Alloo 994940

NBS PUBLICATIONS



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



QC-100

. U56

1981 c. 2

81-2367

U.S. DEPARTMENT OF COMMERCE

NBSIR 81-2367

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

HATIONAL BUREAU OF BTANDARDS LIBRARY JAN 8 1982 Not acc - Circ, QC100 .U56 No 81-5367 1981 C.2

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 1. 199 至4 1. 196 197 至4 1. 196 197 至4 1. 196 197 至4



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

				Page
SUMMA PREFA NOTAT	ARY . ACE . TION	• • • • • •		iii iv ix
1.0 2.0	INTE THEC	ODUCT	IONAL CONSIDERATIONS	1 3
	2.1 2.2 2.3 2.4	Stea Grad The Loss	dy Uniform Flow in Open Channels ually Varied Flow in Open Channels Hydraulic Jump Coefficients at Channel Slope Transitions	3 5 8 11
3.0	CALC	ULATI	ON TECHNIQUES AND PRESENTATION OF RESULTS	12
	3.1 3.2 3.3 3.4 3.5	Dete Nume Dete Pres Sele	rmination of Normal and Critical Depths rical Integration for Surface Profiles rmination of Jump Location entation of Results action of Input Data	12 12 13 14 14
4.0 5.0 6.0	DISC CONC REFE	CUSSIC CLUSIC CRENCE	ON OF RESULTS ONS AND FURTHER WORK	15 20 21
AP PEI AP PEI AP PEI AP PEI AP PEI AP PEI	NDIX NDIX NDIX NDIX NDIX NDIX NDIX	1. 2. 3. 4. 5. 6. 7.	JUMP LOCATION IN A 0.075 m DIAMETER PIPE JUMP LOCATION, 0.10 m DIAMETER PIPE JUMP LOCATION, 0.15 m DIAMETER PIPE JUMP LOCATION, 0.075 m WIDE CHANNEL JUMP LOCATION, 0.10 m WIDE CHANNEL JUMP LOCATION, 0.15 m WIDE CHANNEL JUMP FORMATION INDICATOR TABLES FOR CONSTANT MANNING COEFFICIENT OF 0.015 FOR BOTH CIRCULAR AND	A1.1 A2.1 A3.1 A4.1 A5.1 A6.1
APPE	NDIX	8.	RECTANGULAR CHANNELS JUMP FORMATION INDICATOR TABLES FOR 0.15 m PIPE DIAMETER FOR A RANGE AT MANNING COEFFICIENTS FROM	A7.1
AP PE	NDIX	9.	0.009 to 0.018 JUMP LOCATION IN A 0.15 m DIAMETER PIPE AT 1/300 SLOPE CARRYING 6 1/s FOR A RANGE OF MANNING	A8.1
APPE APPE APPE	NDIX NDIX NDIX	10. 11. 12.	COEFFICIENTS SAMPLE OUTPUT, PROGRAM HYDJUMP PROGRAM HYDJUMP PROGRAM HYDSUM	A9.1 A10.1 A11.1 A12.1

LIST OF FIGURES

Figure 1.	Derivation of Chezy Equation for Steady Uniform Flow	22
Figure 2.	Relationship Between Specific Energy and Flow Depth	23
Figure 3.	Basis of Gradually Varied Flow Depth Profile Calculations	24
Figure 4.	Schematic of Numerical Integration to Determine Water Surface Profile	25
Figure 5.	Control Depths Employed in Water Surface Profile Integration	26
Figure 6.	Forces Acting at Hydraulic Jump Location	27
Figure 7.	Summary of Channel Cross Section Shape Calculations	28
Figure 8.	Water Surface Profile and Associated (F&M) Profiles Used to Position Hydraulic Jump	29
Figure 9.	Boundary Conditions Governing Jump Location	30
Figure 10.	Boundary Conditions Employed to Indicate Jump Formation	31
Figure 11.	Schematic Representation of Jump Boundary Conditions	32
Figure 12.	Schematic Representation of Jump Position Identification Technique Employed	33
Figure 13.	Variation of Normal and Critical Depth with Flow Rate and Pipe Slope	34
Figure 14.	Variation of (F&M) Term with Flow Rate and Pipe Slope	35
Figure 15.	Jump Location as a Function of Pipe Slope at 6 1/s Flow for a 0.15 Diameter Pipe	36
Figure 16.	Jump Location in a Rectangular Channel, Width 0.15 m as a Function of Channel Slope	37
Figure 17.	Variation of Jump Location with Flow Rate and Approach Pipe Slope, 0.15 m Diameter Channel	38
Figure 18.	Variation of Jump Location with Flow Rate and Approach Pipe Slope, 0.15 m Width Channel	39

List of Figures (cont.)

		Page
Figure 19.	Pipe Diameter Effect at Q = 1 1/s	40
Figure 20.	Channel Width Effect at $Q = 1 \ 1/s$	41
Figure 21.	Effect of Manning Coefficient on Jump Location. Note n Constant for Approach and Test Pipe	42
Figure 22.	Effect of Manning Coefficient on Jump Location. Note n Constant in Approach Pipe at 0.015, Varied in Test Pipe	43

LIST OF TABLES

Table	1.	Summary of Hydraulic Jump Position Results for the 0.1 m Diameter Partially Filled Pipe with an Approach Pipe Slope of 45°	44
Table 2	2.	Summary of Hydraulic Jump Position Results for the 0.1 m Width Channel with an Approach Channel Slope of 45°	45
Table :	3.	Schematic of Tabulated Jump Boundary Conditions	46

.

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
- Fr Froude number
- g Acceleration due to gravity
- h Flow depth
- h Centroid depth
- h_c Critical flow depth
- hn 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

So 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

- θ₁ 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

(1)

(2)

 $V = C \sqrt{mS_0}$ m = hydraulic mean depth A/P, m S₀ = 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:

$$V = \frac{1}{n} m^{2/3} S_0^{1/2}$$

$$Q = \frac{1}{n} A m^{2/3} S_0^{1/2}$$

where Q is the flow rate, m $^3/s$ A is the flow cross sectional area, m²

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, hn, is commonly referred to as the normal depth.

The specific energy of the flow may be defined as

$$E = h + \frac{v^2}{2g}$$
(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:

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

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

From Figure 2

$$dA = T dh$$
 (5)

(4)

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

 $1 - Q^2 T/g A^3 = 0$

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:

$$\frac{d}{dL} \left\{ \frac{V^2}{2g} + (Z_0 - S_0 L) + h \right\} = - \left\{ \frac{nQ}{Am^2/3} \right\}^2$$
(7)

where $(Z_0 - S_0L)$ is the elevation at distance L along the channel, measured in the downstream direction; S_0 is sin θ , channel bed slope,

hence
$$-\frac{V}{g}\frac{dv}{dL} + S_0 - \frac{dh}{dL} = \frac{nQ}{Am^2/3}^2$$
 (8)

and as, Q = VA

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

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

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

and substituting in equation (8) yields

$$\frac{Q^2 T}{g A^3} \frac{dh}{dL} + S_0 - \frac{dh}{dL} = \left\{ \frac{n Q}{A m^2/3} \right\}^2$$
(9)

$$dL = \left\{ \frac{1 - Q^2 T/g A^3}{S_0 - (nQ/Am^2/3)^2} \right\} dh$$

$$L = \int_{h_0}^{h_1} \frac{1 - Q^2 T/g A^3}{S_0 - (nQ/Am^{2/3})^2} dh$$
 (10)

where L is the distance between two known depths h_0 , 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 $S_0 - (nQ/Am^{2/3})^2$ 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_0 , 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

$$dh = (h_n - h_c)/N, C \text{ to } B$$
(1)

1)

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

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

For the steep slope A to B the increment would be

$$dh = (h_A - h_B)/N$$
(13)

where \mathbf{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

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

$$(F+M)_1 = (F+M)_2$$

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

(15)

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.

$$\Delta E = \{h + \frac{v^2}{2g}\} - \{h + \frac{v^2}{2g}\}$$
(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 l 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

 $X = 1 - Q^2 T / g A^3$

and normal flow depth

 $Y = S_0 - (n Q/Am^{2/3})^2$

It may be assumed that both X and Y have zero values for some value of depth h in the range $0 \le h \le D$ for pipe case or $0 \le h \le W$ 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

$$L = \int_{h_1}^{h_2} \frac{1 - QT^2/gA^3}{S_0 - (nQ/Am^{2/3})^2} dh$$

is achieved by means of Simpson's Rule. Let the integral X = f(h) dh, h₀ then if the interval $h_1 - h_0$ is divided into 2 equal increments, the value of X is given by

$$X = \frac{1}{3} dh \left[(F(h_0) + 4F(h_0 + dh) + F(h_0 + 2dh) \right]$$

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 $x + \Delta x$ 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

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

$$F \& M = \rho g A \overline{h} + \rho \frac{Q^{2}}{A}$$
(17)

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

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

Changes in S_0 , 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_0 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, $S_0 = Sin \theta_2$, the value of $\Delta h/\Delta L$ will be constant, equation (19). Similarly for constant Q, D, n and S_0 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

$$F_{r} = V / \sqrt{gh}$$
 (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

$$L = L_{x} - C^{K} \sin(\theta - \theta_{0})^{0.25}$$
(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 $S_0 = \sin \theta_1 = 1/200$ 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 θ_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 1/40for 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 Q₂ and S₁ 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 U₁.

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 1/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

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)

 $(p_1 - p_2)A + \rho g A \Delta x \sin \theta - \tau_0 \Delta x P = 0$

as dV/dt = 0; steady flow.

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

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

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

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. AL increases as calculation proceeds

- 2. Calculation proceeds downstream from A to give profile $h_0 \leq h < h_c;$ 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.



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

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

Depths h1, h2 known as conjugate depths.

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



Figure 7. Summary of duct cross section parameter calculations.



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.

Normal

$$h_n = D, fuil bore flow$$

 $jump possible,$
 $h_n > h_c$
 $h_n > h_c$
 $h_n > h_c$
 $h_n < h_c$
 $h_n = 0$
 $(F+M)_h = 0$
 $g = h_h = 0$
 $f = 0$

Figure 11. Schematic representation of jump boundary conditions.



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



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 .







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 15.







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 17.

38



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 = $1(1/s) \theta_2 = \sin^{-1}(0.005)$, Manning coefficient = 0.015.



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

Figure 20. Channel width effect at Q = $1(1/s) \theta_2 = \sin^{-1}(0.005)$, 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 (1/s). Pipe 0.15 m diameter.



