 20, it will be seen that considerable difficulty was experienced in producing comparable test cases for the three channel dimensions chosen. This is entirely due to the influence of the boundary conditions introduced in figures 9 to 11. Indeed no jump formation was possible at 1/40 for the full range of test cases dealt with. This result prompted the preparation of tabular data based on the boundary conditions illustrated in figure 10 that would allow the formation of a jump, but not its location, to be predicted at considerably less computing time.

Table 3 illustrates the technique. Full tables for the test cases covered are presented in Appendix 7 and 8.

Referring to table 3, assume that the flow rate is Q_2, approach pipe slope is U_1 and test pipe slope is S_2. Pipe diameter is D and the Manning coefficient is n. The table has been produced by means of equations (2), (6) and (14) and allows the following boundary checks to be made, corresponding to figure 9.

1) Case 1, compare $hn_{1,2}$ to hc_2, if $hn_{1,2} < hc_2$, no jump possible.

2) Case 2, compare $hn_{1,2}$ to hc_2, if $hn_{1,2} > hc_2$, jump possible.

3) Case 3, compare $hn_{1,2}$ to D if $hn_{1,2} = D$, full bore flow, jump forms but location not determined.

4) Case 4, compare the normal flow depth value of (F & M) at Q_2 and S_1 in the test pipe, $(F \& M)_{12}$, to the value of the $(F \& M)^*$ term at pipe entry. It is assumed that this is equal to the terminal $(F \& M)^*$ value in the approach pipe and that the approach pipe was sufficiently long to allow normal flow depth to be established. Approach pipe slope designated U_1.

hence (i) if $(F \& M)_{12} < (F \& M)^*_{12}$, jump possible

(ii) if $(F \& M)_{12} > (F \& M)^*_{12}$, then the jump forms in the approach pipe or is drowned at pipe entry.

Appendix 8 presents similar tables for the 0.15 diameter test pipe case only for a range of Manning coefficient values 0.009 to 0.018. This table was used to determine a suitable test case for an evaluation of the effect of Manning coefficient on the jump location in a 0.15 m diameter channel. From Appendix 8 employing the method outlined above for table 3, a test case based in 6 l/s flow rate at a pipe slope of 1/300 was seen to produce a hydraulic jump at each of the values of Manning coefficient between 0.009 and 0.018 chosen. Appendix 9 contains the results of this test series while figures 21 and 22 summarize the data.

Two test cases were investigated.

1) Manning coefficient constant for both approach pipe and test pipe.

Figure 21 illustrates this case. As is to be expected the jump location moves downstream as the value of Manning coefficient decreases. This is in line with Jaeger [3] comments on the importance of downstream depth as the normal flow depth will decrease with decreasing Manning coefficient.

Similarly this result agrees with the description of jump location movement based on (F & M) values. As n decreases the normal flow depth (F & M) value in the test pipe decreases. For the approach pipe the decreasing n also results in a reduced normal depth, however due to the slope of the (F & M) vs slope curve illustrated by figure 10, this results in an increased value of (F & M) at test pipe entry. This increase in the differential between the entry and target (F & M) values in the test pipe effectively impose a downstream movement on to the intersection point and jump location, figure 12.

2) The Manning coefficient held constant at 0.015 for the approach pipe and only varied for the test pipe.

   The general trend in these results is similar to that described above. The constant value of n = 0.015 for the approach pipe effectively decreases the entry (F & M) value for the n = 0.009 and n = 0.012 cases, comparing figures 21 and 22. Hence the jump position would be expected to move upstream, as is demonstrated by the results. For the n = 0.018 case, the approach pipe effectively has a reduced n value and hence the terminal (F & M) value is increased and the jump position should move downstream. Again the results confirm this.

All the results discussed above were obtained with the assumption that terminal conditions had been achieved in the approach pipe and that the flow downstream of the jump could be considered uniform, i.e., the depth was equal to the normal flow depth defined previously. This assumption was necessary if any order was to be found in the results produced by the computer program. The program however was capable of producing jump location for any combination of pipe lengths, slopes and roughness coefficients.

Appendix 10 presents the full program output for a given set of pipe lengths and slopes. This output may also be used to justify the normal flow depth assumption downstream of the jump, as 95 percent of normal depth is achieved in some 20 pipe diameters. The output also presents the water surface profiles in the approach pipe and upstream of the jump in the test pipe.

Appendix 11 contains the full print out of the program HYDJUMP employed to generate these results and the control data necessary to vary the format of the data output and control the assumptions made in the calculations.

Similarly Appendix 12 presents the program HYDSUM employed to produce the tabular guides to jump formation summarized in table 1.

5. CONCLUSIONS AND FURTHER WORK

The objective of this study was the development and testing of a computer program capable of predicting the location of a hydraulic jump following a change in slope in an open channel or partially filled pipe.

The program HYDJUMP presented has been shown to be capable of jump prediction based on the assumptions inherent in the application of gradually varied flow analysis.

An extensive range of program test conditions were considered within the limits set by parameter values encountered in building drainage system design.

It was found possible to explain the movement of jump location with such parameters as flow rate, pipe slope, and roughness in terms of the criteria determining jump formation in near horizontal channels.

Although a considerable body of literature exists on hydraulic jump formation in civil engineering style open channels,no comparable study was found employing the parameter values presented. Similarly the majority of the available literature referred to straight sided open channels rather than to partially filled pipes of small diameter. All analytical solutions were restricted to the simplest rectangular section channels due to the complexity introduced by the depth to area and centroid position funcitons in non-rectangular sections.

The computer program,as included,has been designed to deal with rectangular or circular section channels. Extension to other shapes requires only that the shape functions be introduced into the two main subroutines, BOUND and CALC, and that the range of control values assigned to the control variable SHAPE be extended accordingly.

It is felt that the next stage in this study should be an experimental phase designed to compare the predictions from HYDJUMP with laboratory observations, incorporating modified assumptions where necessary. The loss at the pipe slope change, although incorporated in the program for future use, has not been investigated as to do so without laboratory test backing would be of little value.

As a result of the computer study, several boundary conditions that govern the formation of a jump were identified. As an aid to future work these boundary conditions were incorporated into a program HYDSUM, also presented, that enables the probability of jump formation to be assumed prior to running the more time consuming HYDJUMP to determine its location. The predictions of HYDSUM could also be used in designing a laboratory test series.

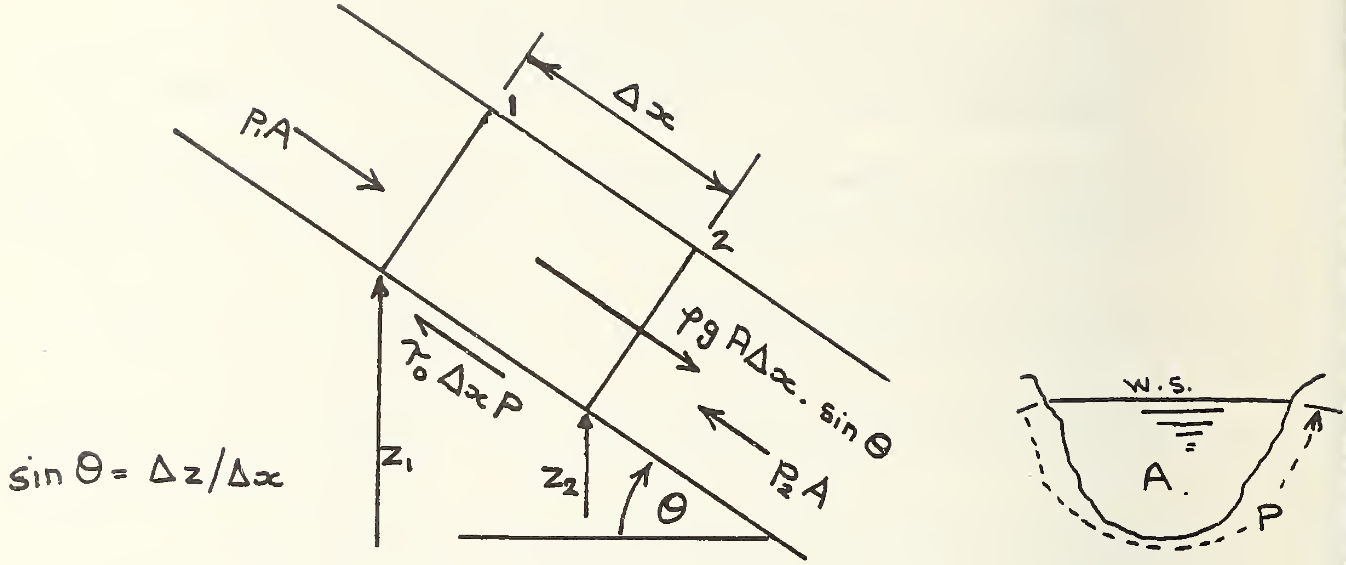
6. REFERENCES

[1] Chow, V.T., Open Channel Hydraulics, McGraw Hill, 1970.

[2] Douglas, J.F, Gasiorek, J.M. and Swaffield, J.A., Fluid Mechanics, Pitman 1979.

[3] Jaeger, C., Engineering Fluid Mechanics, Blackie and Sons, London, 1956.

[4] Streeter, V.L. and Wylie, E.B., Fluid Mechanics, McGraw Hill, 1974.



At stations 1 and 2 the following equations apply:

Energy equation

$$\text{Losses} = h_f = \frac{p_1 - p_2}{\rho g} + z_1 - z_2$$

as $V_1 = V_2$; steady, uniform flow.

Momentum equation (down slope direction)

$$(p_1 - p_2)A + \rho g A \Delta x \sin\theta - \tau_o \Delta x P = 0$$

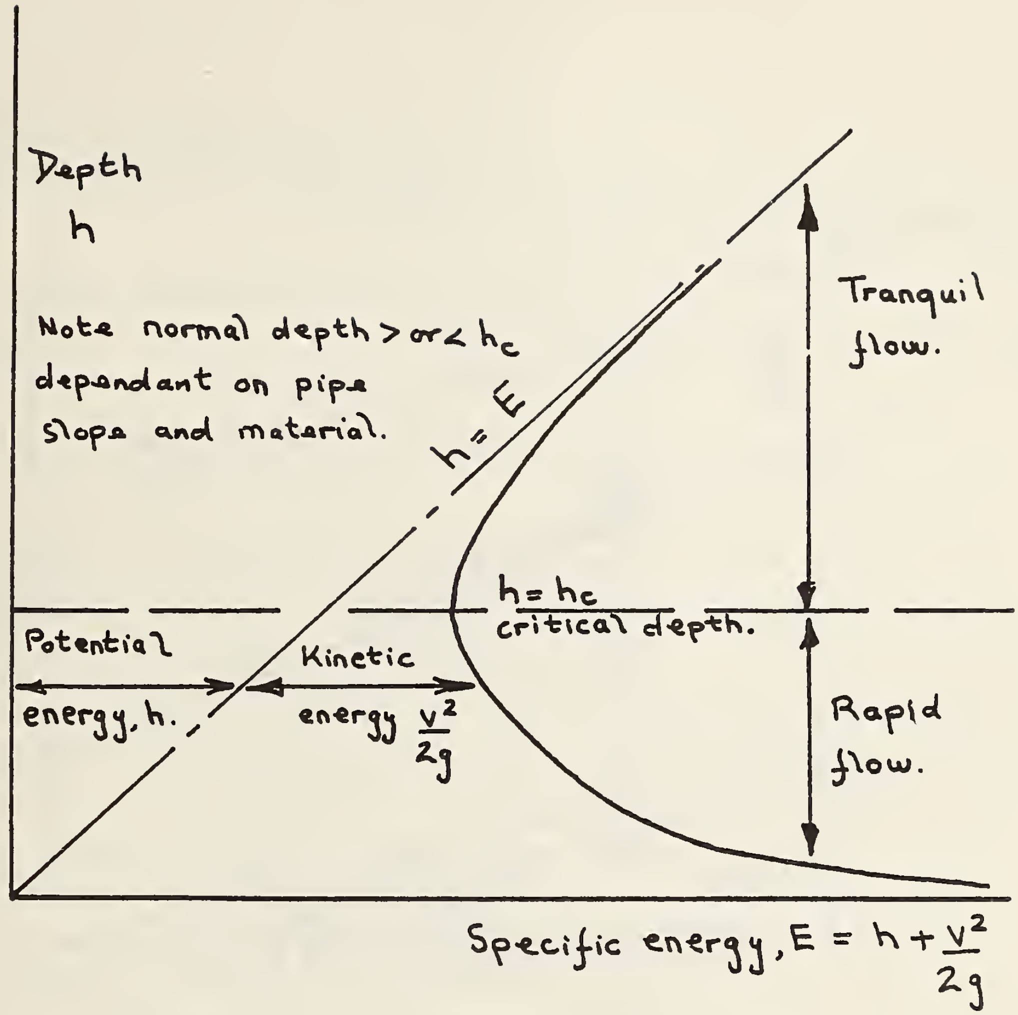
as $dV/dt = 0$; steady flow.

$$\therefore \frac{p_1 - p_2}{\rho g} + \Delta z = \tau_o \frac{\Delta x P}{\rho g A} = h_f$$

For turbulent flow $\tau_o = f \frac{1}{2} \rho v^2$

$$h_f = f \frac{\Delta x V^2}{2gm}, \quad V = C\sqrt{mS_o}, \quad \begin{aligned} S_o &= \sin\theta \\ m &= A/p \\ C &= \text{constant} \end{aligned}$$

Figure 1. Derivation of Chezy equation for steady uniform flow. Note no shape restriction on channel.



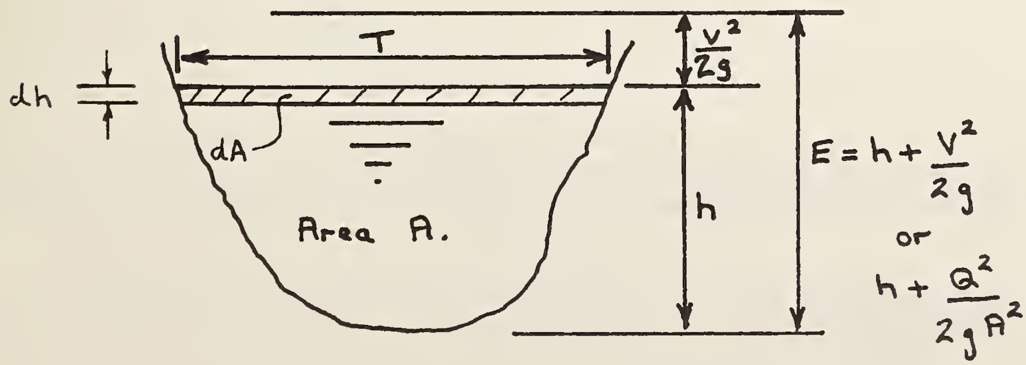
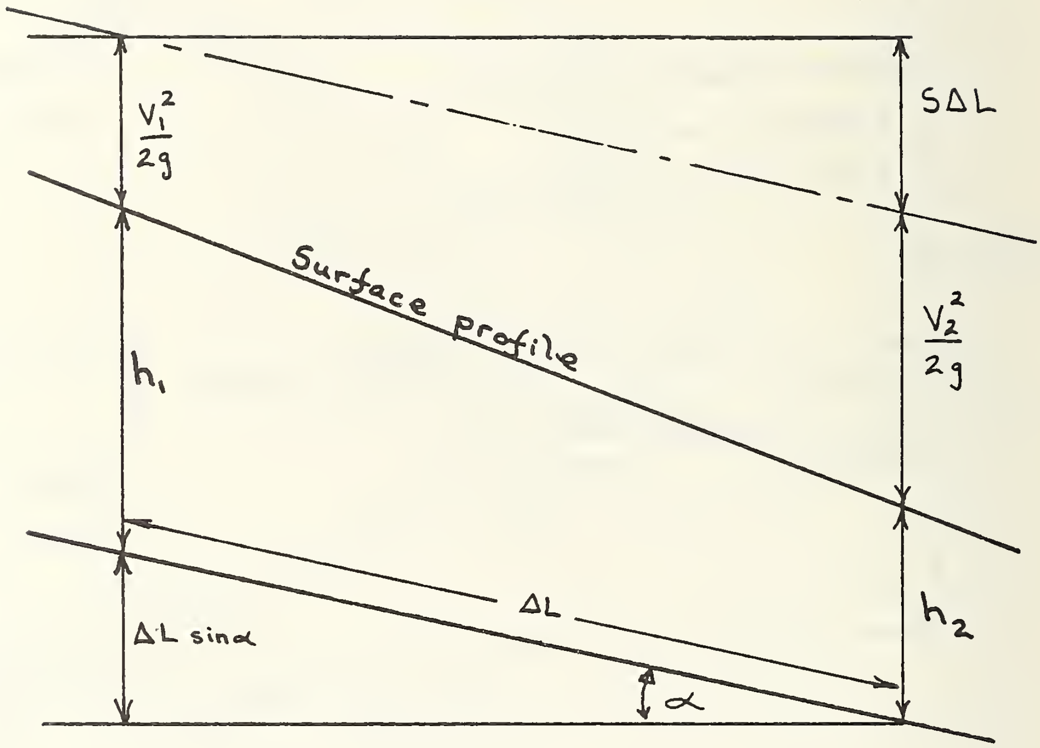


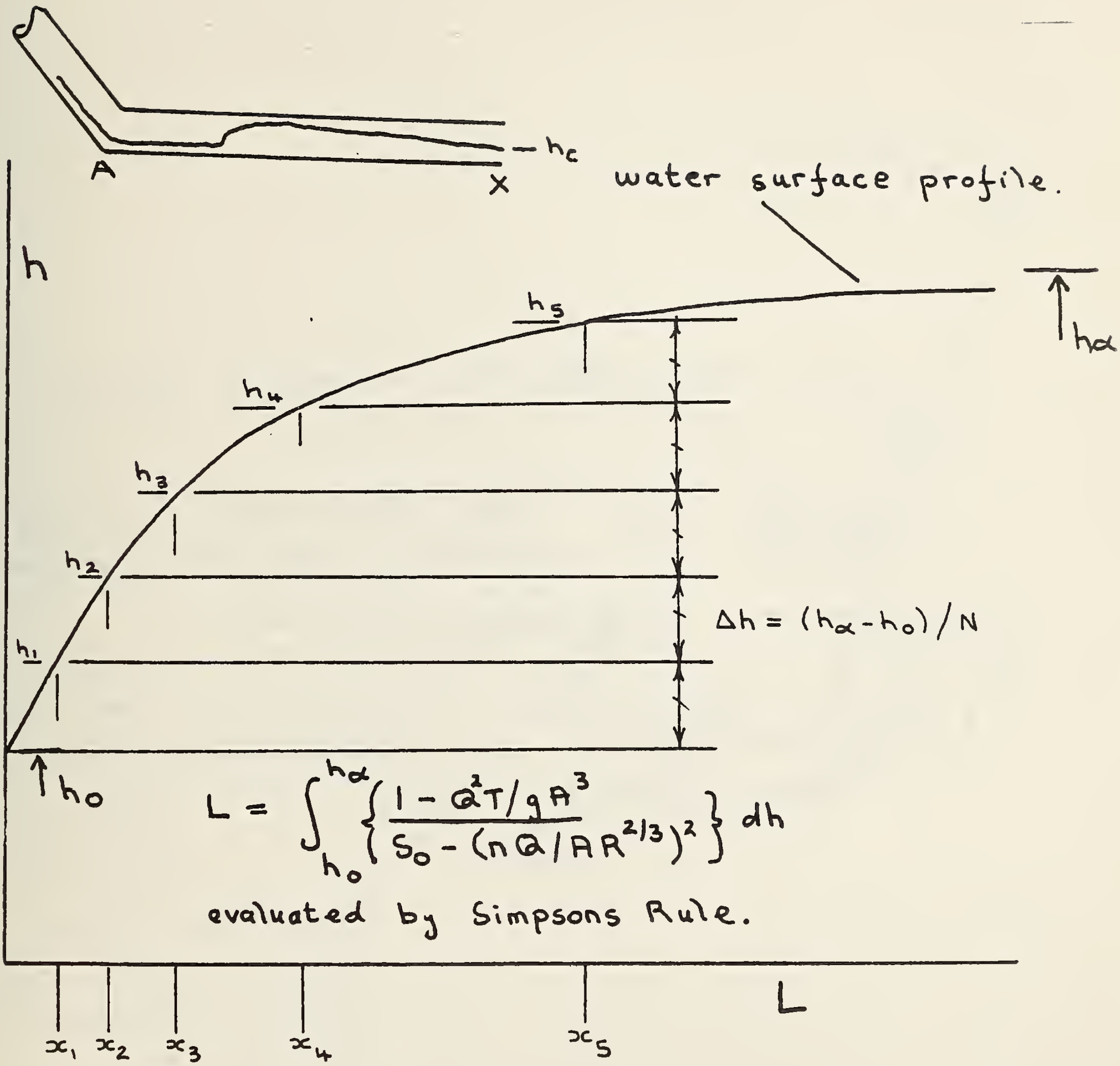
Figure 2. Relationship between specific energy and flow depth, illustrating alternate rapid or tranquil flow regimes.



Gradually varied flow, analysis based on head loss at any section being equal to Manning loss prediction, where

$$S = -\frac{\Delta E}{\Delta L} = \left(\frac{nQ}{Am^{2/3}}\right)^2$$

Figure 3. Representation of the gradually varied flow depth profile model.



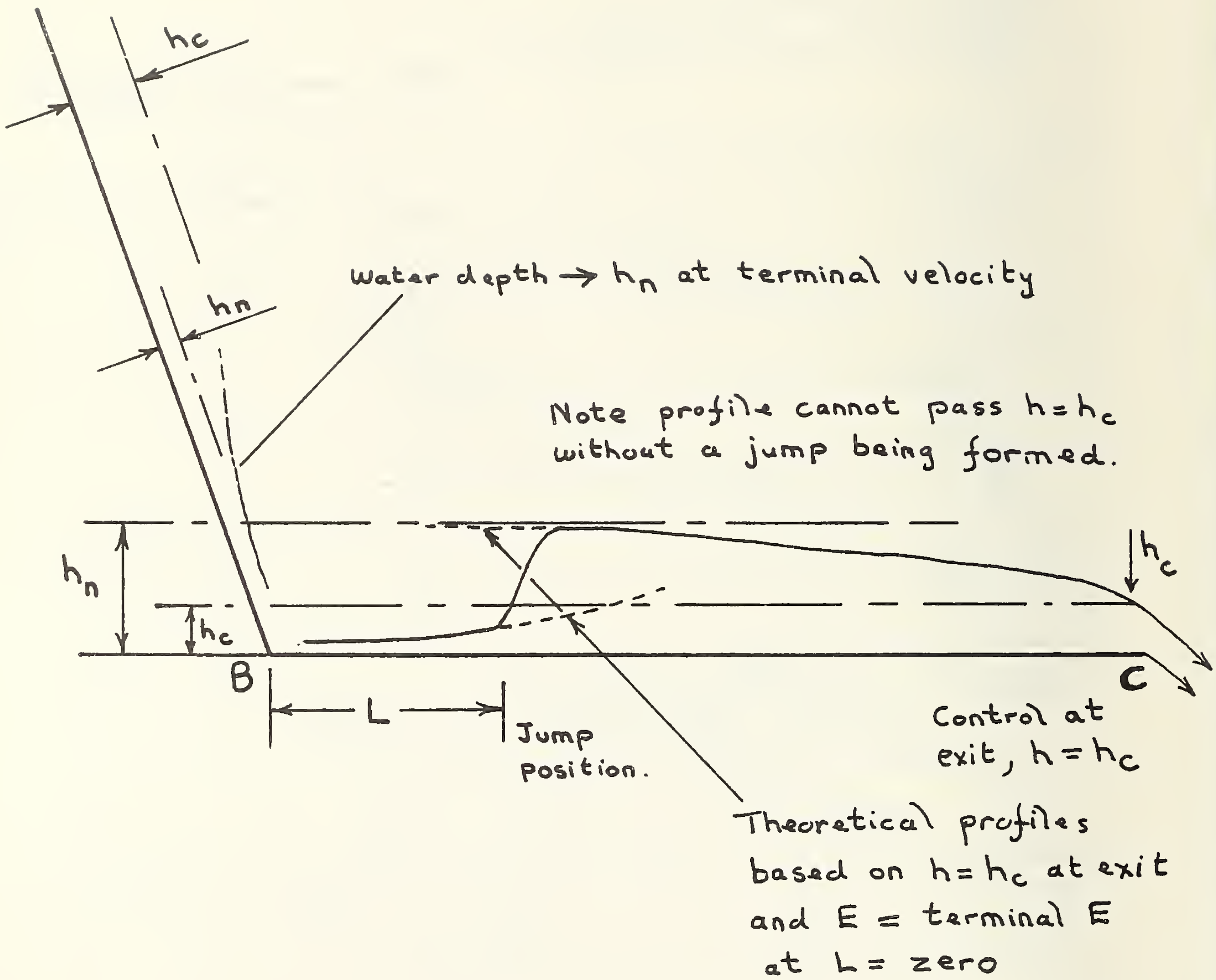
Note 1. ΔL increases as calculation proceeds

2. Calculation proceeds downstream from A to give profile $h_o \leq h < h_c$; h at A taken as intitial condition.

3. Calculation proceeds upstream from X to give profile $h_c \leq h < h_n$; h at X taken equal to critical depth as initial condition.

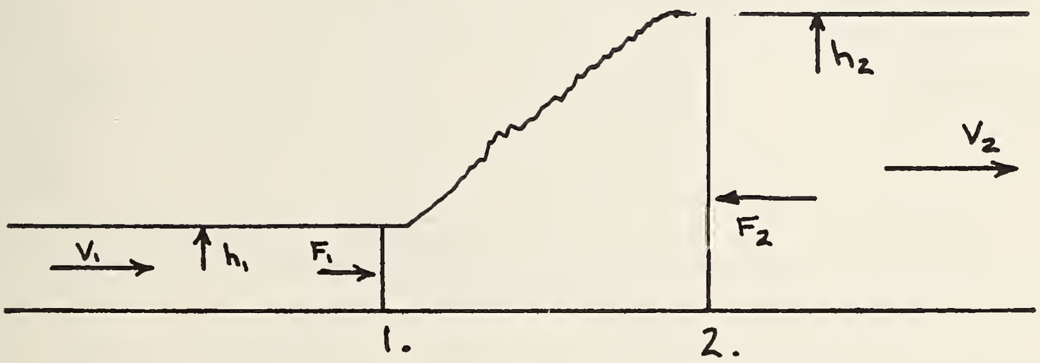
4. Value of N dependent on situation, range 10-30.

Figure 4. Schematic representation of numerical integration to determine water surface profile.



Note: Water surface profiles approach h_n rapidly from an initial condition $h = h_c$.

Figure 5. Control depths employed in determining water surface profiles upstream and downstream of a pipe slope change.

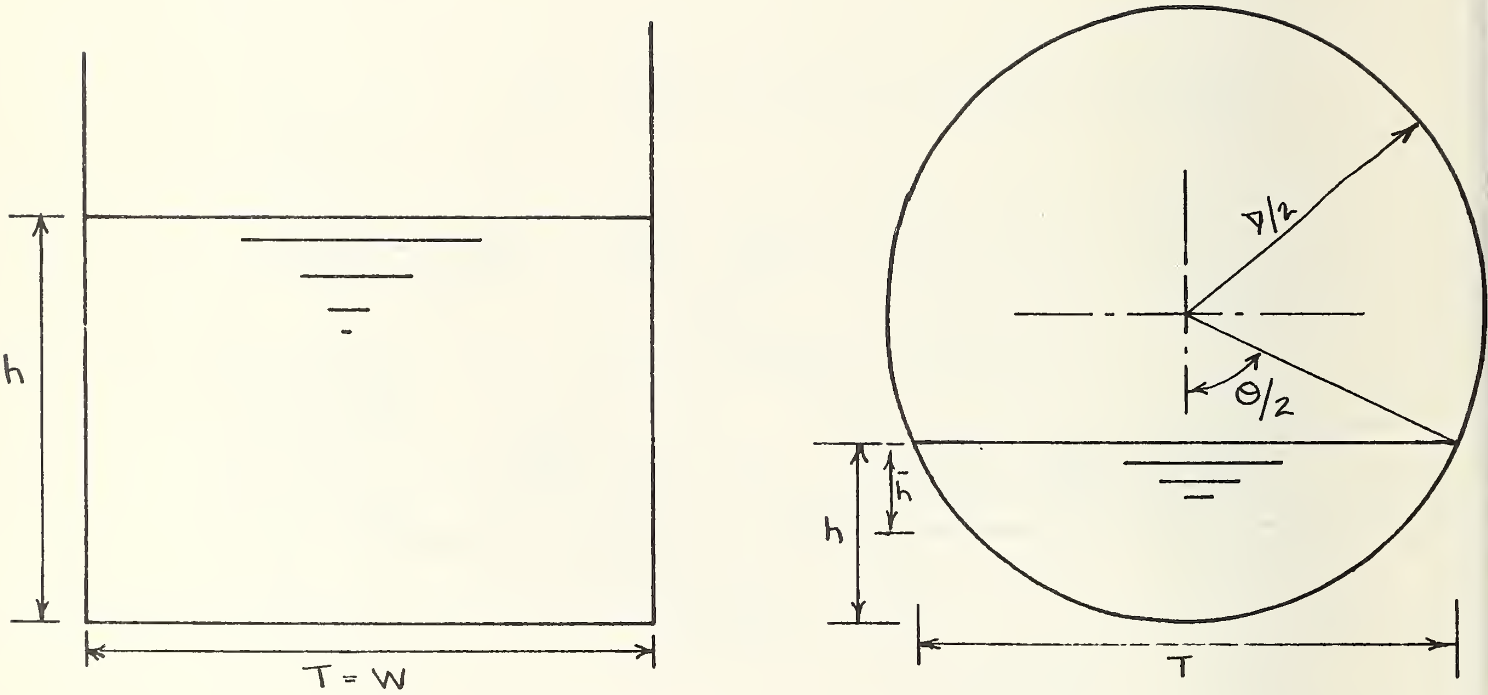


$F_1 = \rho g A_1 \bar{h}_1$	$\bar{h}_{1,2}$ - centroid depth = f(channel shape)
$F_2 = \rho g A_2 \bar{h}_2$	$F_{1,2}$ - hydrostatic forces
$M_1 = (\rho A_1 V_1) V_1$	$M_{1,2}$ - momentum crossing control
$M_2 = (\rho A_2 V_2) V_2$	volume boundaries at 1,2

Jump occurs if $(F+M)_1 = (F+M)_2$.

Depths h_1, h_2 known as conjugate depths.

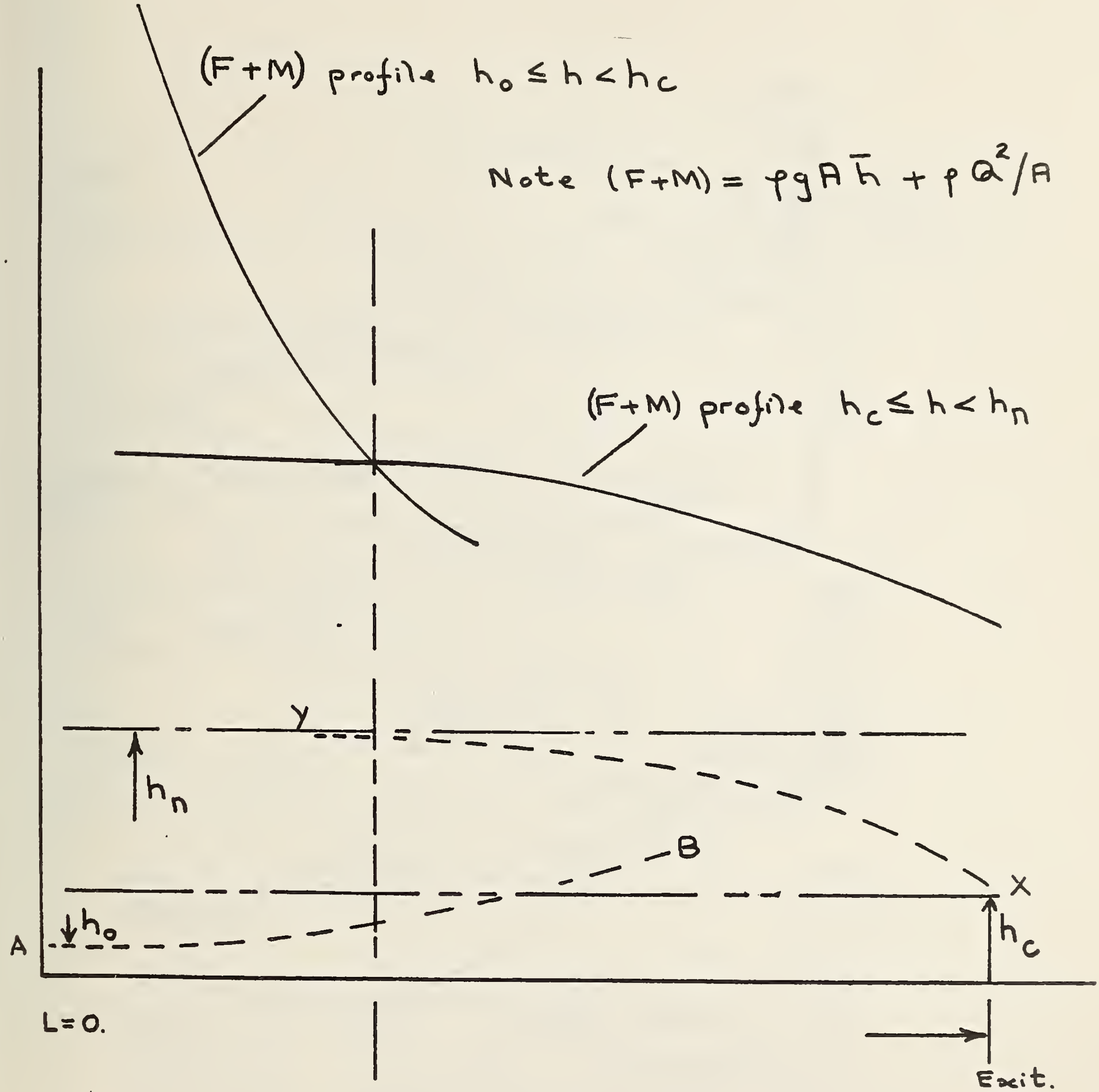
Figure 6. Forces acting at the jump location in a horizontal, or near horizontal channel.



Depth	$= h$	$= h$
Area	$= h \times w$	$= (D^2/8) \times (\theta - \sin\theta)$
Surface width T	$= w$	$= 2.0 \times \sqrt{h \times (D - h)}$
Perimeter	$= 2h + w$	$= D \times \theta/2$
Centroid depth $\overline{h}$	$= h/2$	$= h - D/2 + X_o$

$$X_o = \frac{2}{3} \times \frac{D}{2} \times \left(\frac{3 \times \sin\theta 2 - \sin 3\theta/2}{4 \times (\theta/2 - \frac{1}{2} \times \sin\theta)} \right)$$

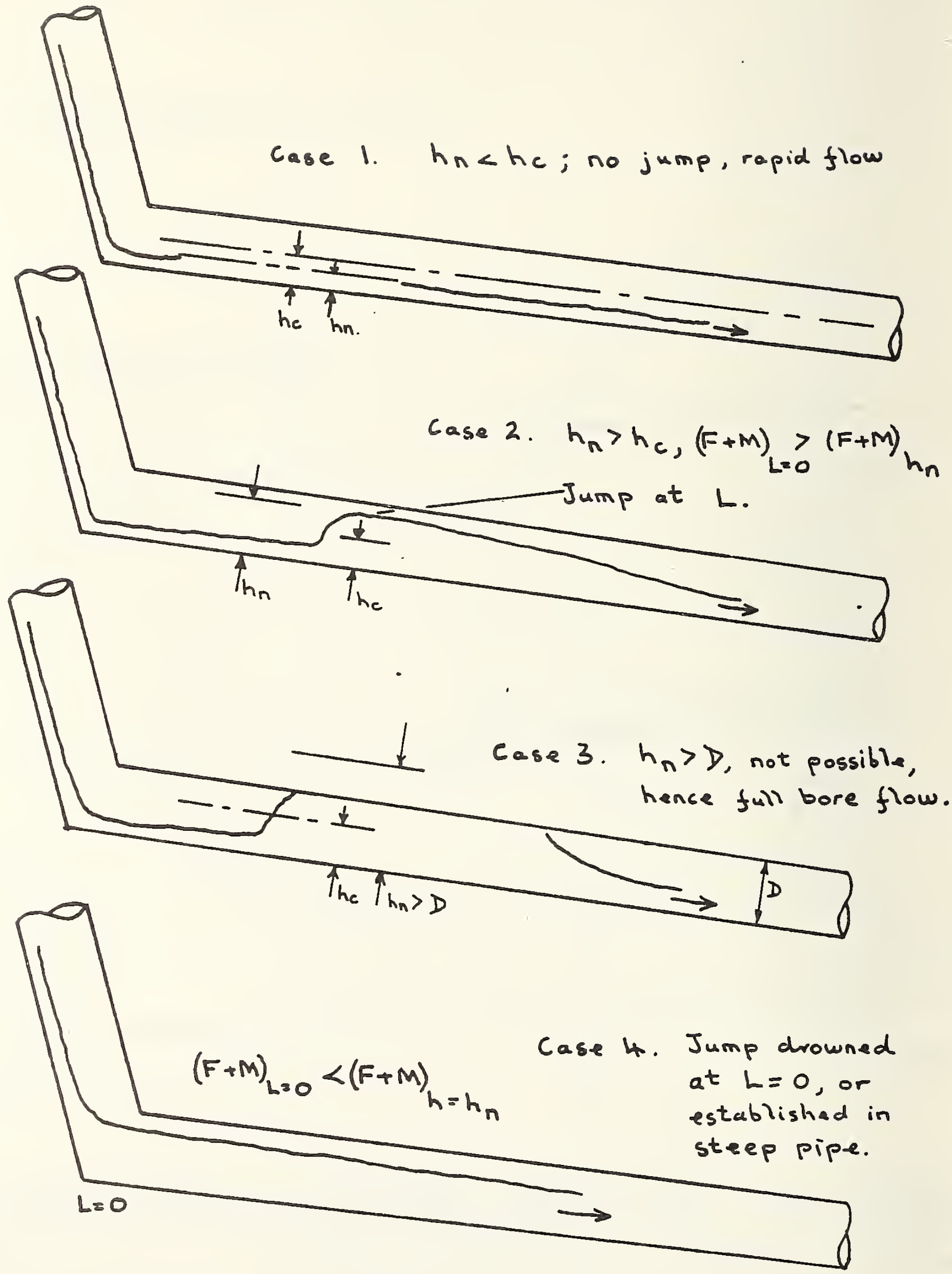
Figure 7. Summary of duct cross section parameter calculations.



Profile AB calculated from h_o with $(h_c - h_o)/N$ as Δh value.

Profile XY calculated from h_c with $(h_n - h_c)/N$ as Δh value

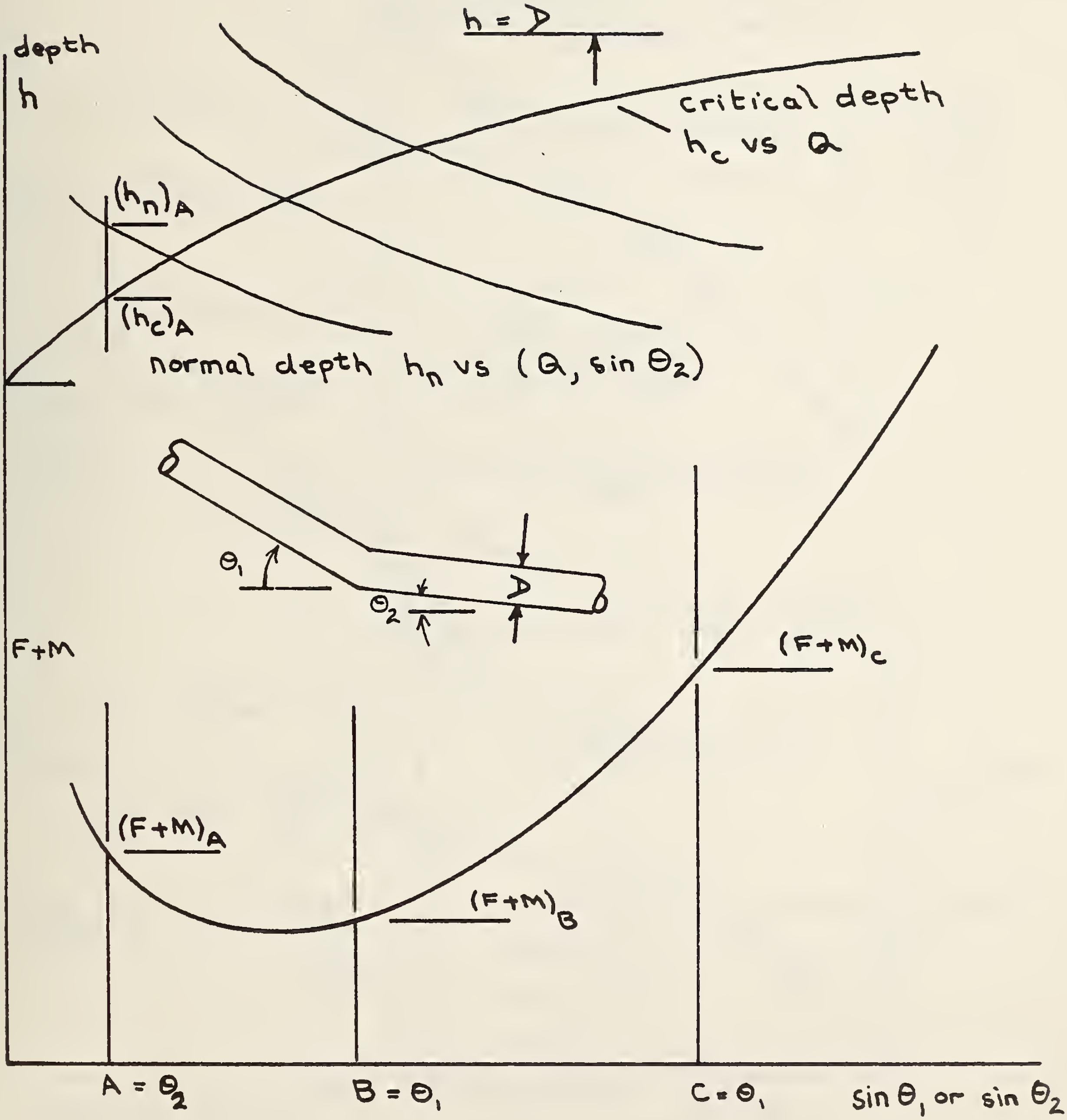
Figure 8. Water surface profiles and associated (F+M) profiles employed to position hydraulic jump.



Note: h_c given by: $Q^2T/gA^3 - 1 = 0$

Note: h_n given by: $S_o - (n\ Q/Am^{2/3})^2 = 0$

Figure 9. Conditions governing jump formation.



Note: if $(F+M)_A > (F+M)_B$ or C, jump drowned at L=0.
if $(F+M)_A < (F+M)_B$ or C, jump possible.
if $(h_n)_A < (h_c)_A$ jump impossible.
if $(h_n)_A > D$, full backflow.

Figure 10. Tests employed to determine the possibility of jump formation.

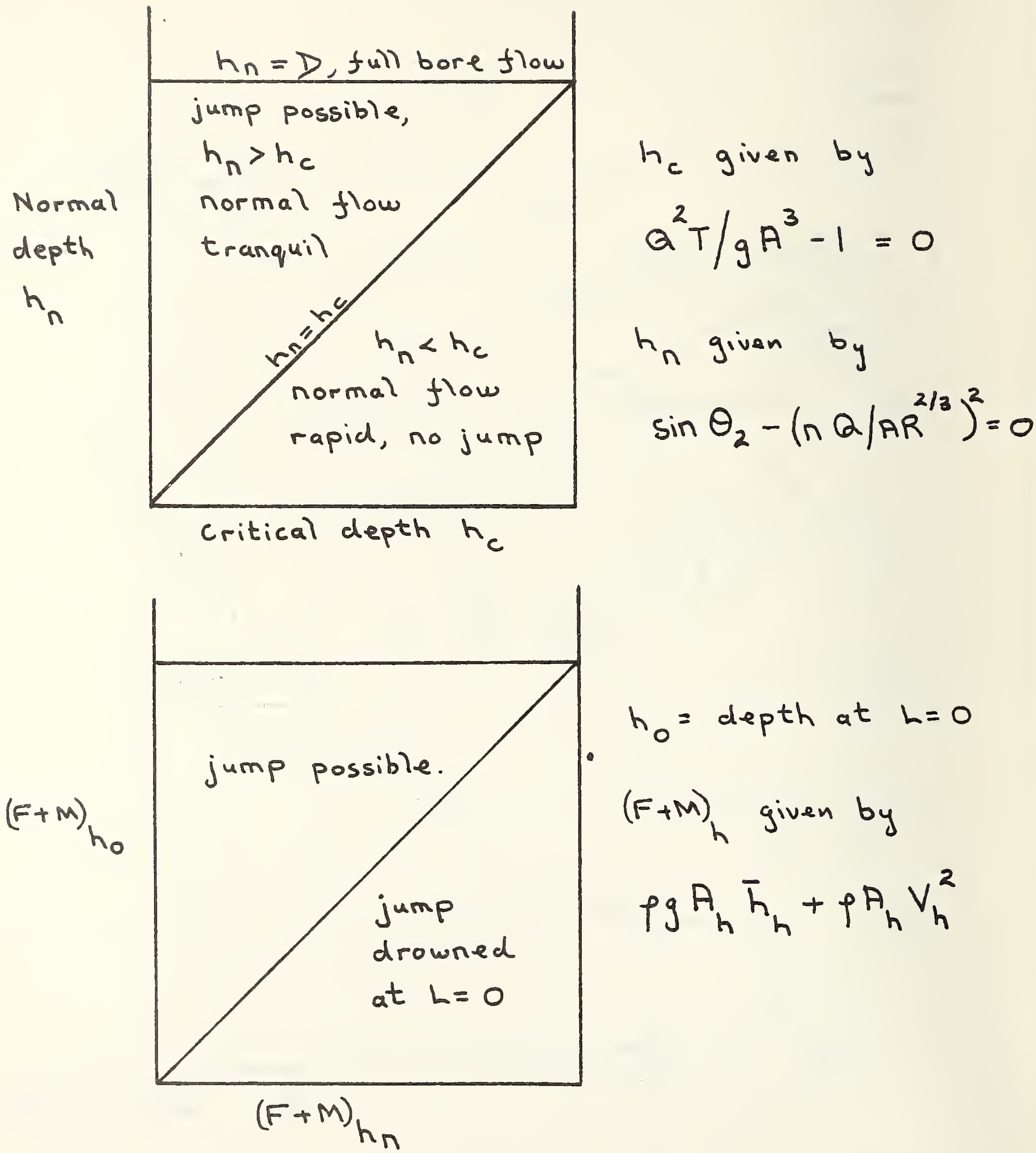


Figure 11. Schematic representation of jump boundary conditions.

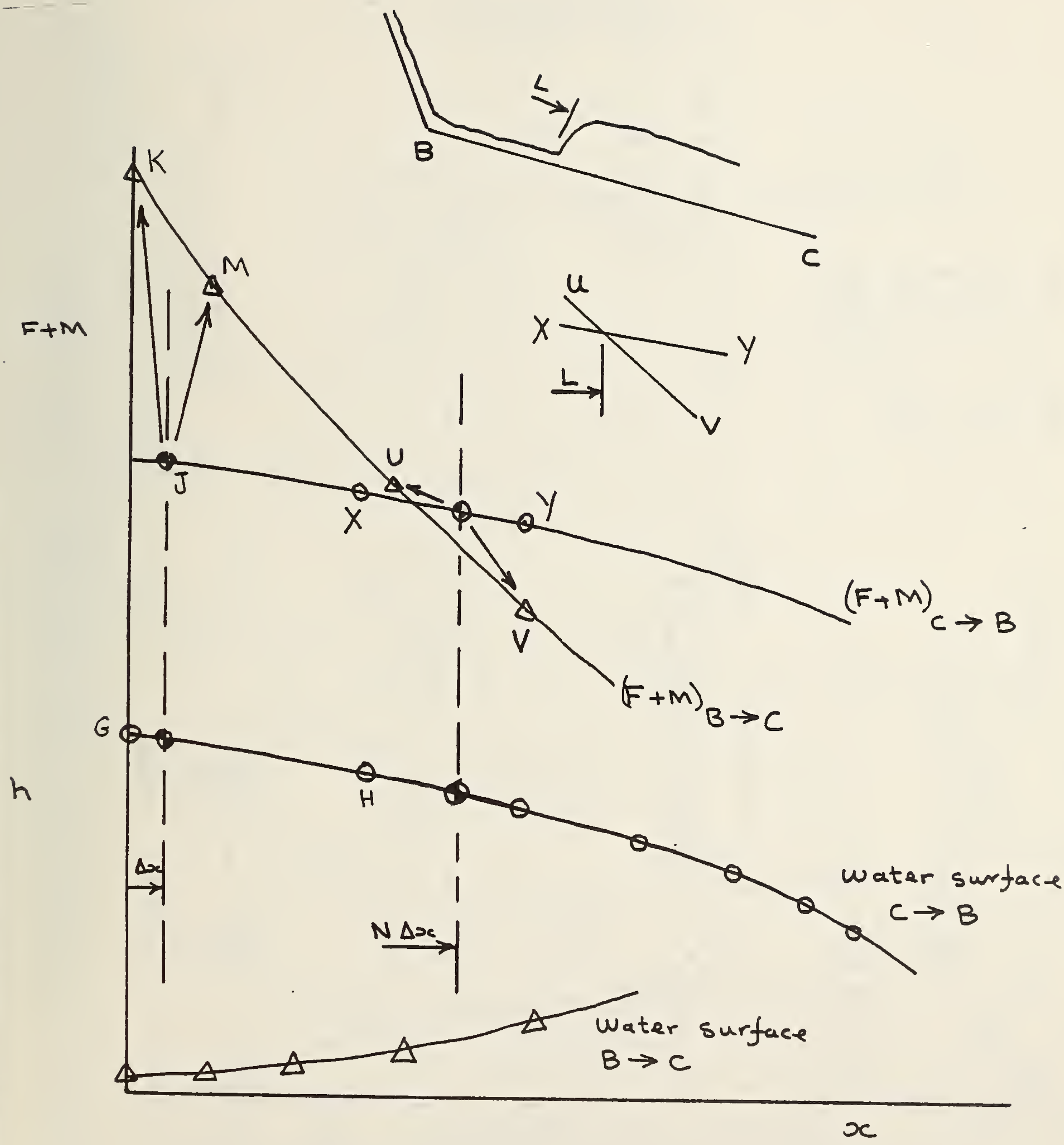


Figure 12. Schematic representation of jump position identification technique employed.

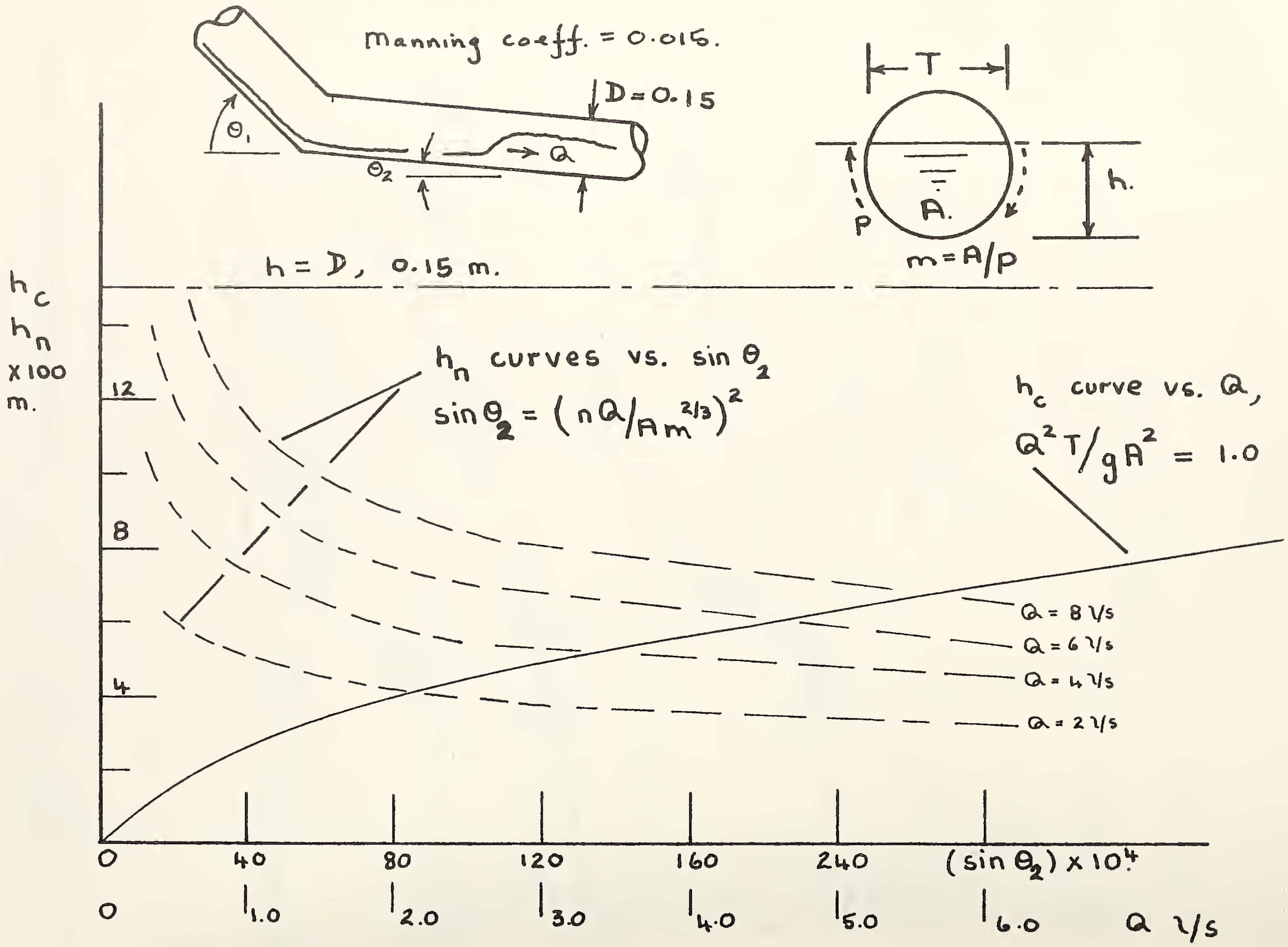


Figure 13. Variation of normal depth, h_n, and critical depth, h_c, with flow rate Q and test pipe slope θ_2. Note values independent of θ_1.

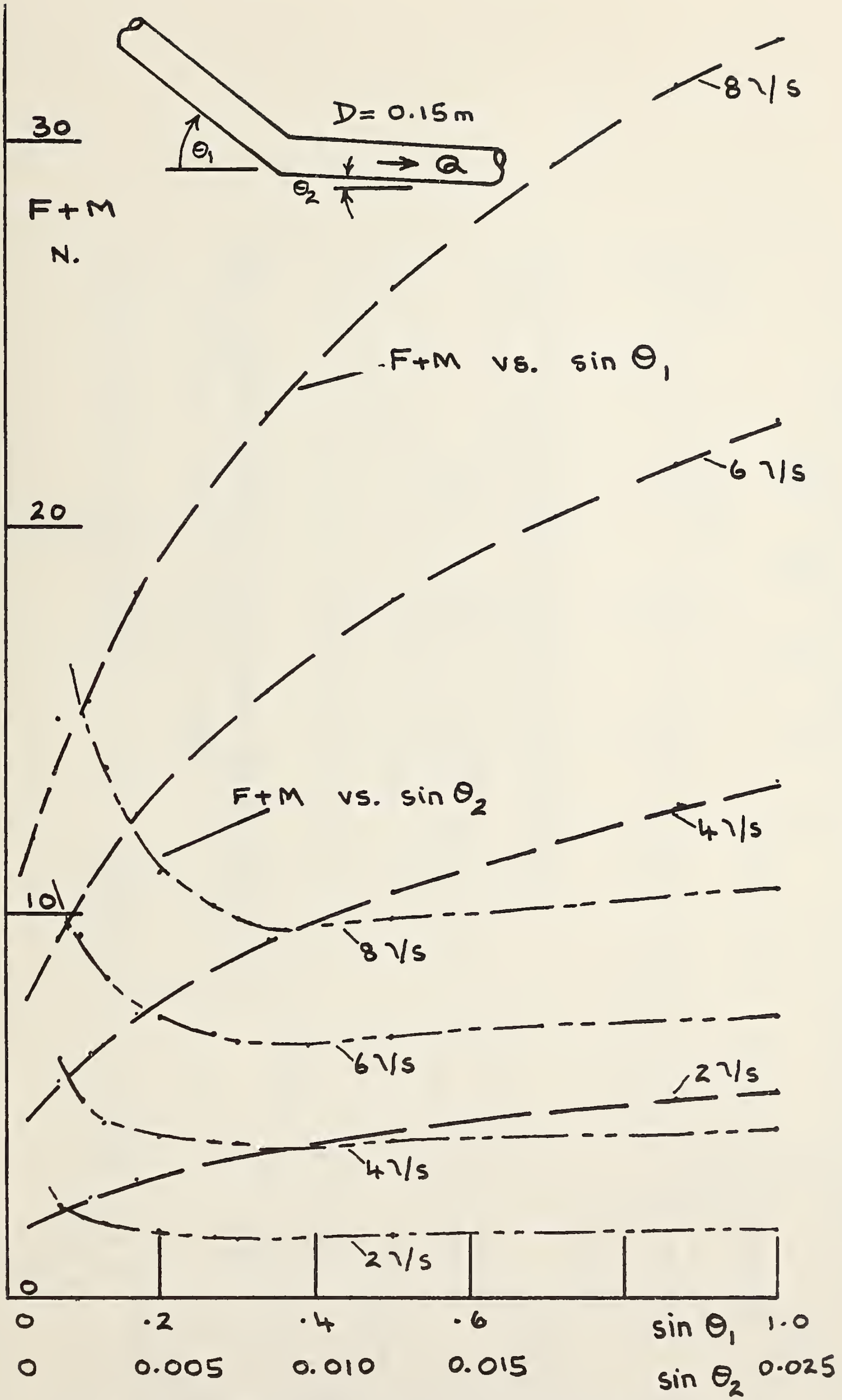


Figure 14. Variation of (F+M) term with pipe slope and flow rate. D = 0.15, n = 0.015.

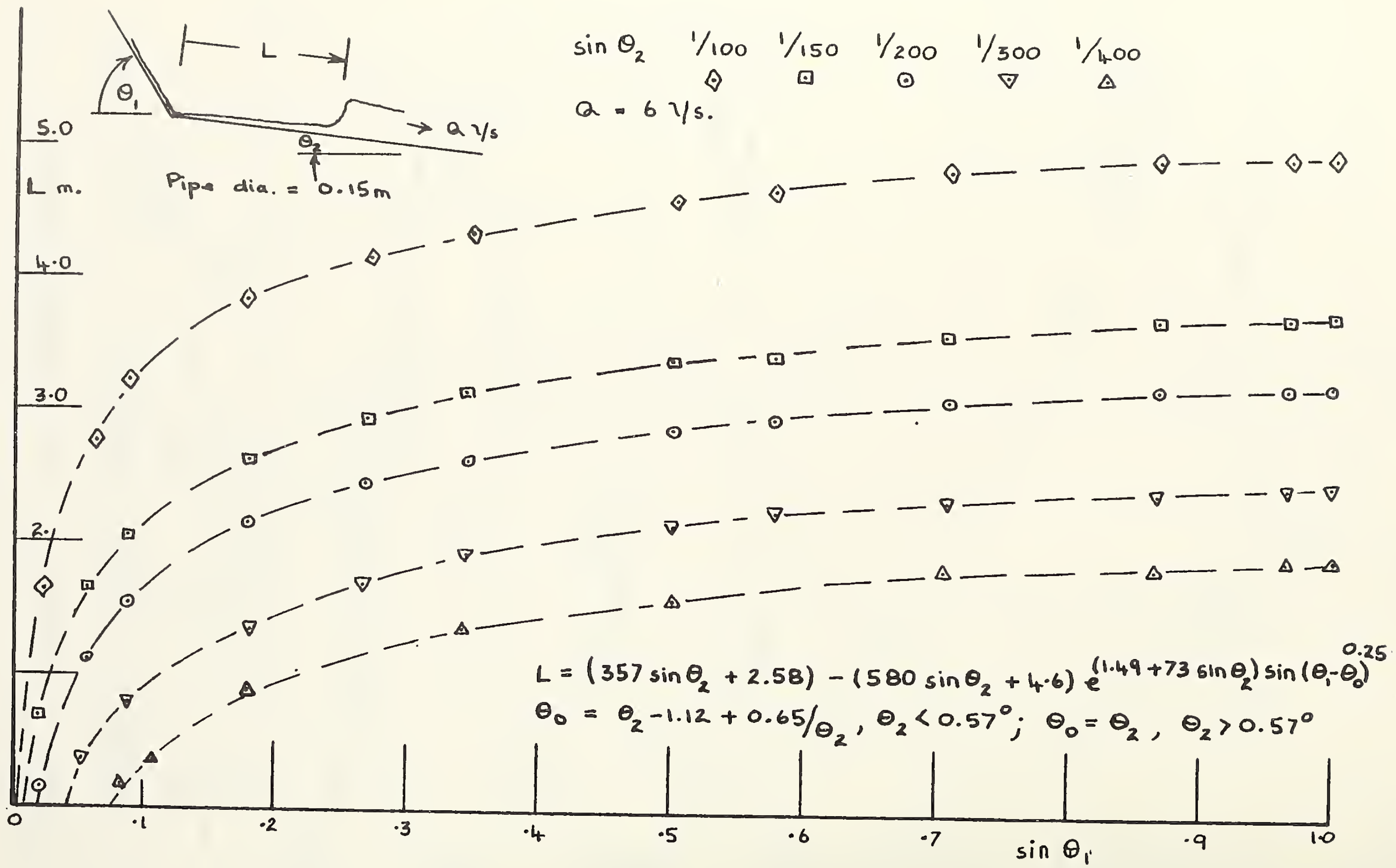


Figure 15. Jump location as a function of pipe slopes θ_1, θ_2 for constant $Q = 6\,(1/s)$ $D = 0.15$ and Manning coefficient = 0.015.

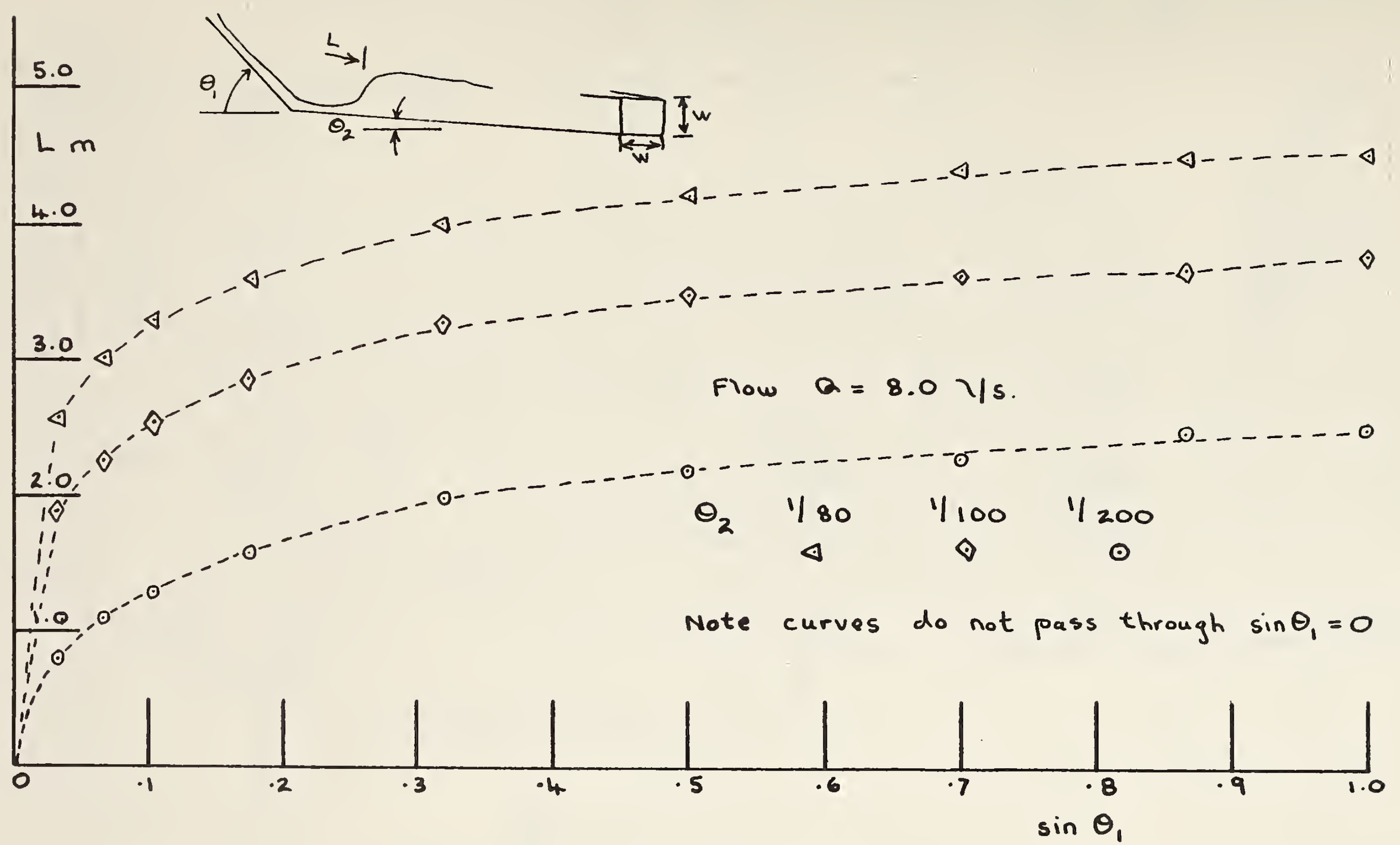


Figure 16. Variation of jump position with test pipe slope 1/80 - 1/200. Flow constant at Q = 8.0 l/s W = 0.15 m, n = 0.015. Rectangular channel results.

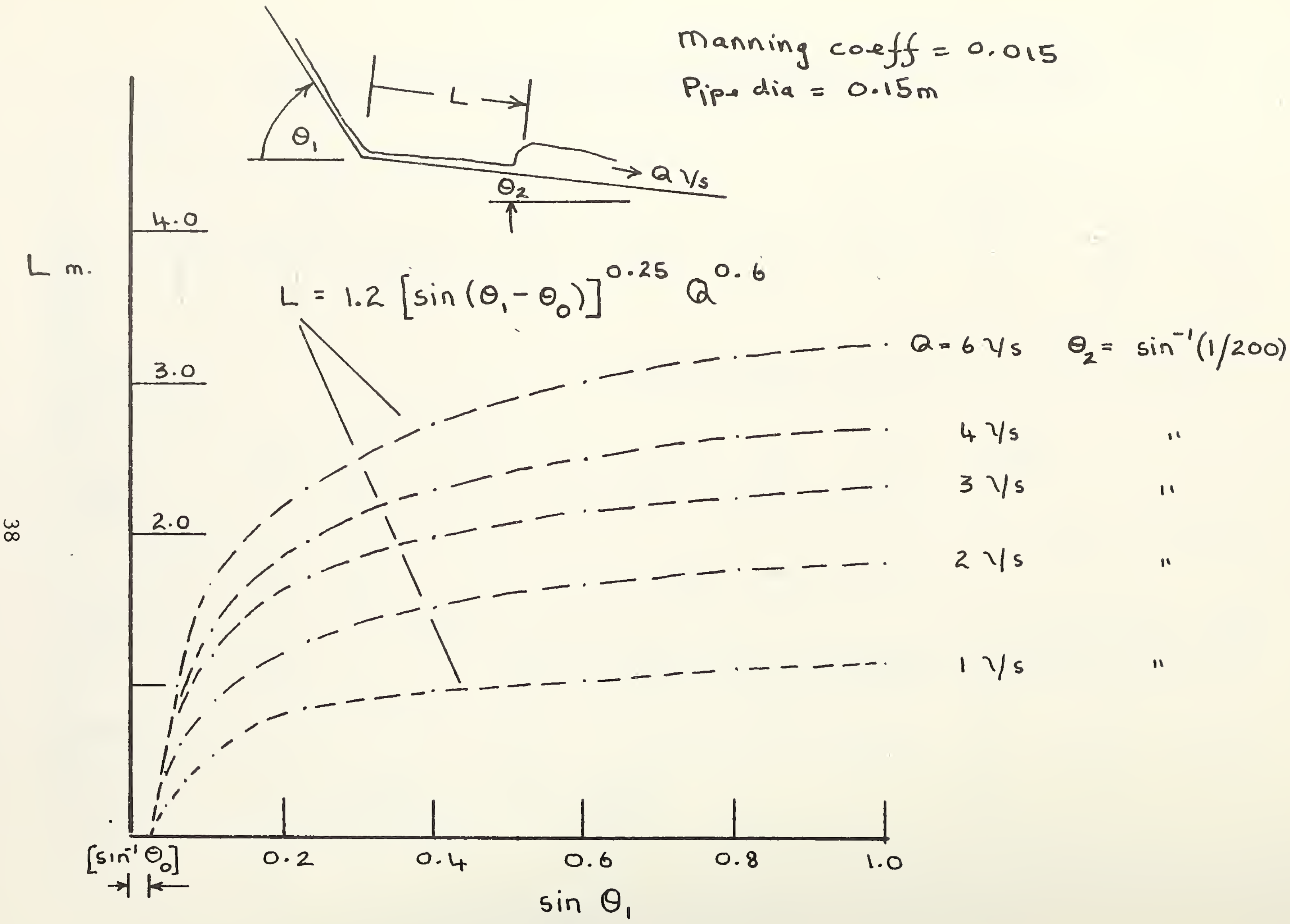


Figure 17. Variation of jump location with flow rate Q and approach pipe slope θ_1, for constant D = 0.015 m, n = 0.015 and 1/200 test pipe slope.

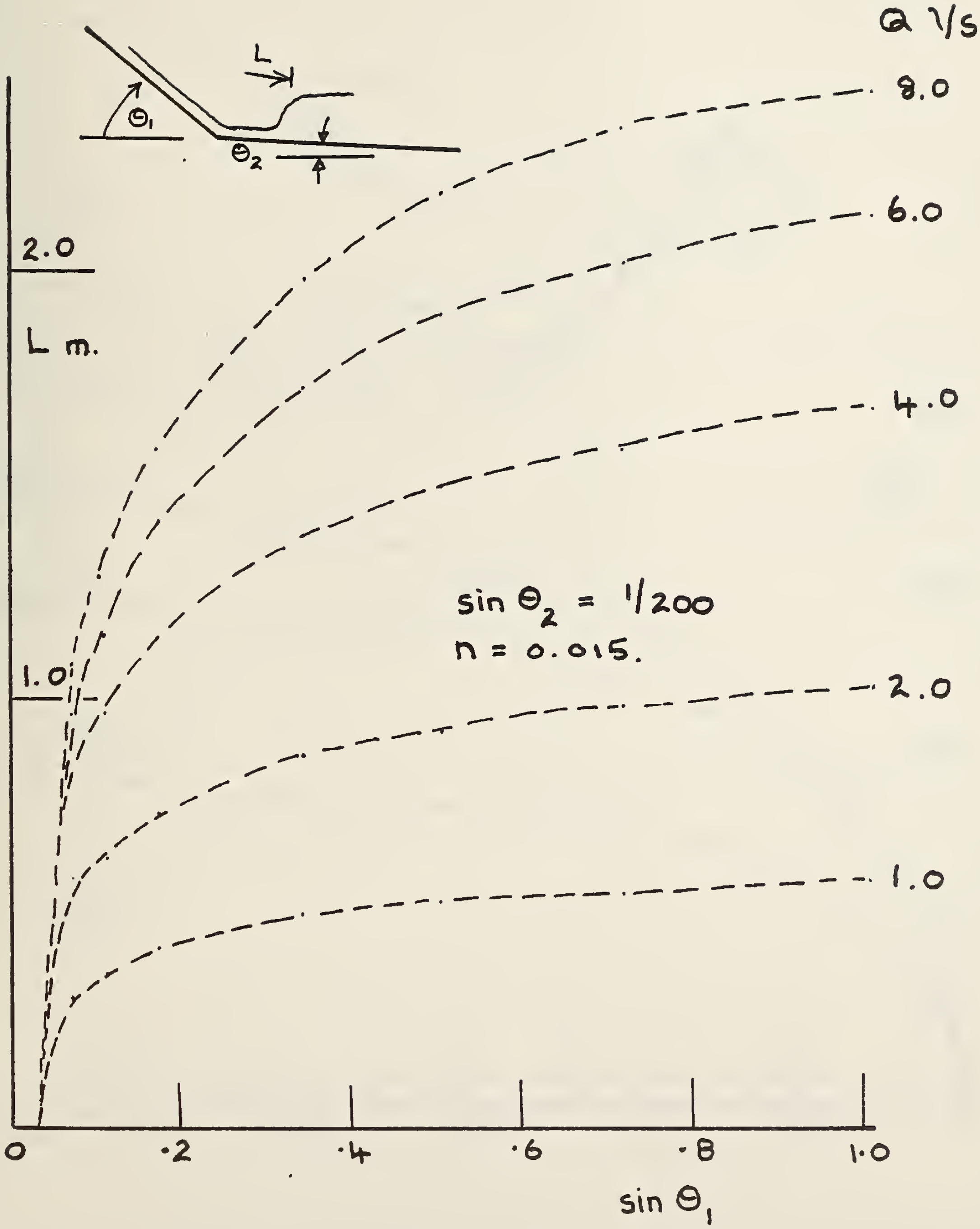
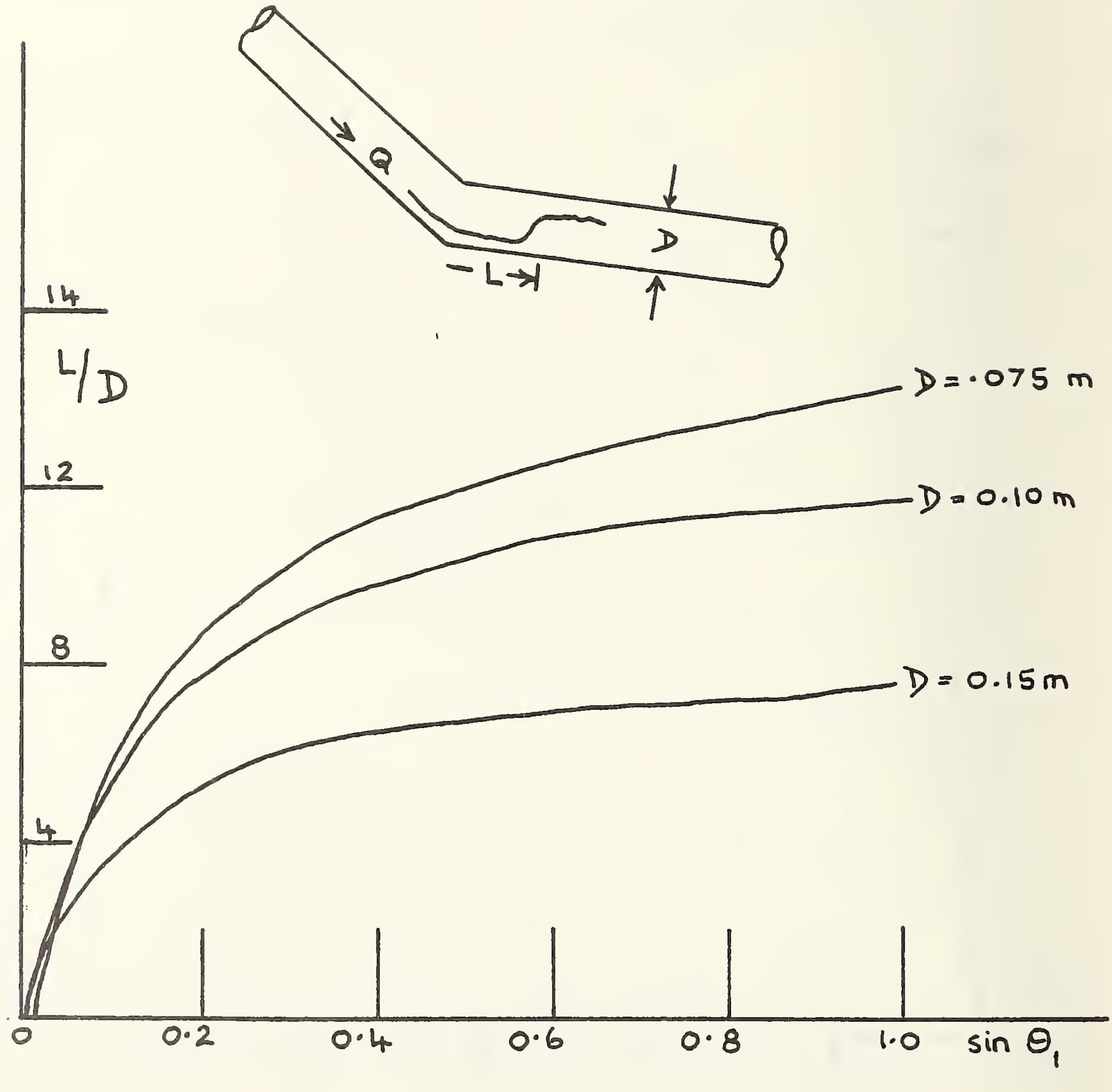
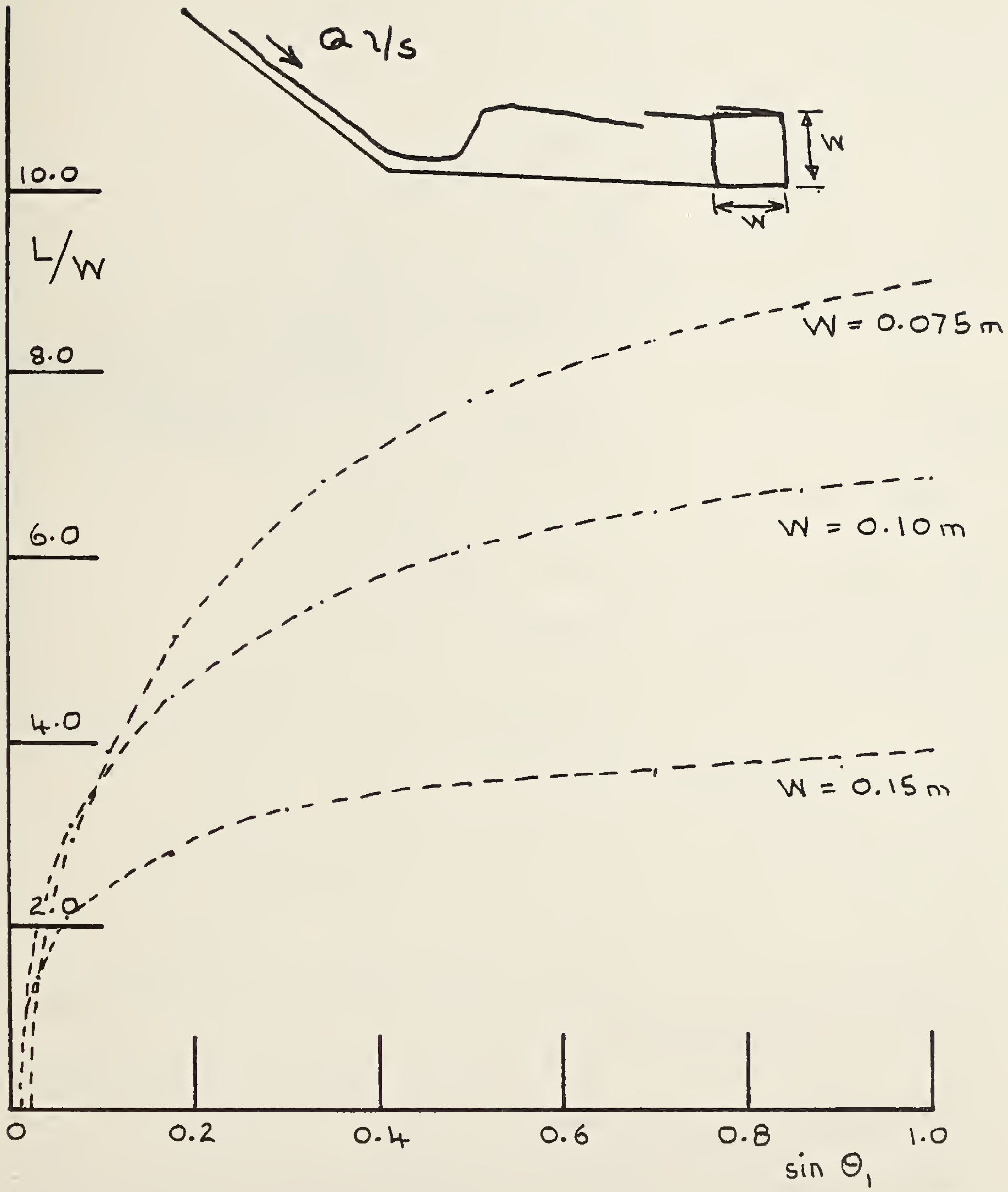


Figure 18. Jump position in a rectangular channel, width 0.15 m, slope 1/200, as a function of flow rate and approach pipe slope.



Note curves do not pass through L = 0.

Figure 19. Pipe diameter effect at Q = 1(l/s) $\theta_2 = \sin^{-1}(0.005)$, Manning coefficient = 0.015.



Note curves do not pass through L/W = 0.

Figure 20. Channel width effect at Q = 1(l/s) $\theta_2 = \sin^{-1}(0.005)$, Manning coefficient = 0.015.

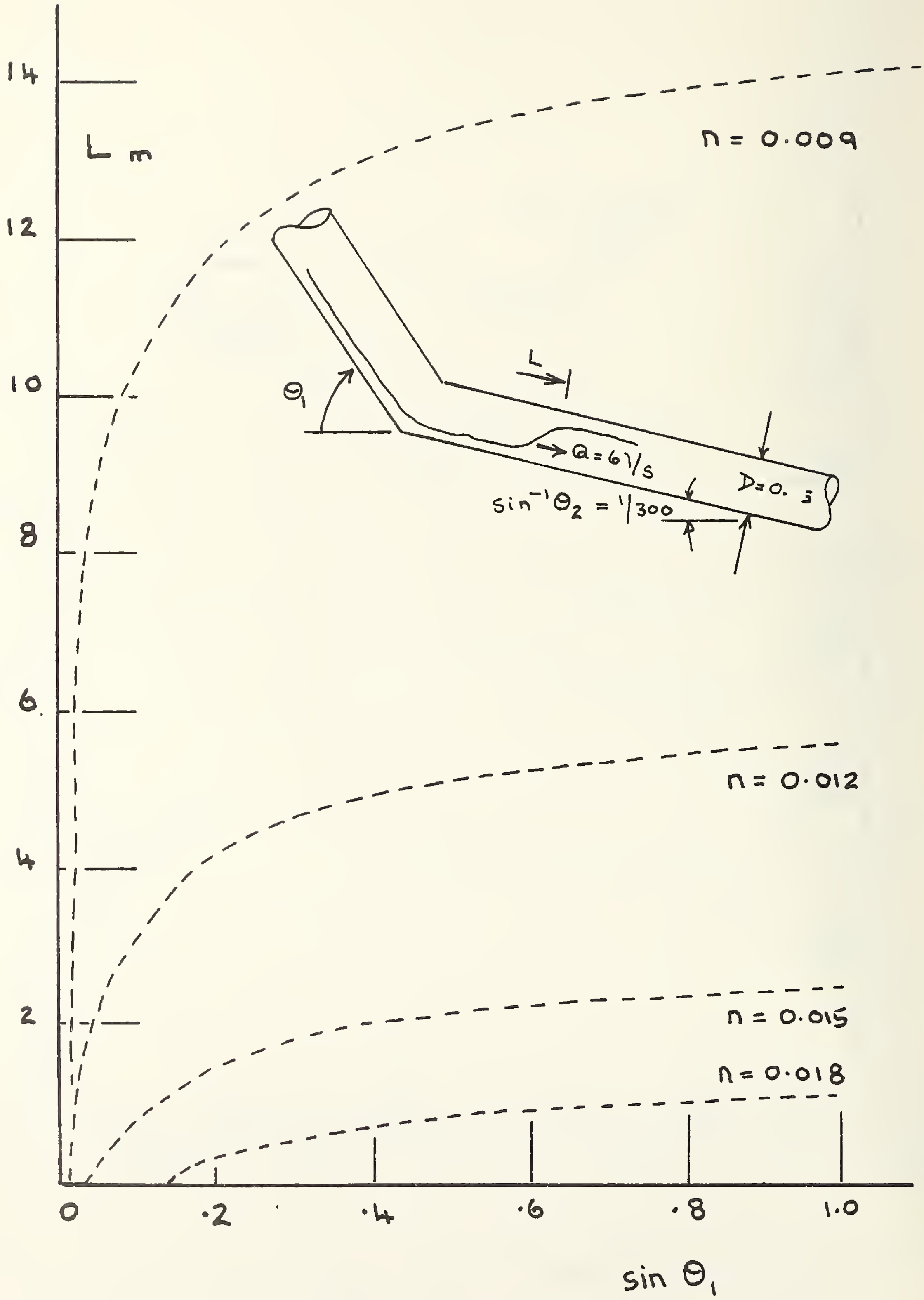


Figure 21. Effect of Manning coefficient n on jump location in a pipe at 1/300 with a flow rate of 6 (l/s). Pipe 0.15 m diameter.

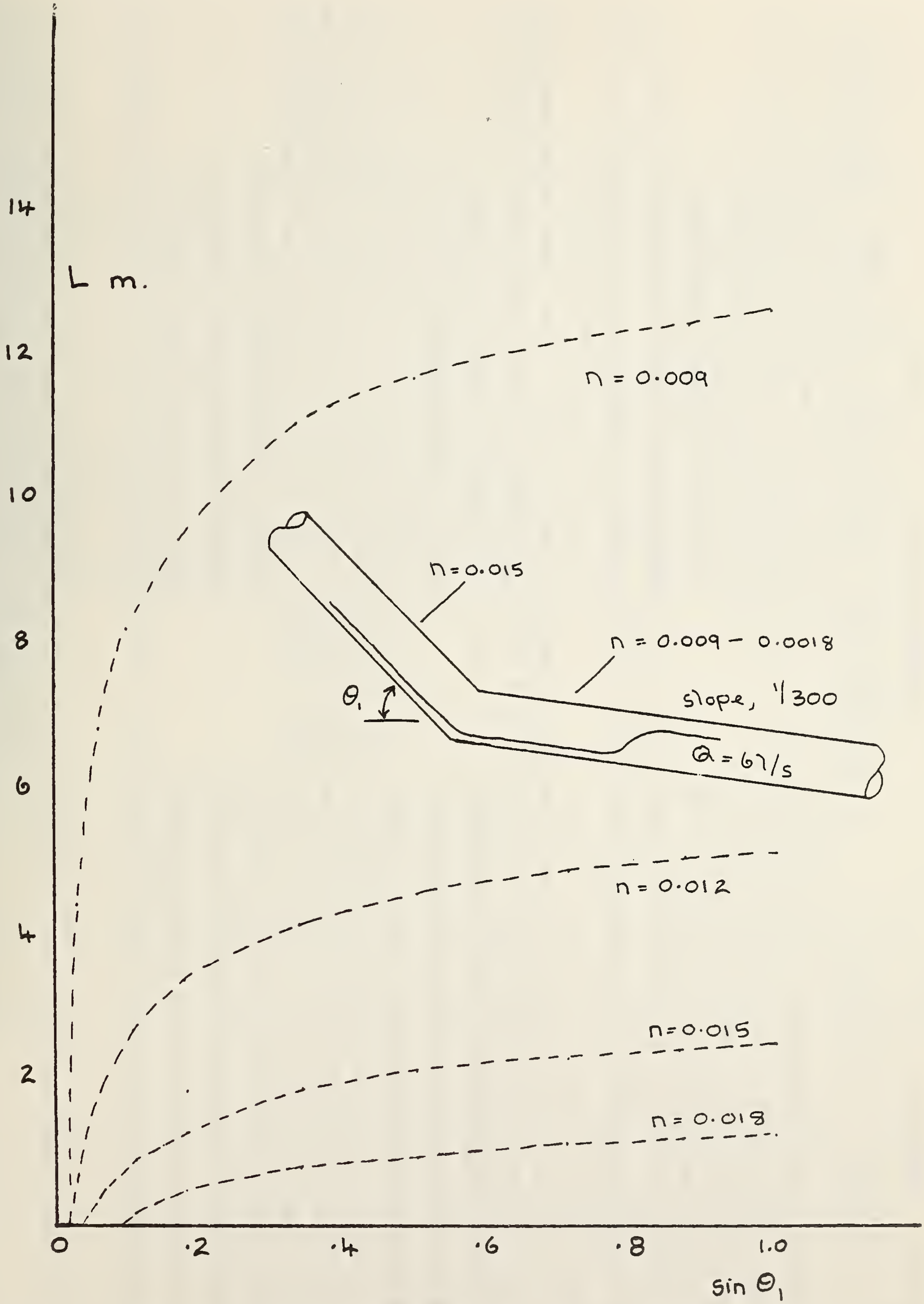


Figure 22. Manning coefficient effect. Note: n constant for approach pipe at 0.015.

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.M M.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP	ENERGY DOWN	ENERGY CHANGE	JUMP F.M.	JUMP POS.
8.0	0.10	0.015	0.7070	0.031	0.772	0.0250	0.089	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.7070	0.027	0.655	0.0250	0.079	0.071				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.10	0.015	0.7070	0.022	0.518	0.0250	0.065	0.054				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.10	0.015	0.7070	0.016	0.345	0.0250	0.045	0.036				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.10	0.015	0.7070	0.011	0.229	0.0250	0.031	0.025				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.10	0.015	0.7070	0.031	0.772	0.0125	0.089	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.7070	0.027	0.655	0.0125	0.079	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.10	0.015	0.7070	0.022	0.518	0.0125	0.065	0.068	0.022	0.491	2.216	0.062	0.068	0.005	0.093	0.093	-0.000	4.477	3.443
2.0	0.10	0.015	0.7070	0.016	0.345	0.0125	0.045	0.044				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.10	0.015	0.7070	0.011	0.229	0.0125	0.031	0.030				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.10	0.015	0.7070	0.031	0.772	0.0100	0.089	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.7070	0.027	0.655	0.0100	0.079	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.10	0.015	0.7070	0.022	0.518	0.0100	0.065	0.074	0.022	0.491	2.216	0.057	0.074	0.017	0.095	0.095	-0.000	4.579	2.936
2.0	0.10	0.015	0.7070	0.016	0.345	0.0100	0.045	0.047	0.016	0.33	4.983	0.044	0.047	0.003	0.062	0.062	-0.000	1.808	2.356
1.0	0.10	0.015	0.7070	0.011	0.229	0.0100	0.031	0.032	0.011	0.21	2.016	0.031	0.032	0.001	0.043	0.043	-0.000	0.743	1.621
8.0	0.10	0.015	0.7070	0.031	0.772	0.0050	0.089	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.7070	0.027	0.655	0.0050	0.079	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.10	0.015	0.7070	0.022	0.518	0.0050	0.065	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.10	0.015	0.7070	0.016	0.345	0.0050	0.045	0.058	0.016	0.33	4.983	0.035	0.058	0.023	0.070	0.067	-0.003	1.994	1.555
1.0	0.10	0.015	0.7070	0.011	0.229	0.0050	0.031	0.039	0.011	0.21	2.016	0.025	0.039	0.013	0.046	0.045	-0.001	0.799	1.335

Table 1. Jump location in a 0.1 m diameter partially filled pipe at an approach pipe slope of 45°.

COMMON DATA Q. L/S	WIDTH M.	MANN. COEFF	APPROACH PIPE DATA SLOPE (SIN)	HN M.	TERM. ENERGY M.	TEST PIPE DATA AND PROGRAM RESULTS. SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.10	0.015	0.7070	0.023	0.651	0.0250	0.087	0.078	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.10	0.015	0.7070	0.019	0.541	0.0250	0.072	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.7070	0.014	0.412	0.0250	0.055	0.046	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.7070	0.009	0.254	0.0250	0.034	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.7070	0.006	0.153	0.0250	0.022	0.017	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.7070	0.023	0.651	0.0125	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.7070	0.019	0.541	0.0125	0.072	0.081	0.013	0.561	9.720	0.063	0.081	0.019	0.109	0.109	-0.000	7.675	2.935
4.0	0.10	0.015	0.7070	0.014	0.412	0.0125	0.055	0.059	0.014	0.431	1.471	0.050	0.059	0.009	0.083	0.083	-0.000	4.425	2.521
2.0	0.10	0.015	0.7070	0.009	0.254	0.0125	0.034	0.036	0.009	0.26	4.504	0.034	0.036	0.002	0.052	0.052	-0.000	1.745	1.311
1.0	0.10	0.015	0.7070	0.006	0.153	0.0125	0.022	0.022	0.006	0.16	1.749	0.022	0.022	0.000	0.033	0.033	-0.000	0.692	1.167
8.0	0.10	0.015	0.7070	0.023	0.651	0.0100	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.7070	0.019	0.541	0.0100	0.072	0.089	0.013	0.561	9.720	0.057	0.089	0.033	0.114	0.112	-0.002	7.939	2.552
4.0	0.10	0.015	0.7070	0.014	0.412	0.0100	0.055	0.065	0.014	0.431	1.471	0.046	0.065	0.019	0.085	0.084	-0.001	4.526	2.133
2.0	0.10	0.015	0.7070	0.009	0.254	0.0100	0.034	0.039	0.009	0.26	4.504	0.031	0.039	0.008	0.052	0.052	-0.000	1.766	1.561
1.0	0.10	0.015	0.7070	0.006	0.153	0.0100	0.022	0.024	0.006	0.16	1.749	0.020	0.024	0.004	0.033	0.033	-0.000	0.697	0.935
8.0	0.10	0.015	0.7070	0.023	0.651	0.0050	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.7070	0.019	0.541	0.0050	0.072	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.7070	0.014	0.412	0.0050	0.055	0.085	0.014	0.431	1.471	0.033	0.085	0.052	0.109	0.096	-0.013	5.427	1.354
2.0	0.10	0.015	0.7070	0.009	0.254	0.0050	0.034	0.050	0.009	0.26	4.504	0.023	0.050	0.027	0.062	0.058	-0.004	2.015	0.935
1.0	0.10	0.015	0.7070	0.006	0.153	0.0050	0.022	0.030	0.006	0.16	1.749	0.015	0.030	0.015	0.038	0.036	-0.002	0.775	0.545

Table 2. Jump location in a 0.1 m wide channel at an approach pipe slope of 45°

Table 3. Schematic of Tabulated Jump Boundary Conditions.