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

	A •								63					96	9.5	21				Ş	
	SC4								3.4					6 • 2 (2 • 3	1.6				ł • 5	
	Junp F +M.								124-4					4-579	1.608	0.743				1.994	662.0
	E V E R G I C - I A M G E	1 PE .	е •	E.	E.	E.	LPE.	1 PE .	-0*000	E.	E.	• 34 1	• 341	-0-000	-0 • 000	-0*000	. I P E .	. I P E .	. 3 1 5	-0,003	-0.001
	E NERGY ODWN	TEST P	114 1S3	EST PLP	EST PLF	EST PLF	TEST P	1 1531	0.093	EST PLI	EST PLP	TEST P	TEST P	660*0	0.062	0+043	LEST P	I TEST	TEST P	0.067	0*045
15.	ENERGY UPJUNP	SHED IN	HC IN I	HC IN T	HC IN I	HC IN 1	SHED EN	SHED IN	0.093	HC IN I	HC LN T	SHED IN	SHED IN	0°0'5	0.062	0.043	SHED IN	SHED IN	SHED IN	0.070	0.046
M RESJL	DEPTH Change M.	ESTABLE	AS HMC	AS MM	AS HNC	AS HNC	ESTABLE	ESTABLE	0.005	AS HNC	AS HMC	ESTABLE	ESTABLE	0.017	0.003	0.001	ESTABLE	ESTABLE	ESTABLE	0.023	0.013
P & JG KA	067TH 067TH	E FLOW	OS SEBLE	OSSIBLE	OS SIBLE	0\$\$\$@LE	E FLOW	E FLOW	0.063	05 5 I BLE	05 SI BLE	E FLOW	E FLON	0-074	1+0-0	U • 032	E FLOW	E FLOW	E FLON	J • 058	4.60° h
ATA AND	UPJUHP DEPTM M.	ULL BOR	AND INP	AND INC	AND LHP	ANI AND	JLL 80K	JLL 808	0.062	ANI ANI	AND AND	ULL BOR	JUL BOR	\$ 0.057	3 0-044	6 0.031	JLL BOR	ULL BOR	JLL BOR	3 0.035	0.025
PIPE DI	ENTRY SY F + M M +	J.	4	147	1	17	F	3	912 . 216	-	-	Ξ.	ц.	912 .210	3 4 .98	1 2.01	ũ	Ξ.	ц,	3 4.98	1 2.014
TEST	ENTRY Energ N.								0.4					2 0.4	b 0.3	1 0.2				6 0.3	1 0.2
	ENTRY DEPTH N.								0.20 ° C					0.02	0.010	0.01				0.010	0.011
	NH NH	0.100	0.071	¢€0°0	0.036	0.025	0.100	0.100	0.068	440-0	0 * 0 30	0.100	0.100	\$20°0	0-047	0.032	0.100	0.100	0.100	0.058	0.039
	3 ° C	0.089	0.079	0.065	0.045	0.034	0.039	0 • 0 7 9	0 • 065	0.045	0.031	0 • 089	0.079	0.065	0.045	0 • 03 1	0.089	0.079	0.065	0.045	160.031
	SLOPE	0 \$ 7 0 \$ 0	0 ~ 0 2 5 0	0°0250	0°0250	0 • 0 5 2 0	0.0125	0.0125	0.0125	0.0125	0.0125	0.100	0.0100	0.0100	0.0100	001000	0 • 00 2 0	0 • 0 0 5 0	0 * 00 5 0	0 • 0 0 5 0	0 \$ 00 \$ 0
DATA	TERM. ENERGY M.	0.772	0.655	0.518	0.345	0.229	0.772	0.655	0.518	0.345	0.229	0.772	0.655	0.518	0.345	0.229	0.772	0.655	0.518	0.345	0.229
I P I PE	HN N.	160.0	0.027	0.022	0.016	0.011	160-0	0 • 027	0.022	0.016	0.011	0.031	0.027	0.022	0.016	0.011	0.031	0.027	0 • 022	0.016	0.011
PPR0ACH	SLOPE (SLM)	0 * 20 7 0	0.7070	0°00	0.7070	0 ~ 20 70	0.7070	0.7070	0*1010	0 * 10 7 0	0*02*0	0 • 70 70	0.7070	0-1010	0.7070	0 * 20 7 0	0-1010	0 * 20 2 0	0-1010	0 * 20 7 0	0.7070
•	2 LL	015	.015	•015	• 015	.015	015	\$10 •0	\$10°0	0.015	0°015	0-015	0.015	0.015	0.015	0.015	0.015	0.015	\$10°0	0.015	0.015
ATA	MAN COE	ò	0	0	0	0	-	-	-												-
HNON DATA	DIA. NAN N. COE	0.10 0.	0.10 0	0.10 0	0.10 0	0.10 0	0.10	0.10	0.10	0.10	01.0	0.10	0•10	0° 10	0* 10	0.10	0.10	0.10	0.10	0.10	0°10

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

44

PIPE DATA APPROAC-CONHON DATA

SLOP E (NIS)

HLAIN . O ż

COEFF NANN.

- / 5

FEST PIPE DATA AND PRJUAM RESULTS.

4142 -564 -JUMN DEPTH ENFRCY ENERGY ENEPCY JUMP JePts Change UpJJMP JOWN Clang: F+M. ż -H. ÷ ÷ ENTRY UPJUMP JUMN ÷ UEPIH ť DEPTH ENEAGY F .M ż ÷ ENTRY **.** N H H. H TERN. SLOPE ENERGY (SIV) ÷ NH H

0.10 0.015 0.7070 0.019 0.541 0.0250 0.072 0.062 0.046 2.0 0.10 0.015 0.7070 0.009 0.254 0.0250 0.034 0.028 1.0 0.10 0.015 0.7070 0.006 0.153 0.0250 0.022 0.017 8.0 0.10 0.015 0.7070 0.023 0.651 0.0125 0.087 0.100 8.0 0.10 0.015 0.7070 0.023 0.651 0.0250 0.087 0.078 4.0 0.10 0.015 0.7070 0.014 0.412 0.0250 0.055 0.0

FULL BORE FLOW ESTABLISHED IN TEST PIPI. PIPE. JUMP IMPOSSIBLE AS HNCHC IN TEST PIPE. JUMP IMPOSSIBLE AS HNCHC IN TEST PIPE. JUMP IMPU, SIBLE AS HNCHE IN TEST PIPE. JUMP IMPOSSIBLE AS MNCHC IN TEST PIPE. JUNP INPOSIBLE AS HNCHC IN TEST

0.109 -0.000 7.675 2.935 0-083 -0-003 4-425 2-521 U.033 -U.003 0.692 1.157 0.052 -0.000 1.745 1.311 FULL BORE FLOA ESTABLISHED IN TEST PIPE. 0.109 0.033 0.083 260.0 0.019 600*0 0000-0 0.002 0.5613.720 0.063 U.081 0.26 4.504 0.034 0.036 60.0 000 174-116+.0 0.16 1.744 0.022 0.022 1.0 0.10 0.015 0.7070 0.006 0.153 0.0125 0.022 0.022 U.306 0-10 0-015 0-7070 0-019 0-541 0-0125 0-072 0-081 0-014 0.10 0.015 0.7070 0.014 0.412 0.0125 0.055 0.059 U.014 2.0 0.10 0.015 0.7070 0.009 0.254 0.0125 0.034 0.036 U.009 d.0 0.10 0.015 0.7070 0.023 0.651 0.0100 U.087 0.100 0.4 6.0

0.064 -0.001 4.526 2.13J 0.085 0.019 0.4311.471 0.046 0.065 4.0 0.10 0.015 0.7070 0.014 0.412 0.0100 0.055 0.065 0.014

0-112 -0.002 7.439 2.552

\$11º0

66U+0

0.5619.720 0.057 0.384

6.0 0.10 0.015 0.7070 0.019 0.541 0.0100 0.072 0.089 3.013

45

U.052 -U.003 1.766 1.541 0.096 -0.013 5.427 1.35 0.056 -0.004 2.015 0.935 U.036 -0.002 0.775 G.545 0.013 -0.000 0.697 U. 915 FULL BURE FLOM ESTABLISHED IN TEST PIPE. FULL BURE FLOW ESTABLISMED IN TEST PIPE. 0.033 0.062 0.109 0.038 0.052 0.004 2 5 0 • 0 U-027 610.0 0.008 J.26 4.504 0.023 U.JSJ 0.26 4.504 0.031 0.034 0.16 1.749 0.020 0.324 0.16 1.749 0.015 J. 33J 0.4311.471 0.U33 U.U85 2.0 0.10 0.015 0.7070 0.009 0.254 0.0100 0.034 0.039 0.009 1.0 0.10 0.015 0.7070 0.006 0.153 0.0100 0.022 0.024 U.036 0.10 0.015 0.7070 0.014 0.412 0.0050 0.055 0.045 0.014 2.0 0.10 0.015 0.7070 0.009 0.254 0.0150 0.034 0.050 0.004 1.0 0.10 0.015 0.7070 0.004 0.153 0.0050 0.022 0.030 0.036 0.10 0.015 0.7070 0.019 0.541 0.0050 0.072 0.100 0.10 0.015 0.7070 0.023 0.651 0.0350 0.047 0.100 9.0 0.4 0.9

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

Flow rate Q	Q_1	Q ₂ Q ₁	D Pipe diameter
Test pipe slope S = sin θ2		Normal flow depth, Q, S values.	
S ₁ S ₂		hn ₁₂ cf hn ₂₂	D D
Si		hn _{i2}	D
Critical depth hc = f(Q)	hc1	hc_2 hc_1	
Flow rate Q Test pipe slope	Q1	Q ₂ Q _i (F+M) test pipe normal depth value	
s ₁		(F+M) ₁₂	
• S3		•	cf
S _i		(F+M) ₁₂	
Approach pipe slope U U _l		(F+M) [*] terminal (i.e. test pipe entry) (F+M)*12	
U2		(F+M)*22	
•			
•			
U _i		(F+ri^i2	

Table 3. Schematic of Tabulated Jump Boundary Conditions.

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

.

	Y JUNP JUNP F+N. POS.									3 1.971 1.445	0.707 3.553		٠		1 2.049 0.15)	0 0.733 0.331					
	SY ENERC CHANGE	PIPE.	. P1PE .	PIPE.	• 3 d 1	SPE.	PIPE.	PIPE.	PIPE.	1 -0+00	7 0.	PIPE.	PIPE.	PIPE.	4 -0-00	-0-0	• 3 4 1 4 ·	PIPE.	PIPE.	PIPE.	NTRY-
	Y ENERG	IN TEST	IN TEST	IN TEST	1651 P	TEST P	IN TEST	IN TEST	IN TEST	2 0.07	2 0.04	IN TEST	IN TEST	IN TEST	5 0°07	8 0.04	IN TEST	IN TEST	IN TEST	IN TEST	P1PE E
115.	ENFRG UPJUNP M	I SHED	I SHED	I SHFD	ICHC IN	I DHO	I SHED	I SHED	I SHED	20*0	0-04	I SHFD	I SHED	I SHED	0.07	0-04	C 3H S 1	L SHED	I SHED	I SHED	TEST
AM RESU	06.PTH CHANGE N.	ESTABL	ESTABL	ESTABL	E AS MH	E AS HN	ESTABL	ESTABL	ESTABL	0.008	0 0 0 0	ESTABL	ESTADL	ESTABL	0.018	0 0 0 0	ESTABL	ESTABL	ESTABL	FSTABL	T L=0 A
D PROGR	P UUWN ULPTH M.	KE FLUM	K.FLON	RE FLOW	055181	0,518-	LE FLOW	(E FLOM	KE FLOW	4 < 0 ° 0	4 0°034	KE FLUM	16 FLOH	KE FLOA	1 0.359	16C.L 3	4E F-04	KE F_JH	גב וּרט⊭	SE FLOH	A Canhu
ATA AN	UPJUM DEPTH M.	מרר מי	וניט אוטו	חרר 201	IFI AND	UHP IH	חרר מסו	NLL 801	חרר ייסו	7 0.04	1 0.03	ULL 801	ערר אסי	חרר אטו	7 0-04	3 0-03	ULL 801	חרור מסו	חרר 100	NLL 80	יאט פאט
P1PE 0	C ENTRY 57 F + M N +	ũ,	<u> </u>	Ū.			ŭ	ŭ	Ľ.	8 2.12	15 0.87	j.	ū	ũ.	8 2.12	15 3.87	u.	Ū.	ų,	ũ.	
1651	r ENTRY 1 ENEKO 1.									0.0	56 0°C				38 0°3	2÷0 •3					
	ENTRI DEPTI	75	75	52	5.2	28	15	52	15	54 0.0	34 0-35	.52	15	75	59 J.0	37 0.03	25	25	25	75	45
	Σ • Σ	74 0-0	0-0 61	57 0.0	0.0 9	14 0°0'	0-0-44	13 0.0	0.0 7	13 0°0	34 0.0	14 0-0	73 0.0	57 0.0	0-0-4	34 0°0	74 0.0	13 0.0	57 0.0	10.0	34 0-0
	HC HC	0 0 0	0.0.0	0 0.00	0 0 0	0 0 0	5 0°0	10-01	:5 0-00	5 0.0	2 0 0	0 0 00	0 0 0	0 0 00	0 0 00	0 0 00	0.0.0	0 0 0	0 0 0	0 0 0	0 0 0
	SLOPE	5 0°072	0.025	0.025	620°0 1	• 0 • 0 2 5	0.012	0.012	0.012	0.012	0.012	0.010	0*070	0°010	0 0 0 10	0-010	500°0 ;	0.005	0 002	0.0.5	0.00
E DATA	TERM. ENERGI M.	5 0.242	5 0.165	0.115	3 0.078	5 0°054	0.242	0.169	0.115	3 0.078	0.054	5 0.242	5 0° 169	0.115	0.078	0.054	5 0.24°	5 0.165	0.11	8 0.076	6 0.05'
CH PIPI	N . N N	0 0 0	0.07	0.054	0.036	0.026	0°075	0.075	0.06	0.036	0.026	0.07	0.07	0.064	0.036	9 0.020	0.07	10.0	€ C• 0¢	0.034	9.020
APPROA	SLUPE (SIN)	0.034	5460*0	0-0345	0.0345	0.0345	5460*0	6.0349	0-0345	0.0345	0.0345	0-0345	0.0345	0*0345	0.034	0*034	0.0345	0.0345	0-034	0-034	0.034
DATA	MANN. COEFF	0.015	0.015	6.015	0.015	0.015	0.015	0.045	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
NONNO	01A. M.	0 0.07	0.07	0.07	20.07	0.07	10.07	0.07	0.07	0.01	0.07	0.07	20.07	10.0 0	0.07	0.07	20.0 0	0.07	0.07	0 0.07	0 0.07
U	4. L/S	60	0	4	. 2.	L.	у. С	.0) = 4	2.	1 ° (6 °	° 0	+	2.1	1.	90°.	•	4	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	