Flow rate Q	Q_1	Q_2	Q_1	D Pipe diameter
Test pipe slope S = sin θ_2		Normal flow depth, Q, S values.		
S_1		hn_{12}	c f	D
S_2		hn_{22}		D
.		.		
.		.		
.		.		
Si		hn_{i2}		D
Critical depth hc = f(Q)	hc_1	hc_2	cf hc_i	
Flow rate Q	Q_1	Q_2	Q_i	
Test pipe slope		(F+M) test pipe normal depth value		
S_1		$(F+M)_{12}$		
.		.		c_f
S_3		.		
.		.		
S_i		$(F+M)_{i2}$		
Approach pipe slope U		$(F+M)^*$ terminal (i.e. test pipe entry)		
U_1		$(F+M)^*{}_{12}$		
U_2		$(F+M)^*{}_{22}$		
.		.		
.		.		
.		.		
U_i		(F+M$^*{}_{i2}$		

APPENDIX 1

JUMP LOCATION IN A 0.075 m DIAMETER PIPE,

MANNING COEFFICIENT 0.015, AT SLOPES 1/40, 1/80, 1/100, 1/200

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M M.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. M.	JUMP POS. M.
8.0	0.07	0.015	0.0349	0.075	0.242	0.0250	0.074	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.07	0.015	0.0349	0.075	0.169	0.0250	0.073	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.07	0.015	0.0349	0.054	0.115	0.0250	0.067	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.0349	0.038	0.078	0.0250	0.049	0.042	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.07	0.015	0.0349	0.026	0.054	0.0250	0.034	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.07	0.015	0.0349	0.075	0.242	0.0125	0.074	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.07	0.015	0.0349	0.075	0.169	0.0125	0.073	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.07	0.015	0.0349	0.064	0.115	0.0125	0.067	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.0349	0.038	0.078	0.0125	0.049	0.054	0.033	0.08	2.127	0.045	0.054	0.008	0.072	0.071	-0.003	1.971	0.463
1.0	0.07	0.015	0.0349	0.026	0.054	0.0125	0.034	0.034	0.026	0.05	0.873	0.034	0.034	0.000	0.047	0.047	0.	0.787	0.553
8.0	0.07	0.015	0.0349	0.075	0.242	0.0100	0.074	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.07	0.015	0.0349	0.075	0.169	0.0100	0.073	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.07	0.015	0.0349	0.064	0.115	0.0100	0.067	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.0349	0.038	0.078	0.0100	0.049	0.059	0.038	0.08	2.127	0.041	0.059	0.018	0.075	0.074	-0.001	2.049	0.153
1.0	0.07	0.015	0.0349	0.026	0.054	0.0100	0.034	0.037	0.025	0.05	0.873	0.032	0.037	0.005	0.048	0.048	-0.000	0.793	0.334
8.0	0.07	0.015	0.0349	0.075	0.242	0.0050	0.074	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.07	0.015	0.0349	0.075	0.169	0.0050	0.073	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.07	0.015	0.0349	0.064	0.115	0.0050	0.067	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.0349	0.038	0.078	0.0050	0.049	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
1.0	0.07	0.015	0.0349	0.026	0.054	0.0050	0.034	0.045	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										

COMMON DATA APPROACH PIPE DATA — TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F*M N.	UPJUMP DEPTH M.	JUMP DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F*M. N.	JUMP POS. M.
8.0	0.07	0.015	0.0698	0.075	0.242	0.0250	0.074	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.07	0.015	0.0698	0.075	0.169	0.0250	0.073	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.07	0.015	0.0698	0.047	0.141	0.0250	0.067	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.0698	0.031	0.098	0.0250	0.049	0.042			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
1.0	0.07	0.015	0.0698	0.022	0.067	0.0250	0.034	0.028			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
8.0	0.07	0.015	0.0698	0.075	0.242	0.0125	0.074	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.07	0.015	0.0698	0.075	0.169	0.0125	0.073	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.07	0.015	0.0698	0.047	0.141	0.0125	0.067	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.0698	0.031	0.098	0.0125	0.049	0.054	0.031	0.10	2.500	0.045	0.054	0.008	0.072	0.071	-0.000	1.971	0.775
1.0	0.07	0.015	0.0698	0.022	0.067	0.0125	0.034	0.034	0.022	0.07	1.034	0.034	0.034	0.000	0.047	0.047	-0.000	0.787	1.038
8.0	0.07	0.015	0.0698	0.075	0.242	0.0100	0.074	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.07	0.015	0.0698	0.075	0.169	0.0100	0.073	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.07	0.015	0.0698	0.047	0.141	0.0100	0.067	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.0698	0.031	0.098	0.0100	0.049	0.059	0.031	0.10	2.500	0.041	0.059	0.018	0.075	0.074	-0.001	2.049	0.552
1.0	0.07	0.015	0.0698	0.022	0.067	0.0100	0.034	0.037	0.022	0.07	1.034	0.032	0.037	0.005	0.048	0.048	-0.000	0.773	0.741
8.0	0.07	0.015	0.0698	0.075	0.242	0.0050	0.074	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.07	0.015	0.0698	0.075	0.169	0.0050	0.073	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.07	0.015	0.0698	0.047	0.141	0.0050	0.067	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.0698	0.031	0.098	0.0050	0.049	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
1.0	0.07	0.015	0.0698	0.022	0.067	0.0050	0.034	0.045	0.022	0.07	1.034	0.025	0.045	0.020	0.055	0.052	-0.003	0.696	0.257

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	JUMP DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.07	0.015	0.1045	0.075	0.242	0.0250	0.074	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.07	0.015	0.1045	0.055	0.206	0.0250	0.073	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.07	0.015	0.1045	0.042	0.170	0.0250	0.067	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.1045	0.028	0.118	0.0250	0.049	0.042				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.07	0.015	0.1045	0.020	0.080	0.0250	0.034	0.028				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.07	0.015	0.1045	0.075	0.242	0.0125	0.074	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.07	0.015	0.1045	0.055	0.206	0.0125	0.073	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.07	0.015	0.1045	0.042	0.170	0.0125	0.067	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.1045	0.028	0.118	0.0125	0.049	0.054	0.029	0.12	2.817	0.045	0.054	0.009	0.072	0.071	-0.000	1.971	1.253
1.0	0.07	0.015	0.1045	0.020	0.080	0.0125	0.034	0.034	0.023	0.08	1.142	0.034	0.034	0.000	0.047	0.047	-0.000	0.787	1.135
8.0	0.07	0.015	0.1045	0.075	0.242	0.0100	0.074	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.07	0.015	0.1045	0.055	0.206	0.0100	0.073	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.07	0.015	0.1045	0.042	0.170	0.0100	0.067	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.1045	0.028	0.118	0.0100	0.049	0.059	0.029	0.12	2.817	0.041	0.059	0.018	0.075	0.074	-0.001	2.049	0.920
1.0	0.07	0.015	0.1045	0.020	0.080	0.0100	0.034	0.037	0.023	0.08	1.142	0.032	0.037	0.005	0.048	0.048	-0.000	0.793	0.995
8.0	0.07	0.015	0.1045	0.075	0.242	0.0050	0.074	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.07	0.015	0.1045	0.055	0.206	0.0050	0.073	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.07	0.015	0.1045	0.042	0.170	0.0050	0.067	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.1045	0.028	0.118	0.0050	0.049	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
1.0	0.07	0.015	0.1045	0.020	0.080	0.0050	0.034	0.045	0.023	0.08	1.142	0.025	0.045	0.020	0.055	0.052	-0.003	0.696	0.633

COMMON DATA APPROACH PIPE DATA — TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.07	0.015	0.1736	0.057	0.309	0.0250	0.074	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.07	0.015	0.1736	0.046	0.274	0.0250	0.073	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.07	0.015	0.1736	0.036	0.224	0.0250	0.067	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.1736	0.025	0.154	0.0250	0.049	0.042	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.07	0.015	0.1736	0.017	0.104	0.0250	0.034	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.07	0.015	0.1736	0.057	0.309	0.0125	0.074	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.07	0.015	0.1736	0.046	0.274	0.0125	0.073	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.07	0.015	0.1736	0.036	0.224	0.0125	0.067	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.1736	0.025	0.154	0.0125	0.049	0.054	0.025	0.15	3.274	0.045	0.054	0.008	0.072	0.071	-0.000	1.971	1.537
1.0	0.07	0.015	0.1736	0.017	0.104	0.0125	0.034	0.034	0.017	0.10	1.356	0.034	0.034	0.000	0.047	0.047	-0.000	0.787	1.413
8.0	0.07	0.015	0.1736	0.057	0.309	0.0100	0.074	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.07	0.015	0.1736	0.046	0.274	0.0100	0.073	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.07	0.015	0.1736	0.036	0.224	0.0100	0.067	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.1736	0.025	0.154	0.0100	0.049	0.059	0.025	0.15	3.274	0.041	0.059	0.018	0.075	0.074	-0.001	2.049	1.177
1.0	0.07	0.015	0.1736	0.017	0.104	0.0100	0.034	0.037	0.017	0.10	1.356	0.032	0.037	0.005	0.048	0.048	-0.000	0.773	1.133
8.0	0.07	0.015	0.1736	0.057	0.309	0.0050	0.074	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.07	0.015	0.1736	0.046	0.274	0.0050	0.073	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.07	0.015	0.1736	0.036	0.224	0.0050	0.067	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.1736	0.025	0.154	0.0050	0.049	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
1.0	0.07	0.015	0.1736	0.017	0.104	0.0050	0.034	0.045	0.017	0.10	1.356	0.025	0.045	0.020	0.055	0.052	-0.003	0.896	0.537

* PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPRO...

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.M. N.	JJ4 POS. %
8.0	0.07	0.015	0.3402	0.044	0.484	0.0250	0.074	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.07	0.015	0.3402	0.037	0.420	0.0250	0.073	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.07	0.015	0.3402	0.030	0.339	0.0250	0.067	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.3402	0.021	0.230	0.0250	0.049	0.042			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
1.0	0.07	0.015	0.3402	0.015	0.155	0.0250	0.034	0.028			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
8.0	0.07	0.015	0.3402	0.044	0.484	0.0125	0.074	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.07	0.015	0.3402	0.037	0.420	0.0125	0.073	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.07	0.015	0.3402	0.030	0.339	0.0125	0.067	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.3402	0.021	0.230	0.0125	0.049	0.054	0.021	0.23	4.133	0.045	0.054	0.008	0.072	0.071	-0.000	1.971	1.993
1.0	0.07	0.015	0.3402	0.015	0.155	0.0125	0.034	0.034	0.015	0.15	1.684	0.034	0.034	0.000	0.047	0.047	-0.000	0.787	1.527
8.0	0.07	0.015	0.3402	0.044	0.484	0.0100	0.074	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.07	0.015	0.3402	0.037	0.420	0.0100	0.073	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.07	0.015	0.3402	0.030	0.339	0.0100	0.067	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.3402	0.021	0.230	0.0100	0.049	0.059	0.021	0.23	4.133	0.041	0.059	0.018	0.075	0.074	-0.001	2.049	1.542
1.0	0.07	0.015	0.3402	0.015	0.155	0.0100	0.034	0.037	0.015	0.15	1.684	0.032	0.037	0.005	0.048	0.048	-0.000	0.793	1.324
8.0	0.07	0.015	0.3402	0.044	0.484	0.0050	0.074	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.07	0.015	0.3402	0.037	0.420	0.0050	0.073	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.07	0.015	0.3402	0.030	0.339	0.0050	0.067	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.3402	0.021	0.230	0.0050	0.049	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
1.0	0.07	0.015	0.3402	0.015	0.155	0.0050	0.034	0.045	0.015	0.15	1.684	0.025	0.045	0.020	0.055	0.052	-0.003	0.696	0.916

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.07	0.015	0.5000	0.039	0.628	0.0250	0.074	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.07	0.015	0.5000	0.033	0.543	0.0250	0.073	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.07	0.015	0.5000	0.027	0.436	0.0250	0.067	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.5000	0.019	0.294	0.0250	0.049	0.042				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.07	0.015	0.5000	0.013	0.197	0.0250	0.034	0.028				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.07	0.015	0.5000	0.039	0.628	0.0125	0.074	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
5.0	0.07	0.015	0.5000	0.033	0.543	0.0125	0.073	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.07	0.015	0.5000	0.027	0.436	0.0125	0.067	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.5000	0.019	0.294	0.0125	0.049	0.054	0.013	0.29	4.696	0.045	0.054	0.008	0.072	0.071	-0.003	1.971	2.033
1.0	0.07	0.015	0.5000	0.013	0.197	0.0125	0.034	0.034	0.013	0.19	1.878	0.034	0.034	0.003	0.047	0.047	-0.000	0.787	1.717
8.0	0.07	0.015	0.5000	0.039	0.628	0.0100	0.074	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.07	0.015	0.5000	0.033	0.543	0.0100	0.073	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.07	0.015	0.5000	0.027	0.436	0.0100	0.067	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.5000	0.019	0.294	0.0100	0.049	0.059	0.013	0.29	4.696	0.041	0.059	0.018	0.075	0.074	-0.001	2.049	1.597
1.0	0.07	0.015	0.5000	0.013	0.197	0.0100	0.034	0.037	0.013	0.19	1.878	0.032	0.037	0.005	0.048	0.048	-0.000	0.793	1.415
3.0	0.07	0.015	0.5000	0.039	0.628	0.0050	0.074	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.07	0.015	0.5000	0.033	0.543	0.0050	0.073	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.07	0.015	0.5000	0.027	0.436	0.0050	0.067	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.5000	0.019	0.294	0.0050	0.049	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
1.0	0.07	0.015	0.5000	0.013	0.197	0.0050	0.034	0.045	0.013	0.19	1.878	0.025	0.045	0.020	0.055	0.052	-0.003	0.896	0.906

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.M N.	UPJUMP DEPTH M.	JUMP DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.M. N.	JUMP POS. M.
8.0	0.07	0.015	0.7070	0.036	0.799	0.0250	0.074	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.07	0.015	0.7070	0.030	0.686	0.0250	0.073	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.07	0.015	0.7070	0.024	0.551	0.0250	0.067	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.7070	0.017	0.370	0.0250	0.049	0.042	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.07	0.015	0.7070	0.012	0.247	0.0250	0.034	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.07	0.015	0.7070	0.036	0.799	0.0125	0.074	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.07	0.015	0.7070	0.030	0.686	0.0125	0.073	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.07	0.015	0.7070	0.024	0.551	0.0125	0.067	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.7070	0.017	0.370	0.0125	0.049	0.054	0.017	0.36	5.264	0.045	0.054	0.008	0.072	0.071	-0.000	1.971	2.155
1.0	0.07	0.015	0.7070	0.012	0.247	0.0125	0.034	0.034	0.012	0.24	2.120	0.034	0.034	0.000	0.047	0.047	-0.000	0.787	1.935
8.0	0.07	0.015	0.7070	0.036	0.799	0.0100	0.074	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.07	0.015	0.7070	0.030	0.686	0.0100	0.073	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.07	0.015	0.7070	0.024	0.551	0.0100	0.067	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.7070	0.017	0.370	0.0100	0.049	0.059	0.017	0.36	5.264	0.041	0.059	0.018	0.075	0.074	-0.001	2.049	1.920
1.0	0.07	0.015	0.7070	0.012	0.247	0.0100	0.034	0.037	0.012	0.24	2.120	0.032	0.037	0.005	0.048	0.048	-0.000	0.793	1.535
8.0	0.07	0.015	0.7070	0.036	0.799	0.0050	0.074	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.07	0.015	0.7070	0.030	0.686	0.0050	0.073	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.07	0.015	0.7070	0.024	0.551	0.0050	0.067	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.7070	0.017	0.370	0.0050	0.049	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
1.0	0.07	0.015	0.7070	0.012	0.247	0.0050	0.034	0.045	0.012	0.24	2.120	0.025	0.045	0.020	0.055	0.052	-0.003	0.696	0.933

COMMON DATA APPROACH PIPE DATA | TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.07	0.015	0.8660	0.034	0.921	0.0250	0.074	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.07	0.015	0.8660	0.029	0.791	0.0250	0.073	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.07	0.015	0.8660	0.023	0.631	0.0250	0.067	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.8660	0.016	0.424	0.0250	0.049	0.042			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
1.0	0.07	0.015	0.8660	0.012	0.283	0.0250	0.034	0.028			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
8.0	0.07	0.015	0.8660	0.034	0.921	0.0125	0.074	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.07	0.015	0.8660	0.029	0.791	0.0125	0.073	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.07	0.015	0.8660	0.023	0.631	0.0125	0.067	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.8660	0.016	0.424	0.0125	0.049	0.054	0.016	0.41	5.598	0.045	0.054	0.008	0.072	0.071	-0.000	1.971	2.228
1.0	0.07	0.015	0.8660	0.012	0.283	0.0125	0.034	0.034	0.012	0.28	2.315	0.034	0.034	0.000	0.047	0.047	-0.000	0.787	1.864
8.0	0.07	0.015	0.8660	0.034	0.921	0.0100	0.074	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.07	0.015	0.8660	0.029	0.791	0.0100	0.073	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.07	0.015	0.8660	0.023	0.631	0.0100	0.067	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.8660	0.016	0.424	0.0100	0.049	0.059	0.016	0.41	5.598	0.041	0.059	0.018	0.075	0.074	-0.001	2.049	1.883
1.0	0.07	0.015	0.8660	0.012	0.283	0.0100	0.034	0.037	0.012	0.28	2.315	0.032	0.037	0.005	0.048	0.048	-0.000	0.793	1.564
8.0	0.07	0.015	0.8660	0.034	0.921	0.0050	0.074	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.07	0.015	0.8660	0.029	0.791	0.0050	0.073	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.07	0.015	0.8660	0.023	0.631	0.0050	0.067	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.8650	0.016	0.424	0.0050	0.049	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
1.0	0.07	0.015	0.8660	0.012	0.283	0.0050	0.034	0.045	0.012	0.28	2.315	0.025	0.045	0.020	0.055	0.052	-0.003	0.696	1.352

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.07	0.015	1.0000	0.032	1.018	0.0250	0.074	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.07	0.015	1.0000	0.028	0.871	0.0250	0.073	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.07	0.015	1.0000	0.022	0.696	0.0250	0.067	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	1.0000	0.016	0.468	0.0250	0.049	0.042				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.07	0.015	1.0000	0.011	0.310	0.0250	0.034	0.028				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.07	0.015	1.0000	0.032	1.018	0.0125	0.074	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.07	0.015	1.0000	0.028	0.871	0.0125	0.073	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.07	0.015	1.0000	0.022	0.696	0.0125	0.067	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	1.0000	0.016	0.468	0.0125	0.049	0.054	0.016	0.46	5.974	0.045	0.054	0.008	0.072	0.071	-0.000	1.971	2.293
1.0	0.07	0.015	1.0000	0.011	0.310	0.0125	0.034	0.034	0.011	0.31	2.425	0.034	0.034	0.000	0.047	0.047	-0.000	0.767	1.393
8.0	0.07	0.015	1.0000	0.032	1.018	0.0100	0.074	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.07	0.015	1.0000	0.028	0.871	0.0100	0.073	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.07	0.015	1.0000	0.022	0.696	0.0100	0.067	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	1.0000	0.016	0.468	0.0100	0.049	0.059	0.016	0.46	5.974	0.041	0.059	0.018	0.075	0.074	-0.001	2.049	1.945
1.0	0.07	0.015	1.0000	0.011	0.310	0.0100	0.034	0.037	0.011	0.31	2.425	0.032	0.037	0.005	0.048	0.048	-0.000	0.793	1.593
8.0	0.07	0.015	1.0000	0.032	1.018	0.0050	0.074	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.07	0.015	1.0000	0.028	0.871	0.0050	0.073	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.07	0.015	1.0000	0.022	0.696	0.0050	0.067	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	1.0000	0.016	0.468	0.0050	0.049	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
1.0	0.07	0.015	1.0000	0.011	0.310	0.0050	0.034	0.045	0.011	0.31	2.425	0.025	0.045	0.020	0.055	0.052	-0.003	0.696	1.081

APPENDIX 2

JUMP LOCATION IN A 0.10 m DIAMETER PIPE,

MANNING COEFFICIENT 0.015, AT SLOPES 1/40, 1/80, 1/100, 1/200

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP	ENERGY DOWN	ENERGY CHANGE	JUMP F+M.	JUMP POS.
8.0	0.10	0.015	0.0349	0.078	0.153	0.0250	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.0349	0.063	0.131	0.0250	0.079	0.071	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.0349	0.049	0.105	0.0250	0.065	0.054	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.0349	0.033	0.072	0.0250	0.045	0.036	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.0349	0.023	0.050	0.0250	0.031	0.025	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.0349	0.078	0.153	0.0125	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.0349	0.063	0.131	0.0125	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.0349	0.049	0.105	0.0125	0.065	0.068	0.049	0.10	4.960	0.062	0.068	0.005	0.093	0.093	-0.000	4.477	1.313
2.0	0.10	0.015	0.0349	0.033	0.072	0.0125	0.045	0.044	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.0349	0.023	0.050	0.0125	0.031	0.030	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.0349	0.078	0.153	0.0100	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.0349	0.063	0.131	0.0100	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.0349	0.049	0.105	0.0100	0.065	0.074	0.049	0.10	4.960	0.057	0.074	0.017	0.095	0.095	-0.000	4.579	0.547
2.0	0.10	0.015	0.0349	0.033	0.072	0.0100	0.045	0.047	0.033	0.07	2.048	0.043	0.047	0.003	0.062	0.062	-0.000	1.808	0.778
1.0	0.10	0.015	0.0349	0.023	0.050	0.0100	0.031	0.032	0.023	0.05	0.844	0.031	0.032	0.001	0.043	0.043	-0.000	0.743	0.585
8.0	0.10	0.015	0.0349	0.078	0.153	0.0050	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.0349	0.063	0.131	0.0050	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.0349	0.049	0.105	0.0050	0.065	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.10	0.015	0.0349	0.033	0.072	0.0050	0.045	0.058	0.033	0.07	2.048	0.035	0.058	0.023	0.069	0.067	-0.003	1.994	0.385
1.0	0.10	0.015	0.0349	0.023	0.050	0.0050	0.031	0.039	0.023	0.05	0.844	0.025	0.039	0.013	0.046	0.045	-0.001	0.799	0.125

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M M.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP	ENERGY DOWN	ENERGY CHANGE	JUMP F+M.	JUMP POS.
8.0	0.10	0.015	0.0698	0.060	0.194	0.0250	0.089	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.10	0.015	0.0698	0.050	0.167	0.0250	0.079	0.071			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
4.0	0.10	0.015	0.0698	0.040	0.134	0.0250	0.065	0.054			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
2.0	0.10	0.015	0.0698	0.028	0.092	0.0250	0.045	0.036			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
1.0	0.10	0.015	0.0698	0.020	0.063	0.0250	0.031	0.025			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
8.0	0.10	0.015	0.0698	0.060	0.194	0.0125	0.089	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.10	0.015	0.0698	0.050	0.167	0.0125	0.079	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.10	0.015	0.0698	0.040	0.134	0.0125	0.065	0.068	0.043	0.13	5.860	0.062	0.063	0.005	0.093	0.093	-0.000	4.477	1.733
2.0	0.10	0.015	0.0698	0.028	0.092	0.0125	0.045	0.044			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
1.0	0.10	0.015	0.0698	0.020	0.063	0.0125	0.031	0.030			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
8.0	0.10	0.015	0.0698	0.060	0.194	0.0100	0.089	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.10	0.015	0.0698	0.050	0.167	0.0100	0.079	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.10	0.015	0.0698	0.040	0.134	0.0100	0.065	0.074	0.043	0.13	5.860	0.057	0.074	0.017	0.095	0.095	-0.000	4.579	1.252
2.0	0.10	0.015	0.0698	0.028	0.092	0.0100	0.045	0.047	0.023	0.09	2.425	0.044	0.047	0.003	0.062	0.062	-0.000	1.808	1.275
1.0	0.10	0.015	0.0698	0.020	0.063	0.0100	0.031	0.032	0.020	0.06	0.984	0.031	0.032	0.001	0.043	0.043	-0.000	0.743	0.334
8.0	0.10	0.015	0.0698	0.060	0.194	0.0050	0.089	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.10	0.015	0.0698	0.050	0.167	0.0050	0.079	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.10	0.015	0.0698	0.040	0.134	0.0050	0.065	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.10	0.015	0.0699	0.028	0.092	0.0050	0.045	0.058	0.023	0.09	2.425	0.035	0.053	0.023	0.069	0.067	-0.003	1.994	0.523
1.0	0.10	0.015	0.0693	0.020	0.063	0.0050	0.031	0.039	0.023	0.06	0.984	0.025	0.039	0.013	0.046	0.045	-0.001	0.739	0.335

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP	ENERGY DOWN	ENERGY CHANGE	JUMP F.M.	JUMP POS.
8.0	0.10	0.015	0.1045	0.053	0.235	0.0250	0.089	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.1045	0.045	0.202	0.0250	0.079	0.071				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.10	0.015	0.1045	0.036	0.163	0.0250	0.065	0.054				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.10	0.015	0.1045	0.025	0.110	0.0250	0.045	0.036				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.10	0.015	0.1045	0.018	0.075	0.0250	0.031	0.025				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.10	0.015	0.1045	0.053	0.235	0.0125	0.089	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.1045	0.045	0.202	0.0125	0.079	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.10	0.015	0.1045	0.036	0.163	0.0125	0.065	0.068	0.036	0.16	6.659	0.062	0.053	0.005	0.093	0.093	-0.003	4.477	2.133
2.0	0.10	0.015	0.1045	0.025	0.110	0.0125	0.045	0.044				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.10	0.015	0.1045	0.018	0.075	0.0125	0.031	0.030				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.10	0.015	0.1045	0.053	0.235	0.0100	0.089	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.1045	0.045	0.202	0.0100	0.079	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.10	0.015	0.1045	0.036	0.163	0.0100	0.065	0.074	0.036	0.16	6.659	0.057	0.074	0.017	0.095	0.095	-0.000	4.579	1.555
2.0	0.10	0.015	0.1045	0.025	0.110	0.0100	0.045	0.047	0.025	0.11	2.695	0.044	0.047	0.003	0.062	0.062	-0.003	1.808	1.536
1.0	0.10	0.015	0.1045	0.018	0.075	0.0100	0.031	0.032	0.018	0.07	1.109	0.031	0.032	0.001	0.043	0.043	-0.000	0.743	1.373
8.0	0.10	0.015	0.1045	0.053	0.235	0.0050	0.089	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.1045	0.045	0.202	0.0050	0.079	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.10	0.015	0.1045	0.036	0.163	0.0050	0.065	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.10	0.015	0.1045	0.025	0.110	0.0050	0.045	0.058	0.025	0.11	2.695	0.035	0.058	0.023	0.069	0.067	-0.003	1.994	0.735
1.0	0.10	0.015	0.1045	0.018	0.075	0.0050	0.031	0.039	0.018	0.07	1.109	0.025	0.039	0.013	0.046	0.045	-0.001	0.799	0.553

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP	ENERGY DOWN	ENERGY CHANGE	JUMP F.N.	JUMP POS.
8.0	0.10	0.015	0.1736	0.046	0.312	0.0250	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.1736	0.039	0.267	0.0250	0.079	0.071	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.1736	0.031	0.214	0.0250	0.065	0.054	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.1736	0.022	0.145	0.0250	0.045	0.036	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.1736	0.016	0.097	0.0250	0.031	0.025	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.1736	0.046	0.312	0.0125	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.1736	0.039	0.267	0.0125	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.1736	0.031	0.214	0.0125	0.065	0.068	0.031	0.21	7.818	0.062	0.068	0.005	0.093	0.093	-0.000	4.477	2.518
2.0	0.10	0.015	0.1736	0.022	0.145	0.0125	0.045	0.044	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.1736	0.016	0.097	0.0125	0.031	0.030	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.1736	0.046	0.312	0.0100	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.1736	0.039	0.267	0.0100	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.1736	0.031	0.214	0.0100	0.065	0.074	0.031	0.21	7.818	0.057	0.074	0.017	0.095	0.095	-0.000	4.579	2.079
2.0	0.10	0.015	0.1736	0.022	0.145	0.0100	0.045	0.047	0.022	0.14	3.143	0.043	0.047	0.003	0.062	0.062	-0.000	1.608	1.775
1.0	0.10	0.015	0.1736	0.016	0.097	0.0100	0.031	0.032	0.016	0.09	1.285	0.031	0.032	0.001	0.043	0.043	-0.000	0.743	1.244
8.0	0.10	0.015	0.1736	0.046	0.312	0.0050	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.1736	0.039	0.267	0.0050	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.1736	0.031	0.214	0.0050	0.065	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.10	0.015	0.1736	0.022	0.145	0.0050	0.045	0.058	0.022	0.14	3.143	0.035	0.058	0.023	0.069	0.067	-0.003	1.994	0.995
1.0	0.10	0.015	0.1736	0.016	0.097	0.0050	0.031	0.039	0.016	0.09	1.285	0.025	0.039	0.013	0.046	0.045	-0.001	0.799	0.724

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M M.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP	ENERGY DOWN	ENERGY CHANGE	JUMP F+M.	JUMP POS.
8.0	0.10	0.015	0.3402	0.038	0.474	0.0250	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.3402	0.033	0.404	0.0250	0.079	0.071	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.3402	0.026	0.322	0.0250	0.065	0.054	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.3402	0.019	0.216	0.0250	0.045	0.036	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.3402	0.013	0.144	0.0250	0.031	0.025	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.3402	0.038	0.474	0.0125	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.3402	0.033	0.404	0.0125	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.3402	0.026	0.322	0.0125	0.065	0.068	0.026	0.32	9.778	0.062	0.068	0.005	0.093	0.093	-0.000	4.477	3.381
2.0	0.10	0.015	0.3402	0.019	0.216	0.0125	0.045	0.044	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.3402	0.013	0.144	0.0125	0.031	0.030	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.3402	0.038	0.474	0.0100	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.3402	0.033	0.404	0.0100	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.3402	0.026	0.322	0.0100	0.065	0.074	0.026	0.32	9.778	0.057	0.074	0.017	0.095	0.095	-0.000	4.579	2.538
2.0	0.10	0.015	0.3402	0.019	0.216	0.0100	0.045	0.047	0.019	0.21	3.929	0.043	0.047	0.003	0.062	0.062	-0.000	1.808	2.088
1.0	0.10	0.015	0.3402	0.013	0.144	0.0100	0.031	0.032	0.013	0.14	1.612	0.031	0.032	0.001	0.043	0.043	-0.000	0.743	1.456
8.0	0.10	0.015	0.3402	0.038	0.474	0.0050	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.3402	0.033	0.404	0.0050	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.3402	0.026	0.322	0.0050	0.065	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.10	0.015	0.3402	0.019	0.216	0.0050	0.045	0.058	0.019	0.21	3.929	0.035	0.058	0.023	0.069	0.067	-0.003	1.994	1.332
1.0	0.10	0.015	0.3402	0.013	0.144	0.0050	0.031	0.039	0.013	0.14	1.612	0.025	0.039	0.013	0.046	0.045	-0.001	0.799	0.332

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP	ENERGY DOWN	ENERGY CHANGE	JUMP F+M.	JUMP POS.
8.0	0.10	0.015	0.5000	0.034	0.611	0.0250	0.089	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.5000	0.029	0.521	0.0250	0.079	0.071				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.10	0.015	0.5000	0.024	0.413	0.0250	0.065	0.054				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.10	0.015	0.5000	0.017	0.276	0.0250	0.045	0.036				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.10	0.015	0.5000	0.012	0.183	0.0250	0.031	0.025				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.10	0.015	0.5000	0.034	0.611	0.0125	0.089	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.5000	0.029	0.521	0.0125	0.079	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.10	0.015	0.5000	0.024	0.413	0.0125	0.065	0.068	0.024	0.411	1.179	0.062	0.063	0.005	0.093	0.093	-0.003	4.477	3.313
2.0	0.10	0.015	0.5000	0.017	0.276	0.0125	0.045	0.044				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.10	0.015	0.5000	0.012	0.183	0.0125	0.031	0.030				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.10	0.015	0.5000	0.034	0.611	0.0100	0.089	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.5000	0.029	0.521	0.0100	0.079	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.10	0.015	0.5000	0.024	0.413	0.0100	0.065	0.074	0.024	0.411	1.179	0.057	0.074	0.017	0.095	0.095	-0.000	4.579	2.755
2.0	0.10	0.015	0.5000	0.017	0.276	0.0100	0.045	0.047	0.017	0.26	4.398	0.044	0.047	0.003	0.062	0.062	-0.003	1.808	2.222
1.0	0.10	0.015	0.5000	0.012	0.183	0.0100	0.031	0.032	0.012	0.17	1.793	0.031	0.032	0.001	0.043	0.043	-0.003	0.743	1.533
8.0	0.10	0.015	0.5000	0.034	0.611	0.0050	0.089	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.5000	0.029	0.521	0.0050	0.079	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.10	0.015	0.5000	0.024	0.413	0.0050	0.065	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.10	0.015	0.5000	0.017	0.276	0.0050	0.045	0.058	0.017	0.26	4.398	0.035	0.058	0.023	0.070	0.067	-0.003	1.994	1.435
1.0	0.10	0.015	0.5000	0.012	0.183	0.0050	0.031	0.039	0.012	0.17	1.793	0.025	0.039	0.013	0.046	0.045	-0.001	0.799	1.313

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.M M.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP	ENERGY DOWN	ENERGY CHANGE	JUMP F.M.	JUMP POS.
8.0	0.10	0.015	0.7070	0.031	0.772	0.0250	0.089	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.10	0.015	0.7070	0.027	0.655	0.0250	0.079	0.071			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
4.0	0.10	0.015	0.7070	0.022	0.518	0.0250	0.065	0.054			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
2.0	0.10	0.015	0.7070	0.016	0.345	0.0250	0.045	0.036			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
1.0	0.10	0.015	0.7070	0.011	0.229	0.0250	0.031	0.025			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
8.0	0.10	0.015	0.7070	0.031	0.772	0.0125	0.089	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.10	0.015	0.7070	0.027	0.655	0.0125	0.079	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.10	0.015	0.7070	0.022	0.518	0.0125	0.065	0.068	0.022	0.491	2.216	0.062	0.063	0.005	0.093	0.093	-0.000	4.477	3.443
2.0	0.10	0.015	0.7070	0.016	0.345	0.0125	0.045	0.044			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
1.0	0.10	0.015	0.7070	0.011	0.229	0.0125	0.031	0.030			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
8.0	0.10	0.015	0.7070	0.031	0.772	0.0100	0.089	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.10	0.015	0.7070	0.027	0.655	0.0100	0.079	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.10	0.015	0.7070	0.022	0.518	0.0100	0.065	0.074	0.022	0.491	2.216	0.057	0.074	0.017	0.095	0.095	-0.000	4.579	2.936
2.0	0.10	0.015	0.7070	0.016	0.345	0.0100	0.045	0.047	0.016	0.33	4.983	0.044	0.047	0.003	0.062	0.062	-0.003	1.808	2.356
1.0	0.10	0.015	0.7070	0.011	0.229	0.0100	0.031	0.032	0.011	0.21	2.016	0.031	0.032	0.001	0.043	0.043	-0.000	0.743	1.621
8.0	0.10	0.015	0.7070	0.031	0.772	0.0050	0.089	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
6.0	0.10	0.015	0.7070	0.027	0.655	0.0050	0.079	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
4.0	0.10	0.015	0.7070	0.022	0.518	0.0050	0.065	0.100			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.10	0.015	0.7070	0.016	0.345	0.0050	0.045	0.058	0.016	0.33	4.983	0.035	0.058	0.023	0.070	0.067	-0.003	1.994	1.555
1.0	0.10	0.015	0.7070	0.011	0.229	0.0050	0.031	0.039	0.011	0.21	2.016	0.025	0.034	0.013	0.046	0.045	-0.001	0.799	1.375

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP	ENERGY DOWN	ENERGY CHANGE	JUMP F+M.	JUMP POS.
8.0	0.10	0.015	0.8660	0.030	0.883	0.0250	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.8660	0.026	0.753	0.0250	0.079	0.071	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.8660	0.021	0.593	0.0250	0.065	0.054	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.8660	0.015	0.395	0.0250	0.045	0.036	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.8660	0.011	0.262	0.0250	0.031	0.025	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.8660	0.030	0.883	0.0125	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.8660	0.026	0.753	0.0125	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.8660	0.021	0.593	0.0125	0.065	0.068	0.021	0.591	3.446	0.062	0.063	0.005	0.093	0.093	-0.000	4.477	3.535
2.0	0.10	0.015	0.8660	0.015	0.395	0.0125	0.045	0.044	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.8660	0.011	0.262	0.0125	0.031	0.030	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.8660	0.030	0.883	0.0100	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.8660	0.026	0.753	0.0100	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.8660	0.021	0.593	0.0100	0.065	0.074	0.021	0.591	3.446	0.057	0.074	0.017	0.095	0.095	-0.000	4.579	3.041
2.0	0.10	0.015	0.8660	0.015	0.395	0.0100	0.045	0.047	0.015	0.39	5.459	0.044	0.047	0.003	0.062	0.062	-0.000	1.808	2.443
1.0	0.10	0.015	0.8660	0.011	0.262	0.0100	0.031	0.032	0.011	0.24	2.148	0.031	0.032	0.001	0.043	0.043	-0.000	0.743	1.651
8.0	0.10	0.015	0.8660	0.030	0.883	0.0050	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.8660	0.026	0.753	0.0050	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.8660	0.021	0.593	0.0050	0.065	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.10	0.015	0.8660	0.015	0.395	0.0050	0.045	0.058	0.015	0.39	5.459	0.035	0.058	0.023	0.070	0.067	-0.003	1.994	1.653
1.0	0.10	0.015	0.8660	0.011	0.262	0.0050	0.031	0.039	0.011	0.24	2.148	0.025	0.039	0.013	0.046	0.045	-0.001	0.799	1.135

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. No.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP	ENERGY DOWN	ENERGY CHANGE	JUMP F.N.	JUMP POS.
8.0	0.10	0.015	0.9659	0.029	0.952	0.0250	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.9659	0.025	0.810	0.0250	0.079	0.071	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.9659	0.020	0.639	0.0250	0.065	0.054	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.9659	0.015	0.426	0.0250	0.045	0.036	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.9659	0.010	0.282	0.0250	0.031	0.025	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.9659	0.029	0.952	0.0125	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.9659	0.025	0.810	0.0125	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.9659	0.020	0.639	0.0125	0.065	0.068	0.023	0.631	3.907	0.062	0.068	0.005	0.093	0.093	-0.003	4.477	3.531
2.0	0.10	0.015	0.9659	0.015	0.426	0.0125	0.045	0.044	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.9659	0.010	0.282	0.0125	0.031	0.030	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.9659	0.029	0.952	0.0100	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.9659	0.025	0.810	0.0100	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.9659	0.020	0.639	0.0100	0.065	0.074	0.020	0.631	3.907	0.057	0.074	0.017	0.095	0.095	-0.000	4.579	3.337
2.0	0.10	0.015	0.9659	0.015	0.426	0.0100	0.045	0.047	0.015	0.39	5.459	0.044	0.047	0.003	0.062	0.062	-0.000	1.808	2.443
1.0	0.10	0.015	0.9659	0.010	0.282	0.0100	0.031	0.032	0.010	0.27	2.296	0.031	0.032	0.001	0.043	0.043	-0.000	0.743	1.731
8.0	0.10	0.015	0.9659	0.029	0.952	0.0050	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.9659	0.025	0.810	0.0050	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.9659	0.020	0.639	0.0050	0.065	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.10	0.015	0.9659	0.015	0.426	0.0050	0.045	0.058	0.015	0.39	5.459	0.035	0.058	0.023	0.070	0.067	-0.003	1.994	1.650
1.0	0.10	0.015	0.9659	0.010	0.282	0.0050	0.031	0.039	0.010	0.27	2.296	0.025	0.039	0.013	0.046	0.045	-0.001	0.799	1.175

COMMON DATA APPROACH PIPE DATA — TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP	ENERGY DOWN	ENERGY CHANGE	JUMP F+M.	JUMP POS.
8.0	0.10	0.015	1.0000	0.029	0.978	0.0250	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	1.0000	0.025	0.827	0.0250	0.079	0.071	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	1.0000	0.020	0.654	0.0250	0.065	0.054	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	1.0000	0.014	0.436	0.0250	0.045	0.036	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	1.0000	0.010	0.288	0.0250	0.031	0.025	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	1.0000	0.029	0.978	0.0125	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	1.0000	0.025	0.827	0.0125	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	1.0000	0.020	0.654	0.0125	0.065	0.068	0.020	0.631	3.907	0.062	0.068	0.005	0.093	0.093	-0.000	4.477	3.631
2.0	0.10	0.015	1.0000	0.014	0.436	0.0125	0.045	0.044	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	1.0000	0.010	0.288	0.0125	0.031	0.030	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	1.0000	0.029	0.978	0.0100	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	1.0000	0.025	0.827	0.0100	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	1.0000	0.020	0.654	0.0100	0.065	0.074	0.020	0.631	3.907	0.057	0.074	0.017	0.095	0.095	-0.000	4.579	3.087
2.0	0.10	0.015	1.0000	0.014	0.436	0.0100	0.045	0.047	0.014	0.43	5.728	0.044	0.047	0.003	0.062	0.062	-0.000	1.808	2.483
1.0	0.10	0.015	1.0000	0.010	0.288	0.0100	0.031	0.032	0.010	0.27	2.296	0.031	0.032	0.001	0.043	0.043	-0.000	0.743	1.721
8.0	0.10	0.015	1.0000	0.029	0.978	0.0050	0.089	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	1.0000	0.025	0.827	0.0050	0.079	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	1.0000	0.020	0.654	0.0050	0.065	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.10	0.015	1.0000	0.014	0.436	0.0050	0.045	0.058	0.014	0.43	5.728	0.035	0.058	0.023	0.069	0.067	-0.003	1.994	1.691
1.0	0.10	0.015	1.0000	0.010	0.288	0.0050	0.031	0.039	0.010	0.27	2.296	0.025	0.039	0.013	0.046	0.045	-0.001	0.799	1.175

APPENDIX 3

JUMP LOCATION IN A 0.15 m DIAMETER PIPE,

MANNING COEFFICIENT 0.015, AT SLOPES

1/40, 1/80, 1/100, 1/150, 1/200, 1/300, 1/400, 1/600

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.0349	0.059	0.136	0.0250	0.082	0.064				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.15	0.015	0.0349	0.050	0.118	0.0250	0.071	0.055				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.0349	0.041	0.095	0.0250	0.057	0.044				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.0349	0.029	0.065	0.0250	0.040	0.031				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.0349	0.021	0.044	0.0250	0.028	0.022				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.0349	0.059	0.136	0.0125	0.082	0.079				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.15	0.015	0.0349	0.050	0.118	0.0125	0.071	0.067				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.0349	0.041	0.095	0.0125	0.057	0.053				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.0349	0.029	0.065	0.0125	0.040	0.037				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.0349	0.021	0.044	0.0125	0.028	0.026				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.0349	0.059	0.138	0.0100	0.082	0.084	0.059	0.141	1.436	0.090	0.084	0.004	0.115	0.115	0.000	9.685	1.972
6.0	0.15	0.015	0.0349	0.050	0.118	0.0100	0.071	0.071	0.051	0.12	7.894	0.071	0.071	0.000	0.098	0.098	0.000	6.795	2.033
4.0	0.15	0.015	0.0349	0.041	0.095	0.0100	0.057	0.057				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.0349	0.029	0.065	0.0100	0.040	0.039				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.0349	0.021	0.044	0.0100	0.028	0.028				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.0349	0.059	0.138	0.0066	0.082	0.096	0.059	0.141	1.436	0.070	0.096	0.027	0.120	0.119	-0.001	10.284	0.853
6.0	0.15	0.015	0.0349	0.050	0.118	0.0066	0.071	0.080	0.051	0.12	7.894	0.062	0.080	0.018	0.101	0.100	0.000	6.973	0.927
4.0	0.15	0.015	0.0349	0.041	0.095	0.0066	0.057	0.063	0.041	0.09	4.708	0.051	0.063	0.012	0.080	0.080	0.000	4.107	0.852
2.0	0.15	0.015	0.0349	0.029	0.065	0.0066	0.040	0.044	0.029	0.06	1.932	0.036	0.044	0.007	0.055	0.055	0.000	1.692	0.571
1.0	0.15	0.015	0.0349	0.021	0.044	0.0066	0.024	0.031	0.021	0.04	0.791	0.025	0.031	0.006	0.038	0.038	0.000	0.706	0.321

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA			APPROACH PIPE DATA			TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.0349	0.059	0.138	0.0050	0.082	0.107	0.059	0.14	11.436	0.062	0.107	0.045	0.130	0.125	-0.005	11.008	0.251
6.0	0.15	0.015	0.0349	0.050	0.118	0.0050	0.071	0.087	0.051	0.12	7.894	0.057	0.087	0.031	0.106	0.103	-0.002	7.313	0.463
4.0	0.15	0.015	0.0349	0.041	0.095	0.0050	0.057	0.069	0.041	0.09	4.708	0.047	0.069	0.021	0.083	0.082	-0.001	4.265	0.498
2.0	0.15	0.015	0.0349	0.029	0.065	0.0050	0.040	0.047	0.029	0.06	1.932	0.034	0.047	0.013	0.057	0.056	-0.001	1.750	0.345
1.0	0.15	0.015	0.0349	0.021	0.044	0.0050	0.028	0.033	0.021	0.04	0.791	0.024	0.033	0.010	0.040	0.039	-0.001	0.730	0.182
8.0	0.15	0.015	0.0349	0.059	0.138	0.0050	0.082	0.132	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.15	0.015	0.0349	0.050	0.118	0.0050	0.071	0.101	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.15	0.015	0.0349	0.041	0.095	0.0050	0.057	0.077	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
2.0	0.15	0.015	0.0349	0.029	0.065	0.0050	0.040	0.053	0.029	0.06	1.932	0.030	0.053	0.023	0.063	0.059	-0.004	1.906	0.041
1.0	0.15	0.015	0.0349	0.021	0.044	0.0050	0.028	0.037	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
8.0	0.15	0.015	0.0349	0.059	0.138	0.0025	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.0349	0.050	0.118	0.0025	0.071	0.112	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.15	0.015	0.0349	0.041	0.095	0.0025	0.057	0.084	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
2.0	0.15	0.015	0.0349	0.029	0.065	0.0025	0.040	0.057	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
1.0	0.15	0.015	0.0349	0.021	0.044	0.0025	0.028	0.039	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
8.0	0.15	0.015	0.0349	0.059	0.138	0.0017	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.0349	0.050	0.118	0.0017	0.071	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.15	0.015	0.0349	0.041	0.095	0.0017	0.057	0.096	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
2.0	0.15	0.015	0.0349	0.029	0.065	0.0017	0.040	0.063	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
1.0	0.15	0.015	0.0349	0.021	0.044	0.0017	0.028	0.044	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.0698	0.049	0.180	0.0250	0.082	0.064				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.15	0.015	0.0699	0.042	0.153	0.0250	0.071	0.055				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.0699	0.034	0.122	0.0250	0.057	0.044				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.0699	0.024	0.083	0.0250	0.040	0.031				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.0699	0.017	0.056	0.0250	0.028	0.022				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.0698	0.049	0.180	0.0125	0.082	0.079				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.15	0.015	0.0698	0.042	0.153	0.0125	0.071	0.067				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.0699	0.034	0.122	0.0125	0.057	0.053				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.0699	0.024	0.083	0.0125	0.040	0.037				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.0699	0.017	0.056	0.0125	0.028	0.026				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.0698	0.049	0.180	0.0100	0.082	0.084	0.049	0.181	3.607	0.080	0.084	0.004	0.115	0.115	0.000	9.685	3.033
6.0	0.15	0.015	0.0698	0.042	0.153	0.0100	0.071	0.071	0.043	0.15	9.388	0.071	0.071	0.000	0.098	0.098	0.000	6.795	2.913
4.0	0.15	0.015	0.0699	0.034	0.122	0.0100	0.057	0.057				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.0698	0.024	0.083	0.0100	0.040	0.039				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.0699	0.017	0.056	0.0100	0.028	0.028				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.0698	0.049	0.180	0.0066	0.082	0.096	0.049	0.181	3.607	0.070	0.096	0.027	0.120	0.119	-0.001	10.284	1.835
6.0	0.15	0.015	0.0699	0.042	0.153	0.0066	0.071	0.080	0.043	0.15	9.388	0.062	0.080	0.018	0.101	0.100	0.000	6.973	1.734
4.0	0.15	0.015	0.0699	0.034	0.122	0.0066	0.057	0.063	0.034	0.12	5.636	0.051	0.063	0.012	0.080	0.080	0.000	4.107	1.510
2.0	0.15	0.015	0.0699	0.024	0.083	0.0066	0.040	0.044	0.025	0.08	2.285	0.036	0.044	0.007	0.055	0.055	0.000	1.692	0.988
1.0	0.15	0.015	0.0699	0.017	0.056	0.0066	0.028	0.031	0.018	0.05	0.918	0.025	0.031	0.006	0.038	0.038	0.000	0.706	0.576

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.15	0.015	0.1045	0.044	0.219	0.0250	0.082	0.064				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.15	0.015	0.1045	0.038	0.186	0.0250	0.071	0.055				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.1045	0.031	0.148	0.0250	0.057	0.044				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.1045	0.022	0.100	0.0250	0.040	0.031				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.1045	0.016	0.067	0.0250	0.028	0.022				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.1045	0.044	0.219	0.0125	0.082	0.079				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.15	0.015	0.1045	0.038	0.186	0.0125	0.071	0.067				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.1045	0.031	0.148	0.0125	0.057	0.053				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.1045	0.022	0.100	0.0125	0.040	0.037				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.1045	0.016	0.067	0.0125	0.028	0.026				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.1045	0.044	0.219	0.0100	0.092	0.084	0.044	0.2215.472		0.081	0.084	0.004	0.115	0.115	0.000	9.685	3.565
6.0	0.15	0.015	0.1045	0.038	0.186	0.0100	0.071	0.071	0.038	0.1810.681		0.071	0.071	0.000	0.098	0.098	0.000	6.795	3.388
4.0	0.15	0.015	0.1045	0.031	0.148	0.0100	0.057	0.057				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.1045	0.022	0.100	0.0100	0.040	0.039				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.1045	0.016	0.067	0.0100	0.028	0.028				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.1045	0.044	0.219	0.0066	0.082	0.096	0.044	0.2215.472		0.070	0.096	0.027	0.120	0.119	-0.00110.284		2.338
6.0	0.15	0.015	0.1045	0.038	0.186	0.0066	0.071	0.080	0.038	0.1810.681		0.062	0.080	0.018	0.101	0.100	0.000	6.973	2.189
4.0	0.15	0.015	0.1045	0.031	0.148	0.0066	0.057	0.063	0.031	0.14	6.271	0.052	0.063	0.012	0.080	0.080	0.000	4.107	1.810
2.0	0.15	0.015	0.1045	0.022	0.100	0.0066	0.040	0.044	0.022	0.10	2.555	0.036	0.044	0.007	0.055	0.055	0.000	1.692	1.199
1.0	0.15	0.015	0.1045	0.016	0.067	0.0066	0.028	0.031	0.016	0.06	1.015	0.025	0.031	0.006	0.038	0.038	0.000	0.706	0.737

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.0699	0.049	0.180	0.0050	0.082	0.107	0.049	0.18	13.607	0.062	0.107	0.045	0.130	0.125	-0.005	11.008	1.157
6.0	0.15	0.015	0.0699	0.042	0.153	0.0050	0.071	0.087	0.043	0.15	9.388	0.057	0.087	0.031	0.106	0.103	-0.002	7.313	1.239
4.0	0.15	0.015	0.0699	0.034	0.122	0.0050	0.057	0.069	0.034	0.12	5.636	0.047	0.069	0.021	0.083	0.082	-0.001	4.265	1.131
2.0	0.15	0.015	0.0699	0.024	0.083	0.0050	0.040	0.047	0.025	0.08	2.285	0.034	0.047	0.013	0.057	0.056	-0.001	1.750	0.745
1.0	0.15	0.015	0.0699	0.017	0.056	0.0050	0.028	0.033	0.018	0.05	0.918	0.024	0.033	0.010	0.040	0.039	-0.001	0.730	0.426
8.0	0.15	0.015	0.0699	0.049	0.180	0.0050	0.082	0.132	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.15	0.015	0.0699	0.042	0.153	0.0050	0.071	0.101	0.043	0.15	9.388	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	0.517
4.0	0.15	0.015	0.0699	0.034	0.122	0.0050	0.057	0.077	0.034	0.12	5.636	0.041	0.077	0.036	0.094	0.087	-0.007	4.712	0.630
2.0	0.15	0.015	0.0698	0.024	0.083	0.0050	0.040	0.053	0.025	0.08	2.285	0.030	0.053	0.023	0.063	0.059	-0.004	1.906	0.441
1.0	0.15	0.015	0.0699	0.017	0.056	0.0050	0.028	0.037	0.018	0.05	0.918	0.021	0.037	0.016	0.044	0.041	-0.003	0.795	0.234
8.0	0.15	0.015	0.0699	0.049	0.180	0.0025	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.0699	0.042	0.153	0.0025	0.071	0.112	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.15	0.015	0.0698	0.034	0.122	0.0025	0.057	0.084	0.034	0.12	5.636	0.037	0.084	0.047	0.107	0.092	-0.015	5.193	0.250
2.0	0.15	0.015	0.0698	0.024	0.083	0.0025	0.040	0.057	0.025	0.08	2.285	0.027	0.057	0.029	0.070	0.062	-0.008	2.670	0.239
1.0	0.15	0.015	0.0698	0.017	0.056	0.0025	0.028	0.039	0.018	0.05	0.918	0.019	0.039	0.020	0.049	0.043	-0.005	0.659	0.094
8.0	0.15	0.015	0.0699	0.049	0.180	0.0017	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.0699	0.042	0.153	0.0017	0.071	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.15	0.015	0.0699	0.034	0.122	0.0017	0.057	0.096	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
2.0	0.15	0.015	0.0698	0.024	0.083	0.0017	0.040	0.063	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
1.0	0.15	0.015	0.0699	0.017	0.056	0.0017	0.028	0.044	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	SPEC. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.1045	0.044	0.219	0.0050	0.082	0.107	0.044	0.22	15.472	0.062	0.107	0.045	0.130	0.125	-0.005	11.008	1.680
6.0	0.15	0.015	0.1045	0.038	0.186	0.0050	0.071	0.087	0.038	0.18	10.681	0.057	0.087	0.031	0.106	0.103	-0.002	7.313	1.686
4.0	0.15	0.015	0.1045	0.031	0.148	0.0050	0.057	0.069	0.031	0.14	6.271	0.047	0.069	0.021	0.083	0.082	-0.001	4.265	1.424
2.0	0.15	0.015	0.1045	0.022	0.100	0.0050	0.040	0.047	0.022	0.10	2.555	0.034	0.047	0.013	0.057	0.056	-0.001	1.750	0.953
1.0	0.15	0.015	0.1045	0.016	0.067	0.0050	0.028	0.033	0.016	0.06	1.015	0.024	0.033	0.010	0.040	0.039	-0.001	0.730	0.553
8.0	0.15	0.015	0.1045	0.044	0.219	0.0050	0.082	0.132	0.044	0.22	15.472	0.049	0.132	0.083	0.181	0.144	-0.037	13.660	0.444
6.0	0.15	0.015	0.1045	0.038	0.186	0.0050	0.071	0.101	0.038	0.18	10.681	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	0.956
4.0	0.15	0.015	0.1045	0.031	0.148	0.0050	0.057	0.077	0.031	0.14	6.271	0.041	0.077	0.036	0.094	0.067	-0.007	4.712	0.923
2.0	0.15	0.015	0.1045	0.022	0.100	0.0050	0.040	0.053	0.022	0.10	2.555	0.030	0.053	0.023	0.063	0.059	-0.004	1.906	0.648
1.0	0.15	0.015	0.1045	0.016	0.067	0.0050	0.028	0.037	0.016	0.06	1.015	0.021	0.037	0.016	0.044	0.041	-0.003	0.795	0.351
8.0	0.15	0.015	0.1045	0.044	0.219	0.0025	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.1045	0.038	0.186	0.0025	0.071	0.112	0.038	0.18	10.681	0.042	0.112	0.070	0.152	0.121	-0.031	9.511	0.387
4.0	0.15	0.015	0.1045	0.031	0.148	0.0025	0.057	0.084	0.031	0.14	6.271	0.037	0.084	0.047	0.107	0.092	-0.015	5.193	0.534
2.0	0.15	0.015	0.1045	0.022	0.100	0.0025	0.040	0.057	0.022	0.10	2.555	0.027	0.057	0.029	0.070	0.062	-0.008	2.070	0.408
1.0	0.15	0.015	0.1045	0.016	0.067	0.0025	0.028	0.039	0.016	0.06	1.015	0.019	0.039	0.020	0.049	0.043	-0.005	0.659	0.217
8.0	0.15	0.015	0.1045	0.044	0.219	0.0017	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.1045	0.038	0.186	0.0017	0.071	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.15	0.015	0.1045	0.031	0.148	0.0017	0.057	0.096	0.031	0.14	6.271	0.032	0.096	0.064	0.141	0.101	-0.040	6.199	0.030
2.0	0.15	0.015	0.1045	0.022	0.100	0.0017	0.040	0.063	0.022	0.10	2.555	0.024	0.063	0.039	0.086	0.067	-0.019	2.386	0.119
1.0	0.15	0.015	0.1045	0.016	0.067	0.0017	0.028	0.044	0.016	0.06	1.015	0.017	0.044	0.027	0.059	0.046	-0.013	0.964	0.035

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA			APPROACH PIPE DATA			TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.15	0.015	0.1736	0.039	0.290	0.0250	0.082	0.064	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.1736	0.033	0.246	0.0250	0.071	0.055	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.1736	0.027	0.195	0.0250	0.057	0.044	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.1736	0.020	0.131	0.0250	0.040	0.031	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.1736	0.014	0.087	0.0250	0.028	0.022	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.1736	0.039	0.290	0.0125	0.082	0.079	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.1736	0.033	0.246	0.0125	0.071	0.067	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.1736	0.027	0.195	0.0125	0.057	0.053	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.1736	0.020	0.131	0.0125	0.040	0.037	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.1736	0.014	0.087	0.0125	0.028	0.026	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.1736	0.039	0.290	0.0100	0.082	0.084	0.039	0.281	8.103	0.081	0.084	0.004	0.115	0.115	0.000	9.085	4.127
6.0	0.15	0.015	0.1736	0.033	0.246	0.0100	0.071	0.071	0.034	0.241	2.499	0.071	0.071	0.000	0.098	0.098	0.000	6.795	3.858
4.0	0.15	0.015	0.1736	0.027	0.195	0.0100	0.057	0.057	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.1736	0.020	0.131	0.0100	0.040	0.039	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.1736	0.014	0.087	0.0100	0.028	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.1736	0.039	0.290	0.0066	0.082	0.096	0.039	0.281	8.103	0.070	0.096	0.027	0.120	0.119	-0.001	10.[illegible]84	2.883
6.0	0.15	0.015	0.1736	0.033	0.246	0.0066	0.071	0.080	0.034	0.241	2.499	0.062	0.080	0.018	0.101	0.100	-0.001	6.973	2.653
4.0	0.15	0.015	0.1736	0.027	0.195	0.0066	0.057	0.063	0.028	0.19	7.361	0.051	0.063	0.012	0.080	0.080	0.000	4.107	2.183
2.0	0.15	0.015	0.1736	0.020	0.131	0.0066	0.040	0.044	0.020	0.12	2.919	0.036	0.044	0.007	0.055	0.055	0.000	1.692	1.412
1.0	0.15	0.015	0.1736	0.014	0.087	0.0066	0.028	0.031	0.014	0.08	1.221	0.025	0.031	0.006	0.038	0.038	0.000	0.706	0.932

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.1736	0.039	0.290	0.0050	0.082	0.107	0.039	0.28	18.103	0.062	0.107	0.045	0.130	0.125	-0.005	11.008	2.214
6.0	0.15	0.015	0.1736	0.033	0.246	0.0050	0.071	0.087	0.034	0.24	12.499	0.057	0.087	0.031	0.106	0.103	-0.002	7.313	2.140
4.0	0.15	0.015	0.1736	0.027	0.195	0.0050	0.057	0.069	0.028	0.19	7.361	0.047	0.069	0.021	0.083	0.082	-0.001	4.265	1.792
2.0	0.15	0.015	0.1736	0.020	0.131	0.0050	0.040	0.047	0.020	0.12	2.919	0.034	0.047	0.013	0.057	0.056	-0.001	1.750	1.151
1.0	0.15	0.015	0.1736	0.014	0.087	0.0050	0.028	0.033	0.014	0.08	1.221	0.024	0.033	0.010	0.040	0.039	-0.001	0.730	0.745
8.0	0.15	0.015	0.1736	0.039	0.290	0.0050	0.082	0.132	0.039	0.28	18.103	0.049	0.132	0.083	0.181	0.144	-0.037	13.860	0.981
6.0	0.15	0.015	0.1736	0.033	0.246	0.0050	0.071	0.101	0.034	0.24	12.499	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	1.419
4.0	0.15	0.015	0.1736	0.027	0.195	0.0050	0.057	0.077	0.028	0.19	7.361	0.041	0.077	0.036	0.094	0.087	-0.007	4.712	1.292
2.0	0.15	0.015	0.1736	0.020	0.131	0.0050	0.040	0.053	0.020	0.12	2.919	0.030	0.053	0.023	0.063	0.059	-0.004	1.906	0.857
1.0	0.15	0.015	0.1736	0.014	0.087	0.0050	0.028	0.037	0.014	0.08	1.221	0.021	0.037	0.016	0.044	0.041	-0.003	0.795	0.553
8.0	0.15	0.015	0.1736	0.039	0.290	0.0025	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.1736	0.033	0.246	0.0025	0.071	0.112	0.034	0.24	12.499	0.042	0.112	0.070	0.152	0.121	-0.031	9.511	0.835
4.0	0.15	0.015	0.1736	0.027	0.195	0.0025	0.057	0.084	0.028	0.19	7.361	0.037	0.084	0.047	0.107	0.092	-0.015	5.193	0.896
2.0	0.15	0.015	0.1736	0.020	0.131	0.0025	0.040	0.057	0.020	0.12	2.919	0.027	0.057	0.029	0.070	0.062	-0.008	2.070	0.613
1.0	0.15	0.015	0.1736	0.014	0.087	0.0025	0.028	0.039	0.014	0.08	1.221	0.019	0.039	0.020	0.049	0.043	-0.005	0.659	0.436
8.0	0.15	0.015	0.1736	0.039	0.290	0.0017	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.1736	0.033	0.246	0.0017	0.071	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.15	0.015	0.1736	0.027	0.195	0.0017	0.057	0.096	0.028	0.19	7.361	0.032	0.096	0.064	0.141	0.101	-0.040	6.199	0.389
2.0	0.15	0.015	0.1736	0.020	0.131	0.0017	0.040	0.063	0.020	0.12	2.919	0.024	0.063	0.039	0.086	0.067	-0.019	2.386	0.322
1.0	0.15	0.015	0.1736	0.014	0.067	0.0017	0.028	0.044	0.014	0.08	1.221	0.017	0.044	0.027	0.059	0.046	-0.013	0.984	0.222

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA			APPROACH PIPE DATA			TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.3402	0.033	0.437	0.0250	0.082	0.064	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.3402	0.028	0.370	0.0250	0.071	0.055	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.3402	0.023	0.292	0.0250	0.057	0.044	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.3402	0.017	0.195	0.0250	0.040	0.031	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.3402	0.012	0.129	0.0250	0.028	0.022	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.3402	0.033	0.437	0.0125	0.082	0.079	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.3402	0.028	0.370	0.0125	0.071	0.067	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.3402	0.023	0.292	0.0125	0.057	0.053	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.3402	0.017	0.195	0.0125	0.040	0.037	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.3402	0.012	0.129	0.0125	0.028	0.026	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.3402	0.033	0.437	0.0100	0.082	0.084	0.033	0.432	2.584	0.081	0.084	0.003	0.115	0.115	0.000	9.885	4.753
6.0	0.15	0.015	0.3402	0.028	0.370	0.0100	0.071	0.071	0.028	0.361	5.666	0.071	0.071	0.000	0.098	0.098	0.000	6.795	4.395
4.0	0.15	0.015	0.3402	0.023	0.292	0.0100	0.057	0.057	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.3402	0.017	0.195	0.0100	0.040	0.039	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.3402	0.012	0.129	0.0100	0.028	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.3402	0.033	0.437	0.0066	0.082	0.096	0.033	0.432	2.584	0.070	0.096	0.027	0.120	0.119	-0.001	10.284	3.502
6.0	0.15	0.015	0.3402	0.028	0.370	0.0066	0.071	0.080	0.028	0.361	5.666	0.062	0.080	0.018	0.101	0.100	0.000	6.973	3.184
4.0	0.15	0.015	0.3402	0.023	0.292	0.0066	0.057	0.063	0.023	0.29	9.341	0.052	0.063	0.012	0.080	0.080	0.000	4.107	2.631
2.0	0.15	0.015	0.3402	0.017	0.195	0.0066	0.040	0.044	0.017	0.18	3.621	0.036	0.044	0.007	0.055	0.055	0.000	1.692	1.693
1.0	0.15	0.015	0.3402	0.012	0.129	0.0066	0.028	0.031	0.012	0.13	1.541	0.025	0.031	0.006	0.038	0.038	0.000	0.706	1.094

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.3402	0.033	0.437	0.0050	0.082	0.107	0.033	0.432	2.584	0.062	0.107	0.045	0.130	0.125	-0.005	11.008	2.830
6.0	0.15	0.015	0.3402	0.028	0.370	0.0050	0.071	0.087	0.028	0.361	5.666	0.057	0.087	0.031	0.106	0.103	-0.002	7.313	2.659
4.0	0.15	0.015	0.3402	0.023	0.292	0.0050	0.057	0.069	0.023	0.29	9.341	0.047	0.069	0.021	0.083	0.082	-0.001	4.265	2.236
2.0	0.15	0.015	0.3402	0.017	0.195	0.0050	0.040	0.047	0.017	0.18	3.621	0.034	0.047	0.013	0.057	0.056	-0.001	1.750	1.436
1.0	0.15	0.015	0.3402	0.012	0.129	0.0050	0.028	0.033	0.012	0.13	1.541	0.024	0.033	0.010	0.040	0.039	-0.001	0.730	0.936
8.0	0.15	0.015	0.3402	0.033	0.437	0.0050	0.082	0.132	0.033	0.432	2.584	0.049	0.132	0.083	0.181	0.144	-0.037	13.660	1.596
6.0	0.15	0.015	0.3402	0.028	0.370	0.0050	0.071	0.101	0.028	0.361	5.666	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	1.948
4.0	0.15	0.015	0.3402	0.023	0.292	0.0050	0.057	0.077	0.023	0.29	9.341	0.041	0.077	0.036	0.094	0.087	-0.007	4.712	1.732
2.0	0.15	0.015	0.3402	0.017	0.195	0.0050	0.040	0.053	0.017	0.18	3.621	0.030	0.053	0.023	0.063	0.059	-0.004	1.906	1.133
1.0	0.15	0.015	0.3402	0.012	0.129	0.0050	0.028	0.037	0.012	0.13	1.541	0.021	0.037	0.016	0.044	0.041	-0.003	0.795	0.743
8.0	0.15	0.015	0.3402	0.033	0.437	0.0025	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.3402	0.028	0.370	0.0025	0.071	0.112	0.028	0.361	5.666	0.042	0.112	0.070	0.152	0.121	-0.031	9.511	1.357
4.0	0.15	0.015	0.3402	0.023	0.292	0.0025	0.057	0.084	0.023	0.29	9.341	0.037	0.084	0.047	0.107	0.092	-0.015	5.193	1.332
2.0	0.15	0.015	0.3402	0.017	0.195	0.0025	0.040	0.057	0.017	0.18	3.621	0.027	0.057	0.029	0.070	0.062	-0.008	2.070	0.886
1.0	0.15	0.015	0.3402	0.012	0.129	0.0025	0.028	0.039	0.012	0.13	1.541	0.019	0.039	0.020	0.049	0.043	-0.005	0.659	0.593
8.0	0.15	0.015	0.3402	0.033	0.437	0.0017	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.3402	0.028	0.370	0.0017	0.071	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.15	0.015	0.3402	0.023	0.292	0.0017	0.057	0.096	0.023	0.29	9.341	0.032	0.096	0.064	0.141	0.101	-0.040	6.199	0.826
2.0	0.15	0.015	0.3402	0.017	0.195	0.0017	0.040	0.063	0.017	0.18	3.621	0.024	0.063	0.039	0.086	0.067	-0.019	2.386	0.594
1.0	0.15	0.015	0.3402	0.012	0.129	0.0017	0.028	0.044	0.012	0.13	1.541	0.017	0.044	0.027	0.059	0.046	-0.013	0.984	0.410

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HV M.	ITERP. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.5000	0.030	0.561	0.0250	0.082	0.064	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.5000	0.026	0.475	0.0250	0.071	0.055	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.5000	0.021	0.374	0.0250	0.057	0.044	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.5000	0.015	0.248	0.0250	0.040	0.031	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.5000	0.011	0.164	0.0250	0.028	0.022	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.5000	0.030	0.561	0.0125	0.082	0.079	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.5000	0.026	0.475	0.0125	0.071	0.067	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.5000	0.021	0.374	0.0125	0.057	0.053	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.5000	0.015	0.248	0.0125	0.040	0.037	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.5000	0.011	0.164	0.0125	0.028	0.026	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.5000	0.030	0.561	0.0100	0.082	0.084	0.030	0.552	5.739	0.081	0.084	0.003	0.115	0.115	0.000	9.685	5.072
6.0	0.15	0.015	0.5000	0.026	0.475	0.0100	0.071	0.071	0.026	0.451	7.550	0.071	0.071	0.000	0.098	0.098	0.000	6.795	4.623
4.0	0.15	0.015	0.5000	0.021	0.374	0.0100	0.057	0.057	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.5000	0.015	0.248	0.0100	0.040	0.039	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.5000	0.011	0.164	0.0100	0.028	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.5000	0.030	0.561	0.0066	0.082	0.096	0.030	0.552	5.739	0.070	0.096	0.027	0.120	0.119	-0.001	10.284	3.813
6.0	0.15	0.015	0.5000	0.026	0.475	0.0066	0.071	0.080	0.026	0.451	7.550	0.062	0.080	0.018	0.101	0.100	0.000	6.973	3.411
4.0	0.15	0.015	0.5000	0.021	0.374	0.0066	0.057	0.063	0.022	0.351	0.248	0.052	0.063	0.012	0.080	0.080	0.000	4.107	2.777
2.0	0.15	0.015	0.5000	0.015	0.248	0.0066	0.040	0.044	0.016	0.22	4.111	0.036	0.044	0.007	0.055	0.055	0.000	1.692	1.826
1.0	0.15	0.015	0.5000	0.011	0.164	0.0066	0.028	0.031	0.011	0.15	1.688	0.025	0.031	0.006	0.038	0.038	0.000	0.706	1.155

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA			APPROACH PIPE DATA			TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.5000	0.030	0.561	0.0050	0.082	0.107	0.030	0.55	25.739	0.062	0.107	0.045	0.130	0.125	-0.005	11.008	3.139
6.0	0.15	0.015	0.5000	0.026	0.475	0.0050	0.071	0.087	0.026	0.45	17.550	0.057	0.087	0.031	0.106	0.103	-0.002	7.313	2.897
4.0	0.15	0.015	0.5000	0.021	0.374	0.0050	0.057	0.069	0.022	0.35	10.248	0.047	0.069	0.021	0.083	0.082	-0.001	4.265	2.383
2.0	0.15	0.015	0.5000	0.015	0.248	0.0050	0.040	0.047	0.016	0.22	4.111	0.034	0.047	0.013	0.057	0.056	-0.001	1.750	1.571
1.0	0.15	0.015	0.5000	0.011	0.164	0.0050	0.028	0.033	0.011	0.15	1.688	0.024	0.033	0.010	0.040	0.039	-0.001	0.730	0.997
8.0	0.15	0.015	0.5000	0.030	0.561	0.0050	0.082	0.132	0.030	0.55	25.739	0.049	0.132	0.083	0.181	0.144	-0.037	13.660	1.905
6.0	0.15	0.015	0.5000	0.026	0.475	0.0050	0.071	0.101	0.026	0.45	17.550	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	2.179
4.0	0.15	0.015	0.5000	0.021	0.374	0.0050	0.057	0.077	0.022	0.35	10.248	0.041	0.077	0.036	0.094	0.087	-0.007	4.712	1.883
2.0	0.15	0.015	0.5000	0.015	0.248	0.0050	0.040	0.053	0.016	0.22	4.111	0.030	0.053	0.023	0.063	0.059	-0.004	1.906	1.259
1.0	0.15	0.015	0.5000	0.011	0.164	0.0050	0.028	0.037	0.011	0.15	1.688	0.021	0.037	0.016	0.044	0.041	-0.003	0.795	0.806
8.0	0.15	0.015	0.5000	0.030	0.561	0.0025	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.5000	0.026	0.475	0.0025	0.071	0.112	0.026	0.45	17.550	0.042	0.112	0.070	0.152	0.121	-0.031	9.511	1.585
4.0	0.15	0.015	0.5000	0.021	0.374	0.0025	0.057	0.084	0.022	0.35	10.248	0.037	0.084	0.047	0.107	0.092	-0.015	5.193	1.478
2.0	0.15	0.015	0.5000	0.015	0.248	0.0025	0.040	0.057	0.016	0.22	4.111	0.027	0.057	0.029	0.070	0.062	-0.006	2.070	1.018
1.0	0.15	0.015	0.5000	0.011	0.164	0.0025	0.028	0.039	0.011	0.15	1.688	0.019	0.039	0.020	0.049	0.043	-0.005	0.659	0.654
8.0	0.15	0.015	0.5000	0.030	0.561	0.0017	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.5000	0.026	0.475	0.0017	0.071	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.15	0.015	0.5000	0.021	0.374	0.0017	0.057	0.096	0.022	0.35	10.248	0.032	0.096	0.064	0.141	0.101	-0.040	6.199	0.971
2.0	0.15	0.015	0.5000	0.015	0.248	0.0017	0.040	0.063	0.016	0.22	4.111	0.024	0.063	0.039	0.086	0.067	-0.019	2.386	0.725
1.0	0.15	0.015	0.5000	0.011	0.164	0.0017	0.028	0.044	0.011	0.15	1.688	0.017	0.044	0.027	0.059	0.046	-0.013	0.984	0.470

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.7070	0.027	0.705	0.0250	0.082	0.064	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.7070	0.024	0.597	0.0250	0.071	0.055	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.7070	0.019	0.469	0.0250	0.057	0.044	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.7070	0.014	0.310	0.0250	0.040	0.031	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.7070	0.010	0.205	0.0250	0.026	0.022	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.7070	0.027	0.705	0.0125	0.082	0.079	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.7070	0.024	0.597	0.0125	0.071	0.067	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.7070	0.019	0.469	0.0125	0.057	0.053	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.7070	0.014	0.310	0.0125	0.040	0.037	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.7070	0.010	0.205	0.0125	0.028	0.026	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.7070	0.027	0.705	0.0100	0.082	0.084	0.028	0.672	8.695	0.081	0.084	0.003	0.115	0.115	0.000	9.685	5.333
6.0	0.15	0.015	0.7070	0.024	0.597	0.0100	0.071	0.071	0.024	0.571	9.900	0.071	0.071	0.000	0.098	0.098	0.000	6.795	4.845
4.0	0.15	0.015	0.7070	0.019	0.469	0.0100	0.057	0.057	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.7070	0.014	0.310	0.0100	0.040	0.039	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.7070	0.010	0.205	0.0100	0.028	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.7070	0.027	0.705	0.0066	0.082	0.096	0.028	0.672	8.695	0.070	0.096	0.027	0.120	0.119	-0.001	10.284	4.042
6.0	0.15	0.015	0.7070	0.024	0.597	0.0066	0.071	0.080	0.024	0.571	9.900	0.062	0.080	0.018	0.101	0.100	-0.001	6.973	3.637
4.0	0.15	0.015	0.7070	0.019	0.469	0.0066	0.057	0.063	0.019	0.471	1.957	0.052	0.063	0.012	0.080	0.080	0.000	4.107	2.992
2.0	0.15	0.015	0.7070	0.014	0.310	0.0066	0.040	0.044	0.014	0.29	4.738	0.036	0.044	0.007	0.055	0.055	0.000	1.692	1.958
1.0	0.15	0.015	0.7070	0.010	0.205	0.0066	0.028	0.031	0.010	0.18	1.861	0.025	0.031	0.006	0.038	0.038	0.000	0.706	1.217

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA			APPROACH PIPE DATA			TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.15	0.015	0.7070	0.027	0.705	0.0050	0.082	0.107	0.026	0.672	8.695	0.062	0.107	0.045	0.130	0.125	-0.005	11.108	3.359
6.0	0.15	0.015	0.7070	0.024	0.597	0.0050	0.071	0.087	0.024	0.571	9.900	0.057	0.087	0.031	0.106	0.103	-0.002	7.313	3.122
4.0	0.15	0.015	0.7070	0.019	0.469	0.0050	0.057	0.069	0.019	0.471	1.957	0.047	0.069	0.021	0.083	0.082	-0.001	4.265	2.593
2.0	0.15	0.015	0.7070	0.014	0.310	0.0050	0.040	0.047	0.014	0.29	4.738	0.034	0.047	0.013	0.057	0.056	-0.001	1.750	1.736
1.0	0.15	0.015	0.7070	0.010	0.205	0.0050	0.028	0.033	0.010	0.18	1.861	0.024	0.033	0.010	0.040	0.039	-0.001	0.730	1.058
8.0	0.15	0.015	0.7070	0.027	0.705	0.0050	0.082	0.132	0.028	0.672	8.695	0.049	0.132	0.083	0.181	0.144	-0.037	13.660	2.132
6.0	0.15	0.015	0.7070	0.024	0.597	0.0050	0.071	0.101	0.024	0.571	9.900	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	2.401
4.0	0.15	0.015	0.7070	0.019	0.469	0.0050	0.057	0.077	0.019	0.471	1.957	0.041	0.077	0.036	0.094	0.087	-0.007	4.712	2.095
2.0	0.15	0.015	0.7070	0.014	0.310	0.0050	0.040	0.053	0.014	0.29	4.738	0.030	0.053	0.023	0.063	0.059	-0.004	1.906	1.399
1.0	0.15	0.015	0.7070	0.010	0.205	0.0050	0.028	0.037	0.010	0.18	1.861	0.021	0.037	0.016	0.044	0.041	-0.003	0.795	0.856
8.0	0.15	0.015	0.7070	0.027	0.705	0.0025	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.7070	0.024	0.597	0.0025	0.071	0.112	0.024	0.571	9.900	0.042	0.112	0.070	0.152	0.121	-0.031	9.511	1.804
4.0	0.15	0.015	0.7070	0.019	0.469	0.0025	0.057	0.084	0.019	0.471	1.957	0.037	0.084	0.047	0.107	0.092	-0.015	5.193	1.638
2.0	0.15	0.015	0.7070	0.014	0.310	0.0025	0.040	0.057	0.014	0.29	4.738	0.027	0.057	0.029	0.070	0.062	-0.006	2.070	1.153
1.0	0.15	0.015	0.7070	0.010	0.205	0.0025	0.028	0.039	0.010	0.18	1.861	0.019	0.039	0.020	0.049	0.043	-0.005	0.659	0.716
8.0	0.15	0.015	0.7070	0.027	0.705	0.0017	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.7070	0.024	0.597	0.0017	0.071	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.15	0.015	0.7070	0.019	0.469	0.0017	0.057	0.096	0.019	0.471	1.957	0.032	0.096	0.064	0.141	0.101	-0.040	6.199	1.182
2.0	0.15	0.015	0.7070	0.014	0.310	0.0017	0.040	0.063	0.014	0.29	4.738	0.024	0.063	0.039	0.086	0.067	-0.019	2.386	0.861
1.0	0.15	0.015	0.7070	0.010	0.205	0.0017	0.028	0.044	0.010	0.18	1.861	0.017	0.044	0.027	0.059	0.046	-0.013	0.964	0.532

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA			APPROACH PIPE DATA			TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.8660	0.026	0.608	0.0250	0.082	0.064	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.8660	0.023	0.483	0.0250	0.071	0.055	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.8660	0.019	0.536	0.0250	0.057	0.044	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.8660	0.013	0.355	0.0250	0.040	0.031	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.8660	0.010	0.234	0.0250	0.028	0.022	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.8660	0.026	0.808	0.0125	0.082	0.079	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.8660	0.023	0.683	0.0125	0.071	0.067	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.8660	0.019	0.536	0.0125	0.057	0.053	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.8660	0.013	0.355	0.0125	0.040	0.037	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.8660	0.010	0.234	0.0125	0.028	0.026	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.8660	0.026	0.808	0.0100	0.082	0.084	0.026	0.783	1.030	0.081	0.084	0.003	0.115	0.115	0.000	9.685	5.455
6.0	0.15	0.015	0.8660	0.023	0.683	0.0100	0.071	0.071	0.023	0.632	0.815	0.071	0.071	0.000	0.098	0.098	0.000	6.795	4.919
4.0	0.15	0.015	0.8660	0.019	0.536	0.0100	0.057	0.057	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.8660	0.013	0.355	0.0100	0.040	0.039	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.8660	0.010	0.234	0.0100	0.028	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.8660	0.026	0.808	0.0066	0.082	0.096	0.026	0.783	1.030	0.070	0.096	0.027	0.120	0.119	-0.001	10.284	4.193
6.0	0.15	0.015	0.8660	0.023	0.683	0.0066	0.071	0.080	0.023	0.632	0.815	0.062	0.080	0.018	0.101	0.100	-0.001	6.973	3.712
4.0	0.15	0.015	0.8660	0.019	0.536	0.0066	0.057	0.063	0.019	0.521	2.645	0.052	0.063	0.012	0.080	0.080	0.000	4.107	3.052
2.0	0.15	0.015	0.8660	0.013	0.355	0.0066	0.040	0.044	0.013	0.34	5.120	0.036	0.044	0.007	0.055	0.055	0.000	1.692	2.023
1.0	0.15	0.015	0.8660	0.010	0.234	0.0066	0.028	0.031	0.010	0.22	2.071	0.025	0.031	0.006	0.038	0.038	0.000	0.706	1.277

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.8660	0.026	0.806	0.0050	0.082	0.107	0.026	0.783	1.030	0.062	0.107	0.045	0.130	0.125	-0.005	11.008	3.519
6.0	0.15	0.015	0.8660	0.023	0.683	0.0050	0.071	0.087	0.023	0.632	0.815	0.057	0.087	0.031	0.106	0.103	-0.002	7.313	3.195
4.0	0.15	0.015	0.8660	0.019	0.536	0.0050	0.057	0.069	0.019	0.521	2.645	0.047	0.069	0.021	0.083	0.082	-0.001	4.265	2.655
2.0	0.15	0.015	0.8660	0.013	0.355	0.0050	0.040	0.047	0.013	0.34	5.120	0.034	0.047	0.013	0.057	0.056	-0.001	1.750	1.772
1.0	0.15	0.015	0.8660	0.010	0.234	0.0050	0.028	0.033	0.010	0.22	2.071	0.024	0.033	0.010	0.040	0.039	-0.001	0.730	1.119
8.0	0.15	0.015	0.8660	0.026	0.808	0.0050	0.082	0.132	0.026	0.783	1.030	0.049	0.132	0.083	0.181	0.144	-0.037	13.660	2.277
6.0	0.15	0.015	0.8660	0.023	0.683	0.0050	0.071	0.101	0.023	0.632	0.815	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	2.472
4.0	0.15	0.015	0.8660	0.019	0.536	0.0050	0.057	0.077	0.019	0.521	2.645	0.041	0.077	0.036	0.094	0.087	-0.007	4.712	2.156
2.0	0.15	0.015	0.8660	0.013	0.355	0.0050	0.040	0.053	0.013	0.34	5.120	0.030	0.053	0.023	0.063	0.059	-0.004	1.906	1.465
1.0	0.15	0.015	0.8660	0.010	0.234	0.0050	0.028	0.037	0.010	0.22	2.071	0.021	0.037	0.016	0.044	0.041	-0.003	0.795	0.926
8.0	0.15	0.015	0.8660	0.026	0.806	0.0025	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.8660	0.023	0.683	0.0025	0.071	0.112	0.023	0.632	0.815	0.042	0.112	0.070	0.152	0.121	-0.031	9.511	1.874
4.0	0.15	0.015	0.8660	0.019	0.536	0.0025	0.057	0.084	0.019	0.521	2.645	0.037	0.084	0.047	0.107	0.092	-0.015	5.193	1.751
2.0	0.15	0.015	0.8660	0.013	0.355	0.0025	0.040	0.057	0.013	0.34	5.120	0.027	0.057	0.029	0.070	0.062	-0.008	2.070	1.218
1.0	0.15	0.015	0.8660	0.010	0.234	0.0025	0.028	0.039	0.010	0.22	2.071	0.019	0.039	0.020	0.049	0.043	-0.005	0.659	0.775
8.0	0.15	0.015	0.8660	0.026	0.806	0.0017	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.8660	0.023	0.683	0.0017	0.071	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.15	0.015	0.8660	0.019	0.536	0.0017	0.057	0.096	0.019	0.521	2.645	0.032	0.096	0.064	0.141	0.101	-0.040	6.199	1.252
2.0	0.15	0.015	0.8660	0.013	0.355	0.0017	0.040	0.063	0.013	0.34	5.120	0.024	0.063	0.039	0.086	0.067	-0.019	2.386	0.924
1.0	0.15	0.015	0.8660	0.010	0.234	0.0017	0.028	0.044	0.010	0.22	2.071	0.017	0.044	0.027	0.059	0.046	-0.013	0.984	0.591

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.9659	0.025	0.871	0.0250	0.082	0.064				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.15	0.015	0.9659	0.022	0.735	0.0250	0.071	0.055				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.9659	0.018	0.578	0.0250	0.057	0.044				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.9659	0.013	0.381	0.0250	0.040	0.031				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.9659	0.009	0.251	0.0250	0.028	0.022				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.9659	0.025	0.871	0.0125	0.082	0.079				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.15	0.015	0.9659	0.022	0.735	0.0125	0.071	0.067				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.9659	0.018	0.578	0.0125	0.057	0.053				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.9659	0.013	0.381	0.0125	0.040	0.037				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.9659	0.009	0.251	0.0125	0.028	0.026				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.9659	0.025	0.871	0.0100	0.082	0.084	0.025	0.853	2.330	0.081	0.084	0.003	0.115	0.115	0.000	9.885	5.531
6.0	0.15	0.015	0.9659	0.022	0.735	0.0100	0.071	0.071	0.022	0.692	1.807	0.071	0.071	0.000	0.098	0.098	0.000	6.795	4.992
4.0	0.15	0.015	0.9659	0.018	0.578	0.0100	0.057	0.057				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.9659	0.013	0.381	0.0100	0.040	0.039				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.9659	0.009	0.251	0.0100	0.028	0.028				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.9659	0.025	0.871	0.0066	0.082	0.096	0.025	0.853	2.330	0.070	0.096	0.027	0.120	0.119	-0.001	10.284	4.258
6.0	0.15	0.015	0.9659	0.022	0.735	0.0066	0.071	0.080	0.022	0.692	1.807	0.062	0.080	0.018	0.101	0.100	-0.001	6.973	3.785
4.0	0.15	0.015	0.9659	0.018	0.578	0.0066	0.057	0.063	0.019	0.521	2.645	0.052	0.063	0.012	0.080	0.080	0.000	4.107	3.052
2.0	0.15	0.015	0.9659	0.013	0.381	0.0066	0.040	0.044	0.013	0.34	5.120	0.036	0.044	0.007	0.055	0.055	0.000	1.692	2.023
1.0	0.15	0.015	0.9659	0.009	0.251	0.0066	0.028	0.031	0.010	0.22	2.071	0.025	0.031	0.006	0.038	0.038	0.000	0.706	1.277

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA			APPROACH PIPE DATA			TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	0.9659	0.025	0.671	0.0050	0.082	0.107	0.025	0.853	2.330	0.062	0.107	0.045	0.130	0.125	-0.005	11.008	3.594
6.0	0.15	0.015	0.9659	0.022	0.735	0.0050	0.071	0.087	0.022	0.692	1.807	0.057	0.087	0.031	0.106	0.103	-0.002	7.313	3.259
4.0	0.15	0.015	0.9659	0.016	0.578	0.0050	0.057	0.069	0.019	0.521	2.645	0.047	0.069	0.021	0.083	0.082	-0.001	4.265	2.655
2.0	0.15	0.015	0.9659	0.013	0.381	0.0050	0.040	0.047	0.013	0.34	5.120	0.034	0.047	0.013	0.057	0.056	-0.001	1.750	1.772
1.0	0.15	0.015	0.9659	0.009	0.251	0.0050	0.028	0.033	0.010	0.22	2.071	0.024	0.033	0.010	0.040	0.039	-0.001	0.730	1.119
8.0	0.15	0.015	0.9659	0.025	0.871	0.0050	0.082	0.132	0.025	0.853	2.330	0.049	0.132	0.083	0.181	0.144	-0.037	13.660	2.355
6.0	0.15	0.015	0.9659	0.022	0.735	0.0050	0.071	0.101	0.022	0.692	1.807	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	2.543
4.0	0.15	0.015	0.9659	0.018	0.578	0.0050	0.057	0.077	0.019	0.521	2.645	0.041	0.077	0.036	0.094	0.087	-0.007	4.712	2.156
2.0	0.15	0.015	0.9659	0.013	0.381	0.0050	0.040	0.053	0.013	0.34	5.120	0.030	0.053	0.023	0.063	0.059	-0.004	1.906	1.465
1.0	0.15	0.015	0.9659	0.009	0.251	0.0050	0.028	0.037	0.010	0.22	2.071	0.021	0.037	0.016	0.044	0.041	-0.003	0.795	0.926
8.0	0.15	0.015	0.9659	0.025	0.871	0.0025	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.9659	0.022	0.735	0.0025	0.071	0.112	0.022	0.692	1.807	0.042	0.112	0.070	0.152	0.121	-0.031	9.511	1.951
4.0	0.15	0.015	0.9659	0.016	0.576	0.0025	0.057	0.084	0.019	0.521	2.645	0.037	0.084	0.047	0.107	0.092	-0.015	5.193	1.751
2.0	0.15	0.015	0.9659	0.013	0.381	0.0025	0.040	0.057	0.013	0.34	5.120	0.027	0.057	0.029	0.070	0.062	-0.008	2.070	1.218
1.0	0.15	0.015	0.9659	0.009	0.251	0.0025	0.026	0.039	0.010	0.22	2.071	0.019	0.039	0.020	0.049	0.043	-0.005	0.659	0.775
8.0	0.15	0.015	0.9659	0.025	0.871	0.0017	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	0.9659	0.022	0.735	0.0017	0.071	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.15	0.015	0.9659	0.016	0.578	0.0017	0.057	0.096	0.019	0.521	2.645	0.032	0.096	0.064	0.141	0.101	-0.040	6.199	1.252
2.0	0.15	0.015	0.9659	0.013	0.381	0.0017	0.040	0.063	0.013	0.34	5.120	0.024	0.063	0.039	0.086	0.067	-0.019	2.386	0.924
1.0	0.15	0.015	0.9659	0.009	0.251	0.0017	0.028	0.044	0.010	0.22	2.071	0.017	0.044	0.027	0.059	0.046	-0.013	0.984	0.591

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA			APPROACH PIPE DATA			TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.15	0.015	1.0000	0.025	0.892	0.0050	0.082	0.107	0.025	0.653	2.330	0.062	0.107	0.045	0.130	0.125	-0.005	11.008	3.594
6.0	0.15	0.015	1.0000	0.022	0.752	0.0050	0.071	0.087	0.022	0.692	1.807	0.057	0.087	0.031	0.106	0.103	-0.002	7.313	3.259
4.0	0.15	0.015	1.0000	0.018	0.591	0.0050	0.057	0.069	0.018	0.581	3.406	0.047	0.069	0.021	0.083	0.082	-0.001	4.265	2.735
2.0	0.15	0.015	1.0000	0.013	0.390	0.0050	0.040	0.047	0.013	0.34	5.120	0.034	0.047	0.013	0.057	0.056	-0.001	1.750	1.772
1.0	0.15	0.015	1.0000	0.009	0.257	0.0050	0.028	0.033	0.010	0.22	2.071	0.024	0.033	0.010	0.040	0.039	-0.001	0.730	1.119
8.0	0.15	0.015	1.0000	0.025	0.892	0.0050	0.082	0.132	0.025	0.853	2.330	0.049	0.132	0.083	0.181	0.144	-0.037	13.660	2.356
6.0	0.15	0.015	1.0000	0.022	0.752	0.0050	0.071	0.101	0.022	0.692	1.807	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	2.543
4.0	0.15	0.015	1.0000	0.018	0.591	0.0050	0.057	0.077	0.018	0.581	3.406	0.041	0.077	0.036	0.094	0.087	-0.007	4.712	2.234
2.0	0.15	0.015	1.0000	0.013	0.390	0.0050	0.040	0.053	0.013	0.34	5.120	0.030	0.053	0.023	0.063	0.059	-0.004	1.906	1.466
1.0	0.15	0.015	1.0000	0.009	0.257	0.0050	0.028	0.037	0.010	0.22	2.071	0.021	0.037	0.016	0.044	0.041	-0.003	0.795	0.926
8.0	0.15	0.015	1.0000	0.025	0.892	0.0025	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	1.0000	0.022	0.752	0.0025	0.071	0.112	0.022	0.692	1.807	0.042	0.112	0.070	0.152	0.121	-0.031	9.511	1.951
4.0	0.15	0.015	1.0000	0.018	0.591	0.0025	0.057	0.084	0.018	0.581	3.406	0.037	0.084	0.047	0.107	0.092	-0.015	5.193	1.833
2.0	0.15	0.015	1.0000	0.013	0.390	0.0025	0.040	0.057	0.013	0.34	5.120	0.027	0.057	0.029	0.070	0.062	-0.006	2.070	1.218
1.0	0.15	0.015	1.0000	0.009	0.257	0.0025	0.028	0.039	0.010	0.22	2.071	0.019	0.039	0.020	0.049	0.043	-0.005	0.659	0.775
8.0	0.15	0.015	1.0000	0.025	0.892	0.0017	0.082	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.15	0.015	1.0000	0.022	0.752	0.0017	0.071	0.150	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.15	0.015	1.0000	0.018	0.591	0.0017	0.057	0.096	0.018	0.581	3.406	0.032	0.096	0.064	0.141	0.101	-0.040	6.199	1.325
2.0	0.15	0.015	1.0000	0.013	0.390	0.0017	0.040	0.063	0.013	0.34	5.120	0.024	0.063	0.039	0.086	0.067	-0.019	2.386	0.924
1.0	0.15	0.015	1.0000	0.009	0.257	0.0017	0.028	0.044	0.010	0.22	2.071	0.017	0.044	0.027	0.059	0.046	-0.013	0.984	0.591

PROGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM OF THE JUMP IN THE TEST PIPE.