A1.2

KE SULTS.	PTH ENEAGY ENERGY ENEPGY JUTP 1J4P Inge upjump domn change f+n. PJ5. H. M. M. M. N. M. M. M.	STABLISHED IN TEST PIPE.	ITABLESHED IN TEST PIPE.	ITABLESHED IN TEST PIPE.	IS HNCHC IN TEST PIPE.	IS HNCHC IN TEST PIPE.	ITABLESHED IN TEST PIPE.	TABLISHED IN TEST PIPE.	ITABLISHED IN TEST PIPE.	1.008 0.072 0.071 -0.000 1.971 3.975).000 0.047 0.047 -0.000 0.787 1.038	STABLISHED IN TEST PIPE.	ITAOLISHED IN TEST PIPE.	ITABLISHED IN TEST PIPE.	1.018 0.075 0.074 -0.001 2.049 3.552	142°C.2420000-048-0780000000000000000000000000000	ITABLESHED IN TEST PIPE.	TABLISHED IN TEST PIPE.	STABLISHED IN TEST PIPE.	ITABLISHED IN TEST PIPE.	3.020 0.055 0.052 -0.003 0.696 3.257	
FEST PIPE DATA AND PLJGRAM	ENTAY FAIRY UPJUMP JUMN D Energy Fam Deptm Deptm Ch m. n. m. m.	FULL BORE FLOM E	FULL BOKE FLUM E	FULL BURE FLOM E	JUMP IMPOSSIBLE	JUMP IMPOSSIBLE	FULL BORE FLOM E	FULL BORE FLOM E	FULL BORE FLOM E	0.10 2.500 0.455 0.054	0.07 1.034 0.034 J.034	FULL BORE FLOM E	FULL BORE FLOM E	FULL BORE FLOM E	0-10 2 -500 0-041 N-054	0.07 1.034 0.032 U.037	FULL BORE FLOM E	FULL BORE FLJM E	FULL BORE FLOM E	FULL BORE FLOM E	<u>0.07</u> 1.034 0.025 U.04045	
-	EATRY E DEPTH E M.	2	2		~			2	IO	160-0 4	0.022	5	5	5	160-0 4	7 0.023		5		5	5 0.022	
	E .	0.07	0.07	0-07	0-04	0.026	0.07	0.07	0-07	0 • 05	0.03	0.07	0 • 0 7	0.07	0.050	0.03	0.07	0.07	0.07	0.07	0.04	
	ч ч	0-074	£70.0	0 - 067	0 - 0 + 9	• 0 0 0 0	0.074	0.073	0.067	0-049	0.034	0.074	E70.0	0.067	0.049	0-034	0.074	0.073	0.067	0.049	0 ° 0 34	
	1026	• 0 4 5 0	•0520-	•0520	•0520	• 0 5 2 0	•0125	•0125	•0125	•0125	• 0125	•0100	.0100	• 0100	.0100	.0100	•0350	.0050	•0050	•0350	• 00 50	
DATA	ERH. NERCY N.	0.242 0	0.169 0	0.141 0	0.098 0	0.067 0	0.242 0	0.169 0	0.141 0	0.098 0	0.067 0	0.242 0	0.169 0	0.141 0	0.098	0.067 0	0.242 0	0.169 0	0.141 0	0.096	0.067	
941 d	HN T	0.075	0.075	2+0-0	160.0	0.022	\$20.0	\$20.0	2+0-0	160.0	0.022	0.075	0.075	2+0-0	0.031	0.022	0.075	\$10.0	1+0-0	0.031	0.022	
P P RJ ACH	SLOPE	0 • 06 98	0.0093	0.0698	0.0638	0.0698	0.069d	0.0093	0.0698	0.0698	0.0698	0.0698	8690-0	0.0698	0.0698	0.0695	0.0638	9690-0	0.0695	0.0690	96.90	
ATA A	MANN. CUEFF	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0:015	0.015	0-015	0.015	0.015	0.015	0.015	0.015	0.015	0-015	
INUN D	о!	0.07	0.07	0.07	0.07	0.07	0.07	0.07 (0.07	10.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	10.07	0.07	0.07	0.07	
00	0.	6.0	6.0	4.0	2 . 0	1.0	0.0	0.0	•••	2.0	1.0	8°0	. 6.0	••0	2.0	1.0	d • 0	6 • 0	0 • ¢	2.0	1.0	

A1.3

•

0.052 -6.003 0.036 0.033 <f1.1 787.0 0.000 0.787 1.135</pre> 0-074 -0.001 2.049 0.32) -442.1 179.1 CO0.0- 170.0 0-048 -0-000 0-793 0-593 4165 P05. -UPJUAP JUAN DEPTH ENERCY ENERCY ENERGY JUAP DEPTH DEANGE UPJUMP DOWN CHANGE FAM. Ę FLUH ESTABLISHED IN TEST PIPL . FULL BORE FLUM ESTABLISHED IN TEST PIPE. ESTABLISHED IN TEST PIPE. PIPE. FULL BORE FLOM ESTAB_ISHED IN IEST PIPE. • 3 4 1 4 FULL BORE FLJA ESTABLISMED IN TEST PIPE. FULL BORE FLOW ESTABLISHED IN TEST PIPE. FULL BORE FLOW ESTABLISHED IN TEST PIPE. FULL BORE FLOM ESTABLISHED IN TEST PIPE. FULL BURE FLUM ESTABLISHED IN TEST PIPE. FULL BURE FLOM ESTABLISHED IN TEST PIPE. FULL BORE FLUM ESTABLISMED IN TEST PIPE. JUMP IMPOSSIBLE AS MMCHC IN TEST PIPE. JUMP IMPOSIBLE AS HNCHC IN TEST PIPE. FULL BORE FLOW ESTABLISHED IN TEST FLOW ESTABLISHED IN TEST ź 0.055 0.072 0.075 0-048 0.047 ÷ 0.020 0.005 0.005 0.003 0.010 . Т 0-12 2-817 0-045 U-054 0-08 1-142 0-025 3-045 0.08 1.142 0.034 J.034 0.38 1.142 0.032 U.037 FULL BURE FLOM 0.12 2.017 0.041 J.057 FULL BORE FULL BORE ż ENTRY ENTRY ENTRY ENTRY ENTRY DEPT4 ENERGY F+M ż ž 0-034 0-023 2.0 0.07 0.015 U.1045 0.028 0.118 0.0100 0.049 0.059 3.029 1. 0 0. U7 0. 015 0. 1045 0. 020 0. 080 0. 0100 0. 034 0. 037 0. 023 2.0 0.07 0.015 0.1045 0.028 0.118 0.0125 0.049 0.054 3.028 0.075 0°075 0.07 0.015 0.1045 0.042 0.170 0.0125 0.067 0.075 0.07 0.015 0.1045 0.055 0.206 0.0100 0.073 0.075 0.075 0.0 0.07 0.015 0.1045 0.055 0.206 0.0050 0.073 0.075 4.0 0.07 0.015 0.1045 0.042 0.170 0.0050 0.067 0.075 2.0 0.07 U.015 0.1045 0.028 0.118 0.0050 0.049 0.075 0.075 0.042 0.028 0.075 0.075 8.0 0.07 0.015 C.1C45 0.075 C.242 0.0100 0.074 0.075 4.0 0.07 0.015 0.1045 0.042 0.170 0.0100 C.067 0.075 Z H 6.0 0.07 0.015 0.1045 0.055 0.206 0.0250 0.073 6.0 0.07 0.015 0.1045 0.055 0.206 0.0125 U.073 d.0 0.07 0.015 0.1045 0.075 0.242 0.0250 0.074 0.07 U.C15 0.1045 0.028 0.118 0.0250 0.049 1.0 0.07 0.015 0.1045 0.020 0.080 0.0250 0.034 8.0 0.07 0.015 0.1045 0.075 0.242 0.0125 0.074 1.0 0.07 0.015 0.1045 0.020 0.080 0.0125 0.034 3.C 0.07 0.015 0.1045 0.075 0.242 0.0050 0.074 ••0 0.07 0.015 0.1045 0.042 0.170 0.0250 0.067 U P E (+15) SLOPE TEAM. ENERGY ÷, H H SLOPE (SIN) NANN. CUFFF 01A. **2.0** 0.0 0.1 ٢/2 • • ۸1.4

TEST PIPE DATA AND PROGRAM RESULTS.