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M N.	JUMP POS. M.
8.0	0.15	0.015	1.0000	0.025	0.692	0.0250	0.082	0.064				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.15	0.015	1.0000	0.022	0.752	0.0250	0.071	0.055				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	1.0000	0.018	0.591	0.0250	0.057	0.044				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	1.0000	0.013	0.390	0.0250	0.040	0.031				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	1.0000	0.009	0.257	0.0250	0.028	0.022				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	1.0000	0.025	0.692	0.0125	0.082	0.079				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.15	0.015	1.0000	0.022	0.752	0.0125	0.071	0.067				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	1.0000	0.018	0.591	0.0125	0.057	0.053				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	1.0000	0.013	0.390	0.0125	0.040	0.037				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	1.0000	0.009	0.257	0.0125	0.028	0.026				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	1.0000	0.025	0.692	0.0100	0.082	0.084	0.025	0.653	2.330	0.081	0.084	0.003	0.115	0.115	0.000	9.685	5.531
6.0	0.15	0.015	1.0000	0.022	0.752	0.0100	0.071	0.071	0.022	0.692	1.807	0.071	0.071	0.000	0.098	0.098	0.000	6.795	4.992
4.0	0.15	0.015	1.0000	0.018	0.591	0.0100	0.057	0.057				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	1.0000	0.013	0.390	0.0100	0.040	0.039				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	1.0000	0.009	0.257	0.0100	0.028	0.028				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	1.0000	0.025	0.692	0.0066	0.082	0.096	0.025	0.653	2.330	0.070	0.096	0.027	0.120	0.119	-0.001	10.284	4.268
6.0	0.15	0.015	1.0000	0.022	0.752	0.0066	0.071	0.080	0.022	0.692	1.807	0.062	0.080	0.018	0.101	0.100	-0.001	6.973	3.785
4.0	0.15	0.015	1.0000	0.018	0.591	0.0066	0.057	0.063	0.018	0.581	3.406	0.052	0.063	0.012	0.080	0.080	0.000	4.107	3.132
2.0	0.15	0.015	1.0000	0.013	0.390	0.0066	0.040	0.044	0.013	0.34	5.120	0.036	0.044	0.007	0.055	0.055	0.000	1.692	2.023
1.0	0.15	0.015	1.0000	0.009	0.257	0.0066	0.028	0.031	0.010	0.22	2.071	0.025	0.031	0.006	0.038	0.038	0.000	0.706	1.277

APPENDIX 4

JUMP LOCATION IN A 0.075 m WIDE RECTANGULAR CHANNEL, MANNING COEFFICIENT 0.015, AT SLOPES 1/40, 1/80, 1/100, 1/200

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.07	0.015	0.0349	0.075	0.178	0.0250	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
6.0	0.07	0.015	0.0349	0.075	0.133	0.0250	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
4.0	0.07	0.015	0.0349	0.054	0.104	0.0250	0.066	0.062				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.07	0.015	0.0349	0.032	0.067	0.0250	0.042	0.036				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.07	0.015	0.0349	0.020	0.043	0.0250	0.026	0.022				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.07	0.015	0.0349	0.075	0.178	0.0125	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
6.0	0.07	0.015	0.0349	0.075	0.133	0.0125	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
4.0	0.07	0.015	0.0349	0.054	0.104	0.0125	0.066	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.0349	0.032	0.067	0.0125	0.042	0.047	0.023	0.09	2.497	0.037	0.047	0.010	0.064	0.063	-0.003	1.949	0.753
1.0	0.07	0.015	0.0349	0.020	0.043	0.0125	0.026	0.028	0.014	0.06	0.999	0.025	0.028	0.004	0.040	0.040	-0.000	0.765	0.522
8.0	0.07	0.015	0.0349	0.075	0.178	0.0100	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
6.0	0.07	0.015	0.0349	0.075	0.133	0.0100	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
4.0	0.07	0.015	0.0349	0.054	0.104	0.0100	0.066	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.0349	0.032	0.067	0.0100	0.042	0.051	0.023	0.09	2.497	0.033	0.051	0.018	0.066	0.065	-0.001	2.009	0.555
1.0	0.07	0.015	0.0349	0.020	0.043	0.0100	0.026	0.030	0.014	0.06	0.999	0.023	0.030	0.003	0.040	0.040	-0.000	0.779	0.476
8.0	0.07	0.015	0.0349	0.075	0.178	0.0050	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
6.0	0.07	0.015	0.0349	0.075	0.133	0.0050	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
4.0	0.07	0.015	0.0349	0.054	0.104	0.0050	0.066	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.0349	0.032	0.067	0.0050	0.042	0.068	0.023	0.09	2.497	0.023	0.068	0.044	0.089	0.076	-0.014	2.474	0.313
1.0	0.07	0.015	0.0349	0.020	0.043	0.0050	0.026	0.039	0.014	0.06	0.999	0.016	0.039	0.023	0.050	0.045	-0.005	0.939	0.124

* [illegible]

COMMON DATA APPROACH PIPE DATA — TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.07	0.015	0.0698	0.072	0.185	0.0250	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.0698	0.057	0.158	0.0250	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.0698	0.041	0.126	0.0250	0.066	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.07	0.015	0.0698	0.025	0.083	0.0250	0.042	0.036	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.07	0.015	0.0698	0.015	0.054	0.0250	0.026	0.022	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.07	0.015	0.0698	0.072	0.185	0.0125	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.0698	0.057	0.158	0.0125	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.0698	0.041	0.126	0.0125	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.0698	0.025	0.083	0.0125	0.042	0.047	0.021	0.10	2.717	0.037	0.047	0.010	0.064	0.063	-0.000	1.949	0.918
1.0	0.07	0.015	0.0698	0.015	0.054	0.0125	0.026	0.028	0.013	0.07	1.089	0.025	0.028	0.004	0.040	0.040	-0.000	0.765	0.725
8.0	0.07	0.015	0.0698	0.072	0.185	0.0100	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.0698	0.057	0.158	0.0100	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.0698	0.041	0.126	0.0100	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.0698	0.025	0.083	0.0100	0.042	0.051	0.021	0.10	2.717	0.033	0.051	0.018	0.066	0.065	-0.001	2.009	0.718
1.0	0.07	0.015	0.0698	0.015	0.054	0.0100	0.026	0.030	0.013	0.07	1.089	0.023	0.030	0.008	0.040	0.040	-0.000	0.779	0.577
8.0	0.07	0.015	0.0698	0.072	0.185	0.0050	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.0698	0.057	0.158	0.0050	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.0698	0.041	0.126	0.0050	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.0698	0.025	0.083	0.0050	0.042	0.068	0.021	0.10	2.717	0.023	0.068	0.044	0.089	0.076	-0.014	2.474	0.151
1.0	0.07	0.015	0.0698	0.015	0.054	0.0050	0.026	0.039	0.013	0.07	1.089	0.016	0.039	0.023	0.050	0.045	-0.005	0.909	0.219

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.07	0.015	0.1045	0.061	0.218	0.0250	0.076	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.1045	0.049	0.187	0.0250	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.1045	0.036	0.150	0.0250	0.066	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.07	0.015	0.1045	0.022	0.099	0.0250	0.042	0.036	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.07	0.015	0.1045	0.013	0.064	0.0250	0.026	0.022	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.07	0.015	0.1045	0.061	0.218	0.0125	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.1045	0.049	0.187	0.0125	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.1045	0.036	0.150	0.0125	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.1045	0.022	0.099	0.0125	0.042	0.047	0.019	0.12	2.927	0.037	0.047	0.010	0.064	0.063	-0.003	1.949	1.330
1.0	0.07	0.015	0.1045	0.013	0.064	0.0125	0.026	0.028	0.012	0.08	1.170	0.025	0.028	0.003	0.040	0.040	-0.000	0.755	0.831
8.0	0.07	0.015	0.1045	0.061	0.218	0.0100	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
5.0	0.07	0.015	0.1045	0.049	0.187	0.0100	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.1045	0.036	0.150	0.0100	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.1045	0.022	0.099	0.0100	0.042	0.051	0.019	0.12	2.927	0.033	0.051	0.018	0.066	0.065	-0.001	2.009	0.836
1.0	0.07	0.015	0.1045	0.013	0.064	0.0100	0.026	0.030	0.012	0.08	1.170	0.022	0.030	0.008	0.040	0.040	-0.000	0.779	0.553
3.0	0.07	0.015	0.1045	0.061	0.218	0.0050	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.1045	0.049	0.187	0.0050	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.1045	0.036	0.150	0.0050	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.1045	0.022	0.099	0.0050	0.042	0.068	0.019	0.12	2.927	0.023	0.058	0.044	0.089	0.076	-0.014	2.474	0.279
1.0	0.07	0.015	0.1045	0.013	0.064	0.0050	0.026	0.039	0.012	0.08	1.170	0.016	0.039	0.023	0.050	0.045	-0.005	0.904	0.293

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F'M No.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F'M No.	JUMP POS. M.
8.0	0.07	0.015	0.1736	0.050	0.284	0.0250	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.1736	0.040	0.244	0.0250	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.1736	0.030	0.195	0.0250	0.066	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.07	0.015	0.1736	0.018	0.129	0.0250	0.042	0.036	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.07	0.015	0.1736	0.011	0.082	0.0250	0.026	0.022	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.07	0.015	0.1736	0.050	0.284	0.0125	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.1736	0.040	0.244	0.0125	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.1736	0.030	0.195	0.0125	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.1736	0.018	0.129	0.0125	0.042	0.047	0.017	0.15	3.282	0.037	0.047	0.010	0.064	0.063	-0.000	1.949	1.139
1.0	0.07	0.015	0.1736	0.011	0.082	0.0125	0.026	0.028	0.011	0.09	1.307	0.025	0.028	0.003	0.040	0.040	-0.000	0.765	0.931
8.0	0.07	0.015	0.1736	0.050	0.284	0.0100	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.1736	0.040	0.244	0.0100	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.1736	0.030	0.195	0.0100	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.1736	0.018	0.129	0.0100	0.042	0.051	0.017	0.15	3.282	0.033	0.051	0.018	0.066	0.065	-0.001	2.009	0.995
1.0	0.07	0.015	0.1736	0.011	0.082	0.0100	0.026	0.030	0.011	0.09	1.307	0.023	0.030	0.008	0.040	0.040	-0.000	0.779	0.769
8.0	0.07	0.015	0.1736	0.050	0.284	0.0050	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.1736	0.040	0.244	0.0050	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.1736	0.030	0.195	0.0050	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.1736	0.018	0.129	0.0050	0.042	0.068	0.017	0.15	3.282	0.023	0.063	0.044	0.089	0.076	-0.014	2.474	0.427
1.0	0.07	0.015	0.1736	0.011	0.082	0.0050	0.026	0.039	0.011	0.09	1.307	0.017	0.037	0.023	0.050	0.045	-0.005	0.909	0.386

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	MN M.	TERM. ENERGY M.	SLOPE (SIN)	MC M.	MN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.07	0.015	0.3402	0.038	0.430	0.0250	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.3402	0.031	0.368	0.0250	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.3402	0.023	0.292	0.0250	0.066	0.062	JUMP IMPOSSIBLE AS MN<MC IN TEST PIPE.										
2.0	0.07	0.015	0.3402	0.014	0.190	0.0250	0.042	0.036	JUMP IMPOSSIBLE AS MN<MC IN TEST PIPE.										
1.0	0.07	0.015	0.3402	0.009	0.119	0.0250	0.026	0.022	JUMP IMPOSSIBLE AS MN<MC IN TEST PIPE.										
8.0	0.07	0.015	0.3402	0.038	0.430	0.0125	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.3402	0.031	0.368	0.0125	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.3402	0.023	0.292	0.0125	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.3402	0.014	0.190	0.0125	0.042	0.047	0.014	0.20	3.928	0.037	0.047	0.010	0.064	0.063	-0.001	1.949	1.411
1.0	0.07	0.015	0.3402	0.009	0.119	0.0125	0.026	0.028	0.009	0.13	1.555	0.025	0.028	0.003	0.040	0.040	-0.000	0.765	1.027
8.0	0.07	0.015	0.3402	0.038	0.430	0.0100	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.3402	0.031	0.368	0.0100	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.3402	0.023	0.292	0.0100	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.3402	0.014	0.190	0.0100	0.042	0.051	0.014	0.20	3.928	0.033	0.051	0.018	0.066	0.065	-0.001	2.009	1.236
1.0	0.07	0.015	0.3402	0.009	0.119	0.0100	0.026	0.030	0.009	0.13	1.555	0.023	0.030	0.008	0.040	0.040	-0.000	0.779	0.975
8.0	0.07	0.015	0.3402	0.038	0.430	0.0050	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.3402	0.031	0.368	0.0050	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.3402	0.023	0.292	0.0050	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.3402	0.014	0.190	0.0050	0.042	0.068	0.014	0.20	3.928	0.024	0.068	0.044	0.089	0.076	-0.014	2.474	0.534
1.0	0.07	0.015	0.3402	0.009	0.119	0.0050	0.026	0.039	0.009	0.13	1.555	0.017	0.039	0.023	0.050	0.045	-0.005	0.909	0.513

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.07	0.015	0.5000	0.033	0.555	0.0250	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
6.0	0.07	0.015	0.5000	0.027	0.473	0.0250	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
4.0	0.07	0.015	0.5000	0.020	0.373	0.0250	0.066	0.062				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.07	0.015	0.5000	0.013	0.239	0.0250	0.042	0.036				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.07	0.015	0.5000	0.008	0.149	0.0250	0.026	0.022				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.07	0.015	0.5000	0.033	0.555	0.0125	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
6.0	0.07	0.015	0.5000	0.027	0.473	0.0125	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
4.0	0.07	0.015	0.5000	0.020	0.373	0.0125	0.066	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.5000	0.013	0.239	0.0125	0.042	0.047	0.012	0.25	4.390	0.037	0.047	0.010	0.064	0.063	-0.000	1.949	1.523
1.0	0.07	0.015	0.5000	0.008	0.149	0.0125	0.026	0.028	0.003	0.16	1.731	0.025	0.028	0.003	0.040	0.040	-0.003	0.765	1.334
8.0	0.07	0.015	0.5000	0.033	0.555	0.0100	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
6.0	0.07	0.015	0.5000	0.027	0.473	0.0100	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
4.0	0.07	0.015	0.5000	0.020	0.373	0.0100	0.066	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.5000	0.013	0.239	0.0100	0.042	0.051	0.012	0.25	4.390	0.033	0.051	0.018	0.066	0.065	-0.001	2.009	1.318
1.0	0.07	0.015	0.5000	0.008	0.149	0.0100	0.026	0.030	0.003	0.16	1.731	0.023	0.030	0.008	0.040	0.040	-0.000	0.779	0.933
8.0	0.07	0.015	0.5000	0.033	0.555	0.0050	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
6.0	0.07	0.015	0.5000	0.027	0.473	0.0050	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
4.0	0.07	0.015	0.5000	0.020	0.373	0.0050	0.066	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.5000	0.013	0.239	0.0050	0.042	0.068	0.012	0.25	4.390	0.024	0.068	0.044	0.089	0.076	-0.014	2.474	0.742
1.0	0.07	0.015	0.5000	0.008	0.149	0.0050	0.026	0.039	0.003	0.16	1.731	0.016	0.039	0.023	0.050	0.045	-0.005	0.909	0.573

[illegible]

COMMON DATA APPROACH PIPE DATA — TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N.	UPJUMP DEPTH M.	JUMP DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N.	JUMP POS. M.
8.0	0.07	0.015	0.7070	0.029	0.701	0.0250	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.7070	0.024	0.595	0.0250	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.7070	0.018	0.466	0.0250	0.066	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.07	0.015	0.7070	0.011	0.297	0.0250	0.042	0.036	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.07	0.015	0.7070	0.007	0.103	0.0250	0.026	0.022	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.07	0.015	0.7070	0.029	0.701	0.0125	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.7070	0.024	0.595	0.0125	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.7070	0.018	0.466	0.0125	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.7070	0.011	0.297	0.0125	0.042	0.047	0.011	0.31	4.870	0.037	0.047	0.010	0.064	0.063	-0.003	1.949	1.583
1.0	0.07	0.015	0.7070	0.007	0.183	0.0125	0.026	0.028	0.007	0.19	1.912	0.025	0.028	0.003	0.040	0.040	-0.003	0.765	1.147
8.0	0.07	0.015	0.7070	0.029	0.701	0.0100	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.7070	0.024	0.595	0.0100	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.7070	0.018	0.466	0.0100	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.7070	0.011	0.297	0.0100	0.042	0.051	0.011	0.31	4.870	0.033	0.051	0.018	0.066	0.065	-0.001	2.009	1.493
1.0	0.07	0.015	0.7070	0.007	0.183	0.0100	0.026	0.030	0.007	0.19	1.912	0.022	0.030	0.006	0.040	0.043	-0.003	0.779	0.932
8.0	0.07	0.015	0.7070	0.029	0.701	0.0050	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	0.7070	0.024	0.595	0.0050	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	0.7070	0.018	0.466	0.0050	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	0.7070	0.011	0.297	0.0050	0.042	0.068	0.011	0.31	4.870	0.023	0.068	0.044	0.089	0.076	-0.014	2.474	0.829
1.0	0.07	0.015	0.7070	~~0.007~~	~~0.183~~	~~0.0050~~	~~0.026~~	0.039	0.007	0.19	1.912	0.017	0.039	0.023	0.050	0.045	-0.005	0.409	0.526

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

J. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	JUMP DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY JUMP M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.07	0.015	0.8660	0.027	0.805	0.0250	0.075	0.075			JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.								
6.0	0.07	0.015	0.8660	0.022	0.681	0.0250	0.075	0.075			JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.								
4.0	0.07	0.015	0.8660	0.017	0.532	0.0250	0.066	0.062			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
2.0	0.07	0.015	0.8660	0.011	0.337	0.0250	0.042	0.036			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
1.0	0.07	0.015	0.8660	0.007	0.207	0.0250	0.026	0.022			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
8.0	0.07	0.015	0.8660	0.027	0.805	0.0125	0.075	0.075			JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.								
6.0	0.07	0.015	0.8660	0.022	0.681	0.0125	0.075	0.075			JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.								
4.0	0.07	0.015	0.8660	0.017	0.532	0.0125	0.066	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.8660	0.011	0.337	0.0125	0.042	0.047	0.010	0.35	5.182	0.037	0.047	0.010	0.064	0.063	-0.000	1.949	1.653
1.0	0.07	0.015	0.8660	0.007	0.207	0.0125	0.026	0.028	0.007	0.21	2.032	0.025	0.028	0.003	0.040	0.040	-0.000	0.765	1.176
8.0	0.07	0.015	0.8660	0.027	0.805	0.0100	0.075	0.075			JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.								
6.0	0.07	0.015	0.8660	0.022	0.681	0.0100	0.075	0.075			JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.								
4.0	0.07	0.015	0.8660	0.017	0.532	0.0100	0.066	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.8660	0.011	0.337	0.0100	0.042	0.051	0.010	0.35	5.182	0.033	0.051	0.018	0.066	0.065	-0.001	2.009	1.443
1.0	0.07	0.015	0.8660	0.007	0.207	0.0100	0.026	0.030	0.007	0.21	2.032	0.023	0.030	0.008	0.040	0.040	-0.000	0.779	1.324
8.0	0.07	0.015	0.8660	0.027	0.805	0.0050	0.075	0.075			JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.								
6.0	0.07	0.015	0.8660	0.022	0.681	0.0050	0.075	0.075			JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.								
4.0	0.07	0.015	0.8660	0.017	0.532	0.0050	0.066	0.075			FULL BORE FLOW ESTABLISHED IN TEST PIPE.								
2.0	0.07	0.015	0.8660	0.011	0.337	0.0050	0.042	0.068	0.010	0.35	5.182	0.024	0.053	0.044	0.089	0.076	-0.014	2.474	3.874
1.0	0.07	0.015	0.8660	0.007	0.207	0.0050	0.026	0.039	0.007	0.21	2.032	0.017	0.039	0.023	0.050	0.045	-0.005	0.909	0.555

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.M. N.	JUMP POS. M.
8.0	0.07	0.015	0.9659	0.026	0.869	0.0250	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
6.0	0.07	0.015	0.9659	0.021	0.733	0.0250	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
4.0	0.07	0.015	0.9659	0.016	0.571	0.0250	0.066	0.062				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.07	0.015	0.9659	0.010	0.360	0.0250	0.042	0.036				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.07	0.015	0.9659	0.006	0.221	0.0250	0.026	0.022				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.07	0.015	0.9659	0.026	0.869	0.0125	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
6.0	0.07	0.015	0.9659	0.021	0.733	0.0125	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
4.0	0.07	0.015	0.9659	0.016	0.571	0.0125	0.066	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.9659	0.010	0.360	0.0125	0.042	0.047	0.010	0.37	5.356	0.037	0.047	0.010	0.064	0.063	-0.001	1.949	1.593
1.0	0.07	0.015	0.9659	0.006	0.221	0.0125	0.026	0.028	0.006	0.23	2.099	0.025	0.028	0.003	0.040	0.040	-0.000	0.755	1.131
8.0	0.07	0.015	0.9659	0.026	0.869	0.0100	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
6.0	0.07	0.015	0.9659	0.021	0.733	0.0100	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
4.0	0.07	0.015	0.9659	0.016	0.571	0.0100	0.066	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.9659	0.010	0.360	0.0100	0.042	0.051	0.010	0.37	5.356	0.033	0.051	0.018	0.066	0.065	-0.001	2.009	1.473
1.0	0.07	0.015	0.9659	0.006	0.221	0.0100	0.026	0.030	0.006	0.23	2.099	0.023	0.033	0.008	0.040	0.040	-0.000	0.779	1.335
8.0	0.07	0.015	0.9659	0.026	0.869	0.0050	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
6.0	0.07	0.015	0.9659	0.021	0.733	0.0050	0.075	0.075				JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.							
4.0	0.07	0.015	0.9659	0.016	0.571	0.0050	0.066	0.075				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
2.0	0.07	0.015	0.9659	0.010	0.360	0.0050	0.042	0.068	0.010	0.37	5.356	0.024	0.063	0.044	0.089	0.076	-0.014	2.474	0.906
1.0	0.07	0.015	0.9659	0.006	0.221	0.0050	0.026	0.039	0.006	0.23	2.099	0.017	0.039	0.023	0.050	0.045	-0.005	0.434	0.573

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.07	0.015	1.0000	0.026	0.890	0.0250	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	1.0000	0.021	0.750	0.0250	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	1.0000	0.016	0.584	0.0250	0.066	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.07	0.015	1.0000	0.010	0.368	0.0250	0.042	0.036	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.07	0.015	1.0000	0.006	0.226	0.0250	0.026	0.022	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.07	0.015	1.0000	0.026	0.890	0.0125	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	1.0000	0.021	0.750	0.0125	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	1.0000	0.016	0.584	0.0125	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	1.0000	0.010	0.368	0.0125	0.042	0.047	0.010	0.38	5.411	0.037	0.047	0.010	0.064	0.063	-0.003	1.949	1.59
1.0	0.07	0.015	1.0000	0.006	0.226	0.0125	0.026	0.028	0.006	0.23	2.121	0.025	0.028	0.003	0.040	0.040	-0.000	0.765	1.17
8.0	0.07	0.015	1.0000	0.026	0.890	0.0100	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	1.0000	0.021	0.750	0.0100	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	1.0000	0.016	0.584	0.0100	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	1.0000	0.010	0.368	0.0100	0.042	0.051	0.010	0.38	5.411	0.033	0.051	0.015	0.066	0.065	-0.001	2.009	1.48
1.0	0.07	0.015	1.0000	0.006	0.226	0.0100	0.026	0.030	0.006	0.23	2.121	0.023	0.030	0.008	0.040	0.040	-0.000	0.779	1.34
8.0	0.07	0.015	1.0000	0.026	0.890	0.0050	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.07	0.015	1.0000	0.021	0.750	0.0050	0.075	0.075	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
4.0	0.07	0.015	1.0000	0.016	0.584	0.0050	0.066	0.075	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
2.0	0.07	0.015	1.0000	0.010	0.368	0.0050	0.042	0.068	0.010	0.38	5.411	0.024	0.068	0.044	0.089	0.076	-0.014	2.474	0.91
1.0	0.07	0.015	1.0000	0.006	0.226	0.0050	0.026	0.039	0.005	0.23	2.121	0.017	0.039	0.023	0.050	0.045	-0.005	0.909	0.57

APPENDIX 5

JUMP LOCATION IN A 0.10 m WIDE RECTANGULAR CHANNEL, MANNING COEFFICIENT 0.015, AT SLOPES 1/40, 1/80, 1/100, 1/200

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.10	0.015	0.0349	0.068	0.138	0.0250	0.087	0.078	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.10	0.015	0.0349	0.055	0.116	0.0250	0.072	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.0349	0.040	0.090	0.0250	0.055	0.046	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.0349	0.025	0.058	0.0250	0.034	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.0349	0.015	0.037	0.0250	0.022	0.017	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.0349	0.068	0.138	0.0125	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.0349	0.055	0.116	0.0125	0.072	0.081	0.040	0.16	9.827	0.063	0.081	0.019	0.109	0.109	-0.000	7.675	1.339
4.0	0.10	0.015	0.0349	0.040	0.090	0.0125	0.055	0.059	0.030	0.12	5.767	0.050	0.059	0.009	0.083	0.083	-0.003	4.425	1.273
2.0	0.10	0.015	0.0349	0.025	0.058	0.0125	0.034	0.036	0.019	0.08	2.307	0.033	0.036	0.002	0.052	0.052	-0.000	1.745	1.043
1.0	0.10	0.015	0.0349	0.015	0.037	0.0125	0.022	0.022	0.012	0.05	0.917	0.022	0.022	0.000	0.033	0.033	-0.000	0.692	0.743
8.0	0.10	0.015	0.0349	0.068	0.138	0.0100	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.0349	0.055	0.116	0.0100	0.072	0.089	0.040	0.16	9.827	0.056	0.089	0.033	0.114	0.112	-0.002	7.939	0.972
4.0	0.10	0.015	0.0349	0.040	0.090	0.0100	0.055	0.065	0.030	0.12	5.767	0.046	0.065	0.019	0.085	0.084	-0.001	4.526	0.959
2.0	0.10	0.015	0.0349	0.025	0.058	0.0100	0.034	0.039	0.019	0.08	2.307	0.031	0.039	0.008	0.052	0.052	-0.003	1.756	0.798
1.0	0.10	0.015	0.0349	0.015	0.037	0.0100	0.022	0.024	0.012	0.05	0.917	0.020	0.024	0.004	0.033	0.033	-0.003	0.697	0.544
8.0	0.10	0.015	0.0349	0.068	0.138	0.0050	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.0349	0.055	0.116	0.0050	0.072	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.0349	0.040	0.090	0.0050	0.055	0.085	0.030	0.12	5.767	0.033	0.085	0.052	0.109	0.096	-0.013	5.427	0.159
2.0	0.10	0.015	0.0349	0.025	0.058	0.0050	0.034	0.050	0.019	0.08	2.307	0.023	0.050	0.027	0.062	0.058	-0.004	2.015	0.256
1.0	0.10	0.015	0.0349	0.015	0.037	0.0050	0.022	0.030	0.012	0.05	0.917	0.015	0.030	0.015	0.038	0.036	-0.002	0.775	0.217

J. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F·N N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F·N. N.	JUMP POS. M.
COMMON DATA			APPROACH PIPE DATA			TEST PIPE DATA AND PROGRAM RESULTS.													
8.0	0.10	0.015	0.0698	0.052	0.172	0.0250	0.087	0.078	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.10	0.015	0.0698	0.042	0.145	0.0250	0.072	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.0698	0.032	0.114	0.0250	0.055	0.046	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.0698	0.019	0.073	0.0250	0.034	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.0698	0.012	0.046	0.0250	0.022	0.017	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.0698	0.052	0.172	0.0125	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.0698	0.042	0.145	0.0125	0.072	0.081	0.036	0.181	0.747	0.063	0.081	0.019	0.109	0.109	-0.005	7.675	1.528
4.0	0.10	0.015	0.0698	0.032	0.114	0.0125	0.055	0.059	0.027	0.14	6.324	0.050	0.059	0.009	0.083	0.083	-0.000	4.425	1.524
2.0	0.10	0.015	0.0698	0.019	0.073	0.0125	0.034	0.036	0.017	0.09	2.533	0.033	0.036	0.002	0.052	0.052	-0.006	1.745	1.235
1.0	0.10	0.015	0.0698	0.012	0.046	0.0125	0.022	0.022	0.011	0.06	1.004	0.022	0.022	0.000	0.033	0.033	-0.003	0.692	0.935
8.0	0.10	0.015	0.0699	0.052	0.172	0.0100	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.0698	0.042	0.145	0.0100	0.072	0.089	0.036	0.181	0.747	0.057	0.089	0.033	0.114	0.112	-0.002	7.939	1.283
4.0	0.10	0.015	0.0698	0.032	0.114	0.0100	0.055	0.065	0.027	0.14	6.324	0.046	0.065	0.019	0.085	0.084	-0.001	4.526	1.236
2.0	0.10	0.015	0.0698	0.019	0.073	0.0100	0.034	0.039	0.017	0.09	2.533	0.031	0.039	0.008	0.052	0.052	-0.000	1.766	0.944
1.0	0.10	0.015	0.0698	0.012	0.046	0.0100	0.022	0.024	0.011	0.06	1.004	0.020	0.024	0.004	0.033	0.033	-0.000	0.697	0.636
8.0	0.10	0.015	0.0698	0.052	0.172	0.0050	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.0698	0.042	0.145	0.0050	0.072	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.0698	0.032	0.114	0.0050	0.055	0.085	0.027	0.14	6.324	0.033	0.085	0.052	0.109	0.096	-0.013	5.427	0.393
2.0	0.10	0.015	0.0698	0.019	0.073	0.0050	0.034	0.050	0.017	0.09	2.533	0.023	0.050	0.027	0.062	0.058	-0.004	2.015	0.412
1.0	0.10	0.015	0.0698	0.012	0.046	0.0050	0.022	0.030	0.011	0.06	1.004	0.015	0.030	0.015	0.038	0.036	-0.002	0.775	0.305

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F+M N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F+M. N.	JUMP POS. M.
8.0	0.10	0.015	0.1045	0.045	0.206	0.0250	0.087	0.078	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.10	0.015	0.1045	0.036	0.175	0.0250	0.072	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.1045	0.027	0.137	0.0250	0.055	0.046	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.1045	0.017	0.087	0.0250	0.034	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.1045	0.011	0.054	0.0250	0.022	0.017	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.1045	0.045	0.206	0.0125	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.1045	0.036	0.175	0.0125	0.072	0.081	0.032	0.21	11.619	0.063	0.081	0.019	0.109	0.109	-0.003	7.675	1.957
4.0	0.10	0.015	0.1045	0.027	0.137	0.0125	0.055	0.059	0.024	0.16	6.841	0.050	0.059	0.009	0.083	0.083	-0.006	4.425	1.735
2.0	0.10	0.015	0.1045	0.017	0.087	0.0125	0.034	0.036	0.015	0.10	2.733	0.034	0.036	0.002	0.052	0.052	-0.003	1.745	1.317
1.0	0.10	0.015	0.1045	0.011	0.054	0.0125	0.022	0.022	0.010	0.06	1.079	0.022	0.022	0.000	0.033	0.033	-0.003	0.692	0.931
8.0	0.10	0.015	0.1045	0.045	0.206	0.0100	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.1045	0.036	0.175	0.0100	0.072	0.089	0.032	0.21	11.619	0.057	0.089	0.033	0.114	0.112	-0.002	7.439	1.485
4.0	0.10	0.015	0.1045	0.027	0.137	0.0100	0.055	0.065	0.024	0.16	6.841	0.046	0.065	0.019	0.085	0.084	-0.001	4.526	1.384
2.0	0.10	0.015	0.1045	0.017	0.087	0.0100	0.034	0.039	0.015	0.10	2.733	0.031	0.039	0.008	0.052	0.052	-0.000	1.766	1.053
1.0	0.10	0.015	0.1045	0.011	0.054	0.0100	0.022	0.024	0.010	0.06	1.079	0.020	0.024	0.004	0.033	0.033	-0.000	0.697	0.701
8.0	0.10	0.015	0.1045	0.045	0.206	0.0050	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.1045	0.036	0.175	0.0050	0.072	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.1045	0.027	0.137	0.0050	0.055	0.085	0.024	0.16	6.841	0.033	0.085	0.052	0.109	0.096	-0.013	5.427	0.552
2.0	0.10	0.015	0.1045	0.017	0.087	0.0050	0.034	0.050	0.015	0.10	2.733	0.023	0.050	0.027	0.062	0.058	-0.004	2.015	0.519
1.0	0.10	0.015	0.1045	0.011	0.054	0.0050	0.022	0.030	0.010	0.06	1.079	0.015	0.030	0.015	0.038	0.036	-0.002	0.775	0.357

COMMON DATA			APPROACH PIPE DATA			TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.10	0.015	0.1736	0.037	0.271	0.0250	0.087	0.078	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.10	0.015	0.1736	0.030	0.229	0.0250	0.072	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.1736	0.023	0.178	0.0250	0.055	0.046	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.1736	0.014	0.113	0.0250	0.034	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.1736	0.009	0.070	0.0250	0.022	0.017	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.1736	0.037	0.271	0.0125	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.1736	0.030	0.229	0.0125	0.072	0.081	0.028	0.261	3.111	0.063	0.081	0.019	0.109	0.109	-0.000	7.675	2.159
4.0	0.10	0.015	0.1736	0.023	0.178	0.0125	0.055	0.059	0.021	0.20	7.699	0.050	0.054	0.009	0.083	0.083	-0.006	4.425	1.930
2.0	0.10	0.015	0.1736	0.014	0.113	0.0125	0.034	0.036	0.013	0.13	3.064	0.034	0.036	0.002	0.052	0.052	-0.000	1.745	1.453
1.0	0.10	0.015	0.1736	0.009	0.070	0.0125	0.022	0.022	0.009	0.08	1.204	0.022	0.022	0.000	0.033	0.033	-0.000	0.692	0.985
8.0	0.10	0.015	0.1736	0.037	0.271	0.0100	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.1736	0.030	0.229	0.0100	0.072	0.089	0.028	0.261	3.111	0.057	0.089	0.033	0.114	0.112	-0.002	7.939	1.783
4.0	0.10	0.015	0.1736	0.023	0.178	0.0100	0.055	0.065	0.021	0.20	7.699	0.046	0.065	0.019	0.085	0.084	-0.001	4.526	1.614
2.0	0.10	0.015	0.1736	0.014	0.113	0.0100	0.034	0.039	0.013	0.13	3.064	0.031	0.039	0.008	0.052	0.052	-0.000	1.766	1.137
1.0	0.10	0.015	0.1736	0.009	0.070	0.0100	0.022	0.024	0.009	0.08	1.204	0.020	0.024	0.004	0.033	0.033	-0.000	0.697	0.783
8.0	0.10	0.015	0.1736	0.037	0.271	0.0050	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.1736	0.030	0.229	0.0050	0.072	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.1736	0.023	0.178	0.0050	0.055	0.085	0.021	0.20	7.699	0.033	0.085	0.052	0.109	0.096	-0.013	5.427	0.737
2.0	0.10	0.015	0.1736	0.014	0.113	0.0050	0.034	0.050	0.013	0.13	3.064	0.023	0.050	0.027	0.062	0.058	-0.004	2.015	0.555
1.0	0.10	0.015	0.1736	0.009	0.070	0.0050	0.022	0.030	0.009	0.08	1.204	0.015	0.030	0.015	0.038	0.036	-0.002	0.775	0.441

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.10	0.015	0.3402	0.029	0.408	0.0250	0.087	0.078				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.10	0.015	0.3402	0.024	0.342	0.0250	0.072	0.062				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.10	0.015	0.3402	0.018	0.263	0.0250	0.055	0.046				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.10	0.015	0.3402	0.012	0.164	0.0250	0.034	0.028				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.10	0.015	0.3402	0.007	0.100	0.0250	0.022	0.017				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.10	0.015	0.3402	0.029	0.408	0.0125	0.087	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.3402	0.024	0.342	0.0125	0.072	0.081	0.023	0.361	5.796	0.063	0.081	0.019	0.109	0.109	-0.005	7.675	2.559
4.0	0.10	0.015	0.3402	0.018	0.263	0.0125	0.055	0.059	0.013	0.28	9.240	0.050	0.059	0.009	0.083	0.083	-0.000	4.425	2.240
2.0	0.10	0.015	0.3402	0.012	0.164	0.0125	0.034	0.036	0.011	0.18	3.651	0.034	0.036	0.002	0.052	0.052	-0.000	1.745	1.544
1.0	0.10	0.015	0.3402	0.007	0.100	0.0125	0.022	0.022	0.007	0.11	1.426	0.022	0.022	0.000	0.033	0.033	-0.000	0.692	1.390
8.0	0.10	0.015	0.3402	0.029	0.408	0.0100	0.087	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.3402	0.024	0.342	0.0100	0.072	0.089	0.023	0.361	5.798	0.057	0.089	0.033	0.114	0.112	-0.002	7.439	2.133
4.0	0.10	0.015	0.3402	0.018	0.263	0.0100	0.055	0.065	0.013	0.28	9.240	0.046	0.065	0.019	0.085	0.084	-0.001	4.526	1.912
2.0	0.10	0.015	0.3402	0.012	0.164	0.0100	0.034	0.039	0.011	0.19	3.651	0.031	0.039	0.008	0.052	0.052	-0.000	1.756	1.375
1.0	0.10	0.015	0.3402	0.007	0.100	0.0100	0.022	0.024	0.007	0.11	1.426	0.020	0.024	0.004	0.033	0.033	-0.003	0.697	0.393
8.0	0.10	0.015	0.3402	0.029	0.408	0.0050	0.087	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
6.0	0.10	0.015	0.3402	0.024	0.342	0.0050	0.072	0.100				FULL BORE FLOW ESTABLISHED IN TEST PIPE.							
4.0	0.10	0.015	0.3402	0.018	0.263	0.0050	0.055	0.085	0.013	0.28	9.240	0.033	0.085	0.052	0.109	0.096	-0.013	5.427	1.378
2.0	0.10	0.015	0.3402	0.012	0.164	0.0050	0.034	0.050	0.011	0.19	3.651	0.023	0.050	0.027	0.062	0.058	-0.004	2.015	0.931
1.0	0.10	0.015	0.3402	0.007	0.100	0.0050	0.022	0.010	0.007	0.11	1.426	0.015	0.030	0.015	0.036	0.036	-0.002	0.775	0.557

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY FOM N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP FOM. N.	JUMP POS. M.
8.0	0.10	0.015	0.5000	0.026	0.521	0.0250	0.087	0.078	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.10	0.015	0.5000	0.021	0.434	0.0250	0.072	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.5000	0.016	0.333	0.0250	0.055	0.046	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.5000	0.010	0.206	0.0250	0.034	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.5000	0.007	0.125	0.0250	0.022	0.017	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.5000	0.026	0.521	0.0125	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.5000	0.021	0.434	0.0125	0.072	0.081	0.021	0.45	17.715	0.063	0.081	0.019	0.109	0.109	-0.000	7.675	2.759
4.0	0.10	0.015	0.5000	0.016	0.333	0.0125	0.055	0.059	0.016	0.35	10.337	0.050	0.059	0.009	0.083	0.083	-0.003	4.425	2.376
2.0	0.10	0.015	0.5000	0.010	0.206	0.0125	0.034	0.036	0.010	0.22	4.071	0.034	0.036	0.002	0.052	0.052	-0.000	1.745	1.735
1.0	0.10	0.015	0.5000	0.007	0.125	0.0125	0.022	0.022	0.006	0.13	1.566	0.022	0.022	0.000	0.033	0.033	-0.000	0.692	1.143
8.0	0.10	0.015	0.5000	0.026	0.521	0.0100	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.5000	0.021	0.434	0.0100	0.072	0.089	0.021	0.45	17.715	0.057	0.089	0.033	0.114	0.112	-0.002	7.939	2.386
4.0	0.10	0.015	0.5000	0.016	0.333	0.0100	0.055	0.065	0.016	0.35	10.337	0.046	0.065	0.019	0.085	0.084	-0.001	4.526	2.055
2.0	0.10	0.015	0.5000	0.010	0.206	0.0100	0.034	0.039	0.010	0.22	4.071	0.031	0.039	0.008	0.052	0.052	-0.000	1.766	1.157
1.0	0.10	0.015	0.5000	0.007	0.125	0.0100	0.022	0.024	0.006	0.13	1.566	0.020	0.024	0.004	0.033	0.033	-0.000	0.697	0.742
8.0	0.10	0.015	0.5000	0.026	0.521	0.0050	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.5000	0.021	0.434	0.0050	0.072	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.5000	0.016	0.333	0.0050	0.055	0.085	0.016	0.35	10.337	0.033	0.085	0.052	0.109	0.096	-0.013	5.427	1.232
2.0	0.10	0.015	0.5000	0.010	0.206	0.0050	0.034	0.050	0.010	0.22	4.071	0.023	0.050	0.027	0.062	0.058	-0.004	2.015	0.721
1.0	0.10	0.015	0.5000	0.007	0.125	0.0050	0.022	0.030	0.006	0.13	1.566	0.015	0.030	0.015	0.038	0.031	-0.002	0.775	0.534

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.10	0.015	0.7070	0.023	0.651	0.0250	0.087	0.078	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.10	0.015	0.7070	0.019	0.541	0.0250	0.072	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.7070	0.014	0.412	0.0250	0.055	0.046	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.7070	0.009	0.254	0.0250	0.034	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.7070	0.006	0.153	0.0250	0.022	0.017	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.7070	0.023	0.651	0.0125	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.7070	0.019	0.541	0.0125	0.072	0.081	0.013	0.561	9.720	0.063	0.081	0.019	0.109	0.109	-0.003	7.675	2.935
4.0	0.10	0.015	0.7070	0.014	0.412	0.0125	0.055	0.059	0.014	0.431	1.471	0.050	0.059	0.009	0.083	0.083	-0.000	4.425	2.521
2.0	0.10	0.015	0.7070	0.009	0.254	0.0125	0.034	0.036	0.009	0.26	4.504	0.034	0.035	0.002	0.052	0.052	-0.000	1.745	1.311
1.0	0.10	0.015	0.7070	0.006	0.153	0.0125	0.022	0.022	0.006	0.16	1.749	0.022	0.022	0.000	0.033	0.033	-0.000	0.692	1.107
8.0	0.10	0.015	0.7070	0.023	0.651	0.0100	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.7070	0.019	0.541	0.0100	0.072	0.089	0.013	0.561	9.720	0.057	0.089	0.033	0.114	0.112	-0.002	7.939	2.552
4.0	0.10	0.015	0.7070	0.014	0.412	0.0100	0.055	0.065	0.014	0.431	1.471	0.046	0.065	0.019	0.085	0.084	-0.001	4.526	2.170
2.0	0.10	0.015	0.7070	0.009	0.254	0.0100	0.034	0.039	0.009	0.26	4.504	0.031	0.039	0.008	0.052	0.052	-0.000	1.756	1.561
1.0	0.10	0.015	0.7070	0.006	0.153	0.0100	0.022	0.024	0.006	0.16	1.749	0.020	0.024	0.004	0.033	0.033	-0.000	0.697	0.935
8.0	0.10	0.015	0.7070	0.023	0.651	0.0050	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.7070	0.019	0.541	0.0050	0.072	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.7070	0.014	0.412	0.0050	0.055	0.085	0.014	0.431	1.471	0.033	0.085	0.052	0.109	0.096	-0.013	5.427	1.354
2.0	0.10	0.015	0.7070	0.009	0.254	0.0050	0.034	0.057	0.009	0.26	4.504	0.023	0.050	0.027	0.062	0.056	-0.006	2.015	0.995
1.0	0.10	0.015	0.7070	0.006	0.153	0.0050	0.022	0.030	0.006	0.16	1.749	0.015	0.030	0.015	0.038	0.036	-0.002	0.775	0.545

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	JUMP DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.10	0.015	0.8660	0.021	0.743	0.0250	0.087	0.078	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.10	0.015	0.8660	0.018	0.615	0.0250	0.072	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.8660	0.013	0.468	0.0250	0.055	0.046	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.8660	0.009	0.287	0.0250	0.034	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.8660	0.006	0.172	0.0250	0.022	0.017	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.8660	0.021	0.743	0.0125	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.8660	0.018	0.615	0.0125	0.072	0.081	0.017	0.632	0.996	0.063	0.081	0.019	0.109	0.109	-0.000	7.675	3.025
4.0	0.10	0.015	0.8660	0.013	0.468	0.0125	0.055	0.059	0.013	0.481	2.208	0.050	0.059	0.009	0.083	0.083	-0.000	4.425	2.537
2.0	0.10	0.015	0.8660	0.009	0.287	0.0125	0.034	0.036	0.003	0.30	4.784	0.034	0.036	0.002	0.052	0.052	-0.003	1.745	1.532
1.0	0.10	0.015	0.8660	0.006	0.172	0.0125	0.022	0.022	0.005	0.18	1.854	0.022	0.022	0.000	0.033	0.033	-0.003	0.692	1.210
8.0	0.10	0.015	0.8660	0.021	0.743	0.0100	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.8660	0.018	0.615	0.0100	0.072	0.089	0.017	0.632	0.996	0.057	0.089	0.033	0.114	0.112	-0.002	7.439	2.542
4.0	0.10	0.015	0.8660	0.013	0.468	0.0100	0.055	0.065	0.013	0.481	2.206	0.046	0.065	0.019	0.085	0.084	-0.001	4.526	2.259
2.0	0.10	0.015	0.8660	0.009	0.287	0.0100	0.034	0.039	0.003	0.30	4.784	0.031	0.039	0.008	0.052	0.052	-0.000	1.766	1.581
1.0	0.10	0.015	0.8660	0.006	0.172	0.0100	0.022	0.024	0.005	0.18	1.854	0.020	0.024	0.004	0.033	0.033	-0.006	0.697	1.310
8.0	0.10	0.015	0.8660	0.021	0.743	0.0050	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.8660	0.018	0.615	0.0050	0.072	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.8660	0.013	0.468	0.0050	0.055	0.085	0.013	0.481	2.208	0.033	0.085	0.052	0.109	0.096	-0.013	5.427	1.420
2.0	0.10	0.015	0.8660	0.009	0.287	0.0050	0.034	0.050	0.033	0.30	4.784	0.023	0.050	0.027	0.062	0.058	-0.004	2.015	1.336
1.0	0.10	0.015	0.8660	0.006	0.172	0.0050	0.022	0.030	0.005	0.18	1.854	0.015	0.030	0.015	0.038	0.036	-0.002	0.775	0.557

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.10	0.015	0.9659	0.020	0.797	0.0250	0.087	0.078	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.10	0.015	0.9659	0.017	0.661	0.0250	0.072	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	0.9659	0.013	0.501	0.0250	0.055	0.046	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	0.9659	0.008	0.307	0.0250	0.034	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	0.9659	0.005	0.184	0.0250	0.022	0.017	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	0.9659	0.020	0.797	0.0125	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.9659	0.017	0.661	0.0125	0.072	0.081	0.017	0.682	1.738	0.063	0.081	0.019	0.109	0.109	-0.000	7.675	3.973
4.0	0.10	0.015	0.9659	0.013	0.501	0.0125	0.055	0.059	0.013	0.511	2.620	0.050	0.059	0.009	0.083	0.083	-0.000	4.425	2.526
2.0	0.10	0.015	0.9659	0.008	0.307	0.0125	0.034	0.036	0.008	0.32	4.943	0.034	0.035	0.002	0.052	0.052	-0.003	1.745	1.373
1.0	0.10	0.015	0.9659	0.005	0.184	0.0125	0.022	0.022	0.005	0.19	1.915	0.022	0.022	0.000	0.033	0.033	-0.003	0.692	1.222
8.0	0.10	0.015	0.9659	0.020	0.797	0.0100	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.9659	0.017	0.661	0.0100	0.072	0.089	0.017	0.682	1.738	0.057	0.089	0.033	0.114	0.112	-0.002	7.439	2.536
4.0	0.10	0.015	0.9659	0.013	0.501	0.0100	0.055	0.065	0.013	0.511	2.620	0.046	0.065	0.019	0.085	0.084	-0.001	4.526	2.292
2.0	0.10	0.015	0.9659	0.008	0.307	0.0100	0.034	0.039	0.008	0.32	4.943	0.031	0.039	0.008	0.052	0.052	-0.003	1.766	1.631
1.0	0.10	0.015	0.9659	0.005	0.184	0.0100	0.022	0.024	0.005	0.19	1.915	0.020	0.024	0.004	0.033	0.033	-0.003	0.697	1.022
8.0	0.10	0.015	0.9659	0.020	0.797	0.0050	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	0.9659	0.017	0.661	0.0050	0.072	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	0.9659	0.013	0.501	0.0050	0.055	0.085	0.013	0.511	2.620	0.033	0.085	0.052	0.109	0.096	-0.013	5.427	1.455
2.0	0.10	0.015	0.9659	0.008	0.307	0.0050	0.034	0.050	0.005	0.32	4.943	0.023	0.050	0.027	0.062	0.058	-0.004	2.615	1.357
1.0	0.10	0.015	0.9659	0.005	0.184	0.0050	0.022	0.030	0.005	0.19	1.915	0.015	0.030	0.015	0.038	0.036	-0.002	0.775	0.531

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.10	0.015	1.0000	0.020	0.816	0.0250	0.087	0.078	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.10	0.015	1.0000	0.017	0.676	0.0250	0.072	0.062	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.10	0.015	1.0000	0.013	0.512	0.0250	0.055	0.046	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.10	0.015	1.0000	0.008	0.313	0.0250	0.034	0.028	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.10	0.015	1.0000	0.005	0.188	0.0250	0.022	0.017	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.10	0.015	1.0000	0.020	0.816	0.0125	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	1.0000	0.017	0.676	0.0125	0.072	0.081	0.016	0.692	1.979	0.063	0.081	0.019	0.109	0.109	-0.000	7.675	3.039
4.0	0.10	0.015	1.0000	0.013	0.512	0.0125	0.055	0.059	0.013	0.521	2.756	0.050	0.059	0.009	0.083	0.083	-0.000	4.425	2.539
2.0	0.10	0.015	1.0000	0.008	0.313	0.0125	0.034	0.036	0.008	0.32	4.991	0.034	0.036	0.002	0.052	0.052	-0.000	1.745	1.379
1.0	0.10	0.015	1.0000	0.005	0.188	0.0125	0.022	0.022	0.005	0.19	1.934	0.022	0.022	0.000	0.033	0.033	-0.000	0.692	1.225
8.0	0.10	0.015	1.0000	0.020	0.816	0.0100	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
6.0	0.10	0.015	1.0000	0.017	0.676	0.0100	0.072	0.089	0.016	0.592	1.979	0.057	0.089	0.033	0.114	0.112	-0.002	7.939	2.733
4.0	0.10	0.015	1.0000	0.013	0.512	0.0100	0.055	0.065	0.013	0.521	2.756	0.046	0.065	0.019	0.085	0.084	-0.001	4.526	2.303
2.0	0.10	0.015	1.0000	0.008	0.313	0.0100	0.034	0.039	0.003	0.32	4.991	0.031	0.039	0.008	0.052	0.052	-0.000	1.766	1.507
1.0	0.10	0.015	1.0000	0.005	0.188	0.0100	0.022	0.024	0.005	0.19	1.934	0.020	0.024	0.004	0.033	0.033	-0.000	0.697	1.325
8.0	0.10	0.015	1.0000	0.020	0.816	0.0050	0.087	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
5.0	0.10	0.015	1.0000	0.017	0.676	0.0050	0.072	0.100	FULL BORE FLOW ESTABLISHED IN TEST PIPE.										
4.0	0.10	0.015	1.0000	0.013	0.512	0.0050	0.055	0.085	0.013	0.521	2.756	0.033	0.085	0.052	0.109	0.096	-0.013	5.427	1.457
2.0	0.10	0.015	1.0000	0.008	0.313	0.0050	0.034	0.050	0.008	0.32	4.991	0.023	0.050	0.027	0.062	0.058	-0.004	2.015	1.353
1.0	0.10	0.015	1.0000	0.005	0.188	0.0050	0.022	0.030	0.005	0.19	1.934	0.015	0.030	0.015	0.038	0.036	-0.002	0.775	0.684

APPENDIX 6

JUMP LOCATION IN A 0.15 m WIDE RECTANGULAR CHANNEL, MANNING COEFFICIENT 0.015, AT SLOPES 1/60, 1/80, 1/100, 1/200

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. M.	UPJUMP DEPTH M.	JUMP DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. M.	JUMP POS. M.
8.0	0.15	0.015	0.0349	0.046	0.115	0.0250	0.066	0.052	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.0349	0.038	0.095	0.0250	0.055	0.042	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.0349	0.028	0.073	0.0250	0.042	0.032	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.0349	0.018	0.046	0.0250	0.026	0.020	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.0349	0.012	0.029	0.0250	0.017	0.013	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.0349	0.046	0.115	0.0125	0.066	0.067	0.036	0.151	2.933	0.066	0.067	0.000	0.099	0.099	-0.000	9.670	2.517
6.0	0.15	0.015	0.0349	0.038	0.095	0.0125	0.055	0.054	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.0349	0.028	0.073	0.0125	0.042	0.040	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.0349	0.018	0.046	0.0125	0.026	0.025	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.0349	0.012	0.029	0.0125	0.017	0.016	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.0349	0.046	0.115	0.0100	0.066	0.072	0.036	0.151	2.933	0.061	0.072	0.012	0.100	0.100	-0.003	9.746	1.883
6.0	0.15	0.015	0.0349	0.038	0.095	0.0100	0.055	0.058	0.029	0.12	8.836	0.051	0.056	0.007	0.082	0.082	-0.000	6.620	1.638
4.0	0.15	0.015	0.0349	0.028	0.073	0.0100	0.042	0.044	0.022	0.10	5.160	0.040	0.044	0.004	0.063	0.063	-0.003	3.846	1.432
2.0	0.15	0.015	0.0349	0.018	0.046	0.0100	0.026	0.027	0.014	0.06	2.045	0.025	0.027	0.002	0.039	0.039	-0.000	1.525	0.333
1.0	0.15	0.015	0.0349	0.012	0.029	0.0100	0.017	0.017	0.009	0.04	0.807	0.016	0.017	0.001	0.025	0.025	-0.000	0.605	0.517
8.0	0.15	0.015	0.0349	0.046	0.115	0.0050	0.066	0.094	0.036	0.151	2.933	0.045	0.094	0.049	0.118	0.110	-0.007	11.037	0.681
6.0	0.15	0.015	0.0349	0.038	0.095	0.0050	0.055	0.076	0.029	0.12	8.836	0.038	0.076	0.037	0.094	0.090	-0.005	7.374	0.671
4.0	0.15	0.015	0.0349	0.028	0.073	0.0050	0.042	0.056	0.022	0.10	5.160	0.030	0.056	0.026	0.070	0.068	-0.003	4.212	0.596
2.0	0.15	0.015	0.0349	0.018	0.046	0.0050	0.026	0.034	0.014	0.05	2.045	0.020	0.034	0.015	0.043	0.042	-0.001	1.645	0.435
1.0	0.15	0.015	0.0349	0.012	0.029	0.0050	0.017	0.022	0.009	0.04	0.807	0.012	0.022	0.009	0.027	0.026	-0.001	0.652	0.217