APPROACH PIPE DATA

DATA

COMMUM

UH2 5.e									. 537	. 11 3				1132	((1))					162.
- N - N									1 126	187 1				1 640	1 662					8 9 6 3
101 J									0 1.	•0 0				1 2.	-0 C					3 0-1
NERG Ange M	PE.	PE.	. P.E		•	• E •	PE .	P£.	00 • 0-	00.0	Př.	• •	PF.	00 • ò-	CO * O .	њЕ.	P E •	P.E.	PE .	-0• 00
264 E	I II	51 P.I	51 P.I	PIPE	91PE	ST PI	51 P1	14 15	- 110	- 240	14 15	51 P.	ST PI	. 120	- 840	51 P.I	ST PI	ST PI	I IS	- 240
ENE DOWN	H TE	N TE	N TE	TEST	TEST	N TE:	N TE:	N TE	•0	•0	N TE	N TE	N TE	• 0	• 0	N TE	H TE	N TE	N TE	• 0
ERGY IUNP N.	EU I	I DJ	1 03	N	N	1 03	EC I	1 0 J	•072	•047	E D I	ED I	FU I	•075	-040	ff D I	IE D I	1E 0 1	103	•055
CPJ	121	11 SH	1115	JH 2 M	UN CHC	1154	IL I SH	151-1	99 0	0 0	1115	LI SH	ILI SH	9	5 0	12.1.5	ILISP	115	11124	0
DEPTHANCE	ESTAF	ESTAB	ESTAB	AS F	AS H	ESTAB	ESTAB	ESTAB	0*0	0•00	ESTAB	ESTAB	ESTAB	0.01	0.00	ESTAB	ESTAB	ESTAB	ESTAB	0, 02
N I I	LOW	LOH	104	1946	IBLE	101	LUW	101	054	460	L 0 4	LJA	HCJ	650	037	101	row	104	. 407	045
H DEP	JRE F	DXE F	JRE F	4P.0.5	1P055	DKE F	JKE F	OKE F	45 U.	34 U.	JRE F	ORE F	JRE F	41 U.	32 0.	JRE F	JRE F	URE F	JRE F	•ر دغ
UPJU DEPTI M.	LL BI	רר מו	רר או	MP LI	HP LI	רר פּוָ	LL B(۲۲ B	,0*0	0•0	LL d(LL B	LL B	0.0	0.0	LL B	LL 81	רר או	רר אנ	0 • 0
Т N.	Fυ	۴u	FU	U.F) L	FU	FU	FU	•274	• 350	F U	FU	FU	•22•	• 356	Fu	FU	FU	FU	• 356
KY EN									.15 3	10 1				.15 3	101					101
ENE									ò	0				0	ŏ					°0
							•		 Image: A second s	~				- 4N .	Pro-		-			Pro 1
ЕЧТ К V D L P T H M.							•		0-025	0.017				\$20-0	0.017		·			3.017
НМ ЕЧТВР М. ОЕРТН М.	0.075	0-075	0.075	0+0+2	0.028	0-075	0.075	0.075	0.054 0.025	110-0 480-0	0.075	0.075	0.075	\$20.0 640.0	110.0 160.017	0°0 75	0.075	0.075	0.075	0.045 3.017
НС НИ ЕЧТКУ М. М. DLPTH	•074 0-075	.073 0.075	.067 0.075	.049 0.042	.034 0.028	•074 0.075	.073 0.075	.067 0.075	•049 0•054 0•025	034 0°034 0°011	.074 0.075	.073 0.675	.067 0.075	•0+4 0-059 0-32\$	10.0 7 EU.0 + EO.	•074 0.075	• 073 0•075	• 067 0.075	•0+9 0•075	• 034 0•045 3•017
E HC HN EVTRY J M. M. DLPTH M.	50 0.074 0.075	50 0.073 0.U75	50 U.067 0.075	50 0.049 0.042	50 0.034 0.028	25 0.074 0.075	25 0.073 0.075	25 0.067 0.U75	25 0°049 0°054 0°025	25 0.034 0.034 0.01/	00 0.074 0.075	00 U.073 0.675	00 0.067 0.075	\$2C*0 650*0 640*0 00	00 0.034 0.U37 0.017	50 0 °074 0 °075	50 0.073 0.075	50 0.067 0.075	50 0.049 0.075	50 0.034 0.045 3.017
SLOPE HC HH EYTRY (SIA) M. M. DLPTH M.	0*0550 0*00*0	0.0250 0.073 0.075	0.0250 0.067 0.075	0.0250 0.049 0.042	0.0250 0.034 0.028	0*0125 0*074 0*075	0.0125 0.073 0.075	0.0125 0.067 0.075	0.0125 0.049 0.054 0.025	0.0125 0.03% 0.03% 0.01%	0.0100 0.074 0.075	0.0100 0.073 0.075	0.0100 0.067 0.075	\$2C*0 650*0 640 0°0100	0.0100 0.034 0.037 0.017	0.0350 0.074 0.075	0.0050 0.073 0.075	0.0050 0.067 0.075	0.0350 0.049 0.075	0.0350 0.034 0.045 3.017
KM. SLOPE MC MN ENTRY ILRCY (SI4) M. M. DLPTM M. M.	• 309 0 • 0520 0 • 0 4 0 • 0 1 5	•274 0.0250 0.073 0.075	•224 0.0250 0.067 0.075	•154 0.0250 0.049 0.042	.104 0.0250 0.034 0.028	•309 0.0125 0.074 0.075	•274 0.0125 0.073 0.075	.224 0.0125 0.067 0.075	.154 0.0125 0.049 0.054 0.025	•104 0.0125 0.034 0.034 0.01/	•309 0•0100 0•074 0•075	•274 0•0100 0•073 0•075	.224 0.0100 0.067 0.075	•154 0.0100 0.044 0.059 0.32\$	•10+ 0-0100 0-034 0-037 0-017	.309 0.0350 0.074 0.075	.274 0.0050 0.073 0.075	«224 0.0050 0.067 0.075	•154 0.0350 0.049 0.075	* 104 0.0150 0.034 0.045 3.017
N TEKN. SLOPE HC HN EYTRY • ENERGY (SIA) M. H. DEPTH M. M. M.	357 0.309 0.0250 0.074 0.075	0+6 0-274 0-0250 0-073 0-U75)36 0.224 0.0250 U.067 0.075	125 0.154 0.0250 0.049 0.042	117 0.104 0.0250 U.034 0.028	157 0.309 0.0125 0.074 0.075	346 0.274 0.0125 0.073 0.075)36 0.224 0.0125 0.067 0.075)25 0.154 0.0125 0.049 0.054 0.025	117 0.104 0.0125 0.034 0.034 0.011	057 0.309 0.0100 0.074 0.075	146 0.274 0.0100 U.073 0.075	336 0.224 0.0100 0.067 0.075	225 0.154 0.0100 0.044 0.059 0.325	017 0.104 0.0100 0.034 0.037 0.017	057 0.309 0.0050 0.074 0.075	346 0.274 0.0050 0.073 0.075	036 0.224 0.0050 0.067 0.075	325 0.154 0.0350 0.049 0.075	017 0.104 0.0050 0.034 0.045 3.017
HN TEKN. SLOPE HC HN EYTRY M. ENERGY (SIA) M. M. DEPTH M. M.	6 0.057 0.309 0.0250 0.074 0.075	6 0.046 0.274 0.0250 0.073 0.U75	6 0.036 0.224 0.0250 U.067 0.075	6 0.025 0.154 0.0250 0.049 0.042	6 0.017 0.104 0.0250 U.034 0.028	6 0.057 0.309 0.0125 0.074 0.075	6 0.046 0.274 0.0125 0.073 0.075	0.036 0.224 0.0125 0.067 0.075	6 0.025 0.154 0.0125 0.049 0.054 0.025	5 0.017 0.104 0.0125 0.034 0.034 0.017	6 0.057 0.309 0.0100 0.074 0.075	6 0.046 0.274 0.0100 U.073 0.075	6 0.036 0.224 0.0100 0.067 0.075	6 0.025 0.154 0.0100 0.044 0.059 0.325	6 0.017 0.104 0.0100 0.034 0.037 0.017	0 0.057 0.309 0.0350 0.074 0.075	6 0.046 0.274 0.0050 0.073 0.075	0 0.036 0.224 0.0050 0.067 0.075	6 0.025 0.154 0.0350 0.049 0.075	6 0.017 0.104 0.0350 0.034 0.045 3.017 FEALULL FOUNTFILLE T.F
SLUPE HN TEKN. SLOPE HC HN EYTRY ISIN) N. ENLRGY (SIA) M. M. DLPTH M.	0.1736 0.057 0.309 0.0250 0.074 0.075	0.1736 0.046 0.274 0.0250 0.073 0.U75	0.1736 0.036 0.224 0.0250 U.067 0.075	0.1736 0.025 0.154 0.0250 0.049 0.042	0.1736 0.017 0.104 0.0250 0.034 0.028	0*1736 0*057 0*309 0*0125 0*074 0*075	0.1736 0.046 0.274 0.0125 0.073 0.075	0.1736 0.036 0.224 0.0125 0.067 0.075	0.1736 0.025 0.154 0.0125 0.049 0.054 0.025	0.1736 0.017 0.104 0.0125 0.034 0.034 0.017	0.1736 0.057 0.309 0.0100 0.074 0.075	0.1736 0.046 0.274 0.0100 U.073 0.075	0.1736 0.036 0.224 0.0100 0.067 0.075	0.1736 0.025 0.154 0.0100 0.044 0.059 0.325	0.1736 0.017 0.104 0.0100 0.034 0.037 0.017	0.1736 0.057 0.309 0.0350 0.074 0.075	0.1736 0.046 0.274 0.0050 0.073 0.075	0.1736 0.036 0.224 0.0050 0.067 0.075	0.1736 0.025 0.154 0.0050 0.049 0.075	0.1736 0.017 0.104 0.0350 0.034 0.045 3.017 so na scourse fountsense to vie
ANM. SLOPE HN TEKN. SLOPE HC HN EYTRY Deff (SIN) M. Energy (SIA) M. M. Depth M.	015 0-1736 0-057 0-309 0-0270 0-074 0-075	.015 0.1736 0.046 0.274 0.0250 0.073 0.U75	.015 0.1736 0.036 0.224 0.0250 U.067 0.075	.015 0.1736 0.025 0.154 0.0250 0.049 0.042	.015 0.1736 0.017 0.104 0.0250 0.034 0.028	015 0.1736 0.057 0.309 0.0125 0.074 0.075	015 0.1736 0.046 0.274 0.0125 0.073 0.075	015 0.1736 0.036 0.224 0.0125 0.067 0.075	.015 0.1736 0.025 0.154 0.0125 0.049 0.054 0.025	.015 0.1736 0.017 0.104 0.0125 0.034 0.034 0.017	.015 0.1736 0.057 0.309 0.0100 0.074 0.075	.015 0.1736 0.046 0.274 0.0100 U.073 0.675	.015 0.1736 0.036 0.224 0.0100 0.067 0.075	.015 0.1736 0.025 0.154 0.0100 0.044 0.059 0.325	.015 0.1736 0.017 0.104 0.0100 0.034 0.037 0.017	.015 0.1736 0.057 0.309 0.0350 0.074 0.075	.015 0.1736 0.046 0.274 0.0050 0.073 0.075	.015 0.1736 0.036 0.224 0.0050 0.067 0.075	.015 0.1736 0.025 0.154 0.0350 0.049 0.075	•015 0•1736 0•017 0•104 0•0350 0•034 0•045 3•017 • ••••• •• ••••••••
A. MANN. SLUPE HN TEKN. SLOPE HC HN EYTRY Coeff (SIN) M. Energy (SI4) M. M. Depth M.	01 0.015 0.1736 0.057 0.309 0.0250 0.074 0.075	07 0.015 0.1736 0.046 0.274 0.0250 0.073 0.U75	07 0.015 0.1736 0.036 0.224 0.0250 0.067 0.075	07 0.015 0.1736 0.025 0.154 0.0250 0.049 0.042	07 0.015 0.1736 0.017 0.104 0.0250 0.034 0.028	07 0.015 0.1736 0.057 0.309 0.0125 0.074 0.075	07 0.015 0.1736 0.046 0.274 0.0125 0.073 0.075	07 0.015 0.1736 0.036 0.224 0.0125 0.067 0.075	07 0.015 0.1736 0.025 0.154 0.0125 0.049 0.054 0.025	07 0.015 0.1736 0.017 0.104 0.0125 0.034 0.034 0.017	07 0.015 0.1736 0.057 0.309 0.0100 0.074 0.075	07 0.015 0.1736 0.046 0.274 0.0100 U.073 0.075	07 0.015 0.1736 0.036 0.224 0.0100 0.067 0.075	07 0.015 0.1736 0.025 0.154 0.0100 0.044 0.059 0.325	07 0.015 0.1736 0.017 0.104 0.0130 0.034 0.037 0.017	07 0.015 0.1736 0.057 0.309 0.0350 0.074 0.075	07 0.015 0.1736 0.046 0.274 0.0050 0.073 0.075	07 0.015 0.1735 0.036 0.224 0.0050 0.067 0.075	07 0.015 0.1736 0.025 0.154 0.0350 0.049 0.075	07 0.015 0.1736 0.017 0.104 0.0350 0.034 0.045 3.017 cut te baeen na febutut fnuntfinte tu tu fin
DIA, MANN, SLUPE HN TEKM, SLOPE HC HN EYTRY M. COEFF (SIM) M. ENLRGY (SIM) M. M. DLPTH M. M.	0 0.07 0.015 0.1736 0.057 0.309 0.0250 0.074 0.075	0 0.07 0.015 0.1736 0.046 0.274 0.0250 0.073 0.075	0 0.07 0.015 0.1736 0.036 0.224 0.0250 0.067 0.075	0 0.07 0.015 0.1736 0.025 0.154 0.0250 0.049 0.042	0 0.07 0.015 0.1736 0.017 0.104 0.0250 0.034 0.028	0 0.07 0.015 0.1736 0.057 0.309 0.0125 0.074 0.075	0 0.07 0.015 0.1736 0.046 0.274 0.0125 0.073 0.075	0 0.07 0.015 0.1736 0.036 0.224 0.0125 0.067 0.075	0 0.07 0.015 0.1736 0.025 0.154 0.0125 0.049 0.054 0.025	0 0.07 0.015 0.1736 0.017 0.104 0.0125 0.034 0.034 0.017	0 0.07 0.015 0.1736 0.057 0.309 0.0100 0.074 0.075	0 0.07 0.015 0.1736 0.046 0.274 0.0100 0.073 0.075	0 9.07 0.015 0.1736 0.036 0.224 0.0100 0.067 0.075	0 0.07 0.015 0.1736 0.025 0.154 0.0100 0.044 0.059 0.325	0 0.07 0.015 0.1736 0.017 0.104 0.0100 0.034 0.037 0.017	0 0.07 0.015 0.1736 0.057 0.309 0.0350 0.074 0.075	0 0.07 0.015 0.1736 0.046 0.274 0.0050 0.073 0.075	0 0.07 0.015 0.1736 0.036 0.224 0.0050 0.067 0.075	0 0.07 0.015 0.1736 0.025 0.154 0.0350 0.049 0.075	0 0.07 U.015 0.1736 0.017 0.104 0.0350 0.034 0.045 3.017 w octin te baeen ny teomenia founttine in tie
J. DIA. MANN. SLOPE HN TEKN. SLOPE HC HN EYTRY L/S M. COEFF (SIN) M. ENERCY (SIA) M. M. DLPTH M.	8.0 0.07 0.015 0.1736 0.057 0.309 0.0250 0.074 0.075	0.0 0.07 0.015 0.1736 0.046 0.274 0.0250 0.073 0.U75	4.0 0.07 0.015 0.1735 0.036 0.224 0.0250 0.067 0.075	2.0 0.07 0.015 0.1736 0.025 0.154 0.0250 0.049 0.042	1.0 0.07 0.015 0.1736 0.017 0.104 0.0250 0.034 0.028	8.0 0.07 0.015 0.1736 0.057 0.309 0.0125 0.074 0.075	6.0 0.07 0.015 0.1736 0.046 0.274 0.0125 0.073 0.075	4.0 0.07 0.015 0.1736 0.036 0.224 0.0125 0.067 0.075	2.0 0.07 0.015 0.1736 0.025 0.154 0.0125 0.049 0.054 0.025	1.0 0.07 0.015 0.1736 0.017 0.104 0.0125 0.034 0.034 0.017	8.0 0.07 0.015 0.1736 0.057 0.309 0.0100 0.074 0.075	6.0 0.07 0.015 0.1736 0.046 0.274 0.0100 0.073 0.075	4.0 0.07 0.015 0.1736 0.036 0.224 0.0100 0.067 0.075	2.0 0.07 0.015 0.1736 0.025 0.154 0.0100 0.044 0.059 0.325	1.0 0.07 0.015 0.1736 0.017 0.104 0.0100 0.034 0.037 0.017	d.0 0.07 0.015 0.1736 0.057 0.309 0.0350 0.074 0.075	6.0 0.07 0.015 0.1736 0.046 0.274 0.0050 0.073 0.075	\$•0 0.07 0.015 0.1735 0.036 0.224 0.0050 0.067 0.075	2.0 0.07 0.015 0.1736 0.025 0.154 0.0350 0.049 0.075	1.0 0.07 U.015 0.1736 0.017 0.104 0.0150 0.034 0.045 3.017

TEST PIPE DATA AND PANGAAM NESULTS.

COMMON DATA APPROACH PIPE DATA

.

.

•

٢

r

r

.

8

A1.

.

.

,

9

.

8

	1345 PUS.										1.993	1.527				1.342	1.324					3.916
	Fen.										1.971	0.747				2-049	0.793					0-696
	ENEPCY MANGE	1 P E .	• 3 4 1	1 P E .	F.	E.	IPE.	. 341	IPE.		-0-000	-0°000	IPE.	1 PE .	1 P E .	-0-001	-0 - 000	1 P E .	1 P.E .	. 191	IPE .	-0-003
	NERGY WN C	TEST P	TEST P	TEST P	ST PIP	ST PIP	TEST P	TEST P	TEST P		0.071	2+0-0	TEST P	TEST P	TEST P	0-074	0.046	TEST P	TEST P	TEST P	TEST P	0.052
•	FRGY E UMP DO M.	ED IN	FD IN	ED IN	IN TE	IN TE	ED IN	FD IN	ED IN		•072	-047	ED IM	ED IM	FD IM	-075	-048	EO IN	ED IM	ED IN	ED IN	•055
ESULTS	TH EN GE UPJ M.	ABLISH	ABLISH	AGLISH	НМ<НС	ни<иС	ABLESH	ABLISH	ABLISH		009 0	0 000	ABLISH	ABLISH	ABLISH	010 0	0 500	ABLISH	ABLISH	ABLISH	ABLISH	0 0 2 0
SKAM K	CHAN	DH EST	DH EST	DH EST	SK 316	BLE AS	M EST	DH EST	DH EST		• • 0 • •	34 0-6	DH EST	H EST	N EST	6.4 0°(37 0.0	14 EST	H EST	IS3 HO	IN EST	÷5 0.
ICA4 ON	HP JUN	ORE FL	JRE FL	DRE FLI	122041	1PO> 511	ואב גרי	JKE FL	JAE FLO		0-0 54	94 9=0	JKE FLI	JRE FLI	JRE FL	1 0-0	32 0.0	JKE FL	DRE FLI	JRE FLI	DKE FL	25 J. 0
DATA A	CEPTO CEPTO	יענו או	יערר או	יטער שו	IUMP II	JUMP I	חרר אנ	חרר פו	יערר אנ		0-0 66	9+ 0-0	יטנר פו	חרר או:	חרר או	0-0 66	14 0-0	חרר או:	יערר שנ	חרר גו	חרר או	34 0°U
PIPE	Y F +M			66-	·	·		-	-		3 4.13	5 1.66		u.		3 4-13	5 1.60			~		5 1-66
TESF	ENTRY ENERG										1 0.2	5 0.1				₽ 0°5	5 0.1					5 0.1
	ENTRY UEPTH M.										0.02	0-01				0.02	J.0.L	10				10-6 0
	I .	0-075	6.0.0	0-075	0-042	0-026	0.075	0 0 75	0.075		0.054	0-034	0-075	0°075	0.075	0.059	0.037	0.075	520-0	0.075	0.075	0-045
	HC HC	420°0	610.0	0 - 067	0 • 0 4 9	4E0 = 0	0.074	0.073	0.067		0 - 0 49	0.034	0.074	610.0	0.067	0 • 0 1 9	0°034	0-074	E70.0	0 = 0 67	0.049	0.034
	5L0PE (51%)	0 - 0 2 5 0	0-0250	0 - 0 - 5 0	0\$20.0	0 ~ 0 2 5 0	0.0125	0.0125	0.0125	ť	0425	0125	001000	0010-0	0.0100	0010-0	0 0 1 0 0	0 • 0 0 • 0	0 • 0 0 2 0	0-00-0	0 - 00 - 0	0 \$ 0 0 \$ 0
DATA	нк ж. И н Р С Ч	0.484	0-420	0.339 (0.230	0-155	0.454 (0- 420	0.339 (0.230 (0.155 (0-484	0-420 (0.339	0.230	0.155 (0.484	0-420	0.339 (0-230	0.155 0
PIPE	NN NN NN		150.0	0:030	0.021	0-015	0-044 (1 20-037	0.030		0.021	010 0	9+0-0	0.037	0:030	0.021	0.015		760-0	0.030	0.021	0.015 (
PRUACH	LUPE	3402	3402	.3492	.3492	3402	.3402	3402	.3402 (. 1402 (3402 6	3492	1402 (3402	3402 (-3402 (2046-	3402	-3402	-3402	2046.
A AP	ANN. S	015 0.	015 0.	015 0	015 0.	015 0.	015 0.	015 0.	015 0		0 510	015 0	015 0.	015 0	0 510	015 0.	015 0	015 C	015 0	0 510	0 510	0 510
AN DA	14. H	.070.	.070.	.070.	.070.	.07 9.	.070.	.070.	.070-		.07 0-	.070-	.070.	.070.	.07 0.	.070.	.070.	.070.	.07 0.	.070.	.070.	.070.
CCM	0. 0 L/S H	d. 0 0.	0 0°9	4=0 0.	2.0 0	1.0 0.	d.0 0.	6.0 0.	4.0 0.		2.0 0.	1.0 0.	6.0 0.	6.0 0.	\$+0 0.	2.0 0.	1.0 0.	d.0 0.	0 0 0	4.0 0	2.0 0	1.0 0.
												A1.	6									

r

4

.

.

•

8

	PUS.									6 60 . 2 1 7 4	107 1.717				192.1 940	•	414-1 664					896 0.936
	ENERGY JUP Hange Fom. M.	1 PE .	IPE.	l Pć .	Е.	•	196.	IPE.	IPE.	-1 CO0-0-	-0 000-0-	IPE.	IPE .	l P E .	-0-001 2-0		-0-000 0-1	196.	IPE.	IPE.	1 PE .	-0-003-0-
	Y ENERGY DOWN C	IN TEST P	IN TEST P	IN TEST P	TEST PLP	TEST PIP	IN TEST P	IN TEST P	IN TEST P	2 0.071	1 0.047	IN TEST P	IN TEST P	IN TEST P	5 0-074		0.040	IN TEST P	IN TEST P	IN TEST P	IN TEST P	5 0.052
SULTS.	H ENERG	ISH I SHED	IBLI SHED	BLISHED	HNCHC IN	HNCHC IN	B_1 SHED	BLISHED	BLI SHED	08 0-07	\$0*0 CO	BLISHED	BLISHED	BLISHED	10 0 PT		02 0°04	BLISHED	ABL I SHED	UBLI SHED	U 3HE T 181	20 0.05
2 JGRAM KE	JAN DEFT PTH CHANG	FLOM ESTA	FLUM ESTA	FLOM ESTA	SIBLE AS	SIBLE AS	FLUN ESTA	FLON ESTA	FLON ESTA	•054 0.0	0.0 466.	FLOM ESTA	FLUM ESTA	FLON ESTA	0-0 650-		0.0 160.	F_UM ESTA	FLON ESTA	FLOM ESTA	FLOM ESTA	•0+5 0•0
ATA AND P	UPJUAP J DEPTH DC M.	טרר אטאנ	טור טקאב	ULL BORE	UHP IMPOS	UMP IMPUS	ULL BORÉ	ULL BURE	ULL BURE	0 <*0.0 0	8 0-V3+ U	ULL BORE	ULL BORE	ULL BORE	0.041 J		8 0.032 J	ULL JORG	ULL BORE	ULL BURE	ULL BURE	U 424.0 H
ST PIPE 0	TRY FUTRY ERGY FOM	ŭ	ŭ	4	7	7	ų.	ŭ	ŭ	0-29 4-69	10.19 1.07	u.	u.	ι <u>ι</u>	0.29 4.69		0.19 1.87	Ľ.	ũ.	u.	•	0.19 1.87
15	E4121 EN 06PT4 EN M.			0	•					¢10*0 +	610-0		10		÷ 0°013		1 0-013	10	2	2	5	6 U.013
	H.H.	0.07	0.07	0.07	0-042	0.024	0.075	0.075	0.07	0.654	0.034	0.075	0.07	0.075	0.05		0.037	0.075	1 0-07	0.07	0.079	· 0 • 0 •
	U.F.	0.074	0.073	0.067	0 • 0 4 6	0.034	0.074	0.073	0.067	0 • 0 4 6	0.034	0.074	0 - 073	0.067	0 - 049		0+034	0.074	0-073	0.067	0 • 0 4 6	0 • 034
	\$10°E	0 • 0 2 5 0	0 * 05 5 0	0 • 0 5 2 0	0 • 0 5 5 0	0 • 0 5 2 0	0.0125	0.0125	0-0125	0.0125	0.0125	0 * 0 1 0 0	0.0100	0010-0	0010-0		00100	0 < 0 0 * 0	0 - 0 0 5 0	0.0050	0 • 0 0 5 0	0 4 0 0 4 0
E DATA	TEKM. ENERGY M.	9 0.628	3 0-543	7 0.436	9 0. 294	3 0.197	9 0.628	3 0.543	7 0.436	9 0.294	3 0. 197	9 0.628	3 0.543	7 0.436	9 0.294		3 0.197	9 0.628	3 0-543	7 0.436	9 0.294	3 0.197
	N .	0.03	0.03	0.02	0.01	0.01	E0*0	E0*0 (0.02	10-0	0.01	0.03	0.03	0.02	10-01		0.01	0.03	0.03	0 0.02	10.0 0	0.01
APPKOA	SLCPE (SIN)	0.5000	0.5000	0.5000	0.5000	0.5000	0*5000	0-5000	0.5000	0.5000	0.5000	0.5006	0.5000	0.5000	0-5000		0-5000	0.5000	005-0	0-5000	0.5000	0.500
N DATA	A. MANN COEFF	510.0 70	7 0.015	17 0.015	17 0.015	510.0 1	17 0.015	10.015	17 0.015	1 0-015	\$10.015	17 0.015	12 0.015	17 0-015	17 0.015		17 0.015	17 0.015	01 0-015	7 0.015	7 0.015	7 0.015
IONNO:	о. 10 ог	8.0 0.0	0.0 0.0	4.0 0.0	2.0 0.0	1.0 0.0	3.0 0.0	5.0 0.0	4.0 0.0	2.0 0.0	1.0 0.0	9 °0 °0	0.0.0.0	4.0 0.0	2.0 0.0		1.0 0.0	3.0 0.0	0 0 0 · 0	4.0 0.C	2.0 0.5	1.0 0.0
												Δ1	.7									