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY FOM N.	UPJUMP DEPTH M.	JUMP DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP FOM. N.	JUMP POS. M.
8.0	0.15	0.015	0.0698	0.036	0.148	0.0250	0.066	0.052	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.0698	0.030	0.123	0.0250	0.055	0.042	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.0698	0.023	0.094	0.0250	0.042	0.032	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.0698	0.014	0.058	0.0250	0.026	0.020	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.0698	0.009	0.036	0.0250	0.017	0.013	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.0698	0.036	0.148	0.0125	0.066	0.067	0.031	0.181	4.344	0.066	0.067	0.000	0.099	0.099	-0.000	9.670	3.333
6.0	0.15	0.015	0.0698	0.030	0.123	0.0125	0.055	0.054	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.0698	0.023	0.094	0.0125	0.042	0.040	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.0698	0.014	0.058	0.0125	0.026	0.025	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.0698	0.009	0.036	0.0125	0.017	0.016	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.0698	0.036	0.148	0.0100	0.066	0.072	0.031	0.181	4.344	0.061	0.072	0.012	0.100	0.100	-0.000	9.746	2.253
6.0	0.15	0.015	0.0698	0.030	0.123	0.0100	0.055	0.058	0.026	0.15	9.796	0.051	0.058	0.007	0.082	0.082	-0.000	6.620	2.333
4.0	0.15	0.015	0.0698	0.023	0.094	0.0100	0.042	0.044	0.020	0.11	5.706	0.040	0.044	0.004	0.063	0.063	-0.000	3.846	1.533
2.0	0.15	0.015	0.0698	0.014	0.058	0.0100	0.026	0.027	0.012	0.07	2.251	0.025	0.027	0.002	0.039	0.039	-0.000	1.525	1.334
1.0	0.15	0.015	0.0698	0.009	0.036	0.0100	0.017	0.017	0.003	0.04	0.883	0.016	0.017	0.001	0.025	0.025	-0.000	0.605	0.534
8.0	0.15	0.015	0.0698	0.036	0.148	0.0050	0.066	0.094	0.031	0.181	4.344	0.045	0.094	0.049	0.118	0.110	-0.007	11.037	1.333
6.0	0.15	0.015	0.0698	0.030	0.123	0.0050	0.055	0.076	0.026	0.15	9.796	0.038	0.076	0.037	0.094	0.090	-0.005	7.374	0.951
4.0	0.15	0.015	0.0698	0.023	0.094	0.0050	0.042	0.056	0.020	0.11	5.706	0.030	0.055	0.026	0.070	0.069	-0.003	4.212	0.911
2.0	0.15	0.015	0.0698	0.014	0.058	0.0050	0.026	0.034	0.012	0.07	2.251	0.020	0.034	0.015	0.043	0.042	-0.001	1.645	0.583
1.0	0.15	0.015	0.0698	0.009	0.036	0.0050	0.017	0.022	0.003	0.04	0.883	0.012	0.022	0.009	0.027	0.026	-0.001	0.652	0.305

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. M.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. M.	JUMP POS. M.
8.0	0.15	0.015	0.1045	0.031	0.179	0.0250	0.066	0.052	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.1045	0.026	0.148	0.0250	0.055	0.042	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.1045	0.020	0.113	0.0250	0.042	0.032	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.1045	0.013	0.069	0.0250	0.026	0.020	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.1045	0.008	0.042	0.0250	0.017	0.013	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.1045	0.031	0.179	0.0125	0.066	0.067	0.028	0.211	5.578	0.066	0.067	0.000	0.099	0.099	-0.066	9.670	3.258
6.0	0.15	0.015	0.1045	0.026	0.148	0.0125	0.055	0.054	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.1045	0.020	0.113	0.0125	0.042	0.040	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.1045	0.013	0.069	0.0125	0.026	0.025	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.1045	0.006	0.042	0.0125	0.017	0.016	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.1045	0.031	0.179	0.0100	0.066	0.072	0.028	0.211	5.578	0.061	0.072	0.012	0.100	0.100	-0.006	9.746	2.535
6.0	0.15	0.015	0.1045	0.026	0.148	0.0100	0.055	0.058	0.023	0.171	0.630	0.051	0.058	0.007	0.082	0.082	-0.003	6.620	2.233
4.0	0.15	0.015	0.1045	0.020	0.113	0.0100	0.042	0.044	0.018	0.13	6.182	0.040	0.044	0.004	0.063	0.063	-0.003	3.646	1.793
2.0	0.15	0.015	0.1045	0.013	0.069	0.0100	0.026	0.027	0.011	0.08	2.429	0.025	0.027	0.002	0.039	0.039	-0.003	1.525	1.123
1.0	0.15	0.015	0.1045	0.008	0.042	0.0100	0.017	0.017	0.007	0.05	0.949	0.016	0.017	0.001	0.025	0.025	-0.003	0.605	0.533
8.0	0.15	0.015	0.1045	0.031	0.179	0.0050	0.066	0.094	0.028	0.211	5.578	0.045	0.094	0.049	0.118	0.110	-0.007	11.037	1.273
6.0	0.15	0.015	0.1045	0.026	0.148	0.0050	0.055	0.076	0.023	0.171	0.630	0.038	0.076	0.037	0.094	0.090	-0.005	7.374	1.155
4.0	0.15	0.015	0.1045	0.020	0.113	0.0050	0.042	0.056	0.018	0.13	6.182	0.030	0.056	0.026	0.070	0.068	-0.003	4.212	0.933
2.0	0.15	0.015	0.1045	0.013	0.069	0.0050	0.026	0.034	0.011	0.08	2.429	0.020	0.034	0.015	0.043	0.042	-0.001	1.645	0.588
1.0	0.15	0.015	0.1045	0.008	0.042	0.0050	0.017	0.022	0.007	0.05	0.949	0.012	0.022	0.009	0.027	0.026	-0.001	0.652	0.353

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.15	0.015	0.1736	0.026	0.234	0.0250	0.066	0.052				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.15	0.015	0.1736	0.022	0.193	0.0250	0.055	0.042				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.1736	0.017	0.146	0.0250	0.042	0.032				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.1736	0.011	0.089	0.0250	0.026	0.020				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.1736	0.007	0.054	0.0250	0.017	0.013				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.1736	0.026	0.234	0.0125	0.065	0.067	0.025	0.261	7.582	0.066	0.067	0.000	0.099	0.099	-0.003	9.670	3.592
6.0	0.15	0.015	0.1736	0.022	0.193	0.0125	0.055	0.054				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.1736	0.017	0.146	0.0125	0.042	0.040				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.1736	0.011	0.089	0.0125	0.026	0.025				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.1736	0.007	0.054	0.0125	0.017	0.016				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.1736	0.026	0.234	0.0100	0.066	0.072	0.025	0.261	7.582	0.061	0.072	0.012	0.100	0.100	-0.003	9.746	2.920
6.0	0.15	0.015	0.1736	0.022	0.193	0.0100	0.055	0.058	0.021	0.211	1.979	0.051	0.058	0.007	0.082	0.082	-0.003	6.620	2.671
4.0	0.15	0.015	0.1736	0.017	0.146	0.0100	0.042	0.044	0.016	0.16	6.947	0.040	0.044	0.004	0.063	0.063	-0.003	3.816	1.376
2.0	0.15	0.015	0.1736	0.011	0.089	0.0100	0.026	0.027	0.010	0.10	2.719	0.026	0.027	0.002	0.034	0.033	-0.003	1.525	1.235
1.0	0.15	0.015	0.1736	0.007	0.054	0.0100	0.017	0.017	0.007	0.06	1.056	0.016	0.017	0.001	0.025	0.025	-0.003	0.605	0.731
8.0	0.15	0.015	0.1736	0.026	0.234	0.0050	0.066	0.094	0.025	0.261	7.582	0.045	0.094	0.049	0.118	0.113	-0.003	11.037	1.532
5.0	0.15	0.015	0.1736	0.022	0.193	0.0050	0.055	0.076	0.021	0.211	1.979	0.038	0.076	0.037	0.094	0.090	-0.005	7.374	1.611
4.0	0.15	0.015	0.1736	0.017	0.146	0.0050	0.042	0.056	0.016	0.16	6.947	0.030	0.055	0.026	0.070	0.068	-0.003	4.212	1.166
2.0	0.15	0.015	0.1736	0.011	0.089	0.0050	0.026	0.034	0.010	0.10	2.719	0.020	0.034	0.015	0.043	0.042	-0.001	1.645	5.722
1.0	0.15	0.015	0.1736	0.007	0.054	0.0050	0.017	0.022	0.007	0.06	1.056	0.012	0.022	0.004	0.027	0.026	-0.001	0.652	0.613

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F NO.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F NO.	JUMP POS. M.
8.0	0.15	0.015	0.3402	0.021	0.345	0.0250	0.066	0.052				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.15	0.015	0.3402	0.018	0.283	0.0250	0.055	0.042				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.3402	0.014	0.212	0.0250	0.042	0.032				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.3402	0.009	0.128	0.0250	0.026	0.020				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.3402	0.006	0.076	0.0250	0.017	0.013				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.3402	0.021	0.345	0.0125	0.066	0.067	0.023	0.372	1.131	0.066	0.067	0.000	0.099	0.099	-0.000	9.670	3.331
6.0	0.15	0.015	0.3402	0.018	0.283	0.0125	0.055	0.054				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.3402	0.014	0.212	0.0125	0.042	0.040				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.3402	0.009	0.128	0.0125	0.026	0.025				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.3402	0.006	0.076	0.0125	0.017	0.016				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.3402	0.021	0.345	0.0100	0.066	0.072	0.023	0.372	1.131	0.061	0.072	0.012	0.100	0.100	-0.003	9.746	3.223
6.0	0.15	0.015	0.3402	0.018	0.283	0.0100	0.055	0.058	0.017	0.301	4.346	0.051	0.051	0.007	0.082	0.082	-0.003	6.620	2.732
4.0	0.15	0.015	0.3402	0.014	0.212	0.0100	0.042	0.044	0.013	0.23	3.289	0.040	0.044	0.004	0.063	0.053	-0.003	3.846	2.297
2.0	0.15	0.015	0.3402	0.009	0.128	0.0100	0.026	0.027	0.009	0.14	3.225	0.026	0.027	0.002	0.039	0.039	-0.003	1.525	1.371
1.0	0.15	0.015	0.3402	0.006	0.076	0.0100	0.017	0.017	0.005	0.08	1.245	0.016	0.017	0.001	0.025	0.025	-0.003	0.605	0.777
8.0	0.15	0.015	0.3402	0.021	0.345	0.0050	0.066	0.094	0.023	0.372	1.131	0.045	0.094	0.049	0.118	0.113	-0.007	11.037	1.372
6.0	0.15	0.015	0.3402	0.018	0.283	0.0050	0.055	0.076	0.017	0.301	4.346	0.038	0.075	0.037	0.094	0.090	-0.005	7.374	1.725
4.0	0.15	0.015	0.3402	0.014	0.212	0.0050	0.042	0.056	0.013	0.23	3.289	0.030	0.056	0.026	0.070	0.068	-0.003	4.212	1.373
2.0	0.15	0.015	0.3402	0.009	0.128	0.0050	0.026	0.034	0.005	0.14	3.225	0.020	0.034	0.015	0.043	0.042	-0.001	1.645	0.836
1.0	0.15	0.015	0.3402	0.006	0.076	0.0050	0.017	0.022	0.005	0.09	1.245	0.012	0.022	0.009	0.027	0.026	-0.001	0.652	0.433

COMMON DATA APPROACH PIPE DATA — TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N M.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. M.	JUMP LOSS. M.
8.0	0.15	0.015	0.5000	0.019	0.435	0.0250	0.066	0.052				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
6.0	0.15	0.015	0.5000	0.015	0.356	0.0250	0.055	0.042				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.5000	0.012	0.266	0.0250	0.042	0.032				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.5000	0.008	0.160	0.0250	0.026	0.020				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.5000	0.005	0.095	0.0250	0.017	0.013				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.5000	0.019	0.435	0.0125	0.066	0.067	0.013	0.452	3.619	0.066	0.067	0.000	0.099	0.099	-0.003	9.670	4.181
6.0	0.15	0.015	0.5000	0.015	0.356	0.0125	0.055	0.054				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
4.0	0.15	0.015	0.5000	0.012	0.266	0.0125	0.042	0.040				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
2.0	0.15	0.015	0.5000	0.008	0.160	0.0125	0.026	0.025				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
1.0	0.15	0.015	0.5000	0.005	0.095	0.0125	0.017	0.016				JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.							
8.0	0.15	0.015	0.5000	0.019	0.435	0.0100	0.066	0.072	0.018	0.452	3.619	0.061	0.072	0.012	0.100	0.100	-0.000	9.746	3.425
6.0	0.15	0.015	0.5000	0.015	0.356	0.0100	0.055	0.058	0.015	0.371	6.020	0.051	0.058	0.007	0.082	0.082	-0.003	6.620	2.354
4.0	0.15	0.015	0.5000	0.012	0.266	0.0100	0.042	0.044	0.012	0.28	9.236	0.040	0.044	0.004	0.063	0.063	-0.000	3.646	2.325
2.0	0.15	0.015	0.5000	0.008	0.160	0.0100	0.026	0.027	0.009	0.17	3.582	0.026	0.027	0.002	0.039	0.039	-0.003	1.525	1.661
1.0	0.15	0.015	0.5000	0.005	0.095	0.0100	0.017	0.017	0.005	0.10	1.380	0.016	0.017	0.001	0.025	0.025	-0.003	0.605	0.819
8.0	0.15	0.015	0.5000	0.019	0.435	0.0050	0.066	0.094	0.013	0.452	3.619	0.045	0.094	0.049	0.118	0.110	-0.007	11.037	2.171
6.0	0.15	0.015	0.5000	0.015	0.356	0.0050	0.055	0.076	0.015	0.371	6.020	0.038	0.076	0.037	0.094	0.090	-0.005	7.374	1.335
4.0	0.15	0.015	0.5000	0.012	0.266	0.0050	0.042	0.056	0.012	0.23	9.236	0.030	0.056	0.026	0.070	0.068	-0.003	4.212	1.192
2.0	0.15	0.015	0.5000	0.008	0.160	0.0050	0.026	0.034	0.009	0.17	3.582	0.020	0.034	0.015	0.043	0.042	-0.001	1.645	0.926
1.0	0.15	0.015	0.5000	0.005	0.095	0.0050	0.017	0.022	0.005	0.10	1.380	0.012	0.022	0.009	0.027	0.025	-0.001	0.652	0.524

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N.	JUMP POS. M.
8.0	0.15	0.015	0.7070	0.017	0.539	0.0250	0.066	0.052	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	0.7070	0.014	0.439	0.0250	0.055	0.042	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.7070	0.011	0.327	0.0250	0.042	0.032	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.7070	0.007	0.195	0.0250	0.026	0.020	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.7070	0.005	0.115	0.0250	0.017	0.013	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.7070	0.017	0.539	0.0125	0.066	0.067	0.016	0.562	6.223	0.060	0.067	0.000	0.099	0.099	-0.003	9.670	4.365
6.0	0.15	0.015	0.7070	0.014	0.439	0.0125	0.055	0.054	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	0.7070	0.011	0.327	0.0125	0.042	0.040	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	0.7070	0.007	0.195	0.0125	0.026	0.025	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	0.7070	0.005	0.115	0.0125	0.017	0.016	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	0.7070	0.017	0.539	0.0100	0.066	0.072	0.016	0.562	6.223	0.061	0.072	0.012	0.100	0.100	-0.006	9.746	3.531
6.0	0.15	0.015	0.7070	0.014	0.439	0.0100	0.055	0.058	0.014	0.451	7.743	0.051	0.058	0.007	0.082	0.082	-0.006	6.620	3.335
4.0	0.15	0.015	0.7070	0.011	0.327	0.0100	0.042	0.044	0.011	0.341	0.215	0.040	0.044	0.004	0.063	0.063	-0.003	3.646	2.422
2.0	0.15	0.015	0.7070	0.007	0.195	0.0100	0.026	0.027	0.007	0.20	0.950	0.026	0.027	0.002	0.039	0.039	-0.003	1.525	1.477
1.0	0.15	0.015	0.7070	0.005	0.115	0.0100	0.017	0.017	0.004	0.12	1.519	0.016	0.017	0.001	0.025	0.025	-0.003	0.605	0.351
8.0	0.15	0.015	0.7070	0.017	0.539	0.0050	0.066	0.094	0.016	0.562	6.223	0.045	0.094	0.049	0.118	0.110	-0.007	11.037	2.337
6.0	0.15	0.015	0.7070	0.014	0.439	0.0050	0.055	0.076	0.014	0.451	7.743	0.038	0.076	0.037	0.094	0.090	-0.005	7.374	2.316
4.0	0.15	0.015	0.7070	0.011	0.327	0.0050	0.042	0.056	0.011	0.341	0.215	0.030	0.056	0.026	0.070	0.068	-0.003	4.212	1.533
2.0	0.15	0.015	0.7070	0.007	0.195	0.0050	0.026	0.034	0.007	0.20	0.950	0.020	0.034	0.015	0.043	0.042	-0.001	1.645	0.377
1.0	0.15	0.015	0.7070	0.005	0.115	0.0050	0.017	0.022	0.004	0.12	1.519	0.012	0.022	0.009	0.027	0.026	-0.001	0.652	0.553

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.N. N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.N. N.	JUMP POS. M.
8.0	0.15	0.015	0.8660	0.016	0.611	0.0250	0.066	0.052			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
6.0	0.15	0.015	0.8660	0.013	0.498	0.0250	0.055	0.042			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
4.0	0.15	0.015	0.8660	0.010	0.369	0.0250	0.042	0.032			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
2.0	0.15	0.015	0.8660	0.007	0.220	0.0250	0.026	0.020			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
1.0	0.15	0.015	0.8660	0.004	0.130	0.0250	0.017	0.013			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
8.0	0.15	0.015	0.8660	0.016	0.611	0.0125	0.066	0.067	0.015	0.632	7.865	0.066	0.067	0.000	0.099	0.099	-0.003	9.670	4.033
6.0	0.15	0.015	0.8660	0.013	0.498	0.0125	0.055	0.054			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
4.0	0.15	0.015	0.8660	0.010	0.369	0.0125	0.042	0.040			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
2.0	0.15	0.015	0.8660	0.007	0.220	0.0125	0.026	0.025			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
1.0	0.15	0.015	0.8660	0.004	0.130	0.0125	0.017	0.016			JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.								
8.0	0.15	0.015	0.8660	0.016	0.611	0.0100	0.066	0.072	0.015	0.632	7.865	0.061	0.072	0.012	0.100	0.100	-0.000	9.796	3.579
6.0	0.15	0.015	0.8660	0.013	0.498	0.0100	0.055	0.058	0.013	0.511	8.867	0.051	0.058	0.007	0.082	0.082	-0.003	6.620	3.157
4.0	0.15	0.015	0.8660	0.010	0.369	0.0100	0.042	0.044	0.010	0.381	0.840	0.040	0.044	0.004	0.063	0.063	-0.003	3.896	2.876
2.0	0.15	0.015	0.8660	0.007	0.220	0.0100	0.026	0.027	0.006	0.23	4.186	0.026	0.027	0.002	0.039	0.039	-0.003	1.525	1.527
1.0	0.15	0.015	0.8660	0.004	0.130	0.0100	0.017	0.017	0.004	0.13	1.609	0.016	0.017	0.001	0.025	0.025	-0.003	0.605	[illegible]
8.0	0.15	0.015	0.8660	0.016	0.611	0.0050	0.066	0.094	0.015	0.632	7.865	0.045	0.094	0.049	0.118	0.110	-0.007	11.037	2.423
6.0	0.15	0.015	0.8660	0.013	0.498	0.0050	0.055	0.076	0.013	0.511	8.867	0.038	0.076	0.037	0.094	0.090	-0.005	7.374	2.355
4.0	0.15	0.015	0.8660	0.010	0.369	0.0050	0.042	0.056	0.010	0.381	0.840	0.030	0.056	0.026	0.070	0.068	-0.003	4.212	1.560
2.0	0.15	0.015	0.8660	0.007	0.220	0.0050	0.026	0.034	0.006	0.23	4.186	0.020	0.034	0.015	0.043	0.042	-0.001	1.645	1.338
1.0	0.15	0.015	0.8660	0.004	0.130	0.0050	0.017	0.022	0.004	0.13	1.609	0.012	0.022	0.009	0.027	0.026	-0.001	0.652	0.577

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	MN M.	TERM. ENERGY M.	SLOPE (SIN)	MC M.	MN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY FORM N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP FORM. N.	JUMP POS. M.
8.0	0.15	0.015	0.9659	0.015	0.654	0.0250	0.066	0.052				JUMP IMPOSSIBLE AS MN<MC IN TEST PIPE.							
6.0	0.15	0.015	0.9659	0.013	0.532	0.0250	0.055	0.042				JUMP IMPOSSIBLE AS MN<MC IN TEST PIPE.							
4.0	0.15	0.015	0.9659	0.010	0.395	0.0250	0.042	0.032				JUMP IMPOSSIBLE AS MN<MC IN TEST PIPE.							
2.0	0.15	0.015	0.9659	0.006	0.235	0.0250	0.026	0.020				JUMP IMPOSSIBLE AS MN<MC IN TEST PIPE.							
1.0	0.15	0.015	0.9659	0.004	0.138	0.0250	0.017	0.013				JUMP IMPOSSIBLE AS MN<MC IN TEST PIPE.							
8.0	0.15	0.015	0.9659	0.015	0.654	0.0125	0.066	0.067	0.015	0.672	8.826	0.066	0.067	0.000	0.099	0.099	-0.003	9.670	4.673
6.0	0.15	0.015	0.9659	0.013	0.532	0.0125	0.055	0.054				JUMP IMPOSSIBLE AS MN<MC IN TEST PIPE.							
4.0	0.15	0.015	0.9659	0.010	0.395	0.0125	0.042	0.040				JUMP IMPOSSIBLE AS MN<MC IN TEST PIPE.							
2.0	0.15	0.015	0.9659	0.006	0.235	0.0125	0.026	0.025				JUMP IMPOSSIBLE AS MN<MC IN TEST PIPE.							
1.0	0.15	0.015	0.9659	0.004	0.138	0.0125	0.017	0.016				JUMP IMPOSSIBLE AS MN<MC IN TEST PIPE.							
8.0	0.15	0.015	0.9659	0.015	0.654	0.0100	0.066	0.072	0.015	0.672	8.826	0.061	0.072	0.012	0.100	0.100	-0.000	9.746	3.725
6.0	0.15	0.015	0.9659	0.013	0.532	0.0100	0.055	0.058	0.012	0.541	3.492	0.051	0.058	0.007	0.082	0.082	-0.000	6.620	3.133
4.0	0.15	0.015	0.9659	0.010	0.395	0.0100	0.042	0.044	0.010	0.401	1.207	0.040	0.044	0.004	0.063	0.063	-0.000	3.846	2.531
2.0	0.15	0.015	0.9659	0.006	0.235	0.0100	0.026	0.027	0.006	0.24	4.323	0.026	0.027	0.002	0.039	0.039	-0.00	1.525	1.563
1.0	0.15	0.015	0.9659	0.004	0.138	0.0100	0.017	0.017	0.004	0.14	1.659	0.016	0.017	0.001	0.025	0.025	-0.000	0.605	0.873
3.0	0.15	0.015	0.9659	0.015	0.654	0.0050	0.066	0.094	0.015	0.672	8.826	0.045	0.094	0.049	0.118	0.110	-0.007	11.037	2.456
6.0	0.15	0.015	0.9659	0.013	0.532	0.0050	0.055	0.076	0.012	0.541	9.492	0.038	0.076	0.037	0.094	0.090	-0.005	7.374	2.121
4.0	0.15	0.015	0.9559	0.010	0.395	0.0050	0.042	0.056	0.010	0.401	1.207	0.030	0.056	0.026	0.070	0.068	-0.003	4.212	1.557
2.0	0.15	0.015	0.9659	0.006	0.235	0.0050	0.026	0.034	0.005	0.24	4.323	0.020	0.034	0.015	0.043	0.042	-0.001	1.645	1.323
1.0	0.15	0.015	0.9659	0.004	0.138	0.0050	0.017	0.022	0.004	0.14	1.659	0.012	0.022	0.009	0.027	0.026	-0.001	0.652	0.535

COMMON DATA APPROACH PIPE DATA . TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F'M N.	UPJUMP DEPTH M.	JUMP DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANG: M.	JUMP F'M. N.	JUMP POS. M.
8.0	0.15	0.015	1.0000	0.015	0.668	0.0250	0.066	0.052	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
6.0	0.15	0.015	1.0000	0.012	0.544	0.0250	0.055	0.042	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	1.0000	0.010	0.404	0.0250	0.042	0.032	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	1.0000	0.006	0.240	0.0250	0.026	0.020	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	1.0000	0.004	0.141	0.0250	0.017	0.013	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	1.0000	0.015	0.668	0.0125	0.066	0.067	0.015	0.682	9.128	0.066	0.057	0.000	0.099	0.099	-0.000	9.670	4.492
6.0	0.15	0.015	1.0000	0.012	0.544	0.0125	0.055	0.054	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
4.0	0.15	0.015	1.0000	0.010	0.404	0.0125	0.042	0.040	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
2.0	0.15	0.015	1.0000	0.006	0.240	0.0125	0.026	0.025	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
1.0	0.15	0.015	1.0000	0.004	0.141	0.0125	0.017	0.016	JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.										
8.0	0.15	0.015	1.0000	0.015	0.668	0.0100	0.066	0.072	0.015	0.682	9.128	0.061	0.072	0.012	0.100	0.100	-0.000	9.746	3.739
6.0	0.15	0.015	1.0000	0.012	0.544	0.0100	0.055	0.058	0.012	0.561	9.710	0.051	0.058	0.007	0.082	0.082	-0.000	6.620	3.234
4.0	0.15	0.015	1.0000	0.010	0.404	0.0100	0.042	0.044	0.009	0.411	11.329	0.040	0.044	0.004	0.063	0.063	-0.000	3.646	2.513
2.0	0.15	0.015	1.0000	0.006	0.240	0.0100	0.026	0.027	0.006	0.25	4.365	0.025	0.027	0.002	0.039	0.039	-0.000	1.525	1.567
1.0	0.15	0.015	1.0000	0.004	0.141	0.0100	0.017	0.017	0.004	0.15	1.677	0.016	0.017	0.001	0.025	0.025	-0.000	0.605	0.333
8.0	0.15	0.015	1.0000	0.015	0.668	0.0050	0.066	0.094	0.015	0.682	9.128	0.045	0.094	0.049	0.118	0.110	-0.007	11.637	2.412
6.0	0.15	0.015	1.0000	0.012	0.544	0.0050	0.055	0.076	0.012	0.561	9.710	0.038	0.076	0.037	0.094	0.090	-0.005	7.374	2.131
4.0	0.15	0.015	1.0000	0.010	0.404	0.0050	0.042	0.056	0.009	0.411	11.329	0.030	0.055	0.026	0.070	0.068	-0.003	4.212	1.575
2.0	0.15	0.015	1.0000	0.006	0.240	0.0050	0.026	0.034	0.006	0.25	4.365	0.020	0.034	0.015	0.043	0.042	-0.001	1.645	1.324
1.0	0.15	0.015	1.0000	0.004	0.141	0.0050	0.017	0.022	0.004	0.15	1.677	0.012	0.022	0.009	0.027	0.026	-0.001	0.652	0.531

APPENDIX 7

JUMP FORMATION INDICATOR TAKES FOR CONSTANT MANNING COEFFICIENT OF 0.015 FOR BOTH CIRCULAR AND RECTANGULAR CROSS SECTION CHANNELS

TABULATED NORMAL FLOW DEPTHS FOR A CIRCULAR CROSS SECTION CHANNEL OF DIAMETER 0.1500 M. AND MANNING COEFF. 0.0150

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				NORMAL DEPTH M.					
PIPE SLOPE (SIN)									
0.0017	0.0435	0.0624	0.0795	0.0956	0.1132	0.1499	0.1499	0.1499	0.1500
0.0025	0.0394	0.0567	0.0709	0.0843	0.0976	0.1121	0.1334	0.1499	0.1500
0.0033	0.0369	0.0526	0.0656	0.0774	0.0888	0.1006	0.1136	0.1321	0.1500
0.0050	0.0332	0.0471	0.0585	0.0686	0.0781	0.0874	0.0969	0.1069	0.1500
0.0066	0.0309	0.0438	0.0542	0.0635	0.0720	0.0802	0.0883	0.0965	0.1500
0.0100	0.0279	0.0394	0.0486	0.0567	0.0640	0.0709	0.0776	0.0843	0.1500
0.0125	0.0254	0.0373	0.0459	0.0534	0.0602	0.0665	0.0727	0.0786	0.1500
0.0250	0.0223	0.0314	0.0384	0.0445	0.0500	0.0550	0.0593	0.0644	0.1500
				******					
0.0349	0.0206	0.0289	0.0353	0.0408	0.0458	0.0504	0.0547	0.0588	0.1500
0.0698	0.0174	0.0244	0.0297	0.0343	0.0383	0.0421	0.0456	0.0488	0.1500
0.1045	0.0158	0.0221	0.0269	0.0310	0.0347	0.0380	0.0411	0.0440	0.1500
0.1736	0.0140	0.0195	0.0238	0.0274	0.0306	0.0335	0.0361	0.0386	0.1500
0.3402	0.0120	0.0166	0.0202	0.0232	0.0259	0.0283	0.0306	0.0326	0.1500
0.5000	0.0109	0.0152	0.0184	0.0211	0.0236	0.0258	0.0278	0.0297	0.1500
0.7070	0.0101	0.0140	0.0170	0.0195	0.0217	0.0237	0.0255	0.0273	0.1500
0.8660	0.0096	0.0133	0.0162	0.0185	0.0206	0.0225	0.0243	0.0259	0.1500
0.9659	0.0094	0.0130	0.0157	0.0181	0.0201	0.0220	0.0237	0.0253	0.1500
1.0000	0.0093	0.0129	0.0156	0.0179	0.0199	0.0218	0.0235	0.0250	0.1500
CRITICAL DEPTH M.	0.0280	0.0400	0.0493	0.0572	0.0643	0.0707	0.0767	0.0821	

TABULATED VALUES OF F+M AT NORMAL DEPTHS IN A CIRCULAR CROSS SECTION CHANNEL DIAMETER 0.1500 M. AND MANNING COEFF. 0.013

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				F+M VALUE AT NORMAL DEPTH, M.					
PIPE SLOPE (SIN)									
0.0017	0.9844	2.3856	4.1076	6.1988	8.8620	15.0137	15.7493	16.5982	0.1500
0.0025	0.8589	2.0697	3.5129	5.1930	7.1472	9.5115	13.1413	16.5982	0.1500
0.0033	0.7951	1.9059	3.2200	4.7119	6.3926	8.3087	10.5882	13.8604	0.1500
0.0050	0.7304	1.7497	2.9383	4.2653	5.7245	7.3133	9.0654	11.0078	0.1500
0.0066	0.7059	1.6923	2.8366	4.1065	5.4857	6.9729	8.5674	10.2835	0.1500
0.0100	0.6937	1.6678	2.7930	4.0332	5.3707	6.7951	8.2992	9.8852	0.1500
0.0125	0.6980	1.6808	2.8159	4.0647	5.4080	6.8343	8.3347	9.9054	0.1500
0.0250	0.7546	1.8286	3.0707	4.4351	5.8970	7.4453	9.0672	10.7473	0.1500
				******					
0.0349	0.8036	1.9541	3.2853	4.7502	6.3174	7.9801	9.7118	11.5125	0.1500
0.0698	0.9512	2.3248	3.9208	5.6741	7.5635	9.5548	11.6299	13.8159	0.1500
0.1045	1.0657	2.6122	4.4071	6.3860	8.5183	10.7741	13.1394	15.5854	0.1500
0.1736	1.2452	3.0598	5.1666	7.4932	9.9927	12.6432	15.4262	18.3234	0.1500
0.3402	1.5474	3.8077	6.4485	9.3483	12.4756	15.7973	19.2824	22.9158	0.1500
0.5000	1.7556	4.3266	7.3248	10.6593	14.2320	18.0141	21.9978	26.1227	0.1500
0.7070	1.9737	4.8691	8.2446	11.9879	15.9899	20.2867	24.7411	29.4151	0.1500
0.8660	2.1164	5.2191	8.8396	12.8413	17.1735	21.7516	26.5538	31.5457	0.1500
0.9659	2.1947	5.4112	9.1817	13.3386	17.8022	22.5836	27.5516	32.7849	0.1500
1.0000	2.2198	5.4780	9.2905	13.4955	18.0367	22.8553	27.9198	33.1944	0.1500

TABULATED NORMAL FLOW DEPTHS FOR A CIRCULAR CROSS SECTION CHANNEL OF DIAMETER 0.1000 M. AND MANNING COEFF. 0.0150

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				NORMAL DEPTH M.					
PIPE SLOPE (SIN)									
0.0017	0.0524	0.0999	0.0999	0.0999	0.0999	0.0999	0.0999	0.0999	0.1000
0.0025	0.0468	0.0737	0.0999	0.0999	0.0999	0.0999	0.0999	0.0999	0.1000
0.0033	0.0433	0.0663	0.0999	0.0999	0.0999	0.0999	0.0999	0.0999	0.1000
0.0050	0.0396	0.0577	0.0776	0.0999	0.0999	0.0999	0.0999	0.0999	0.1000
0.0066	0.0358	0.0524	0.0692	0.0999	0.0999	0.0999	0.0999	0.0999	0.1000
0.0100	0.0321	0.0468	0.0599	0.0737	0.0999	0.0999	0.0999	0.0999	0.1000
0.0125	0.0303	0.0439	0.0557	0.0675	0.0818	0.0999	0.0999	0.0999	0.1000
0.0250	0.0254	0.0364	0.0454	0.0538	0.0620	0.0707	0.0809	0.0999	0.1000
				******					
0.0349	0.0234	0.0333	0.0414	0.0487	0.0557	0.0626	0.0700	0.0783	0.1000
0.0698	0.0196	0.0278	0.0344	0.0401	0.0454	0.0504	0.0553	0.0602	0.1000
0.1045	0.0178	0.0251	0.0309	0.0359	0.0406	0.0448	0.0490	0.0531	0.1000
0.1736	0.0157	0.0221	0.0271	0.0314	0.0353	0.0390	0.0424	0.0457	0.1000
0.3402	0.0134	0.0187	0.0229	0.0264	0.0297	0.0326	0.0353	0.0380	0.1000
0.5000	0.0122	0.0170	0.0208	0.0240	0.0269	0.0295	0.0320	0.0343	0.1000
0.7070	0.0112	0.0157	0.0191	0.0220	0.0246	0.0270	0.0292	0.0313	0.1000
0.8660	0.0107	0.0149	0.0182	0.0209	0.0234	0.0256	0.0277	0.0297	0.1000
0.9659	0.0104	0.0145	0.0177	0.0204	0.0228	0.0249	0.0270	0.0289	0.1000
1.0000	0.0103	0.0144	0.0175	0.0202	0.0225	0.0247	0.0267	0.0286	0.1000
CRITICAL DEPTH M.	0.0315	0.0451	0.0557	0.0648	0.0725	0.0792	0.0848	0.0892	

TABULATED VALUES OF F•M AT NORMAL DEPTHS IN A CIRCULAR CROSS SECTION CHANNEL DIAMETER 0.1000 M. AND MANNING COEFF. 0.015

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				F•M VALUE AT NORMAL DEPTH, N.					
PIPE SLOPE (SIN)									
0.0017	1.1524	4.3542	4.9908	5.8821	7.0281	8.4287	10.0840	11.9940	0.1000
0.0025	0.9765	2.6443	4.9908	5.8821	7.0281	8.4287	10.0840	11.9940	0.1000
0.0033	0.8879	2.2964	4.9908	5.8821	7.0281	8.4287	10.0840	11.9940	0.1000
0.0050	0.7993	1.9942	3.6201	5.8821	7.0281	8.4287	10.0840	11.9940	0.1000
0.0066	0.7647	1.8813	3.2872	5.8821	7.0281	8.4287	10.0840	11.9940	0.1000
0.0100	0.7429	1.8081	3.3794	4.5785	7.0281	8.4287	10.0840	11.9940	0.1000
0.0125	0.7441	1.6060	3.0544	4.4767	6.1556	8.4287	10.0840	11.9940	0.1000
0.0250	0.7980	1.9333	3.2447	4.6871	6.2380	7.8872	9.0582	11.9940	0.1000

••••••

0.0349	0.8479	2.0586	3.4539	4.9816	6.6116	8.3339	10.1267	11.9907	0.1000
0.0698	1.0033	2.4436	4.1026	5.9253	7.8626	9.8981	12.0249	14.2135	0.1000
0.1045	1.1254	2.7435	4.6206	6.6778	8.8645	11.1807	13.5908	16.0513	0.1000
0.1736	1.3126	3.2151	5.4151	7.8421	10.4335	13.1515	16.0075	18.9462	0.1000
0.3402	1.6337	4.0108	6.7653	9.8076	13.0490	16.4949	20.1069	23.8240	0.1000
0.5000	1.8574	4.5672	7.7140	11.1868	14.8881	18.8540	22.9368	27.2368	0.1000
0.7070	2.0902	5.1354	8.6901	12.5945	16.6191	21.2520	25.8695	30.7542	0.1000
0.8660	2.2383	5.5082	9.3199	13.5039	18.0339	22.8261	27.8166	32.9663	0.1000
0.9659	2.3254	5.7202	9.5667	14.0281	18.7102	23.6962	28.8592	34.2663	0.1000
1.0000	2.3531	5.7894	9.7810	14.1951	18.9650	23.9560	29.2229	34.7480	0.1000

TABULATED NORMAL FLOW DEPTHS FOR A CIRCULAR CROSS SECTION CHANNEL OF DIAMETER 0.0750 M. AND MANNING COEFF. 0.0150

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				NORMAL DEPTH M.					
PIPE SLOPE (S1M)									
0.0017	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0025	0.0590	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0033	0.0525	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0050	0.0454	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0066	0.0415	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0100	0.0367	0.0590	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0125	0.0344	0.0536	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0250	0.0284	0.0422	0.0563	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
				******					
0.0349	0.0259	0.0381	0.0495	0.0637	0.0749	0.0749	0.0749	0.0749	0.0750
0.0698	0.0217	0.0313	0.0395	0.0475	0.0561	0.0749	0.0749	0.0749	0.0750
0.1045	0.0195	0.0280	0.0351	0.0416	0.0482	0.0552	0.0646	0.0749	0.0750
0.1736	0.0172	0.0245	0.0305	0.0358	0.0408	0.0459	0.0511	0.0569	0.0750
0.3402	0.0146	0.0206	0.0254	0.0296	0.0336	0.0372	0.0408	0.0444	0.0750
0.5000	0.0132	0.0187	0.0230	0.0267	0.0302	0.0333	0.0364	0.0394	0.0750
0.7070	0.0122	0.0171	0.0210	0.0244	0.0274	0.0303	0.0330	0.0356	0.0750
0.8660	0.0116	0.0163	0.0200	0.0231	0.0260	0.0287	0.0312	0.0336	0.0750
0.9659	0.0113	0.0158	0.0194	0.0225	0.0253	0.0279	0.0303	0.0326	0.0750
1.0000	0.0112	0.0157	0.0192	0.0223	0.0250	0.0276	0.0300	0.0323	0.0750
CRITICAL DEPTH M.	0.0343	0.0493	0.0602	0.0675	0.0714	0.0732	0.0740	0.0745	

TABULATED VALUES OF F*M AT NORMAL DEPTHS IN A CIRCULAR CROSS SECTION CHANNEL DIAMETER 0.0750 M. AND MANNING COEFF. 0.015

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				F*M VALUE AT NORMAL DEPTH, N.					
PIPE SLOPE (SIN)									
0.0017	1.8484	2.5275	3.6593	5.2439	7.2812	9.7712	12.7140	16.1094	0.0750
0.0025	1.2441	2.5275	3.6593	5.2439	7.2812	9.7712	12.7140	16.1094	0.0750
0.0033	1.0537	2.5275	3.6593	5.2439	7.2812	9.7712	12.7140	16.1094	0.0750
0.0050	0.8959	2.5275	3.6593	5.2439	7.2812	9.7712	12.7140	16.1094	0.0750
0.0066	0.8359	2.5275	3.6593	5.2439	7.2812	9.7712	12.7140	16.1094	0.0750
0.0100	0.7929	2.0488	3.6593	5.2439	7.2812	9.7712	12.7140	16.1094	0.0750
0.0125	0.7871	1.9713	3.6593	5.2439	7.2812	9.7712	12.7140	16.1094	0.0750
0.0250	0.8308	2.0162	3.4093	5.2439	7.2812	9.7712	12.7140	16.1094	0.0750
				******					
0.0349	0.8805	2.1314	3.5674	5.1546	7.2812	9.7712	12.7140	16.1094	0.0750
0.0698	1.0383	2.5161	4.2028	6.0213	7.9212	9.7712	12.7140	16.1094	0.0750
0.1045	1.1647	2.8276	4.7304	6.7920	8.9567	11.1711	13.2922	16.1094	0.0750
0.1736	1.3606	3.3120	5.5568	7.9967	10.5875	13.2590	15.9919	18.7031	0.0750
0.3402	1.6932	4.1399	6.9687	10.0487	13.3254	16.7799	20.3471	23.9933	0.0750
0.5000	1.9250	4.7151	7.9481	11.4903	15.2496	19.2302	23.3491	27.5645	0.0750
0.7070	2.1709	5.3153	8.9725	12.9768	17.2390	21.7318	26.4124	31.2599	0.0750
0.8660	2.3273	5.7003	9.5076	13.9265	18.5060	23.3802	28.4258	33.6524	0.0750
0.9659	2.4134	5.9220	9.9834	14.4520	19.2647	24.2779	29.5510	35.0188	0.0750
1.0000	2.4414	5.9995	10.1146	14.6464	19.4924	24.5776	29.9298	35.4296	0.0750

TABULATED NORMAL FLOW DEPTHS FOR A RECTANGULAR CHANNEL OF WIDTH 0.1500 M. AND MANNING COEFF. 0.0150

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				NORMAL DEPTH M.					
PIPE SLOPE (SIN)									
0.0017	0.0310	0.0501	0.0673	0.0836	0.0992	0.1145	0.1294	0.1442	0.1500
0.0025	0.0272	0.0438	0.0585	0.0723	0.0855	0.0984	0.1110	0.1234	0.1500
0.0033	0.0248	0.0397	0.0528	0.0652	0.0770	0.0884	0.0995	0.1105	0.1500
0.0050	0.0216	0.0344	0.0456	0.0560	0.0660	0.0755	0.0849	0.0940	0.1500
0.0066	0.0197	0.0313	0.0413	0.0507	0.0596	0.0681	0.0764	0.0844	0.1500
0.0100	0.0172	0.0272	0.0358	0.0438	0.0512	0.0585	0.0654	0.0723	0.1500
0.0125	0.0160	0.0252	0.0332	0.0405	0.0474	0.0539	0.0603	0.0665	0.1500
0.0250	0.0128	0.0201	0.0262	0.0318	0.0371	0.0422	0.0470	0.0517	0.1500
				••••••					
0.0349	0.0115	0.0180	0.0235	0.0284	0.0331	0.0375	0.0418	0.0459	0.1500
0.0698	0.0093	0.0144	0.0187	0.0226	0.0262	0.0296	0.0329	0.0360	0.1500
0.1045	0.0082	0.0126	0.0164	0.0198	0.0229	0.0258	0.0287	0.0314	0.1500
0.1736	0.0070	0.0108	0.0139	0.0168	0.0194	0.0218	0.0242	0.0265	0.1500
0.3402	0.0057	0.0087	0.0112	0.0135	0.0156	0.0175	0.0194	0.0211	0.1500
0.5000	0.0050	0.0077	0.0100	0.0119	0.0138	0.0155	0.0171	0.0187	0.1500
0.7070	0.0045	0.0069	0.0089	0.0107	0.0123	0.0139	0.0153	0.0167	0.1500
0.8660	0.0042	0.0065	0.0084	0.0100	0.0116	0.0130	0.0143	0.0156	0.1500
0.9659	0.0041	0.0063	0.0081	0.0097	0.0112	0.0125	0.0138	0.0151	0.1500
1.0000	0.0041	0.0062	0.0080	0.0096	0.0111	0.0124	0.0137	0.0149	0.1500
CRITICAL DEPTH M.	0.0165	0.0263	0.0344	0.0417	0.0484	0.0546	0.0605	0.0662	

TABULATED VALUES OF F•M AT NORMAL DEPTHS IN A RECTANGULAR CHANNEL OF WIDTH 0.1500 M. AND MANNING COEFF. 0.0150

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
	F•M VALUE AT NORMAL DEPTH, M.								
PIPE SLOPE (SIN)									
0.0017	0.9207	2.3812	4.2279	6.4147	8.9259	11.7385	14.0474	16.2604	0.1500
0.0025	0.7892	2.0184	3.5425	5.3173	7.3251	9.5587	12.0029	14.6632	0.1500
0.0033	0.7207	1.8297	3.1900	4.7653	6.5248	8.4648	10.5713	12.8478	0.1500
0.0050	0.6517	1.6450	2.8454	4.2118	5.7275	7.3736	9.1500	11.0374	0.1500
0.0066	0.6238	1.5720	2.7089	3.9958	5.4092	6.9353	8.5698	10.2994	0.1500
0.0100	0.6053	1.5247	2.6189	3.8465	5.1843	6.6202	8.1427	9.7462	0.1500
0.0125	0.6050	1.5254	2.6184	3.8407	5.1694	6.5901	8.0926	9.6698	0.1500
0.0250	0.6408	1.6258	2.7932	4.0959	5.5052	7.0010	8.5768	10.2216	0.1500

••••••

0.0349	0.6761	1.7204	2.9628	4.3460	5.8427	7.4304	9.1025	10.8475	0.1500
0.0698	0.7821	2.0063	3.4666	5.0996	6.8659	8.7509	10.7337	12.8007	0.1500
0.1045	0.8658	2.2267	3.8570	5.6861	7.6620	9.7804	12.0038	14.3267	0.1500
0.1736	0.9920	2.5640	4.4514	6.5699	8.8718	11.3378	13.9357	16.6408	0.1500
0.3402	1.2009	3.1170	5.4340	8.0330	10.8806	13.9151	17.1231	20.5037	0.1500
0.5000	1.3438	3.4970	6.1019	9.0329	12.2514	15.6786	19.3262	23.1233	0.1500
0.7070	1.4898	3.8806	6.7769	10.0508	13.6267	17.4673	21.5503	25.8244	0.1500
0.8660	1.5835	4.1250	7.2102	10.6948	14.5120	18.6237	22.9502	27.5126	0.1500
0.9659	1.6351	4.2658	7.4576	11.0709	15.0256	19.2641	23.7548	28.4972	0.1500
1.0000	1.6531	4.3088	7.5328	11.1954	15.1722	19.4879	24.0361	28.8070	0.1500

TABULATED NORMAL FLOW DEPTHS FOR A RECTANGULAR CHANNEL OF WIDTH 0.0100 M. AND MANNING COEFF. 0.0150

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				NORMAL DEPTH M.					
PIPE SLOPE (SIN)									
0.0017	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.0025	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.0033	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.0050	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.0066	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.0125	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.0250	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
					******				
0.0349	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.0698	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.1045	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.1736	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.3402	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.5000	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.7070	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.8660	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
0.9659	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
1.0000	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
CRITICAL DEPTH M.	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	

TABULATED VALUES OF F*M AT NORMAL DEPTHS IN A RECTANGULAR CHANNEL OF WIDTH 0.0100 M. AND MANNING COEFF. 0.0150

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
	F*M VALUE AT NORMAL DEPTH, M.								
PIPE SLOPE (SIN)									
0.0017	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.0025	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.0033	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.0050	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.0066	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.0100	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.0125	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.0250	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
				••••••					
0.0349	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.0698	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.1045	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.1736	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.3402	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.5000	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.7070	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.8660	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
0.9659	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100
1.0000	10.0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.0100

TABULATED NORMAL FLOW DEPTHS FOR A RECTANGULAR CHANNEL OF WIDTH 0.0750 M. AND MANNING COEFF. 0.0150

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				NORMAL DEPTH M.					
PIPE SLOPE (SIN)									
0.0017	0.0599	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0025	0.0514	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0033	0.0462	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0050	0.0394	0.0677	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0066	0.0355	0.0605	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0100	0.0305	0.0514	0.0710	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0125	0.0281	0.0471	0.0649	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.0250	0.0219	0.0362	0.0493	0.0619	0.0742	0.0749	0.0749	0.0749	0.0750
				******					
0.0349	0.0195	0.0320	0.0434	0.0542	0.0648	0.0749	0.0749	0.0749	0.0750
0.0698	0.0154	0.0249	0.0335	0.0415	0.0493	0.0568	0.0642	0.0715	0.0750
0.1045	0.0134	0.0216	0.0288	0.0357	0.0422	0.0485	0.0547	0.0608	0.0750
0.1736	0.0113	0.0181	0.0240	0.0296	0.0348	0.0400	0.0449	0.0498	0.0750
0.3402	0.0091	0.0144	0.0190	0.0232	0.0272	0.0311	0.0348	0.0385	0.0750
0.5000	0.0080	0.0126	0.0166	0.0203	0.0237	0.0270	0.0302	0.0333	0.0750
0.7070	0.0072	0.0113	0.0148	0.0180	0.0210	0.0239	0.0267	0.0294	0.0750
0.8660	0.0067	0.0105	0.0138	0.0168	0.0196	0.0222	0.0248	0.0273	0.0750
0.9659	0.0065	0.0102	0.0133	0.0162	0.0188	0.0214	0.0239	0.0262	0.0750
1.0000	0.0064	0.0101	0.0132	0.0160	0.0186	0.0211	0.0236	0.0259	0.0750
CRITICAL DEPTH M.	0.0263	0.0417	0.0546	0.0662	0.0749	0.0749	0.0749	0.0749	

TABULATED VALUES OF F+M AT NORMAL DEPTHS IN A RECTANGULAR CHANNEL OF WIDTH 0.0750 M. AND MANNING COEFF. 0.0150

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				F+M VALUE AT NORMAL DEPTH, M.					
PIPE SLOPE (SIN)									
0.0017	1.5415	2.7771	3.6668	4.9125	6.5140	8.4715	10.7849	13.4542	0.0750
0.0025	1.2306	2.7771	3.6668	4.9125	6.5140	8.4715	10.7849	13.4542	0.0750
0.0033	1.0732	2.7771	3.6668	4.9125	6.5140	8.4715	10.7849	13.4542	0.0750
0.0050	0.9088	2.4743	3.6668	4.9125	6.5140	8.4715	10.7849	13.4542	0.0750
0.0066	0.8393	2.2291	3.5668	4.9125	6.5140	8.4715	10.7849	13.4542	0.0750
0.0100	0.7790	2.0092	3.5448	4.9125	6.5140	8.4715	10.7849	13.4542	0.0750
0.0125	0.7649	1.9488	3.3976	4.9125	6.5140	8.4715	10.7849	13.4542	0.0750
0.0250	0.7851	1.9549	3.3278	4.8557	6.5178	8.4715	10.7849	13.4542	0.0750

••••••

0.0349	0.8236	2.0427	3.4580	5.0155	6.6893	8.4715	10.7849	13.4542	0.0750
0.0698	0.9543	2.3686	3.9988	5.7749	7.6600	9.6376	11.6932	13.8130	0.0750
0.1045	1.0591	2.6419	4.4670	6.4516	8.5617	10.7564	13.0491	15.3898	0.0750
0.1736	1.2228	3.0671	5.2040	7.5358	10.0129	12.6012	15.2826	18.0574	0.0750
0.3402	1.4977	3.7842	6.4524	9.3797	12.5151	15.7853	19.1764	22.7159	0.0750
0.5000	1.6852	4.2771	7.3232	10.6758	14.2643	18.0175	21.4478	26.0012	0.0750
0.7070	1.8754	4.7790	8.1963	11.9774	16.0336	20.2977	24.7510	29.3541	0.0750
0.8660	1.9994	5.1020	8.7676	12.8159	17.1703	21.7577	26.5591	31.5306	0.0750
0.9659	2.0682	5.2815	9.0859	13.2981	17.8220	22.5932	27.5929	32.7748	0.0750
1.0000	2.0912	5.3379	9.1849	13.4473	18.0277	22.8610	27.9282	33.1822	0.0750

APPENDIX 8

JUMP FORMATION INDICATOR TABLES FOR 0.15 m PIPE DIAMETER

FOR A RANGE OF MANNING COEFFICIENTS FROM

0.009 TO 0.018

TABULATED NORMAL FLOW DEPTHS FOR A CIRCULAR CROSS SECTION CHANNEL OF DIAMETER 0.1500 M. AND MANNING COEFF. 0.0180

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				NORMAL DEPTH M.					
PIPE SLOPE (SIN)									
0.0017	0.0479	0.0697	0.0890	0.1094	0.1499	0.1499	0.1499	0.1499	0.1500
0.0025	0.0433	0.0625	0.0790	0.0948	0.1121	0.1499	0.1499	0.1499	0.1500
0.0033	0.0403	0.0580	0.0728	0.0866	0.1006	0.1165	0.1499	0.1499	0.1500
0.0050	0.0363	0.0519	0.0646	0.0762	0.0874	0.0988	0.1113	0.1271	0.1500
0.0066	0.0339	0.0482	0.0599	0.0703	0.0802	0.0899	0.0998	0.1107	0.1500
0.0100	0.0306	0.0433	0.0535	0.0625	0.0709	0.0790	0.0868	0.0948	0.1500
0.0125	0.0289	0.0409	0.0504	0.0589	0.0665	0.0739	0.0811	0.0881	0.1500
0.0250	0.0244	0.0343	0.0422	0.0489	0.0550	0.0608	0.0662	0.0714	0.1500
				******					
0.0349	0.0225	0.0316	0.0387	0.0449	0.0504	0.0555	0.0603	0.0649	0.1500
0.0698	0.0190	0.0266	0.0325	0.0376	0.0421	0.0463	0.0501	0.0538	0.1500
0.1045	0.0173	0.0242	0.0295	0.0340	0.0380	0.0416	0.0451	0.0484	0.1500
0.1736	0.0153	0.0213	0.0260	0.0299	0.0335	0.0367	0.0396	0.0424	0.1500
0.3402	0.0130	0.0182	0.0221	0.0254	0.0283	0.0310	0.0335	0.0358	0.1500
0.5000	0.0119	0.0166	0.0201	0.0231	0.0258	0.0282	0.0304	0.0325	0.1500
0.7070	0.0110	0.0152	0.0185	0.0213	0.0237	0.0259	0.0279	0.0298	0.1500
0.8660	0.0105	0.0145	0.0176	0.0202	0.0225	0.0246	0.0266	0.0284	0.1500
0.9659	0.0102	0.0142	0.0172	0.0197	0.0220	0.0240	0.0259	0.0276	0.1500
1.0000	0.0101	0.0140	0.0170	0.0195	0.0218	0.0238	0.0257	0.0274	0.1500
CRITICAL DEPTH M.	0.0280	0.0400	0.0493	0.0572	0.0643	0.0707	0.0767	0.0821	

TABULATED VALUES OF F+M AT NORMAL DEPTHS IN A CIRCULAR CROSS SECTION CHANNEL DIAMETER 0.1500 M. AND MANNING COEFF. 0.01

F+M VALUE AT NORMAL DEPTH, M.

FLOW RATE = PIPE SLOPE (SIN)	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
0.0017	1.1497	2.8170	4.9391	7.7482	14.3911	15.0137	15.7493	16.5982	0.1500
0.0025	0.9769	2.3649	4.0733	6.1259	8.7352	15.0137	15.7493	16.5982	0.1500
0.0033	0.6832	2.1300	3.6278	5.3807	7.4354	10.0377	15.7493	16.5982	0.1500
0.0050	0.7846	1.8831	3.1749	4.6410	6.2839	8.1512	10.3355	13.1922	0.1500
0.0066	0.7405	1.7754	2.9831	4.3346	5.8291	7.4668	9.2828	11.3472	0.1500
0.0100	0.7030	1.6862	2.8247	4.0862	5.4579	6.9329	8.5061	10.2006	0.1500
0.0125	0.6948	1.6687	2.7945	4.0379	5.3811	6.8165	8.3394	9.9506	0.1500
0.0250	0.7166	1.7319	2.9036	4.1925	5.5738	7.0368	8.5717	10.1684	0.1500

••••••

0.0349	0.7504	1.8196	3.0543	4.4097	5.8673	7.4052	9.0159	10.6923	0.1500
0.0698	0.8662	2.1107	3.5540	5.1371	6.8461	8.6404	10.5224	12.4816	0.1500
0.1045	0.9603	2.3491	3.9598	5.7368	7.6462	9.6684	11.7778	13.9551	0.1500
0.1736	1.1120	2.7306	4.6096	6.6785	8.9005	11.2529	13.7371	16.3096	0.1500
0.3402	1.3736	3.3763	5.7122	8.2796	11.0505	13.9804	17.0665	20.2746	0.1500
0.5000	1.5574	3.8312	6.4811	9.4097	12.5733	15.9100	19.4035	23.0919	0.1500
0.7070	1.7472	4.3045	7.2840	10.5819	14.1396	17.9074	21.8374	25.9891	0.1500
0.8660	1.8705	4.6032	7.8089	11.3462	15.1510	19.1890	23.4088	27.8297	0.1500
0.9659	1.9382	4.7793	8.0946	11.7669	15.7251	19.8942	24.2992	28.9225	0.1500
1.0000	1.9635	4.8419	8.1941	11.9240	15.9137	20.1543	24.5919	29.2493	0.1500

TABULATED NORMAL FLOW DEPTHS FOR A CIRCULAR CROSS SECTION CHANNEL OF DIAMETER 0.1500 M. AND MANNING COEFF. 0.0150

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				NORMAL DEPTH M.					
PIPE SLOPE (SIN)									
0.0017	0.0435	0.0629	0.0795	0.0956	0.1132	0.1499	0.1499	0.1499	0.1500
0.0025	0.0394	0.0567	0.0709	0.0843	0.0976	0.1121	0.1334	0.1499	0.1500
0.0033	0.0368	0.0526	0.0656	0.0774	0.0888	0.1006	0.1136	0.1321	0.1500
0.0050	0.0332	0.0471	0.0585	0.0686	0.0781	0.0874	0.0969	0.1069	0.1500
0.0066	0.0309	0.0438	0.0542	0.0635	0.0720	0.0802	0.0883	0.0965	0.1500
0.0100	0.0279	0.0394	0.0486	0.0567	0.0640	0.0709	0.0776	0.0843	0.1500
0.0125	0.0264	0.0373	0.0459	0.0534	0.0602	0.0665	0.0727	0.0786	0.1500
0.0250	0.0223	0.0314	0.0384	0.0445	0.0500	0.0550	0.0598	0.0644	0.1500
				******					
0.0349	0.0206	0.0269	0.0353	0.0408	0.0458	0.0504	0.0547	0.0588	0.1500
0.0698	0.0174	0.0244	0.0297	0.0343	0.0383	0.0421	0.0456	0.0488	0.1500
0.1045	0.0158	0.0221	0.0269	0.0310	0.0347	0.0380	0.0411	0.0440	0.1500
0.1736	0.0140	0.0195	0.0238	0.0274	0.0306	0.0335	0.0361	0.0386	0.1500
0.3402	0.0120	0.0166	0.0202	0.0232	0.0259	0.0283	0.0306	0.0326	0.1500
0.5000	0.0109	0.0152	0.0184	0.0211	0.0236	0.0258	0.0278	0.0297	0.1500
0.7070	0.0101	0.0140	0.0170	0.0195	0.0217	0.0237	0.0255	0.0273	0.1500
0.8660	0.0096	0.0133	0.0162	0.0185	0.0206	0.0225	0.0243	0.0259	0.1500
0.9659	0.0094	0.0130	0.0157	0.0181	0.0201	0.0220	0.0237	0.0253	0.1500
1.0000	0.0093	0.0129	0.0156	0.0179	0.0199	0.0218	0.0235	0.0250	0.1500
CRITICAL DEPTH M.	0.0280	0.0400	0.0493	0.0572	0.0643	0.0707	0.0767	0.0821	

TABULATED VALUES OF F•M AT NORMAL DEPTHS IN A CIRCULAR CROSS SECTION CHANNEL DIAMETER 0.1500 M. AND MANNING COEFF.

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				F•M VALUE AT NORMAL DEPTH, M.					
PIPE SLOPE (SIN)									
0.0017	0.9844	2.3856	4.1076	6.1988	8.8620	15.0137	15.7493	16.5982	0.1500
0.0025	0.8549	2.0697	3.5129	5.1930	7.1472	9.5115	13.1413	16.5982	0.1500
0.0033	0.7951	1.9059	3.2200	4.7119	6.3926	8.3087	10.5882	13.8604	0.1500
0.0050	0.7304	1.7497	2.9383	4.2653	5.7245	7.3133	9.0654	11.0078	0.1500
0.0066	0.7059	1.6923	2.8366	4.1065	5.4857	6.9729	8.5674	10.2835	0.1500
0.0100	0.6937	1.6678	2.7930	4.0332	5.3707	6.7951	8.2992	9.8852	0.1500
0.0125	0.6980	1.6808	2.8159	4.0647	5.4080	6.8343	8.3347	9.9054	0.1500
0.0250	0.7546	1.8286	3.0707	4.4351	5.8970	7.4453	9.0672	10.7473	0.1500
				••••••					
0.0349	0.8036	1.9541	3.2853	4.7502	6.3174	7.9801	9.7118	11.5125	0.1500
0.0698	0.9512	2.3248	3.9208	5.6741	7.5635	9.5548	11.6299	13.8159	0.1500
0.1045	1.0657	2.6122	4.4071	6.3860	8.5183	10.7741	13.1394	15.5854	0.1500
0.1736	1.2452	3.0598	5.1666	7.4932	9.9927	12.6432	15.4262	18.3234	0.1500
0.3402	1.5474	3.8077	6.4485	9.3483	12.4756	15.7973	19.2824	22.9158	0.1500
0.5000	1.7556	4.3266	7.3240	10.6593	14.2320	18.0141	21.9978	26.1227	0.1500
0.7070	1.9737	4.8691	8.2446	11.9879	15.9899	20.2867	24.7411	29.4151	0.1500
0.8660	2.1164	5.2191	8.8396	12.8413	17.1735	21.7516	26.5538	31.5457	0.1500
0.9659	2.1947	5.4112	9.1817	13.3366	17.8022	22.5836	27.5516	32.7849	0.1500
1.0000	2.2198	5.4780	9.2905	13.4955	18.0367	22.8553	27.9198	33.1944	0.1500

TABULATED NORMAL FLOW DEPTHS FOR A CIRCULAR CROSS SECTION CHANNEL OF DIAMETER 0.1500 M. AND MANNING COEFF. 0.0120

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
					NORMAL DEPTH M.				
PIPE SLOPE (SIN)									
0.0017	0.0389	0.0557	0.0697	0.0827	0.0956	0.1094	0.1272	0.1499	0.1500
0.0025	0.0352	0.0503	0.0625	0.0736	0.0843	0.0948	0.1060	0.1190	0.1500
0.0033	0.0329	0.0468	0.0580	0.0680	0.0774	0.0866	0.0959	0.1055	0.1500
0.0050	0.0297	0.0·20	0.0519	0.0605	0.0686	0.0762	0.0837	0.0912	0.1500
0.0066	0.0277	0.0391	0.0482	0.0561	0.0635	0.0703	0.0770	0.0834	0.1500
0.0100	0.0250	0.0352	0.0433	0.0503	0.0567	0.0625	0.0682	0.0736	0.1500
0.0125	0.0237	0.0333	0.0409	0.0474	0.0534	0.0589	0.0641	0.0690	0.1500
0.0250	0.0201	0.0281	0.0343	0.0397	0.0445	0.0489	0.0531	0.0570	0.1500
					******				
0.0349	0.0185	0.0259	0.0316	0.0365	0.0408	0.0449	0.0486	0.0521	0.1500
0.0698	0.0157	0.0219	0.0266	0.0307	0.0343	0.0376	0.0406	0.0435	0.1500
0.1045	0.0143	0.0198	0.0242	0.0278	0.0310	0.0340	0.0367	0.0392	0.1500
0.1736	0.0126	0.0176	0.0213	0.0246	0.0274	0.0299	0.0323	0.0346	0.1500
0.3402	0.0108	0.0150	0.0182	0.0209	0.0232	0.0254	0.0274	0.0292	0.1500
0.5000	0.0098	0.0137	0.0166	0.0190	0.0211	0.0231	0.0249	0.0266	0.1500
0.7070	0.0091	0.0126	0.0152	0.0175	0.0195	0.0213	0.0229	0.0244	0.1500
0.8660	0.0086	0.0120	0.0145	0.0167	0.0185	0.0202	0.0218	0.0233	0.1500
0.9659	0.0084	0.0117	0.0142	0.0162	0.0181	0.0197	0.0212	0.0227	0.1500
1.0000	0.0084	0.0116	0.0140	0.0161	0.0179	0.0195	0.0211	0.0225	0.1500
CRITICAL DEPTH M.	0.0280	0.0400	0.0493	0.0572	0.0643	0.0707	0.0767	0.0821	

TABULATED VALUES OF F*M AT NORMAL DEPTHS IN A CIRCULAR CROSS SECTION CHANNEL DIAMETER 0.1500 M. AND MANNING COEFF. 0.

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
PIPE SLOPE (SIN)				F*M VALUE AT NORMAL DEPTH, M.					
0.0017	0.8436	2.0284	3.4389	5.0708	6.9560	9.1971	12.2726	16.5982	0.1500
0.0025	0.7639	1.8317	3.0021	4.4945	6.0728	7.8237	9.8111	12.2134	0.1500
0.0033	0.7270	1.7418	2.9232	4.2432	5.6901	7.2714	8.9948	10.8991	0.1500
0.0050	0.6977	1.6743	2.8048	4.0541	5.4081	6.8571	8.4016	10.0445	0.1500
0.0066	0.6933	1.6665	2.7943	4.0350	5.3720	6.7953	8.2976	9.8787	0.1500
0.0100	0.7091	1.7117	2.8684	4.1411	5.5059	6.9552	8.4740	10.0584	0.1500
0.0125	0.7270	1.7565	2.9496	4.2590	5.6619	7.1473	8.7044	10.3270	0.1500
0.0250	0.8233	2.0028	3.3716	4.8776	6.4855	8.1927	9.9794	11.8190	0.1500

******

0.0349	0.8911	2.1763	3.6658	5.3003	7.0616	8.9145	10.8599	12.8866	0.1500
0.0698	1.0796	2.6448	4.4672	6.4706	8.6300	10.9023	13.3123	15.7753	0.1500
0.1045	1.2200	3.0003	5.0639	7.3513	9.7936	12.3963	15.1384	17.9724	0.1500
0.1736	1.4366	3.5309	5.9807	8.6668	11.5725	14.6512	17.8740	21.2261	0.1500
0.3402	1.7939	4.4169	7.4871	10.8707	14.5161	18.3784	22.4505	26.6696	0.1500
0.5000	2.0429	5.0367	8.5329	12.3845	16.5833	20.9727	25.5187	30.4470	0.1500
0.7070	2.3000	5.6754	9.5141	13.9651	18.6726	23.6475	28.8796	34.3322	0.1500
0.8660	2.4650	6.0827	10.3053	14.9715	20.0126	25.3859	30.9843	36.8267	0.1500
0.9659	2.5595	6.3058	10.5941	15.5614	20.7930	26.3412	32.2200	38.2854	0.1500
1.0000	2.5882	6.3932	10.8363	15.7412	21.0390	26.6977	32.5425	38.7339	0.1500

TABULATED NORMAL FLOW DEPTHS FOR A CIRCULAR CROSS SECTION CHANNEL OF DIAMETER 0.1500 M. AND MANNING COEFF. 0.0090

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
				NORMAL DEPTH M.					
PIPE SLOPE (SIN)									
0.0017	0.0336	0.0479	0.0594	0.0697	0.0795	0.0890	0.0988	0.1094	0.1500
0.0025	0.0306	0.0433	0.0535	0.0625	0.0709	0.0790	0.0868	0.0948	0.1500
0.0033	0.0285	0.0403	0.0497	0.0560	0.0656	0.0728	0.0798	0.0866	0.1500
0.0050	0.0258	0.0363	0.0446	0.0519	0.0585	0.0646	0.0705	0.0762	0.1500
0.0066	0.0241	0.0339	0.0416	0.0482	0.0542	0.0599	0.0651	0.0703	0.1500
0.0100	0.0218	0.0306	0.0374	0.0433	0.0486	0.0535	0.0581	0.0625	0.1500
0.0125	0.0206	0.0289	0.0354	0.0409	0.0459	0.0504	0.0547	0.0589	0.1500
0.0250	0.0175	0.0244	0.0298	0.0343	0.0384	0.0422	0.0456	0.0489	0.1500
				******					
0.0349	0.0161	0.0225	0.0274	0.0316	0.0353	0.0387	0.0419	0.0449	0.1500
0.0698	0.0137	0.0190	0.0232	0.0266	0.0297	0.0325	0.0351	0.0376	0.1500
0.1045	0.0124	0.0173	0.0210	0.0242	0.0269	0.0295	0.0318	0.0340	0.1500
0.1736	0.0110	0.0153	0.0186	0.0213	0.0238	0.0260	0.0280	0.0299	0.1500
0.3402	0.0094	0.0130	0.0158	0.0182	0.0202	0.0221	0.0238	0.0254	0.1500
0.5000	0.0086	0.0119	0.0144	0.0166	0.0184	0.0201	0.0217	0.0231	0.1500
0.7070	0.0079	0.0110	0.0133	0.0152	0.0170	0.0185	0.0199	0.0213	0.1500
0.8660	0.0076	0.0105	0.0127	0.0145	0.0162	0.0176	0.0190	0.0202	0.1500
0.9659	0.0074	0.0102	0.0124	0.0142	0.0157	0.0172	0.0185	0.0197	0.1500
1.0000	0.0073	0.0101	0.0123	0.0140	0.0156	0.0170	0.0183	0.0195	0.1500
CRITICAL DEPTH M.	0.0280	0.0400	0.0493	0.0572	0.0643	0.0707	0.0767	0.0821	

TABULATED VALUES OF F*M AT NORMAL DEPTHS IN A CIRCULAR CROSS SECTION CHANNEL DIAMETER 0.1500 M. AND MANNING COEFF.

F*M VALUE AT NORMAL DEPTH, M.

FLOW RATE =	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
PIPE SLOPE (SIN)									
0.0017	0.7372	1.7665	2.9660	4.3096	5.7904	7.4107	9.2041	11.2255	0.1500
0.0025	0.7030	1.6662	2.8247	4.0862	5.4579	6.9329	8.5061	10.2006	0.1500
0.0033	0.6941	1.6674	2.7924	4.0337	5.3741	6.8040	8.3184	9.9185	0.1500
0.0050	0.7024	1.6934	2.8373	4.0950	5.4468	6.8805	8.3881	9.9597	0.1500
0.0066	0.7212	1.7440	2.9241	4.2208	5.6137	7.0848	8.6320	10.2404	0.1500
0.0100	0.7683	1.8642	3.1333	4.5234	6.0198	7.5984	9.2516	10.9717	0.1500
0.0125	0.8024	1.9519	3.2823	4.7428	6.3096	7.9701	9.7007	11.5005	0.1500
0.0250	0.9489	2.3208	3.9153	5.6672	7.5473	9.5363	11.6299	13.7930	0.1500
					******				
0.0349	1.0434	2.5548	4.3134	6.2506	8.3254	10.5281	12.8359	15.2213	0.1500
0.0698	1.2898	3.1649	5.3513	7.7662	10.3665	13.1106	15.9940	18.9736	0.1500
0.1045	1.4689	3.6083	6.1097	8.8647	11.8299	14.9728	18.2923	21.7196	0.1500
0.1736	1.7349	4.2754	7.2435	10.5309	14.0482	17.8019	21.7185	25.8130	0.1500
0.3402	2.1823	5.3783	9.1054	13.2422	17.7099	22.4234	27.3707	32.5169	0.1500
0.5000	2.4881	6.1371	10.4001	15.1153	20.1848	25.5854	31.2853	37.1610	0.1500
0.7070	2.8013	6.9135	11.7156	17.0475	22.7701	28.8600	35.2458	41.9394	0.1500
0.8660	3.0030	7.4151	12.5648	18.2812	24.4377	30.9914	37.8332	45.0414	0.1500
0.9659	3.1191	7.6896	13.0583	18.9749	25.3953	32.1490	39.3614	46.7453	0.1500
1.0000	3.1537	7.7922	13.2013	19.2265	25.6997	32.5517	39.6135	47.3810	0.1500

APPENDIX 9

JUMP LOCATION IN A 0.15 m DIAMETER PIPE AT SLOPE 1/300,

CARRYING 6 ℓ/s, FOR A RANGE OF MANNING COEFFICIENTS 0.009 to 0.018.

RESULTS PRESENTED FOR UNIFORM MANNING COEFFICIENTS IN BOTH APPROACH PIPE AND

TEST PIPE AND CONSTANT APPROACH PIPE MANNING COEFFICIENT OF 0.015.

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F(N) M.	UPJUMP DEPTH M.	JUMP DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F(N). M.	JUMP POS. M.
6.0	0.15	0.018	0.0349	0.055	0.107	0.0033	0.071	0.117	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.15	0.018	0.0698	0.046	0.132	0.0033	0.071	0.117	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.15	0.018	0.1045	0.042	0.156	0.0033	0.071	0.117	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.15	0.018	0.1736	0.037	0.201	0.0033	0.071	0.117	0.037	0.201	1.218	0.040	0.117	0.076	0.166	0.125	-0.041	10.038	0.293
6.0	0.15	0.018	0.3402	0.031	0.295	0.0033	0.071	0.117	0.031	0.201	3.685	0.040	0.117	0.076	0.166	0.125	-0.041	10.038	0.535
6.0	0.15	0.018	0.5000	0.028	0.375	0.0033	0.071	0.117	0.028	0.361	5.666	0.040	0.117	0.076	0.166	0.125	-0.041	10.038	0.813
6.0	0.15	0.018	0.7070	0.026	0.469	0.0033	0.071	0.117	0.025	0.451	7.550	0.040	0.117	0.076	0.166	0.125	-0.041	10.038	0.959
6.0	0.15	0.018	0.8660	0.025	0.536	0.0033	0.071	0.117	0.025	0.531	9.056	0.040	0.117	0.076	0.166	0.125	-0.041	10.038	1.073
6.0	0.15	0.018	0.9659	0.024	0.575	0.0033	0.071	0.117	0.025	0.531	9.056	0.040	0.117	0.076	0.166	0.125	-0.041	10.038	1.070
6.0	0.15	0.018	1.0000	0.024	0.589	0.0033	0.071	0.117	0.024	0.571	9.900	0.040	0.117	0.076	0.166	0.125	-0.041	10.039	1.124

A9.2

Constant n, test and approach pip

COMMON DATA		APPROACH PIPE DATA				TEST PIPE DATA AND PROGRAM RESULTS.													
Q. L/S	DIA. M.	MANN. COFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F(N) M.	UPJUMP DEPTH M.	JUMP DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F(N). M.	JUMP POS. M.
6.0	0.15	0.015	0.0349	0.050	0.118	0.0033	0.071	0.101	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.15	0.015	0.0698	0.042	0.153	0.0033	0.071	0.101	0.043	0.15	9.388	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	0.630
6.0	0.15	0.015	0.1045	0.038	0.186	0.0033	0.071	0.101	0.033	0.181	0.681	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	0.938
6.0	0.15	0.015	0.1736	0.033	0.246	0.0033	0.071	0.101	0.034	0.241	2.499	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	1.386
6.0	0.15	0.015	0.3402	0.028	0.370	0.0033	0.071	0.101	0.023	0.361	5.666	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	1.910
6.0	0.15	0.015	0.5090	0.026	0.475	0.0033	0.071	0.101	0.025	0.451	7.550	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	2.130
6.0	0.15	0.015	0.7070	0.024	0.597	0.0033	0.071	0.101	0.024	0.571	9.900	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	2.350
6.0	0.15	0.015	0.8660	0.023	0.683	0.0033	0.071	0.101	0.023	0.532	0.815	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	2.412
6.0	0.15	0.015	0.9659	0.022	0.735	0.0033	0.071	0.101	0.022	0.592	1.807	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	2.531
6.0	0.15	0.015	1.0000	0.022	0.752	0.0033	0.071	0.101	0.022	0.692	1.807	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	2.533

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M. / ENTRY F'N M.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F'N M.	JUMP POS. M.
6.0	0.15	0.012	0.0349	0.045	0.138	0.0033	0.071	0.087	0.045	0.14 5.886	0.057	0.087	0.030	0.105	0.103	-0.002	7.271	1.655
6.0	0.15	0.012	0.0698	0.038	0.190	0.0033	0.071	0.087	0.035	0.1913.691	0.057	0.087	0.030	0.105	0.103	-0.002	7.271	2.739
6.0	0.15	0.012	0.1045	0.034	0.237	0.0033	0.071	0.087	0.034	0.2312.150	0.057	0.087	0.029	0.105	0.103	-0.002	7.271	3.332
6.0	0.15	0.012	0.1736	0.030	0.322	0.0033	0.071	0.087	0.030	0.3214.610	0.057	0.087	0.030	0.105	0.103	-0.002	7.271	4.010
6.0	0.15	0.012	0.3402	0.025	0.493	0.0033	0.071	0.087	0.025	0.4918.274	0.057	0.087	0.029	0.105	0.103	-0.002	7.271	4.722
6.0	0.15	0.012	0.5000	0.023	0.636	0.0033	0.071	0.087	0.023	0.6320.815	0.057	0.087	0.029	0.105	0.103	-0.002	7.271	5.050
6.0	0.15	0.012	0.7070	0.021	0.804	0.0033	0.071	0.087	0.022	0.7522.887	0.057	0.087	0.029	0.105	0.103	-0.002	7.271	5.235
6.0	0.15	0.012	0.8660	0.020	0.924	0.0033	0.071	0.087	0.023	0.9225.356	0.057	0.087	0.030	0.105	0.103	-0.002	7.271	5.517
6.0	0.15	0.012	0.9659	0.020	0.994	0.0033	0.071	0.087	0.020	0.9225.356	0.057	0.087	0.030	0.105	0.103	-0.002	7.271	5.517
6.0	0.15	0.012	1.0000	0.020	1.021	0.0033	0.071	0.087	0.020	0.9225.356	0.057	0.087	0.030	0.105	0.103	-0.002	7.271	5.517

COMMON DATA APPROACH PIPE DATA — TEST PIPE DATA AND PROGRAM RESULTS.

Constant n, test and approach pipe

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M. / ENTRY F'N M.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F'N M.	JUMP POS. M.
6.0	0.15	0.009	0.0349	0.039	0.179	0.0033	0.071	0.073	0.039	0.1810.434	0.069	0.073	0.004	0.098	0.098	-0.006	6.604	8.372
6.0	0.15	0.009	0.0698	0.033	0.262	0.0033	0.071	0.073	0.033	0.2512.870	0.069	0.073	0.004	0.098	0.098	-0.006	6.604	9.825
6.0	0.15	0.009	0.1045	0.029	0.335	0.0033	0.071	0.073	0.033	0.3214.610	0.059	0.073	0.004	0.098	0.098	-0.003	6.604	10.591
6.0	0.15	0.009	0.1736	0.026	0.464	0.0033	0.071	0.073	0.025	0.4517.550	0.059	0.073	0.003	0.098	0.098	-0.003	6.604	11.756
6.0	0.15	0.009	0.3402	0.022	0.725	0.0033	0.071	0.073	0.022	0.6921.807	0.059	0.073	0.003	0.098	0.098	-0.003	6.604	12.795
6.0	0.15	0.009	0.5000	0.020	0.939	0.0033	0.071	0.073	0.020	0.9225.350	0.070	0.073	0.003	0.098	0.098	-0.003	6.604	13.485
6.0	0.15	0.009	0.7070	0.019	1.190	0.0033	0.071	0.073	0.019	1.1528.332	0.070	0.073	0.003	0.098	0.099	-0.003	6.604	13.888
6.0	0.15	0.009	0.8660	0.018	1.370	0.0033	0.071	0.073	0.018	1.2930.057	0.070	0.073	0.003	0.098	0.098	-0.003	6.604	14.000
6.0	0.15	0.009	0.9659	0.017	1.474	0.0033	0.071	0.073	0.017	1.4631.972	0.070	0.073	0.003	0.098	0.098	-0.003	6.604	14.195
6.0	0.15	0.009	1.0000	0.017	1.510	0.0033	0.071	0.073	0.017	1.4631.972	0.070	0.073	0.003	0.098	0.098	-0.003	6.604	14.195

COMMON DATA APPROACH PIPE DATA — TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.M N.	UPJUMP DEPTH M.	JUMP DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.M. N.	JUMP POS. M.
6.0	0.15	0.018	0.0349	0.050	0.118	0.0033	0.071	0.117	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
5.0	0.15	0.018	0.0698	0.042	0.153	0.0033	0.071	0.117	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.15	0.018	0.1045	0.038	0.186	0.0033	0.071	0.117	0.033	0.13	13.681	0.040	0.117	0.076	0.166	0.125	-0.041	10.038	0.189
5.0	0.15	0.018	0.1736	0.033	0.246	0.0033	0.071	0.117	0.034	0.24	12.497	0.040	0.117	0.076	0.166	0.125	-0.041	10.039	0.850
6.0	0.15	0.018	0.3402	0.028	0.370	0.0033	0.071	0.117	0.023	0.35	15.665	0.040	0.117	0.075	0.166	0.125	-0.041	10.038	0.818
5.0	0.15	0.018	0.5000	0.026	0.475	0.0033	0.071	0.117	0.025	0.45	17.550	0.040	0.117	0.076	0.166	0.125	-0.041	10.038	0.959
5.0	0.15	0.018	0.7070	0.024	0.597	0.0033	0.071	0.117	0.024	0.57	19.900	0.043	0.117	0.075	0.166	0.125	-0.041	10.038	1.124
5.0	0.15	0.018	0.8660	0.023	0.683	0.0033	0.071	0.117	0.023	0.53	23.815	0.040	0.117	0.076	0.166	0.125	-0.041	10.039	1.175
5.0	0.15	0.018	0.9659	0.022	0.735	0.0033	0.071	0.117	0.022	0.59	21.807	0.040	0.117	0.075	0.166	0.125	-0.041	10.036	1.227
5.0	0.15	0.018	1.0000	0.022	0.752	0.0033	0.071	0.117	0.022	0.59	21.807	0.040	0.117	0.075	0.166	0.125	-0.041	10.039	1.227

Apprach pipe n = 0.015

COMMON DATA APPROACH PIPE DATA — TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY F.M N.	UPJUMP DEPTH M.	JUMP DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP F.M. N.	JUMP POS. M.
5.0	0.15	0.015	0.0349	0.050	0.118	0.0033	0.071	0.101	JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.										
6.0	0.15	0.015	0.0699	0.042	0.153	0.0033	0.071	0.101	0.043	0.15	7.380	0.043	0.101	0.052	0.125	0.112	-0.013	8.309	0.099
5.0	0.15	0.015	0.1045	0.038	0.186	0.0033	0.071	0.101	0.039	0.19	10.681	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	0.900
6.0	0.15	0.015	0.1736	0.033	0.246	0.0033	0.071	0.101	0.034	0.24	12.499	0.043	0.101	0.052	0.125	0.112	-0.013	8.309	1.305
5.0	0.15	0.015	0.3402	0.028	0.370	0.0033	0.071	0.101	0.023	0.36	15.665	0.048	0.101	0.052	0.125	0.112	-0.013	8.339	1.910
5.0	0.15	0.015	0.5000	0.026	0.475	0.0033	0.071	0.101	0.025	0.45	17.550	0.043	0.101	0.052	0.125	0.112	-0.013	8.309	2.199
5.0	0.15	0.015	0.7070	0.024	0.597	0.0033	0.071	0.101	0.024	0.57	19.930	0.048	0.101	0.052	0.125	0.112	-0.013	8.339	2.350
5.0	0.15	0.015	0.8660	0.023	0.683	0.0033	0.071	0.101	0.023	0.63	20.815	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	2.432
5.0	0.15	0.015	0.9659	0.022	0.735	0.0033	0.071	0.101	0.022	0.59	21.807	0.048	0.101	0.052	0.125	0.112	-0.013	8.309	2.503
5.0	0.15	0.015	1.0000	0.022	0.752	0.0033	0.071	0.101	0.022	0.69	21.807	0.048	0.101	0.052	0.125	0.112	-0.013	8.307	2.503

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY FRN N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP FRN. N.	JUMP POS. M.
6.0	0.15	0.012	0.0349	0.050	0.118	0.0033	0.071	0.087	0.051	0.12	7.894	0.057	0.087	0.030	0.105	0.103	-0.002	7.271	0.793
6.0	0.15	0.012	0.0698	0.042	0.153	0.0033	0.071	0.087	0.043	0.15	9.386	0.057	0.087	0.030	0.105	0.103	-0.002	7.271	2.009
6.0	0.15	0.012	0.1045	0.038	0.186	0.0033	0.071	0.087	0.035	0.191	10.681	0.057	0.087	0.030	0.105	0.103	-0.002	7.271	2.709
6.0	0.15	0.012	0.1736	0.033	0.246	0.0033	0.071	0.087	0.330	0.241	12.499	0.057	0.087	0.029	0.105	0.103	-0.002	7.271	3.422
6.0	0.15	0.012	0.3432	0.028	0.370	0.0033	0.071	0.087	0.023	0.361	15.665	0.057	0.087	0.029	0.105	0.103	-0.002	7.271	4.249
6.0	0.15	0.012	0.5000	0.026	0.475	0.0033	0.071	0.087	0.026	0.451	17.550	0.057	0.087	0.029	0.105	0.103	-0.002	7.271	4.605
6.0	0.15	0.012	0.7070	0.024	0.597	0.0033	0.071	0.087	0.024	0.571	19.909	0.057	0.087	0.029	0.105	0.103	-0.002	7.271	4.956
6.0	0.15	0.012	0.8660	0.023	0.683	0.0033	0.071	0.087	0.023	0.532	20.815	0.057	0.087	0.029	0.105	0.103	-0.002	7.271	5.059
6.0	0.15	0.012	0.9659	0.022	0.735	0.0033	0.071	0.087	0.322	0.692	21.807	0.057	0.087	0.029	0.105	0.103	-0.002	7.271	5.182
6.0	0.15	0.012	1.0000	0.022	0.752	0.0033	0.071	0.087	0.322	0.592	21.807	0.057	0.087	0.029	0.105	0.103	-0.002	7.271	5.182

A9.5 - 1

Approach pipe n = 0.015

COMMON DATA APPROACH PIPE DATA TEST PIPE DATA AND PROGRAM RESULTS.

Q. L/S	DIA. M.	MANN. COEFF	SLOPE (SIN)	HN M.	TERM. ENERGY M.	SLOPE (SIN)	HC M.	HN M.	ENTRY DEPTH M.	ENTRY ENERGY M.	ENTRY FRN N.	UPJUMP DEPTH M.	DOWN DEPTH M.	DEPTH CHANGE M.	ENERGY UPJUMP M.	ENERGY DOWN M.	ENERGY CHANGE M.	JUMP FRN. N.	JUMP POS. M.
6.0	0.15	0.009	0.0349	0.050	0.118	0.0033	0.071	0.073	0.051	0.12	7.994	0.059	0.073	0.004	0.098	0.098	-0.003	6.604	4.531
6.0	0.15	0.009	0.0698	0.042	0.153	0.0033	0.071	0.073	0.043	0.15	9.386	0.069	0.073	0.004	0.098	0.098	-0.003	6.604	6.333
6.0	0.15	0.009	0.1045	0.038	0.186	0.0033	0.071	0.073	0.035	0.191	10.681	0.059	0.073	0.304	0.098	0.099	-0.003	6.634	8.293
6.0	0.15	0.009	0.1736	0.033	0.246	0.0033	0.071	0.073	0.336	0.241	12.499	0.057	0.073	0.004	0.093	0.099	-0.003	6.604	9.500
6.0	0.15	0.009	0.3432	0.028	0.370	0.0033	0.071	0.073	0.023	0.361	15.666	0.067	0.073	0.004	0.095	0.096	-0.003	6.604	11.119
6.0	0.15	0.009	0.5000	0.026	0.475	0.0033	0.071	0.073	0.025	0.451	17.550	0.069	0.073	0.003	0.093	0.098	-0.003	6.604	11.756
6.0	0.15	0.009	0.7070	0.024	0.597	0.0033	0.071	0.073	0.024	0.571	19.900	0.079	0.073	0.003	0.095	0.095	-0.006	6.634	12.303
6.0	0.15	0.009	0.8660	0.023	0.683	0.0033	0.071	0.073	0.023	0.532	20.815	0.057	0.073	0.003	0.093	0.098	-0.003	6.504	12.590
6.0	0.15	0.009	0.9659	0.022	0.735	0.0033	0.071	0.073	0.022	0.592	21.807	0.077	0.073	0.003	0.098	0.095	-0.000	6.634	12.795
6.0	0.15	0.009	1.0000	0.022	0.752	0.0033	0.071	0.073	0.322	0.592	21.807	0.069	0.373	0.003	0.093	0.098	-0.003	6.604	12.795

APPENDIX 10

SAMPLE OUTPUT PROGRAM HYDJUMP. THE OUTPUT CONTROL PARAMETER SET TO GIVE WATER SURFACE PROFILES IN BOTH THE APPROACH PIPE AND UPSTREAM AND DOWNSTREAM OF THE JUMP IN THE TEST PIPE

PREDICTION OF THE HYDRAULIC
JUMP POSITION IN A CIRCULAR
CROSS SECTION PIPE AT MILD SLOPE.

PIPE LENGTH = 2.0000 M. PIPE WIDTH OR DIAMETER = 0.1500 M.
MANNING COEFF. = 0.0120 PIPE SLOPE = 0.5000
FLOWRATE = 0.0060 M**3/S. CONTROL DEPTH = 0.0707 M.

NORMAL DEPTH = 0.0231 M. CRITICAL DEPTH = 0.0707 M.

CONTROL IS UPSTREAM, DEPTH = 0.0707 M.

DISTANCE	DEPTH	ENERGY	F+M
0.	0.0707	0.0980	6.7950
0.0001	0.0691	0.0981	6.8004
0.0005	0.0675	0.0983	6.8173
0.0014	0.0660	0.0987	6.8463
0.0025	0.0644	0.0993	6.8881
0.0042	0.0628	0.1001	6.9436
0.0063	0.0612	0.1011	7.0135
0.0090	0.0596	0.1024	7.0990
0.0123	0.0581	0.1041	7.2010
0.0163	0.0565	0.1060	7.3209
0.0212	0.0549	0.1084	7.4601
0.0271	0.0533	0.1113	7.6201
0.0342	0.0517	0.1146	7.8029
0.0425	0.0501	0.1186	8.0104
0.0525	0.0486	0.1234	8.2452
0.0643	0.0470	0.1289	8.5100
0.0783	0.0454	0.1355	8.8079
0.0950	0.0438	0.1433	9.1428
0.1150	0.0422	0.1524	9.5191
0.1390	0.0406	0.1633	9.9418
0.1680	0.0391	0.1762	10.4171
0.2033	0.0375	0.1916	10.9524
0.2469	0.0359	0.2100	11.5562
0.3012	0.0343	0.2321	12.2393
0.3702	0.0327	0.2590	13.0146
0.4590	0.0311	0.2917	13.8981
0.5807	0.0296	0.3321	14.9094
0.7516	0.0280	0.3823	16.0736
1.0150	0.0264	0.4453	17.4224
1.5032	0.0248	0.5256	18.9969
2.0000	0.0246	0.5401	19.2662

PIPE LENGTH = 40.0000 M.   PIPE WIDTH OR DIAMETER = 0.1500 M.
MANNING COEFF. = 0.0120   PIPE SLOPE = 0.0033
FLOWRATE = 0.0060 M**3/S.   CONTROL DEPTH = 0.0247 M.

NORMAL DEPTH = 0.0865 M.   CRITICAL DEPTH = 0.0707 M.

CONTROL IS UPSTREAM, DEPTH = 0.0247 M.

DISTANCE	DEPTH	ENERGY	F+M
0.	0.0247	0.5286	19.0558
0.4772	0.0278	0.3879	16.1981
0.9597	0.0309	0.2978	14.0539
1.4445	0.0339	0.2376	12.4072
1.9237	0.0370	0.1966	11.1211
2.4095	0.0401	0.1676	10.1049
2.8931	0.0431	0.1470	9.2958
3.3459	0.0462	0.1320	8.6501
3.7936	0.0493	0.1211	8.1359
4.2212	0.0523	0.1133	7.7294
4.6222	0.0554	0.1076	7.4131
4.9333	0.0585	0.1036	7.1731
5.3102	0.0615	0.1009	6.9988
5.5722	0.0646	0.0992	6.8820
5.7538	0.0677	0.0983	6.8158
5.8237	0.0707	0.0980	6.7950

PIPE LENGTH = 40.0000 M. PIPE WIDTH OR DIAMETER = 0.1500 M.
MANNING COEFF. = 0.0120 PIPE SLOPE = 0.0033
FLOWRATE = 0.0060 M**3/S. CONTROL DEPTH = 0.0707 M.

NORMAL DEPTH = 0.0865 M. CRITICAL DEPTH = 0.0707 M.

CONTROL IS DOWNSTREAM, DEPTH = 0.0707 M.

DISTANCE	DEPTH	ENERGY	F+M
0.	0.0707	0.0980	6.7950
0.0104	0.0718	0.0981	6.7974
0.0429	0.0728	0.0982	6.8047
0.1014	0.0739	0.0983	6.8164
0.1906	0.0750	0.0985	6.8326
0.3169	0.0760	0.0987	6.8521
0.4830	0.0771	0.0990	6.8768
0.7146	0.0781	0.0993	6.9056
1.0120	0.0792	0.0997	6.9383
1.4023	0.0803	0.1001	6.9749
1.9202	0.0813	0.1005	7.0151
2.6237	0.0824	0.1009	7.0591
3.6227	0.0834	0.1014	7.1066
5.1555	0.0845	0.1019	7.1576
8.0673	0.0856	0.1025	7.2119
40.0000	0.0866	0.1030	7.2696

JUMP POSITION = 4.8547 M FROM PIPE ENTRY.
CONJUGATE DEPTHS = 0.0573 M UPSTREAM AND 0.0865M DOWNSTREAM.
KINETIC ENERGY VALUE = 0.1051M UPSTREAM AND 0.1029 M DOWNSTREAM.
HYDROSTATIC+MOMENTUM = 7.2612 N.

DEPTH CHANGE AT JUMP = 0.29116E-01 M.
ENERGY LOSS AT JUMP = -0.21271E-02 M.

APPENDIX 11

PROGRAM HYDJUMP

PROGRAM HYDJUMP

A full print out of HYDJUMP is included in this appendix. The program was written in Fortran for use on the NBS CBT Perkin Elmer 732 computer. No special facilities are required, single precision sufficient.

The program contains numerous comment blocks describing the calculation technique, however a simple flow diagram is included in this appendix.

Input data to the program is simple, the program being designed to carry out numerous repeat passes to generate the tabular data included in earlier appendices. In order to facilitate use, a set of example data is included in this appendix for a number of options.

It should be noted that all calculations are carried out in SI units. All input data are in SI units with the exception of flow rate; this is entered in litres/s and converted within the program to m^3/s.

HYJUMP   Schematic flow diagram.

Read output control IOUT
1 = summary tables only
0 = water surface profiles.

↓

Read channel shape control SHAPE
1 = rectangular, 2 = circular.

↓

B.

From C.

Read NN, NS, ICON
NN-determines size of Δh in Simpsons Rule
NS- No of steps necessary to complete water surface profile in Simpsons Rule.
ICON - calculation control,
= 0 Approach pipe surface profile calc.
= 1 Pipe entry energy as input data.
= 2 Terminal conditions assumed in approach pipe plus normal flow depth downstream jump in test pipe.

↓

Read B, RMØ, RM1, DEN
B = pipe diameter or channel width
RMØ = approach pipe Manning Coeff.
RM1 = test pipe Manning Coeff.
DEN = loss factor at test pipe entry, 0-1.0

↓

Write titles.

↓

Set pipe count IZ = 0

↓

A. Read PL, SØ, Q, HCONT, ENZ
PL - pipe length, SØ - pipe slope
Q - flow rate, HCONT - calc. control,
= 0, control depths set to flow
critical depth values; = 1, control depth
at pipe entry to be calculated.
ENZ - pipe entry energy, = 0 if ICON = 0 or 2.

From F, G, H.

E. Check PL, = 0 GOTO C, > 0 GOTO D

From E → D. Set pipe count IZ = IZ + 1
1 = approach pipe
2 = test pipe upstream jump
3 = " " downstream "

If IZ > 3, IZ set to 1.

Check ICON, IZ = 1

ICON = 0, 2.

ICON = 1
Calculate pipe entry depth
from entry energy ENZ
and flow rate Q.
Set pipe count to 2

Calculate normal and critical flow
depth h_n, h_c.

Determine control depth position,
from HCONT input.

F. Calculation abort checks,
$h_n > B$ for IZ = 2, full bore flow, GOTO A
$h_n > B$ for IZ = 3, " " " , GOTO A
$h_n < h_c$ for IZ = 2 and 3, no jump, GOTO A.

Calculate water surface profiles,
check ICON, IZ values.

ICON = 0, IZ = 1,2,3:
Calculate water surface profiles

ICON = 2, IZ = 1
Terminal conditions in approach pipe,
set depth = h_n, energy = $h_n + Q^2/2gA_n^2$

ICON = 2, IZ = 3
Normal flow depth downstream jump
Set depth = h_n, calculate $(F+M)_n$.

ICON = 1, IZ = 2, 3
Calculate water surface profiles.

(Note (F+M) values calculated with water surface profiles)

Jump location determination.

G. Abort check, if (F+M) IZ = 3, L = 0 > (F+M) IZ = 1, terminal value then write "jump drowned", GOTO A

Check ICON

ICON = 2
Employ (F+M) at normal depth for IZ = 3 as interpolation target on (F+M) profile IZ = 2

ICON < 2
Use full intersection (F+M) curve technique for IZ = 2, 3.

Write out results, format control
IOUT = 1 , summary tables only
= 0 , water surface profiles.