FEST PIPE DATA AND PRJGRAM RESULTS.	ENTRY ENTRY UPJUMP JU4M DEPTM ENTRGY ENERGY ENEPCY JUAP JJ4P Energy F+M dept4 dept4 Change Upjump down Change F+M. Pus. M. N. K. M. M. M. M. M. M. M. M.	FULL BORE FLOM ESTABLISMED IN TEST PIPE.	FULL BORE FLOW ESTABLISHED IN TEST PIPE.	FULL JORE FLOM ESTABLISHED IN TEST PIPE.	JUMP IMPUSSIBLE AS HNCHC IN TEST PIPE.	JUMP IMPUSSIBLE AS HACHE IN TEST PIPE.	FULL BORE FLOW ESTABLISMED IN TEST PIPE.	FULL WORE FLOM ESTABLISHED IN TEST PIPE.	FULL BORE FLOM ESTABLISHED IN TEST PIPE.	0.36 5.264 4.445 J.054 0.008 0.072 0.071 -0.000 1.971 2.15	0.24 2.120 0.034 U.034 0.000 0.047 0.047 -0.050 0.787 1.93	FULL BORE FLJM ESTABLISHED IN TEST PIPE.	FULL BORE FLOM ESTABLISHED IN TEST PIPE.	FULL BURE FLOW ESTABLISHED IN TEST PIPE.	0.36 5.264 0.041 0.054 0.018 0.075 0.074 -0.001 2.049 1.52	0.24 2.120 0.v32 J.J37 0.005 0.048 0.048 -6.000 0.793 1.33	FULL DUKE ² .04 Established in test Pipe.	FULL BORE FLOW ESTABLISHED IN TEST PIPE.	FULL BORE FLOW ESTABLISMED IN TEST PIPE.	FULL BURE FLOW ESTABLISHED IN TEST PIPE.	0 14 1 130 0 016 - 444 0 010 6 046 0 041 - 0 003 0 404 3 01
	SLOPE MC MN ENTRY (SLM) M. M. OEPIA M.	0°0720 0°012	0.0250 0.073 0.075	0.0250 0.067 0.075	0°0250 0°04% 0°042	0°0750 0°034 0°078	0.0125 0.074 0.075	0.0125 0.073 0.675	0.0125 0.067 0.075	0.0125 0.049 0.054 0.017	0.0125 0.034 0.034 0.012	0*0100 0*014 0*0 12	0.0100 0.073 0.475	0.0100 0.067 0.075	0.0100 0.049 0.059 0.017	0.0100 0.03% 0.037 0.01?	0.0050 0.074 0.U75	0.0050 0.073 0.075	0.0050 0.067 0.075	0.0050 0.049 0.075	0,0450 0,034 0,645 0,017
COMMON DATA APPROACH PIPE DATA	J. DIA. MANN. SLUPE HN TEAM. L/S M. CUEFF (SIN) M. ENERGY M.	8.0 0.07 0.015 0.7070 C.036 0.759	0.0 0.07 0.015 0.7070 0.030 U.686	4.0 0.07 0.015 0.7070 0.024 0.551	2.0 0.07 0.015 0.7070 0.017 0.370	1.0 0.07 U.015 0.7070 0.012 0.247	3.0 0.07 0.015 0.7070 0.036 0.799	5.0 0.07 0.015 0.7070 0.030 0.686	4.0 0.07 0.015 0.7070 0.024 0.551	2.0 0.07 0.015 0.7070 0.017 0.370	1.0 0.07 0.015 0.7070 0.012 U.247	8.0 0.07 0.015 0.7070 0.036 0.799	6.0 0.07 0.015 0.7070 0.030 0.686	4.0 0.07 0.015 0.7373 0.024 0.551	2.0 0.07 0.015 0.7073 0.017 0.370	1.0 0.07 0.015 0.7070 0.012 0.247	4.0 0.UT 6.015 0.1070 0.036 0.799	1.0 0.07 0.015 0.7070 0.039 0.686	4.0 0.07 0.015 0.2070 0.024 0.551	2.0 0.07 0.015 0.7070 0.017 0.370	1.0 0.07 6.015 0.7070 0.012 0.247

* * *

.

8

.

:

A1.8

-

•

•

•

-

RAM RESULTS.	DEPTH ENERGY ENERGY ENERGY JURP JJ4P CHANGE UPJUMP DOWN CHANGE F+N. PJS. M. M. M. M. M. M.	# ESTABLISHED IN TEST PIPE.	M ESTABLISHED IN TEST PIPE.	M ESTABLISHED IN TEST PIPE.	LE AS HNCHC IN TEST PIPE.	LE AS HN <hc in="" pipe.<="" test="" th=""><th>M ESTABLISHED IN TEST PIPE.</th><th>M ESTABLISHED IN TEST PIPE.</th><th># ESTABLISHED IN TEST PIPE.</th><th>+ 0.008 0.072 0.071 -0.000 1.971 2.28</th><th>+ 0.000 0.047 0.047 -0.000 0.787 1.864</th><th># ESTABLISHED IN TEST PIPE.</th><th>M ESTABLISHED IN TEST PIPE.</th><th>M ESTABLISHED IN TEST PIPE.</th><th>9 0.018 0.075 0.074 -0.001 2.049 1.883</th><th>7 0.005 0.048 0.048 -0.000 0.793 1.564</th><th>A ESTABLISHED IN TEST PIPE.</th><th>M ESTABLISHEG IN TEST PIPE.</th><th>M ESTABLISHED IN TEST PIPE.</th><th># ESTABLISHED IN TEST PIPE.</th><th>> 0.020 0.055 0.052 -0.003 0.696 1.352</th><th></th></hc>	M ESTABLISHED IN TEST PIPE.	M ESTABLISHED IN TEST PIPE.	# ESTABLISHED IN TEST PIPE.	+ 0.008 0.072 0.071 -0.000 1.971 2.28	+ 0.000 0.047 0.047 -0.000 0.787 1.864	# ESTABLISHED IN TEST PIPE.	M ESTABLISHED IN TEST PIPE.	M ESTABLISHED IN TEST PIPE.	9 0.018 0.075 0.074 -0.001 2.049 1.883	7 0.005 0.048 0.048 -0.000 0.793 1.564	A ESTABLISHED IN TEST PIPE.	M ESTABLISHEG IN TEST PIPE.	M ESTABLISHED IN TEST PIPE.	# ESTABLISHED IN TEST PIPE.	> 0.020 0.055 0.052 -0.003 0.696 1.352	
TEST PIPE DATA AND PAJO	ENTRY ENTRY UPJUMP ULMP ENERGY F.M. DEPTH DEPTP M. N. M. M. M.	FULL BURE FL	FULL BURE FL	FULL BORE FL	JUMP IMPOSSI	INPOSSION INPOSSION	FULL BURE FLO	FULL BORE FL	FULL BORE FL	0.41 5.548 0.045 U.0	0.28 2.315 0.034 0.0	FULL BORE FLO	FULL BORE FL	FULL BORE FL	0.41 5.598 0.041 U.0	0.28 2.315 0.032 0.0	FULL BORE FL	FULL BORE FL	FULL BORE FL	FULL BORE FL	0.28 2.315 0.025 J.0	•
-	HN ENTAV E M. DEPTH E M. M.	•075	• 0 7 5	.075	•0+2	.028	•075	.075	.075	.054 0.016	•034 0.012	.075	• 0 7 5	•075	.059 0.016	-037 0-012	•075	.075	•075	.075	.045 0.012	
	H HC	0520 0.074 0	0 620 0.073 0	0 290 0.067 0	1250 0.049 0	0 + 60 • 0 3 4 0	0 +20 0 210	0 620 .073 0	0125 0.067 0	125 0-049 0	0 460.0 34 0	0 +20 0 0010	0 620.0 0010	0 100 0.067 0	0 640 0 0010	0 460 0 0010	0 \$20 0.074 0	0 620 0.023 0.	0 290 0.067 0	0 640 0.049 0	0 460 0 0500	
TPE DATA	IN TEKN. SLI ENERCY (S.	034 0.921 0.	029 0.791 0.	023 0.631 0.0	016 0.424 0.0	012 0.283 0.0	034 0.921 7.	029 0.791 0.0	023 0.631 0.0	016 0.424 0.6	012 0.283 0.0	034 0.921 0.0	076 0.791 0.0	023 0.631 0.0	016 0.424 0.0	012 0.283 0.0	034 0.921 0.0	029 0.791 0.0	073 0.631 0.	016 0.424 0.0	012 0.283 0.0	
APPROACH P	SLUPE H	5 0.8660 0.	0.0000.0.	0.8660 0.	0.8660 0.	5 0.8660 0.	5 0.8660 0.	5 0.8660 0 .	5 0.8660 0.	0.8660 0.	0.8660 0.	0.8660 0.	5 0.8660 0.	5 0.8660 0 .	5 0.8660 0.	5 0.6660 0.	5 0.8660 0.	5 0.8660 0.	5 0.8660 0.	5 0.8650 0°	0 0 0 0 0 0 0	
HHON DATA	DIA. MANN. M. COEFI	0.07 0.01	0.07 0.01	0.07 0.01:	0.07 0.015	0.07 0.01	0.07 0.01	0.07 0.01	0.07 0.01	0.07 0.015	0.07 0.015	0.07 0.01	0.07 0.01	0.07 0.01	0.07 0.01	0.07 0.019	0.07 0.01	0.07 0.01	0.07 0.01	0.07 0.01	0.07 0.01	
CO	0. L/S	d . 0	6.0	• • 0	2.0	1.0	ð • 0	6 • 0	4.0	2.0	1.0	0. 20 A 1	0.0		2.0	1.0	0°9	0.0	4.0	2.0	1.0	

I

TEST PIPE DATA AND PAJGRAM RESULTS.



0. 0.011 N. FLUNE N. FLUNE N. FLUNE N. FLUNE N. FLUNE N. FLUNE N. M. M. <thm.< th=""> M. M. M.<</thm.<>	ENTRY ENTRY UPJUMP JJWN DEPTH ENERGY ENERGY ENERGY JUMP JUMP D Energy F+M Depth Depth Change upjump down Change F+M. Pus. M. N. M.	FULL BURE FLOW ESTABLISHED IN TEST PIPE.	FULL BURE FLOM ESTABLISHED IN TEST PIPE.	FULL BORE FLUM ESTABLISHED IN TEST PIPE.	JUMP IMPOSSIBLE AS HNCHC IN TEST PIPE.	JUMP INPOSSIBLE AS HNKHC IN TEST PIPE.	FULL BORE FLOW ESTAULISHED IN TEST PIPE.	FULL BORE FLOW ESTABLISHED IN TEST PIPE.	FULL BORE FLOW ESTABLISHED IN TEST PIPE.	b 0.46 5.974 0.045 U.054 0.008 0.072 0.071 -0.000 1.971 2.233	1 0.31 2.425 0.034 0.034 0.000 0.047 0.047 -0.000 0.767 1.333	FULL BURE FLOW ESTAULISHED IN TEST PIPE.	FULL BOKE FLOW ESTABLISHED IN TEST PIPE.	FULL BORE FLOM ESTABLISHED IN TEST PIPE.	£ 0.46 5.974 0.041 0.059 0.018 0.075 0.074 -0.001 2.049 1.945	1 0.31 2.425 0.032 0.031 0.005 0.048 0.048 -0.000 0.793 1.573	FULL BURE FLUM ESTABLISHED IN TEST PIPE.	FULL BORE FLOW ESTABLISHED IN TEST PIPE.	FULL BORE FLOM ESTABLISHED IN TEST PIPE.	. FULL ADRE FLOW ESTABLISHED IN TEST PIPE.	1 0.31 2.425 0.025 U.045 0.020 0.055 0.052 -0.003 0.696 1.081	
¹	IN ENTRY	075	075	075	042	028	0.75	0.75	075	054 0-01	10-0 460	075	075	075	059 0.01	037 0-01	0 75	0.75	075	0.75	045 0.01	
O. Dia. Hann. Sturf A Hann. Sturf COFFF Hann. Sturf Sini Han Kan Fuektor Sturf Sini 1.0 0.07 0.015 1.0010 0.032 1.018 0.0250 4.0 0.07 0.015 1.0000 0.022 0.0250 0.0250 4.0 0.07 0.015 1.0000 0.022 0.0250 0.0250 2.0 0.077 0.015 1.0000 0.022 0.0250 0.0250 2.0 0.077 0.015 1.0000 0.011 0.0125 0.0125 3.0 0.077 0.015 1.0000 0.012 0.0125 0.0125 4.0 0.077 0.015 1.0000 0.012 0.0125 0.0125 4.0 0.017 0.015 1.0000 0.012 0.0125 0.0125 4.0 0.011 0.011 0.011 0.0125 0.0125 0.0125 4.0 0.011 1.0000 0.011 0.0126 0.0125 0.0125 4.0	0 + 1 E	0 - 01 - 0	0.073 0.	0.067 0.	0.049 0.	0.034 0.	0.074 0.	0.073 0.	0.067 0.	0.049 0.	0 460.0	0.074 0.	0.073 0.	0.067 0.	0.049 0.	0.034 0.	0.074 0.	0.073 0.	0.067 0.	0.049 0.	0.034 0.	
Q. DIA. MANN. SLUF HN TERH. J.O Q.OT COEFF (SIN) A. ENLHCY J.O Q.OT U.OUIS L.OUTO Q.OS D.471 J.O Q.OT U.OUIS L.OUTO Q.OS D.471 J.O Q.OT U.OUIS L.OUTO Q.OS D.471 J.O Q.OT Q.OUIS L.OUTO Q.OS D.471 J.O Q.OT Q.OUIS L.OUTO Q.OS D.471 J.O Q.OT Q.OUIS L.OUTO Q.OS D.491 J.O Q.OT L.OUTO Q.OLIS L.OUTO D.491 J.O Q.OT Q.OTS L.OUTO Q.OS D.491 J.O	SL07E (514)	0 < 7 0 * 6	0 • 05 50	0 • 0 5 0	0 * 0 7 2 0	0 \$ 7 0 * 0	0.0125	0.0125	0.0125	0.0125	0.0125	0.0100	0.0100	0.0100	0.0100	0.0100	0 • 00 2 0	0.0050	0.0050	0,00,0	0.0050	
Q. DIA. MANN. SLUF H J.O Q.O V.OLS L.0000 Q.O J.O Q.O Q.O V.OLS L.0000 Q.O J.O Q.O Q.O Q.O Q.O Q.O J.O Q.O Q.O Q.O Q.O Q.O Q.O J.O Q.O Q.O Q.O Q.O Q.O Q.O Q.O J.O Q.O Q.O Q.O Q.O Q.O Q.O Q.O Q.O Z.O Q.O Q.O Q.O Q.O Q.O Q.O Q.O Z.O Q.O Q.O Q.O Q.O Q.O Q.O Q.O Z.O Q.O	TERM. ENERGY M.	32 1.018	28 0.871	2 0.696	6 0.466	11 0.310	1.018	8 0.871	2 0.696	16 0.468	1 0.310	12 1.018	28 0.871	22 0.696	16 0.468	11 0.310	32 1.018	28 0.871	22 0.696	16 0.468	11 0.310	
0 DIA MANN SLUP 4.0 0.07 0.015 1.000 6.0 0.07 0.015 1.000 4.0 0.07 0.015 1.000 4.0 0.07 0.015 1.000 2.0 0.07 0.015 1.000 2.0 0.07 0.015 1.000 2.0 0.07 0.015 1.000 4.0 0.07 0.015 1.000 4.0 0.07 0.015 1.000 4.0 0.07 0.015 1.000 2.0 0.07 0.015 1.000 4.0 0.07 0.015 1.000 4.0 0.017 0.015 1.000 4.0 0.017 0.015 1.000 4.0 0.017 0.015 1.000 4.0 0.017 0.015 1.000 4.0 0.017 0.015 1.000 4.0 0.017 0.015 1.000	Z ·	0*0 00	0.0.00	0 0 0	10 0.01	0 0.01	0 0 00	0 0 00	0 0.02	0.00	0 0.01	0 0 00	0.0	0 0 00	10 0 00	0 0 00	0 0 00	0 0 00	0 0 00	10 0 00	0.0.00	
0.01 0.01 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 2.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.07 0.01 4.0 0.017 0.01 4.0 0.017 0.01 4.0 0.017 0.01 4.0 0.017 0.01 4.0 0.017 0.015 4.0 0.017 0.015 4.0 0.017 0.015 <	SLUP:	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
 PIA PIA PIA PA PA<td>COEFF</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0.015</td><td>0 - 015</td><td>0.015</td><td></td>	COEFF	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0 - 015	0.015	
	р[д. Ч.	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	20.0	10.07	0.07	
	0.	5 0	6.0	4 • 0	2 • 0	1.0	а. 0	¢ • 0	4 • 0	2 • 0	1.0	8 • 0	6.0	• •	2.0	1.0	d • Ú	6.0	4 • 0	2.0	1 - 0	