H. GOTO A.

From E

C. Read SHAPE = 0 run terminated
> 0 GOTO B

Example DATA program HYDJUMP

Case 1 Rectangular and circular channels, 2 approach pipe slopes. Note ▽ indicates space in format field.

Line 1 IOUT, Format I3
▽▽0 (full output)
Line 2 SHAPE, Format I3
▽▽1 (rectangular section)
Line 3 NN, NS, ICON, Format 3I4
▽▽30▽200▽▽▽0
Line 4 B, RMØ, RMI, DEN, Format 4F10.4
▽▽▽▽0.1500▽▽▽▽0.0150▽▽▽▽0.0150▽▽▽▽1.0000
Line 5 PL, SØ, Q, HCONT, ENZ, Format 5F10.4
(approach pipe data)
▽▽▽▽2.0000▽▽▽▽0.5000▽▽▽▽6.0000▽▽▽▽0.0000▽▽▽▽0.C
Line 6 PL, SØ, Q, HCONT, ENZ, Format 5F10.4
▽▽▽40.0000▽▽▽▽0.0025▽▽▽▽6.0000▽▽▽▽1.0000▽▽▽▽0.C
(test pipe, upstream jump)
Line 7 PL, SØ, Q, HCONT, ENZ Format 5F10.4
▽▽▽40.0000▽▽▽▽0.0025▽▽▽▽6.0000▽▽▽▽0.0000▽▽▽▽0.0C
(test pipe, downstream jump)

Line 8 Repeat Line 5, SØ = approach slope set ▽▽▽▽0.5
Line 9 Repeat Line 6
Line 10 Repeat Line 7

Line 11 PL, SØ, Q, HCONT, ENZ, Format 5F10.4
▽▽▽▽0.0000▽▽▽▽0.0000 . . . . .
(indicates end data section)

Line 12 SHAPE Format I3
▽▽2 (circular section)
Line 13 – 21 Repeat Line 3 – 11

Line 22 SHAPE Format I3
▽▽0 indicates end of data file.

Case 2 — Repeat case 1 but summary data only required.

Line 1 — IOUT, Format I3
▽▽1

Line 2-22 — as Case 1

Case 3. — Repeat case 1 but terminal conditions assumed in approach pipe, normal flow downstream jump in test pipe.

Line 1-2 — Repeat case 1

Line 3 — NN, NS, ICON, Format 3I4
▽▽30▽200▽▽▽2

Line 4-22 — Repeat case 1.

Case 4 — Manning coefficient 0.015 approach pipe but 0.009 in test pipe.

Line 1-3 — Repeat case 1

Line 4 — B, RMØ, RMI, DEN, format 4F10.4
▽▽▽▽0.1500▽▽▽▽0.0150▽▽▽▽0.0090▽▽▽▽1.000

Line 5-13 — Repeat case 1

Line 14 — Repeat Line 4 above.

Line 14-22 — Repeat case 1

```
C
C
C     PROGRAM HYDJUMP REFERS TO A PROGRAM DESIGNED TO
C     CALCULATE THE HYDRAULIC JUMP POSITION AFTER A CHANGE IN
C     SLOPE IN EITHER A RECTANGULAR OR CIRCULAR CROSS
C     SECTION PIPE.
      DIMENSION X(2,100),F(2,100),FP(2,2),IM(6)
      DIMENSION DP(2,2),EN(2,100),DEP(2,100),IP(2),HJ(2),EJ(2)
      DIMENSION QT(300),S1(300),HN1(300),S2(300),HC2(300)
      DIMENSION HN2(300),TEN1(300),EEN(300),HEN(300),HUP(300)
      DIMENSION HDN(300),EUP(300),EDN(300),CFPM(300)
      DIMENSION FFM(300),DJM(300),DEJ(300),XJUMP(300)
      INTEGER SHAPE
      COMMON/CM1/P,C,G,CON,SO,GAM,RHO,HCRIT,HNORM,AREA,PER,FPM,ENERG
      COMMON/CM2/SHAPE
      COMMON/CM3/IZ
      READ(4,702)IOUT
      READ(4,702)SHAPE
C     IOUT IS A OUTPUT FORMAT CONTROL CODE,=1 ONLY OUTPUT
C     IS A SUMMARY TABLE,=0 OUTPUT INCLUDES WATER SURFACE
C     PROFILES.
702   FORMAT(I3)
902   READ(4,120)NN,NS,ICON
      READ(4,121)B,RHO,R41,DEN
121   FORMAT(4F10.4)
      G=9.81
C
C
C
C
C
C
C
C
C
      IC=0
      ICOUNT=0
      IZ=0
300   CONTINUE
      IF(IZ.EQ.3) GOTO 9010
9011  CONTINUE
      IF(IZ.GT.1)IM(IZ)=IS
      IZ=IZ+1
      IF(IZ.EQ.1)WRITE(3,504)
504   FORMAT(1H1,/////)
      IF(IZ.EQ.1.AND.SHAPE.EQ.1)WRITE(3,505)
505   FORMAT(///////////,20X,'PREDICTION OF THE HYDRAULIC',
     1/,20X,'JUMP POSITION IN A RECTANGULAR',/20X,
     2'CROSS SECTION PIPE AT MILD SLOPE.',///////)
      IF(SHAPE.EQ.2.AND.IZ.EQ.1)WRITE(3,500)
500   FORMAT(20X,'PREDICTION OF THE HYDRAULIC',/,20X,
     1'JUMP POSITION IN A CIRCULAR',/,20X,
     2'CROSS SECTION PIPE AT MILD SLOPE.',/////)
      IF(IZ.GT.3)IZ=1
      IF(IZ.EQ.1)IC=IC+1
      READ(4,100)PL,SO,Q,HCONT,ENZ
C
C
C
C
C
```

```
C     IF ICON=2 THE ANALYSIS IS BASED ON THE ASSUMPTION OF
C     TERMINAL FLOW CONDITIONS AT THE DISCHARGE FROM THE
C     APPROACH PIPE.
C     ICON = 2 ALSO INTRODUCES THE CONSTRAINT THAT THE
C     TEST PIPE IS LONG ENOUGH FOR NORMAL FLOW DEPTH
C     TO BE ESTABLISHED DOWNSTREAM OF THE JUMP. NORMAL
C     DEPTH THEN BECOMES THE DOWNSTREAM CONJUGATE DEPTH
C     WHICH ALLOWS CALCULATION OF THE 'F+M' TERM WITHOUT
C     CALCULATING THE WATER SURFACE PROFILE DOWNSTREAM OF THE
C     JUMP.
C     IF ICON=1 THE FLOW ANALYSIS IS BASED ON AN INPUT ENERGY AT
C     ENTRY TO THE MILD SLOPE PIPE, TERM ENZ. SIMILARLY THE LOSS
C     COEFFICIENT AT PIPE ENTRY MAY BE EXPRESSED AS A FACTOR,DEN,
C     VALUE 0 TO 1.0, TO BE MULTIPLIED BY THE ENZ TERM.
C     AS THE ENTRY FLOW DEPTH IS TO BE CALCULATED FROM ENZ*DEN
C     AND NOT BASED ON FLOW CRITICAL DEPTH, THE CONTROL TERM
C     HCONT IS SET TO 1.0. THE OTHER PARAMETERS REFER TO PIPE FLOW
C     RATE AND DIMENSIONS.
100   FORMAT(5F10.4)
      IF(PL.EQ.0.0)GOTO 901
C     PL-PIPE LENGTH, B-WIDTH, RM-MANNING COEFF, SO-SLOPE,
C     Q-FLOWRATE IN L/S TO BE USED IN M**3/S, HCONT-CONTROL DEPTH
C     SET TO ZERO IF CRITICAL DEPTH ASSUMED.
      Q=Q/1000.0
      RHO=1000.0
      IF(IZ.EQ.1) RM=RMO
      IF(IZ.GT.1) RM=RM1
      CON=RM**2/SO
      GAM=G*RHO
C
C
C
      QT(IC)=Q*1000.0
      IF(IZ.EQ.1)S1(IC)=SO
      IF(IZ.EQ.2)S2(IC)=SO
C     PROGRAM CONTROL DATA.
120   FORMAT(3I4)
C     NN-SIZE OF THE DH STEP IN SIMPSONS RULE,NS-NO.
C     STEPS IN DEPTH CALC.,ICON DETERMINES WHETHER ENERGY
C     INPUT OR UPSTREAM SLOPE IS USED, DEN IS THE ENERGY
C     LOSS FACTOR FOR THE PIPE ENTRY,IN EITHER ENTRY CASE.
C     ENZ-INPUT ENERGY TO REPLACE SLOPE IF ICON = 1.
      IF (ICON.EQ.1) GOTO 650
      GOTO 651
650   ENZ=DEN*ENZ
      CALL BOUND(ENZ,Q,B,HB)
      IZ=2
      HCONT=HB
      GOTO 18
651   CONTINUE
      IF(HCONT.EQ.1.0) GOTO 17


      GOTO 18
17    ENGD=DEN*ENGD
      CALL BOUND(ENGD,Q,B,HB)
      HCONT=HB
18    CONTINUE
C
```

```
C
C
C
C
C
CC
C      DETERMINATION OF CRITICAL AND NORMAL DEPTHS.
C      THIS SECTION CALCULATES THE NORMAL AND CRITICAL DEPTH IN
C      EACH PIPE LENGTH FOR LATER COMPARISON TO THE CONTROL DEPTH
C      INPUT.
C      CALCULATION OF CRITICAL DEPTH.
       UP=B
       DN=0.0
       HC=UP/2.0
7      CONTINUE
       CALL CALC(HC,DL)
       IF(HCRIT)3,4,5
3      DN=HC
       GOTO 6
5      UP=HC
6      HCN=(UP+DN)/2.0
       IF(ABS((HCN-HC)/HC).LE.0.001) GOTO 8
       HC=HCN
       GOTO 7
8      HC=HCN
4      IF(HCONT.EQ.0.0)HCONT=HC
C      CALCULATION OF NORMAL DEPTH.
       UP=B
       DN=0.0
       HN=UP/2.0
9      CONTINUE
       CALL CALC(HN,DL)
C
C
C
C
C
C
C
C
C
C
       IF(HNORM) 10,11,12
10     DN=HN
       GOTO 13
12     UP=HN
13     HNN=(UP+DN)/2.0
       IF(ABS((HNN-HN)/HN).LE.0.001) GOTO 14
       HN=HNN
       GOTO 9
14     HN=HNN
11     CONTINUE
       IF(IOUT.EQ.1) GOTO 31)
       WRITE(3,200)PL,B,KM,S,Q,HCONT
```

```
200   FORMAT(////20X,'PIPE LENGTH =',F10.4,' M.',5X,
     1'PIPE WIDTH OR DIAMETER =',F10.4,' M.',/,20X,'MANNING COEFF. =',
     2F10.4,5X,'PIPE SLOPE =',F10.4,/,20X,'FLOWRATE =',
     3F10.4,' M**3/S.',3X,'CONTROL DEPTH =',F10.4,' M.',//)
      WRITE(3,201)HN,HC
201   FORMAT(20X,'NORMAL DEPTH =',F10.4,' M.',4X,'CRITICAL DEPTH =',
     1F10.4,' M.',//)
C     FORMATION OF A HYDRAULIC JUMP REQUIRES THAT DEPTH
C     CHANGES FROM BELOW CRITICAL TO ABOVE CRITICAL, HENCE
C     IF NORMAL DEPTH IS LESS THAN CRITICAL NO JUMPFORMS.
      IF(IZ.GT.1.AND.HN.LE.HC)WRITE(3,209)
209   FORMAT(/,20X,'JUMP FORMATION IMPOSSIBLE AS HN<HC.',/)
310   CONTINUE
C
C
C
C
C
C
C
C
C
C
C
      IF(IZ.EQ.1)HN1(IC)=HN
      IF(IZ.GT.1)HN2(IC)=HN
      IF(IZ.GT.1)HC2(IC)=HC
      IF(IZ.GT.1.AND.HN.LE.HC)GOTO 800
C     FULL BORE FLOW IS NOT DEALT WITH BY THIS PROGRAM.
C     IF THE VALUE OF HN > PIPE DIAMETER SOLUTION IS
C     TERMINATED.
      IF(IZ.EQ.3.AND.ICON.EQ.2) GOTO 946
      GOTO 947
C     IF THE TEST PIPE IS LONG THEN A CONSIDERABLE SIMPLIFICATION IS
C     POSSIBLE AS THE FLOW DEPTH MAY BE ASSUMED TO BE 'NORMAL'
C     DEPTH AND THE (F+M) VALUE AT THE JUMP IS FIXED.
946   CALL CALC(HN,DL)
      FX=FPM
      EX2=ENERG
      HX2=HN
      HLIM=B*0.99
      IF(HN.GE.HLIM) HN2(IC)=B
      IF(HN.GE.HLIM) GOTO 800
      DO 949 J6=1,IS-1
C      IF THE F+M TERM AT ENTRY IS LESS THAN THE F+M VALUE
C      FOR THE NORMAL FLOW DEPTH THIS INDICATES THAT THE
C      JUMP HAS MOVED TO L=0 AS A DROWNED JUMP.
      FEN(IC)=F(1,1)
      IF(FX.GT.F(1,1)) GOTO 330
      IF(F(1,J6).GE.FX.AND.F(1,J6+1).LE.FX) GOTO 948
949   CONTINUE
C
C
C
C
C
```

```
      HX1=DEP(1,J6)+R*(DEP(1,J6+1)-DEP(1,J6))
      EX1=EN(1,J6)+R*(EN(1,J6+1)-EN(1,J6))
      CHH=HN-HX1
      CHE=EX2-EX1
      IF(IOUT.EQ.1) GOTO 311
      WRITE(3,952)
952   FORMAT(/20X,'TEST PIPE ASSUMED LONG,NORMAL FLOW DEPTH ',
     1'ESTABLISHED DOWNSTREAM OF THE JUMP.',/)
      WRITE(3,107)XX,HX1,HX2,EX1,EX2,FX,CHH,CHE
      GOTO 800
311   CONTINUE
      HUP(IC)=HX1
      HDN(IC)=HN
      EUP(IC)=EX1
      EDN(IC)=EX2
      DJH(IC)=CHH
      DEJ(IC)=CHE
      CFPM(IC)=FX
      XJUMP(IC)=XX
      GOTO 800
330   IF(IOUT.EQ.0) WRITE(3,332)
332   FORMAT(/20X,'JUMP DROWNED AT L=0',/)
      FEN(IC)=F(1,1)
      CFPM(IC)=FX
      GOTO 800
C
C
C
C
C
C
C
C
C
C
947   CONTINUE
C     THE APPROACH PIPE LENGTH MAY BE IGNORED IF TERMINAL
C     CONDITIONS ARE ASSUMED. THIS SECTION USES THIS OPTION
C     BY CHECKING ON THE PIPE NUMBER ,IZ, AND THE VALUE OF
C     ICON WHICH IS SET TO 2
      IF(IZ.EQ.1.AND.ICON.EQ.2) GOTO 943
      GOTO 945
943   H=HN
      CALL CALC(H,DL)
      ENGD=ENERG
      IF(IOUT.EQ.1)GOTO 312
      WRITE(3,944)H,ENGD
944   FORMAT(/20X,'TERMINAL VELOCITY CONDITIONS IN APPROACH PIPE.',
     1/20X,'DEPTH = ',F10.4,' M.',5X,'ENERGY = ',F10.4,' M.',/)
      GOTO 800
312   CONTINUE
      TEN1(IC)=ENGD
      GOTO 800
945   CONTINUE
      HLIM=0.99*B
      IF(IOUT.EQ.1) GOTO 313
      IF(IZ.GT.1.AND.HN.GE.HLIM)WRITE(3,790)
313   IF(HN.GE.HLIM) HN2(IC)=B
      IF(IZ.GT.1.AND.HN.GE.HLIM)GOTO 800
C
```

```
C
C
C
C
C
C     THIS SECTION PREPARES FOR THE PROFILE CALCULATIONS
C     BY SORTING FLOWS BASED ON PIPE SLOPE AND THE NORMAL AND
C     CRITICAL DEPTH VALUES.
      IF(HN.LT.HC) GOTO 50
C     MILD SLOPE.
      IF(HCONT.LT.HC) GOTO 45
C     SUBCRITICAL FLOW, HCONT GT. HC.
      SIGN=-1.0
      DH=(HCONT-HN)*0.998/FLOAT(NN)
      IF(IOUT.EQ.0) WRITE(3,202)HCONT
202   FORMAT(20X,'CONTROL IS DOWNSTREAM, DEPTH =',F10.4,' M.')
      GOTO 60
C     SUPERCRITICAL FLOW, HCONT LT. HC.
45    SIGN=1.0
      DH=(HC-HCONT)/FLOAT(NN)
      IF(IOUT.EQ.0) WRITE(3,203)HCONT
203   FORMAT(20X,'CONTROL IS UPSTREAM, DEPTH =',F10.4,' M.')
      GOTO 60
C     STEEP SLOPE, HN LT HC.
50    IF(HCONT.LE.HC) GOTO 55
C     SUBCRITICAL FLOW, HCONT GT HC.
      SIGN=-1.0
      DH=(HCONT-HC)/FLOAT(NN)
      IF(IOUT.EQ.0) WRITE(3,202)HCONT
      GOTO 60
C
C
C
C
C
C
C
C
C
C
C
C     SUPERCRITICAL FLOW, HCONT LT HC.
55    SIGN=1.0
      N2=NN*2
      DH=(HN-HCONT)*0.998/FLOAT(N2)
      IF(IOUT.EQ.0) WRITE(3,203)HCONT
60    SL=0.0
      IS=1
      H=HCONT
      CALL CALC(H,CL)
      E=ENERG
      FM=FPM
      IF(IZ.GT.1)F(IZ-1,IS)=FM
      IF(IZ.EQ.2)X(1,IS)=0.0
      IF(IZ.EQ.3)X(2,IS)=PL
      IF(IZ.GT.1)DEP(IZ-1,IS)=H
      IF(IZ.GT.1)EN(IZ-1,IS)=E
```

```
      IF(IOUT.EQ.1) GOTO 314
      WRITE(3,204)
204   FORMAT(////,19X,' DISTANCE ','   DEPTH   ','   ENERGY  ','  F+M')
      WRITE(3,205)SL,H,E,FM
205   FORMAT(18X,4F10.4)
314   IF(IZ.EQ.2)HEN(IC)=H
      IF(IZ.EQ.2)EEN(IC)=E
C
C
C
C
C
C
C
C
C
C
C
C
C     WATER SURFACE PROFILE CALCULATIONS USING SIMPSONS RULE
C     TO EVALUATE THE INTEGRAL.
      DO 80 I=1,NS,2
      SLO=SL
      IS=IS+1
      H2=HCONT+SIGN*DH*FLOAT(I+1)
      H3=HCONT+SIGN*FLOAT(I)*DH
      CALL CALC(H,DL)
      CALL CALC(H2,DL2)
      CALL CALC(H3,DL3)
      DX=DH*(DL+DL2+4.0*DL3)/3.0
      SL=SL+DX
      IF(SL.GE.PL)GOTO 82
      H=H2
      CALL CALC(H,DL)
      E=ENERG
      FM=FPM
904   CONTINUE
      IF(IZ.EQ.1.AND.H.LE.HN)GOTO 911
      GOTO 912
911   SL=PL
      H=HN
      CALL CALC(H,DL)
      E=ENERG
      FM=FPM
912   CONTINUE
      IF(IZ.EQ.3.AND.H.GE.3) GOTO 811
      HHX=ABS((H-HN)/HN)
      IF(IZ.EQ.3.AND.HHX.LE.0.001)SL=PL
811   CONTINUE
C
C
C
C
C
C
C
C
C
C
```

```
      IF(IZ.GT.1)F(IZ-1,IS)=FM
      IF(IZ.EQ.2)X(1,IS)=SL



      IF(IZ.EQ.3)X(2,IS)=PL-SL
      IF(IZ.GT.1)DEP(IZ-1,IS)=H
      IF(IZ.GT.1)EN(IZ-1,IS)=E
      IF(IZ.EQ.2.AND.H.GT.HC) GOTO 800
      IF(IZ.EQ.3.AND.H.GE.B) GOTO 806
      IF(IOUT.EQ.1) GOTO 315
      WRITE(3,205)SL,H,E,FM
315   CONTINUE
      IF(IZ.EQ.1.AND.SL.GE.PL) GOTO 801
      IF(IZ.EQ.1.AND.SL.LE.SLO) GOTO 801
      IF(IZ.EQ.3.AND.SL.GE.PL) GOTO 900
30    CONTINUE
801   ENGD=E
      IF(IZ.EQ.3) GOTO 900
      GOTO 800
32    H=H2-SIGN*2.0*DH*(SL-PL)/DX
      CALL CALC(H,LL)
      E=ENERG
      FM=FPM
      ENGD=E
      SL=PL
      GOTO 904
906   CONTINUE
C
C
CC
C
C     THIS SECTION DEALS WITH THE POSSIBILITY OF FULL BORE FLOW
C     BECOMING ESTABLISHED IN THE PIPE DOWNSTREAM OF THE JUMP
C     LOCATION. THE POSITION OF THE HYDRAULIC JUMP IS
C     DETERMINED BY EQUIVALENCE OF THE F+M TERM BETWEEN THE
C     FULL BORE FLOW AND THE UPSTREAM SUPERCRITICAL FLOW.
      IF(SHAPE.EQ.1) AREA=B**2
      IF(SHAPE.EQ.2) AREA=(3.142*B**2)/4.0
      IF(IOUT.EQ.1) GOTO 316
      WRITE(3,790)
790   FORMAT(/,20X,'FULL BORE FLOW ESTABLISHED.'/)
316    CONTINUE
      EN(2,IS)=B+(Q**2)/(2.0*G*AREA**2)
      F(2,IS)=RHO*Q*Q/AREA+GAM*AREA*B/2.0
      IF(IOUT.EQ.1) GOTO 317
      WRITE(3,205)SL,B,EN(2,IS),F(2,IS)
317    CONTINUE
      XL=PL-SL
      IS=IS+1
      DEP(2,IS)=B
      X(2,IS)=0.0
      SL=PL
      EN(2,IS)=EN(2,IS-1)
      F(2,IS)=RHO*Q*Q/AREA+GAM*AREA*(B/2.0)
      IF(IOUT.EQ.1) GOTO 3171
      WRITE(3,205)SL,B,EN(2,IS),F(2,IS)
3171  CONTINUE
      GOTO 900
900   CONTINUE
C
```

```
C
C
C
C     IDENTIFICATION OF JUMP POSITION BY EQUIVALENCE
C     OF THE F+M TERM.
      IF(F(1,1).LT.F(2,IS).AND.IOUT.EQ.0)WRITE(3,385)
385   FORMAT(/20X,'JUMP DROWNED AT L=0 AT TEST PIPE ENTRY',/)
      IF(F(1,1).LT.F(2,IS)) GOTO 800
      XP=0.0
      DELX=PL/500.0
103   XP=XP+DELX
      DO 102 I=1,100
      J=2
      IF(X(J,I+1).LE.XP.AND.X(J,I).GE.XP) GOTO 108
      IF(X(J,I+1).EQ.0.0) GOTO 103
102   CONTINUE
108   CALL INTER(X(J,I+1),F(J,I+1),X(J,I),F(J,I),XP,FX)
      J=1
      DO 104 K=1,100
      IF(K.GT.IM(2)) GOTO103
      IF(X(J,K).LE.XP.AND.X(J,K+1).GT.XP)GOTO 109
      GOTO 104
109   CONTINUE
      IF(F(J,K).GE.FX.AND.F(J,K+1).LE.FX)GOTO 110
104   CONTINUE
C
C
C
C
C
C
C
CC
110   CONTINUE
      FP(1,1)=F(1,K)
      FP(1,2)=F(1,K+1)
      DP(1,1)=X(1,K)
      DP(1,2)=X(1,K+1)
      FP(2,1)=F(2,I+1)
      FP(2,2)=F(2,I)
      DP(2,1)=X(2,I+1)
      DP(2,2)=X(2,I)
      IP(1)=K
      IP(2)=I
      CALL SOLVE(DP(1,1),FP(1,1),DP(1,2),FP(1,2),DP(2,1),FP(2,1),
     1DP(2,2),FP(2,2),XJ,FJ)
C     CALCULATION OF DEPTH AND ENERGY CHANGES AT THE JUMP.
      DO 49 K=1,2
      CALL INTER(X(K,IP(K)),DEP(K,IP(K)),X(K,IP(K)+1),
     1DEP(K,IP(K)+1),XJ,HJ(K))
      CALL INTER(X(K,IP(K)),EN(K,IP(K)),X(K,IP(K)+1),
     1EN(K,IP(K)+1),XJ,EJ(K))
49    CONTINUE
C
C
C
C
```

```
      CHH=HJ(2)-HJ(1)
      CHE=EJ(2)-EJ(1)
      IF(IOUT.EQ.1) GOTO 318
      WRITE(3,107)XJ,HJ(1),HJ(2),EJ(1),EJ(2),FX,CHH,CHE
107   FORMAT(////,20X,'JUMP POSITION          =',F10.4,
     1' M FROM PIPE ENTRY.',
     1/,20X,'CONJUGATE DEPTHS      =  ',F8.4,' M UPSTREAM AND ',
     1F6.4,'M DOWNSTREAM.',/,20X,
     1'KINETIC ENERGY VALUE =  ',F8.4,'M UPSTREAM AND ',F8.4,
     1' M DOWNSTREAM.',/,20X,
     1'HYDROSTATIC+MOMENTUM = ',F9.4,' N.',/,
     1/,20X,'DEPTH CHANGE AT JUMP = ',E14.5,' M.',
     2/,20X,'ENERGY LOSS AT JUMP  = ',E14.5,' M.')
318   CONTINUE
      HUP(IC)=HJ(1)
      HDN(IC)=HJ(2)
      EUP(IC)=EJ(1)
      EDN(IC)=EJ(2)
      DJH(IC)=CHH
      DEJ(IC)=CHE
      CFPM(IC)=FX
      XJUMP(IC)=XJ
      IZ=0
      GOTO 400
C
C
C
C
C
C
C
C
C
C
C
C
9010   CONTINUE
      IF(IOUT.EQ.0) GOTO 320
C     THIS OUTPUT SECTION IS ONLY USED IF IOUT=1,TABULAR
C     OUTPUT ONLY
      IF(ICON.EQ.2.AND.ICOUNT.EQ.0) WRITE(3,325)
325   FORMAT('1 PROGRAM RESULTS BASED ON TERMINAL CONDITIONS',
     1' IN THE APPROACH PIPE AND NORMAL FLOW DEPTH DOWNSTREAM',
     2' OF THE JUMP IN THE TEST PIPE.',//)
      IF(ICON.EQ.2.AND.ICOUNT.EQ.0)WRITE(3,321)
      I=IC
      IF(ICOUNT.EQ.20.AND.ICON.EQ.2)WRITE(3,325)
      IF(ICOUNT.EQ.20)WRITE(3,321)
      IF(ICOUNT.EQ.20)ICOUNT=0
      ICOUNT=ICOUNT+1
      IF(HN2(I).LT.HC2(I)) GOTO 370
      IF(HN2(I).EQ.B) GOTO 371
      IF(FEN(I).LE.CFPM(I)) GOTO 372
      WRITE(3,323)QT(I),B,RM,S1(I),HN1(I),TEN1(I),S2(I),HC2(I),
     1HN2(I),HEN(I),EEN(I),FEN(I),HUP(I),HDN(I),DJH(I),EUP(I),EDN(I),
     2DEJ(I),CFPM(I),XJUMP(I)
      GOTO 322
370   WRITE(3,380)QT(I),B,RM,S1(I),HN1(I),TEN1(I),S2(I),HC2(I),HN2(I)
```

```
      GOTO 322
371   WRITE(3,381)CT(I),B,RM,S1(I),HN1(I),TEN1(I),S2(I),HC2(I),HN2(I)
      GOTO 322
372   WRITE(3,382)CT(I),B,RM,S1(I),HN1(I),TEN1(I),S2(I),HC2(I),HN2(I)
      GOTO 322
322   CONTINUE
C
323   FORMAT(/5X,F4.1,F5.2,F6.3,F7.4,2F6.3,F7.4,3F6.3,F6.2,3F6.3,
     14F7.3,2F6.3)
380   FORMAT(/5X,F4.1,F5.2,F6.3,F7.4,2F6.3,F7.4,2F6.3,15X,
     1' JUMP IMPOSSIBLE AS HN<HC IN TEST PIPE.')
381   FORMAT(/5X,F4.1,F5.2,F6.3,F7.4,2F6.3,F7.4,2F6.3,15X,
     1' FULL BORE FLOW ESTABLISHED IN TEST PIPE.')
382   FORMAT(/5X,F4.1,F5.2,F6.3,F7.4,2F6.3,F7.4,2F6.3,15X,
     1' JUMP DROWNED AT L=0 AT TEST PIPE ENTRY.')
321   FORMAT(///5X,'  COMMON DATA  ','APPROACH PIPE DATA ',
     125X,'TEST PIPE DATA AND PROGRAM RESULTS.',//,
     25X,' Q. DIA. MANN. SLOPE   HN  TERM.  SLOPE   HC    HN  ',
     3'ENTRY ENTRY ENTRY UPJUMP DOWN  DEPTH  ENERGY ENERGY ENERGY',
     4' JUMP  JUMP ',/,5X,'L/S  M.   COEFF (SIN)   M.  ENERGY',
     5' (SIN)   M.    M.  DEPTH ENERGY F+M  DEPTH  DEPTH CHANGE ',
     6'UPJUMP DOWN   CHANGE F+M.  POS. ',/,5X,
     728X,'  M.  ',19X,'  M.    M.    M.    M.    M.    M.  ',
     8'   M.    M.      M.    M.     M.',/)
320   CONTINUE
      GOTO 9011
901   CONTINUE
      READ(4,702)SHAPE
      IF(SHAPE.GT.0) GOTO 902
      END
C
C
C
      SUBROUTINE INTER(A,B,C,D,X,Y)
C     SUBROUTINE INTER SIMPLY INTERPOLATES LINEARLY BETWEEN
C     TWO SETS OF DATA POINTS AND IS USED TO CALCULATE
C     JUMP DEPTH AND ENERGY CHANGES AS WELL AS POSITION.
      Y=B+(X-A)*(D-B)/(C-A)
      RETURN
      END
C
C
C
      SUBROUTINE SOLVE(X1,Y1,X2,Y2,X3,Y3,X4,Y4,X5,Y5)


C     SUBROUTINE SOLVE DETERMINES THE INTERSECTION POINT OF
C     TWO STRAIGHT LINES DRAWN BETWEEN FPM-X COORDINATES
C     IDENTIFIED AS LYING ON EITHER SIDE OF THE JUMP POSITION.
      A=(Y1-Y2)/(X1-X2)
      B=Y1-X1*A
      C=(Y3-Y4)/(X3-X4)
      D=Y3-X3*C
      X5=(D-B)/(A-C)
      Y5=A*X5+B
      RETURN
      END
C
C
C
C
```

```
C
C
      SUBROUTINE BOUND(E,Q,B,HB)
      INTEGER SHAPE
      COMMON/CP2/SHAPE
C     SUBROUTINE BOUND CALCULATES THE ENTRY CONDITION TO THE
C     MILD SLOPE PIPE (IZ=2) BY REFERENCE TO THE ENERGY AT
C     DISCHARGE FROM THE STEEP SLOPE PIPE (IZ=1), OR SIMPLY
C     FROM THE ENERGY INPUT DATA IF THAT MODE IS CHOOSEN
C     BY THE INPUT OF ICON = 1 IN THE INITIAL READ STATEMENTS.
C     PIPE CROSS SECTION IS CONTROLLED BY THE VALUE OF
C     TERM SHAPE, 1=RECTANGULAR OR 2=CIRCULAR, IN THE INPUT.
      G=9.81
      IF(SHAPE.GT.1) GOTO 2
      Y1=0.0
      HB=Q/(B*(2.0*G*E)**0.5)
      DH=HB/200.0
      HX=HB/2.0
      DO 75 I=1,100
      IF(I.GT.1) Y1=Y
      HX=HX+DH
      Y=(Q**2)/(2.0*G)+((B*HX)**2)*(HX-E)
      IF(I.EQ.1)GOTO 75
      IF(Y1.GE.0.0.AND.Y.LE.0.0) GOTO 76
      IF(Y1.LE.0.0.AND.Y.GE.0.0) GOTO 76
75    CONTINUE
76    HB=HX
      GOTO 1
2     CONTINUE
      H=0.0
      EC1=0.0
      DELH=B/200.0
      PI=3.142
      R=B/2.0
3     H=H+DELH
      IF(H.LT.R) THETA=2.0*ATAN(SQRT(H*(B-H))/(R-H))
      IF(H.EQ.R) THETA=PI
      IF(H.GT.R) THETA=PI+2.0*ATAN((H-R)/(SQRT(H*(B-H))))
      AREA=((B**2)/8.0)*(THETA-SIN(THETA))
      EC2=H+(Q**2)/((AREA**2)*2.0*G)
      IF(EC2.LE.E.AND.EC1.GE.E) GOTO 4
      EC1=EC2
      GOTO 3
4     HB=H


1     CONTINUE
      RETURN
      END
C
C
C
C
C
C
C
C
C
```

```
C
C
C
      SUBROUTINE CALC(H,DL)
C     SUBROUTINE CALC IS USED THROUGHOUT THE PROGRAM TO
C     DETERMINE THE FLOW-PIPE PARAMETERS SUCH AS FLOW
C     DEPTH,AREA,WETTED PERIMETER AS WELL AS BEING USED
C     IN THE BISECTION METHOD CALCULATION OF NORMAL AND
C     CRITICAL DEPTHS IN EACH OF THE PIPE LENGTHS.
C     IN THE CIRCULAR PIPE CROSS SECTION CASE IT ALSO
C     CALCULATES SUBTENDED ANGLE AND THE WATER SURFACE
C     WIDTH AS DEPTH CHANGES.
C     AS IN BOUND AND MAIN PROGRAM THE PIPE SHAPE IS DETERMINED
C     BY THE VALUE OF THE TERM SHAPE INPUT AS DATA.
      INTEGER SHAPE
      COMMON/CM1/B,Q,G,CON,SO,GAM,RHO,HCRIT,HNORM,AREA,PER,FPM,ENERG
      COMMON/CM2/SHAPE
      COMMON/CM3/IZ
      IF(SHAPE.GT.1)GOTO 1
      IF(IZ.EQ.3.AND.H.GE.B)H=B
      AREA=H*B
      PER=B+2.0*H
      HCRIT=1.0-(Q**2)*B/(G*AREA**3)
      HNORM=1.0-(Q**2)*CON/((AREA**3.333)/(PER**1.333))
      DL=HCRIT/(HNORM*SO)
      FPM=(GAM*AREA*H/2.0)+(RHO*Q*Q/AREA)
      ENERG=H+(Q**2)/((AREA**2)*2.0*G)
      GOTO 2
1     R=B*0.5
      PI=3.142
      IF(IZ.EQ.3.AND.H.GE.B) GOTO 20
      IF(H.LT.R) THETA=2.0*ATAN(SQRT(H*(B-H))/(B/2.0-H))
      IF(H.EQ.R) THETA=PI
      IF(H.GT.R) THETA=PI+2.0*ATAN((H-B/2.0)/(SQRT(H*(B-H))))
      GOTO 22
20    H=B
      THETA=2.0*PI
      AREA=PI*(B/2.0)**2
C
      PER=PI*B
      XO=B/2.0



      GOTO 21
22    CONTINUE
      AREA=((B**2)/8.0)*(THETA-SIN(THETA))
      PER=B*THETA/2.0
      T=2.0*((H*(B-H))**0.5)
      HCRIT=1.0-(Q**2.0)*T/(G*AREA**3)
      HNORM=1.0-(Q**2.0)*CON/((AREA**3.333)/(PER**1.333))
      DL=HCRIT/(HNORM*SO)
      XO=(2.0/3.0)*(B/2.0)*(3.0*SIN(THETA/2.0)-SIN(3.0*THETA/2.0))
     1/(4.0*(THETA/2.0-0.5*SIN(THETA)))
21    HBAR=XO+H-B/2.0
      FPM=GAM*AREA*HBAR+RHO*Q*Q/AREA
      ENERG=H+(Q**2)/((AREA**2)*2.0*G)
2     CONTINUE
      RETURN
      END
$BEND
```

APPENDIX 12

PROGRAM HYDSUM

PROGRAM HYDSUM

A full printout of program HYDSUM is included in this appendix. The program was written in Fortran for use on the NBS CBT Perkin Elmer 732 computer. No special facilities are required, single precision sufficient.

The program is designed to calculate the critical and normal flow depths based on pipe slope, cross sectional size and shape, flow rate and Manning coefficient. No flow chart is included as the program is directly copied from the early sections of HYDJUMP.

The output is in tabular form and presents critical and normal depths as functions of pipe slope and flow rate for set values of Manning coefficients. In addition (F & M) values based on normal flow depths are calculated and tabulated as functions of pipe slope and flow rate.

Sample data are included in this appendix.

All calculations are carried out in SI units and all data are input in these units with the exception of flow rate which is input in litres/s and converted in the program to m^3/s.

Sample DATA Program HYDSUM

Case 1 Tabulation of h_n, h_c, (F+M) for a range of 8 flow rates for circular and rectangular channels.

Line 1 SHAPE 1 = rectangular
2 = circular

Format I3
∇∇2

Line 2 T (diameter or width), RM(Manning coefficient), QMIN(lowest flow rate), DQ(flow increment) NI(N° of test pipe slopes), N2(N° of approach pipe slopes).

Format 4F10.4, 2I3
∇∇∇∇0.1500∇∇∇∇0.0150∇∇∇∇1.0000∇∇∇∇1.0000∇∇2∇∇3

Line 3 S1 test pipe slope, Format F10.4.
∇∇∇∇0.0025

Line 4 S1 test pipe slope, Format F10.4
∇∇∇∇0.0050

Line 5 S2 approach pipe slope, Format F10.4
∇∇∇∇0.5000

Line 6 S2 approach pipe slope, Format F10.4
∇∇∇∇0.7070

Line 7 S2 approach pipe slope, Format F10.4
∇∇∇∇0.8660

Line 8 SHAPE Format I3
∇∇1

Line 9 B, RM, QMIN, DQ, N1, N2
Repeat Line 2

Line 10 SHAPE
∇∇0 - indicates end of file.

```
$BATCH
C     HYDSUM CALCULATES VALUES OF HC AND HN TO DETERMINE
C     WHETHER JUMP FOMATION IS POSSIBLE, ALSO VALUES OF
C     F+M ARE CALCULATED TO INDICATE WHETHER THE JUMP IS
C     DROWNED ET PIPE ENTRY.
      DIMENSION QT(10),SLOPE(100),HNP(100,10),HCP(10),F(100,10)
      INTEGER SHAPE
      COMMON/CM1/B,Q,G,CON,SO,GAM,RHO,HCRIT,HNORM,AREA,PER,FPM,ENERG
      COMMON/CM2/SHAPE
      READ(4,702)SHAPE
702   FORMAT(I3)
      READ(4,600)B,RM,QMIN,DQ,N1,N2
600   FORMAT(4F10.4,2I3)
      QT(1)=QMIN
      DO 601 K=2,8
      QT(K)=QT(K-1)+DQ
601   CONTINUE
      I=0
      DO 602 J=1,N1
      I=I+1
      READ(4,603)S1
603   FORMAT(F10.4)
      SLOPE(I)=S1
602   CONTINUE
      DO 604 J=1,N2
      I=I+1
      READ(4,603)S2
      SLOPE(I)=S2
604   CONTINUE
      N3=N1+N2
      N4=N1
622   CONTINUE
      DO 605 I=1,N3
      DO 606 K=1,8
      Q=QT(K)/1000.0
      G=9.81
      RHO=1000.0
      GAM=G*RHO
      SO=SLOPE(I)
      CON=(RM**2)/SO
C     DETERMINATION OF CRITICAL AND NORMAL DEPTHS.
C     CALCULATION OF CRITICAL DEPTH.
      UP=B
      DN=0.0
      HC=UP/2.0
7     CONTINUE
      CALL CALC(HC,DL)
      IF(HCRIT)3,4,5
3     DN=HC
      GOTO 6
5     UP=HC
6     HCN=(UP+DN)/2.0
      IF(ABS((HCN-HC)/HC).LE.0.001) GOTO 8
      HC=HCN
      GOTO 7
8     HC=HCN
4     IF(HCONT.EQ.0.0)HCONT=HC
C     CALCULATION OF NORMAL DEPTH.
      UP=B
      DN=0.0
      HN=UP/2.0
9     CONTINUE
```

```
      IF(HNORM) 10,11,12
10    DN=HN
      GOTO 13
12    UP=HN
13    HNN=(UP+DN)/2.0
      IF(ABS((HNN-HN)/HN).LE.0.001) GOTO 14
      HN=HNN
      GOTO 9
14    HN=HNN
11    CONTINUE
      IF(HN.GE.B) HN=B
      CALL CALC(HN,DL)
      HNP(I,K)=HN
      HCP(K)=HC
      F(I,K)=FPM
606   CONTINUE
605   CONTINUE
      IF(SHAPE.EQ.1) WRITE(3,607)B,RM
      IF(SHAPE.EQ.2) WRITE(3,608)B,RM
607   FORMAT(1H1,1X,//,5X,'TABULATED NORMAL FLOW DEPTHS',
     1' FOR A RECTANGULAR CHANNEL OF WIDTH ',F10.4,' M. ',
     2'AND MANNING COEFF.',F10.4,/)
608   FORMAT(1H1,1X,//////,'      TABULATED NORMAL FLOW DEPTHS FOR A ',
     1'CIRCULAR CROSS SECTION CHANNEL OF DIAMETER ',F10.4,
     2' M. AND MANNING COEFF. ',F10.4,/)
      WRITE(3,609)(GT(K),K=1,8)
609   FORMAT(//,5X,'FLOW RATE = ',8F10.4,' L/S.',5X,
     1'PIPE DIA. OR',/,107X,'WIDTH M.')
      WRITE(3,619)
619   FORMAT(/50X,'NORMAL DEPTH M.')
      WRITE(3,610)SLOPE(1),(HNP(1,K),K=1,8),B
610   FORMAT(5X,'PIPE SLOPE',2X,/,7X,'(SIN)',/,5X,
     1F10.4,2X,8F10.4,10X,F10.4)
      DO 611 I=2,N1
      WRITE(3,612)SLOPE(I),(HNP(I,K),K=1,8),B
612   FORMAT(5X,F10.4,2X,8F10.4,10X,F10.4)
611   CONTINUE
      I=N4
      WRITE(3,613)
613   FORMAT(//,56X,'******',//)
      N5=N4+1
      DO 614 I=N5,N3
      WRITE(3,612)SLOPE(I),(HNP(I,K),K=1,8),B
614   CONTINUE
      WRITE(3,615)(HCP(K),K=1,8)
615   FORMAT(//,5X,'CRITICAL',4X,8F10.4,/,5X,'DEPTH M.',/)
      IF(SHAPE.EQ.1)WRITE(3,616)B,RM
      IF(SHAPE.EQ.2)WRITE(3,617)B,RM
616   FORMAT(1H1,1X,//////5X,'TABULATED VALUES OF F*M AT NORMAL ',
     1'DEPTHS IN A RECTANGULAR CHANNEL OF WIDTH ',F10.4,
     2' M. AND MANNING COEFF. ',F10.4,/)
617   FORMAT(1H1,1X,//////5X,'TABULATED VALUES OF F*M AT NORMAL ',
     1'DEPTHS IN A CIRCULAR CROSS SECTION CHANNEL DIAMETER ',
     2F10.4,' M. AND MANNING COEFF. ',F10.4,/)
      WRITE(3,609)(GT(K),K=1,8)
      WRITE(3,620)
620   FORMAT(/43X,'F*M VALUE AT NORMAL DEPTH, N.')
      WRITE(3,610)SLOPE(1),(F(1,K),K=1,8),B
      DO 618 I=2,N3
      IF(I.LE.N4)WRITE(3,612)SLOPE(I),(F(I,K),K=1,8),B
      IF(I.GT.N4)WRITE(3,612)SLOPE(I),(F(I,K),K=1,8),B
      IF(I.EQ.N4)WRITE(3,613)
```

```
618   CONTINUE
      READ(4,702)SHAPE
      IF(SHAPE.EQ.0) GOTO 621
      READ(4,600)B,RM,QMIN,DQ,N1,N2
      GOTO 622
621   CONTINUE
      END
      SUBROUTINE CALC(H,DL)
C     SUBROUTINE CALC IS USED THROUGHOUT THE PROGRAM TO
C     DETERMINE THE FLOW-PIPE PARAMETERS SUCH AS FLOW
C     DEPTH,AREA,WETTED PERIMETER AS WELL AS BEING USED
C     IN THE BISECTION METHOD CALCULATION OF NORMAL AND
C     CRITICAL DEPTHS IN EACH OF THE PIPE LENGTHS.
C     IN THE CIRCULAR PIPE CROSS SECTION CASE IT ALSO
C     CALCULATES SUBTENDED ANGLE AND THE WATER SURFACE
C     WIDTH AS DEPTH CHANGES.
C     AS IN BOUND AND MAIN PROGRAM THE PIPE SHAPE IS DETERMINED
C     BY THE VALUE OF THE TERM SHAPE INPUT AS DATA.
      INTEGER SHAPE
      COMMON/CM1/B,Q,G,CON,SO,GAM,RHO,HCRIT,HNORM,AREA,PER,FPM,ENERG
      COMMON/CM2/SHAPE
      COMMON/CM3/IZ
      IF(SHAPE.GT.1)GOTO 1
      IF(IZ.EQ.3.AND.H.GE.B)H=B
      AREA=H*B
      PER=B+2.0*H
      HCRIT=1.0-(Q**2)*B/(G*AREA**3)
      HNORM=1.0-(Q**2)*CON/((AREA**3.333)/(PER**1.333))
      DL=HCRIT/(HNORM*SO)
      FPM=(GAM*AREA*H/2.0)+(RHO*Q*Q/AREA)
      ENERG=H+(Q**2)/((AREA**2)*2.0*G)
      GOTO 2
1     R=B*0.5
      PI=3.142
      IF(IZ.EQ.3.AND.H.GE.B) GOTO 20
      IF(H.LT.R) THETA=2.0*ATAN(SQRT(H*(B-H))/(B/2.0-H))
      IF(H.EQ.R) THETA=PI
      IF(H.GT.R) THETA=PI+2.0*ATAN((H-B/2.0)/(SQRT(H*(B-H))))
      GOTO 22
20    H=B
      THETA=2.0*PI
      AREA=PI*(B/2.0)**2
      PER=PI*B
      XO=B/2.0
      GOTO 21
22    CONTINUE
      AREA=((B**2)/8.0)*(THETA-SIN(THETA))
      PER=B*THETA/2.0
      T=2.0*((H*(B-H))**0.5)
      HCRIT=1.0-(Q**2.0)*T/(G*AREA**3)
      HNORM=1.0-(Q**2.0)*CON/((AREA**3.333)/(PER**1.333))
      DL=HCRIT/(HNORM*SO)
      XO=(2.0/3.0)*(B/2.0)*(3.0*SIN(THETA/2.0)-SIN(3.0*THETA/2.0))
     1/(4.0*(THETA/2.0-0.5*SIN(THETA)))
21    HBAR=XO+H-B/2.0
      FPM=GAM*AREA*HBAR+RHO*Q*Q/AREA
      ENERG=H+(Q**2)/((AREA**2)*2.0*G)
2     CONTINUE
      RETURN
      END
$BEND
```

NBS-114A (REV. 2-80)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET (See instructions)	1. PUBLICATION OR REPORT NO. NBSIR 81-2367	2. Performing Organ. Report No.	3. Publication Date November 1981

4. TITLE AND SUBTITLE

PREDICTION OF THE HYDRAULIC JUMP LOCATION FOLLOWING A CHANGE OF SLOPE IN A PARTIALLY FILLED DRAINAGE PIPE

5. AUTHOR(S)

John A. Swaffield

6. PERFORMING ORGANIZATION (If joint or other than NBS, see instructions)	7. Contract/Grant No.
NATIONAL BUREAU OF STANDARDS DEPARTMENT OF COMMERCE WASHINGTON, D.C. 20234	8. Type of Report & Period Covered

9. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS (Street, City, State, ZIP)

Department of Housing and Urban Development
451 7th Street, SW
Washington, D.C. 20410

10. SUPPLEMENTARY NOTES

[ ] Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

The criteria governing the formation of a hydraulic jump in a partially filled fluid conduit downstream of a slope change are presented together with the necessary techniques to enable water surface profiles and jump location to be predicted.

Computer programs designed to model the conditions leading to jump formation under flow and channel scale conditions compatible with current drainage system design are presented.

The results of a wide range of test conditions in terms of jump formation and position downstream of a change in channel slope are presented together with a set of criteria to be used in evaluating whether a jump will occur for a given set of design conditions.

12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)

building drainage; gradually varied flow; hydraulic jump; partially filled pipe flow.

13. AVAILABILITY	14. NO. OF PRINTED PAGES
[X] Unlimited [ ] For Official Distribution. Do Not Release to NTIS [ ] Order From Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. [X] Order From National Technical Information Service (NTIS), Springfield, VA. 22161	193 15. Price $15.50