TEST PIPE DATA AND PROGRAM RESULTS.

COMMON DATA APPROACH PIPE DATA

#

,



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

ς.

	- 50													. 542	.778	- 585				. 385	
	74 44 2.4								1 224-					. 978 .	.808	0 642-				994 0	700 0
	RGY JI	•					0	•	000			•	•	000	000	0 000		•	•	1 600	0 100
	Y ENF CHA	PIPE	• 3 4 1	• 3 d J	l PE.	l P E 。	PIPE	9414	•0- E	. PE .	1 P E .	P 1 P E	9 1 P E	5 -0-	-0- 2	•0- E	PIPE	9414	P 8 P 6	7 -0.	-
	ENERG DOWN	test	rest P	EST P	TEST P	IEST P	I TEST	TEST	0 0	EST P	EST P	I TEST	TEST	0 ° 0	0 • 00	0 - 04	I TEST	I TEST	I TEST	0.06	0
2.	PJUMP	HED II	C IN 1	C IN 1	C IN 1	CINI	HED IN	HED IN	£60°0	C EN I	C IN 1	HED IN	HED IN	0.095	0•062	0-043	HED IF	HED IN	HED IN	0.069	440-0
RESULT	PTH E Ange u M.	TABLTS	S HM <h< td=""><td>S HN<h< td=""><td>S HNCH</td><td>S HNCH</td><td>TABLIS</td><td>TABLI S</td><td>• 005</td><td>S HNCH</td><td>S HUCH</td><td>I ABLI S</td><td>TABLI S</td><td>210-</td><td>£00°</td><td>100*</td><td>TABL I S</td><td>TABLI S</td><td>TABLIS</td><td>.023</td><td>510</td></h<></td></h<>	S HN <h< td=""><td>S HNCH</td><td>S HNCH</td><td>TABLIS</td><td>TABLI S</td><td>• 005</td><td>S HNCH</td><td>S HUCH</td><td>I ABLI S</td><td>TABLI S</td><td>210-</td><td>£00°</td><td>100*</td><td>TABL I S</td><td>TABLI S</td><td>TABLIS</td><td>.023</td><td>510</td></h<>	S HNCH	S HNCH	TABLIS	TABLI S	• 005	S HNCH	S HUCH	I ABLI S	TABLI S	210-	£00°	100*	TABL I S	TABLI S	TABLIS	.023	510
GRAN	N DE TH CH	OM ES	8LE A	8LE A	BLE A	BLE A	ON ES	OM ES	6 6 0	8 LE A	BLE A	OM ES	04 ES	7 4 0	• 7 • 0	32 0	OM ES	OM ES	0H ES	54 0	0
D PRO	P UUH	RE FL	P 0551	15504	15504	0551	KE FL	RE FL	0.0	1550	15 50	RE FL	KE FL:	0.0	0.0	0-01	RE FL	SE FL	KE FL(0 • n	.0.0
TA AN	UPJUH DEPT	LL 80	HP IN	MP 1M	MP IN	MP IM	LL 80	LL 80	0 • 0 6	HP IN	MP IN	LL 801	LL 801	0 - 05	0+04	0+03	LL 80	רר פחו	LL 801	0.03	0.020
P E DA	N T R Y F + M N +	F U) ľ) r	UL.	U.C.	FU	FU	4 - 960	2	2	, FU	FU	4-960	2 - 048	0 - 844	FU	FU	FUI	2.040	0 - 844
EST PL	NTRY E Mergy M.								0-10					0.10	0-07	0.05	0			0-07	0.05
en e	HTRY E PTH E M.								640-					640-0	• 033	• 023	•			.033	1.023
	TH DE	100	110.	• 50 •	960.	025	100	100	068 0	440	000	100	100	0 420	047 0	032 0	100	100	100	058 0	0 910
	U .	089 0.	0 29 0.	065 0.	045 0	0 160	089 0.	019 0.	065 0.	045 04	031 0.	089 0.	079 0.	065 0.	045 0.	0 160	0 88 0	0.79 0.	065 0.	045 0	0 160
	Ξź	•0 0	•0 0	0 0	0 0	•• 0 0	5 0 • I	5 0.	5 0.	5 0.6	5 0°(0 0	0 0	0 0 0	0 0	•0 0	0 0	• 0 0	• 0 0	0	0 0
	SLOPE	0.025	0 • 025	0°025	0°025	¢20.0	5.01Z	0.012	0 • 01 2	0.012	0 • 01 2	0 - 0 1 0	0.010	0.010	0.010	0.010	0 - 005	\$00°0	0°005	0-005	0-005
DATA	TERM. ENERGY M.	0.153	0.131	0.105	0.072	0-050	0-153	0.131	0.105	0.072	0°050	0.153	161-0	0.105	0-072	0°050	0-153	0.131	0.105	0.072	0-050
516	I t	0-078	E90°0	0-0+9	0 - 033	0.023	0.078	0.063	0-040	0.033	0 - 02 3	0.078	0-063	0•049	660-0	0.023	0.078	690-0	0*0*0	0.033	620-0
PROACH	I NI SI	• 0349	6460*	6460-0	64E0*	64E0*	.0349	• • 03 • 9	•0349	• • • • • •	•0349	-0349	6460-	• 0 3 4 9	64E0-	64 60*	6460*	• 0349	6460-0	6460-0	
TA A	DEFF	.015 0	.015 0	• 015 0	.015 0	.015 0	.015 0	-015 0	.015 0	.015 0	.015 0	.015 0	.015 0	.015 0	.015 0	-015 0	.015 0	-015 0	015 0	.015 0	-015 0
TO NO	- U	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0
COMMI	. M.	•0 0•	•0 0•	• 0 0 •	0.0.	•0 0•	0 0.	0 0.	•0 0•	0 0.	0 0	•0 0•	•0 0	.0 0.	• 0 0 •	.0 0.	•0 0•	• 0 0 •	•0 0•	.0 0.	.0 0.
	5	60	9	æ	2.	1	8	ø	*	2	1	6	Ģ	*	2	-	10	Ó	•	2	-

Λ2.2
									33					. ~ 4	52					53	56
	50.								1.1					1.2	1.2	3 0.1				1 3.5	0 0.1
									1.472						1.605	0-743				1.93	562-0
	NGE .	•					•		000			•	•	000	000	900			•	600	100
	ENE	9914	РЕ.	βE.	р Е.	PE.	3414	9195	-0-	PE.	PE.	9 1 P E	919E	-0-	-0-	-0-	PIPE	2414	P 1 P 6	•0-	• 0 -
	NN	TEST	11 IS	Id 1S	14 1S	14 15	rest	TEST	E60°0	14 15	14 15	I E S I	1231	0.095	0.062	043	resr	TEST	IEST	0.067	0.045
	RP DC	M	N TE	N TE:	N TE	N TES	N	E M	63 (N TES	N TES	INI	N.	95 (62 (43 (I NI	N	H	69	40
.T S.	ENFR	SHE D	HC I	CHC E	CHC I	CHC A	SHED	SHE D	0.0	HC I	НС І	SHED	SHED	0 • 0	0 • 0	0 • 0	SHFD	SHE D	SHED	0 • 0	0 * 0
KESJL	PTH ANGR	IABLI	S HN	S HN	S HM	S HN	I 484 I	TABLE	• 0 0 5	S HN	S HNC	TABL	IABL	• 017	.003	100*	TABLE	TABLI	TABL	.023	.013
KAN	H CH	IN ES	LE A	LE A	LEA	LE A	14 ES	H ES	1 0	LEA	LE A	H ES	M ES	•	1 0	2 0	H ES	H ES	ES	9	6
P < 05	00W4	E FLU	91550	05518	0 Z Z I A	05580	E FLO	E FLO	0.06	05518	05 S L B	E FLO	E FLO	0°C	0.04	0.03	E FLO	E F. 0	E FLO	J • 05	1 • 0 J
ANO	JU4P EPTH M.	BOR	INP	INP	INP	1HP	BOR	BUR	• 062	IMP	IMP	8 D.K (80%	• 05 7	• • • •	160.	BORI	808	N O KI	• 035	• 025
DATA	40 20	FULL	AHUL	ANUL	JUMP	JUNE	FULL	FULL	360 0	JUNE	AMUL	FULL	FULL	0 090	25 0	0 480	FULL	FULL	FULL	125 0	994 0
P I P E	Е А Т 7 - 5 - 7 7 - 6 - 7								3 5 • 6					3 5.6	4 2.4	6 Ja				9 2.4	° 0 •
EST	NTAY NEKG N.								0.1					0.1	0 • 0	0•0				0.0	0 • 0
-	TRY PTS								.040					C+0 *	• 0 • 3	• 020	•			• 029	c 20 •
	E 4	00	11	54	36	25	00	00	68 0	44	30	00	00	74 0	47 0	32 0	00	00	00	58 0	39 0
	H L	0.1	0-0	0.0	0.0	0-0	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0 • 0	0.1	0.1	0.1	0.0	0 0 1
	U + E	60.0	0.079	0•065	0 • 043	0.031	0 - 069	520-0	0.065	0+0+0	0.031	0.089	0.079	0.065	0.045	0 • 03 1	0.089	0.079	0 • 0 6 5	0 - 0 - 5	0 • 031
	3 8	1250	250	250	12 50	250	125	125	125	125	125	100	100	001	100	100	020	050	050	050	150
	V (S1	0.0	7 0.0	4 0.6	2 0.0	3 0.0	0.0	2 0.0	0.0	2 0 0	3 0.0	1 0-0	7 0.0	0 0 4	2 0.0	3 0.0	0-0	7 0.0	4 0.6	2 0.0	3 0.0
DATA	EKM. NERG	0.19	0.16	0.13	0.09	0 • 0 6	0. 19	0.16	0.13	60.09	0 • 00	0.19	0-16	0.13	0 • 0	0. 96	0.19	0.16	0.13	0.09	0• 00
3414	× ·	.060	• 050	• 0 + 0	• 028	• 020	• 0 6 0	• 050	040	.023	. 020	• 0 6 0	• 050	• 0 + 0	• 028	• 920	•090	• 050	• 0 • 0	.028	• 070
ACH	u	0 66	98 0	98 0	38 0	93 0	9.8.0	0 96	98 0	98 0	9 86	0 96	0 86	98 0	94 0	0 86	9. 0	9.6 0	9.8.0	0 66	93 0
APPR0	SLOP	0.06	0.06	0.06	0.06	0 • 09	0.06	0°05	0.06	0.05	0.06	0•06	0.06	0.06	0.06	0.06	0°04	0 • 09	0.06	0 • 0>	0°0
TA	ANN. OEFF	• 015	.015	•015	.015	• 015	• 015	• 015	• 015	• 015	• 015	•015	• 015	•015	• 015	.015	.015	• 015	• 015	• 015	• 015
N DA	•	0 01	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	0 01	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0
COMMO	- N	• 0 0 •	• 0 0 •	• 0 0 •	• 0 0 •	• 0 0 •	• 0 0 •	• 0 0 •	•0 0•	• 0 0 •	• 0 0 •	•0 0•	•0 0•	•0 0•	•0 0•	•0 0•	• 0 0 •	• 0 0 •	• 0 0 •	•0 0.	• 0 0 •
	5	0	¢	•	2	1	0	â	•	2	ч.	10	•	*	2	1	10	0	*	~	1

A2.3

A2.4

	•							18					52	52					56	54
50.								2.5					2.0	1.7	1.2				0 - 0	0.7
4 F F								11+-					• 5 8 9	• 608	. 743				+ 66 *	662.
1 L 2 2 2 2 2 2								6 00					00	1 00	0 0 0				03 1	0 10
ENER Caan	IPE.	F.	E.	E.	e u	IPE.	IPE.	-0-0	÷.	÷.	IPE.	. 3 4 1	-0-0	-0-0	-0-0	. 3 J I .	. 3 d T .	IPE.	-0+0	-0-
ERG V	EST P	I PIF	T PIF	111	T PIF	EST F	EST P	•093	T PIF	T PIF	EST P	EST P	• 0 9 5	• 062	• 043	EST P	EST P	EST #	• 067	• 045
N O O O	I NI	TES	TES	TES	TES	T NI	T NI	3	TES	TES	I NI	IN I	5 0	2 0	3	IN T	I NI	THI	0	9
IP JUM	HED	IC IN	IC IN	ÍC IN	ÍC IN	HED	HED	0 • 0 6	IC IN	IC IN	HED	HED	0.09	0.06	0-04	HED	HED	SHED	0.06	0-04
H S H	ABLIS	HNC	HNA	HNC	HN<	ABLI	ABLIS	500	HNK	HN <	19615	1961	110	E 0 0	100	ABLI S	1961	ABLIS	023	610
DEP CHA	EST	E AS	E AS	E AS	E AS	EST	EST	•0	E AS	E AS	EST	EST	•0	•0	0.	EST	EST	EST	•0	•0
1044 1671	FLON	STBL	5186	SIBL	1815	FL 0H	FLOH	.058	5 I BL	5181	FLOH	FLON	+10-1		• 0 3 2	FLDH	FLOH	FLOW	.058	660.0
HT -	BURE	I MPD>	IHPOS	14005	IMPOS	BORE	BORE	062 (IMPOS	IMPO	BORE	BORE	157 1	043 0	031 0	BORE	BORE	BORE	1 560	0.25
L A U D H	ערר	UNP	UMP	AND	UMP	ULL	חרר	8 0.	UMP	UNP	חרר	חרר	8 0 °(- 0 E	5_0 e	חרר	חרר	חרר	3 0 .	5 0.
N TRY F + N N =	<u>u</u>	7	1	7	7	u.	ũ.	7.61	7	-1	4	Ū.	7.01	3+14	1.•28	ũ.	Ű.	Ū.	3+14	1.28
TAY E Excy 1.								0-21					0.21	0.14	60.0				0-14	0.09
								31					31 (22	16				22	16
ENTR DEPT M.	0	_			-	-	0	0 0		0	0		0 • 0	0.0	0.0		~		0.0	0 • 0
N N N	0.10	0.07	0.054	0.036	0-02	0 - 10(0-10(0.066	0-04	0.030	0.10(0.100	0.074	0+0+1	0-03	0-100	0-100	0-100	0-056	0-03
¥ :	089	079	065	540	160	089	019	065	045	160	080	019	065	045	160	089	610	065	.045	031
**	0 0	0.03	0 0	0 0	50 0.	5 0	5 0.	5 0.	25 0.	25 0.	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 09	0 09	0 0
SLD*E	0 - 025	0-02	0-025	0-025	0 02	0.012	0.012	0.012	0-013	0.012	0.010	0.010	0.010	0.010	0.010	0.00	00000	0.00	0.00	00.00
RGY	312	267	214	145	260	312	267	214	145	260	312	267	214	145	260	312	267	214	145	260
A A A	46 0.	39 0.	31 0.	22 0.	16 0.	46 0.	39 0.	31 0.	22 0.	16 0.	16 0.	39 0.	31 0.	22 0.	16 0.	4 Q O •	39 0.	31 0,	22 0.	16 0.
I E	0 0	0 • 0	0.0	0 - 0	0.0	0 . 0	0.0	0.0	0 . 0	0.0	0 • 0	0 • 0	0.0	0 • 0	0.0	0 • 0	0 . 0	0.0	0 . 0	0 • 0
CPE	1736	1736	1736	1736	1736	1736	1736	1736	1736	1736	1736	1736	1736	1736	1736	1736	1736	1736	1736	4611.
4. SL	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	\$5 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.
COFI	0.0	0.01	0 - 0	0.01	0.0	0 - 0	0.0	0.0	0 • 0	0.0	0.0	0 • 0	0 • 0	0 • 0	0 - 0	0 . 0	0 • 0	0 . 0	0 - 0	0 - 0
ог A. Н.	0.10	0.10	0.10	0.10	0.10	0•10	0.10	0.10	0.10	0•10	0.10	0•10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0-10
.0.	8.0	6.0	••0	2.0	1.0	8.0	6.0	9.0	2.0	1.0	0-0	6.0	0**	2 • 0	1.0	0.0	6.0	••0	2.0	1 • 0
_																				

TEST PIPE DATA AND PAJGRAM RESU.TS.

COMMON DATA APPROACH FIFE DATA

-

-

...

Λ2.5

•

.

c0 ••	DIA.	NANN.	APPROAC SLOPE	HN PIP	E DATA TERM.	SLOPE	НС	NH	ENTRY EI	EST PIPE NTRY ENTI	DATA AND	PROGRAM UUHN D	I RESULT	S. MERGY EN	HERGY E	NERGY	4405	4HC P
۲/۱	*	C OEFF	(11 5 3	H.	ENERG M.	A CSINE	÷	ž	DEPTH E	NEKGY F+I M. N.	H DEPTH	06 P T H C H.	HANGE U M.	PJUMP DC	DWN C	HANGE	F•h.	• 364
0 ° 0	0.10	0.015	0.3402	0.030	8 0.47	4 0-0250	0.089	0.100			FULL BUR	E FLOM E	STABLES	HED IN I	IEST PI	IPE.		
6 • 0	0* 10	0.015	0.3402	0.03	3 0.40	4 0.0250	0.079	0.071			AMI AMUL	0\$ \$18LE	AS HNCH	C IN TES	ST PIPE	•		
0 • ¢	0.10	0.015	0.3492	0-02	6 0.32	2 0.0250	0.065	0.054			JUMP INP	0551BLE	AS HNCH	C IN TES	ST PIPE	•		
2 • 0	0.10	0-015	0.3402	0.01	9 0.21	6 0.0250	0.045	0.036			JUHP INP	05 STBLE	AS HNCH	C IN TES	ST PIPE	•		
1.0	0.10	0.015	0.3402	0.01	3 0.14	• 0-0250	0.031	0-025			JUNP INP	0551816	AS HNCH	C IN TES	T PIPE	•		
8.0	0.10	0.015	0-3402	0.03	8 0.47	4 0°0125	0.089	0.100			FULL BOR	E FLOW E	STABLIS	HED IN I	FEST P1	IPE.		
6.0	0.10	0.015	0.3402	0.03	3 0-40	4 0-0125	0.079	0°100			FULL BOR	E FLOW E	STABLES	HED IN 1	IEST PI	IPE.		
4 • 0	0. 10	0.015	0-3402	0-026	6 0-32	2 0-0125	0.065	0.068	0.026	0.32 9.	778 0.062	0.068	0.005	0.093 (- 660-0	-0-000	224-4	186.6
											×.							
2.0	0.10	0.015	0-3402	0.019	9 0.21	6 0.0125	0.045	0-044			JUMP INP	05510.E	AS HNCH	C IN TES	57 PIPE			1
 1.0	0.10	0.015	0.3432	0.013	3 0.14	4 0.0125	0.031	0.030			JUNP IMP	05 SIBLE	AS HN <h< td=""><td>C IN TES</td><td>ST PLPE</td><td></td><td></td><td></td></h<>	C IN TES	ST PLPE			
8 • 0	0.10	0.015	0.3402	0.036	8 0.47	4 0.0100	0.069	0°100			FULL BOR	E FLON E	STABLIS	HED IN	IEST PI	IPE.		
6 • 0	0.10	0.015	0.3402	0.03	3 0-40	0.10.0	0.079	0.100			FULL BOR	E FLOW E	STABLES	HED IN 1	TEST PI	i PE.		
4 • 0	0.10	0.015	0.3402	0.026	6 0.32	2 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	2.536
2.0	0.10	0.015	0.3402	0.01	9 0.21	6 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	2.006
1.0	0.10	0-015	0.3402	0.01	3 0.14	4 0-0100	0.031	0.032	0.013	0-14 1-0	612 0°031	0 • 0 32	0.001	0.043.	0+043 -	-00000	E+1-0	1.456
8 • 0	.0.10	0.015	0.3402	0-03	8 0.47	4 0.0050	0.089	0.100			FULL BOR	E FLON E	STABLIS	HED IN 1	IEST PI	IPE.		
6 • 0	0.10	0.015	0.3402	0.03	3 0.40	• 0-0050	0.079	0.100		•	FULL BOR	E FLOW E	STABLES	HEO IN 1	IST PI	1 P.E .		
4 • 0	0-10	0.015	0.3402	0.02	6 0.32	2 0.0050	0.065	0-100			FULL BOR	E FLOH E	STABLTS	HED IN 1	IEST PI	IPE.		
2 • 0	0.10	0.015	0.3402	0.01	9 0.21	6 0°0050	440 °0 (0 • 058	0.019	0.21 3.	929 0.035	0.053	0.023	0.069	- 067 -	-0-003	1.994	1.332
1.0	0•10	0.015	0+3402	0.01	3 0.14	4 0-0350	0.031	0.039	013°C	0.14 1.	512 0.025	££0 • ¢	610.0	0.046	- \$+0-0	-0.001	662*0	3.932

Λ2.6

.

	E 774	2 6 2 2 6 4 2 7 9 2 7 9 2 7 9 2 7 9 7 7 7 7 7 7 7 7	
	2	1.8	1.994
		0-000 0-000 0-000 - 0 - 0 - 0 - 0 - 0 -	PE . 0.003
ERCY EL HN CI EST PI FIPE	F PLPE.	- 095 - 062 - 063 - 1	- 067 -
TE SI	IN TEST IN TE IN TE 10 -0 -0 -0 -0 -0 -0 -0 -0 -0 -0 -0 -0 -0 -	5 0. 5 0. 1 1 16 1 11	IN TO 70 0.
LTS. ENER UPJUI UPJUI LSHED ENC II CHC II	CHC IN SHED ISHED 0.00 CHC IN SHED ISHED	0.0 0.0	0.01
A KESU DEPTH CHANGE A. A. A. A. A. A. A. A. A. A. A.	AS 44 ESTABLI ESTABLI 0.005 AS 444 AS 444 ESTABLI	0.017 0.003 0.001 0.001 51ABL	0.023 0.013
KOGKAN DWN I EPTH I FLOW I SIBLE SIBLE	SIBLE FLUM 8 - 104 8 - 104 8 - 104 8 - 104 8 - 104 8	.074 .077 .032 .032 .104 .104	FLOH
AND P UAP U PTH) P BORE IAPUS IAPOS	IMP05 BJRE BJRE BJRE IMP05 BJRE BJRE	057 J. 044 J 031 Q. 80RE 1	BURE (035 J
0A1A Y UPJ Full Jump Jump	JUNP FULL FULL FULL FULL	79 0. 93 0. 91 LL	FULL 98 0. 93 0.
	141.	111-1 	E • 4. 5
TE ST ENTRY A. M.	0 ° 4 j	0.2	0.20
атат Прти П.	¢ . 0 ° 0	0.012 0.012	0-017
НИ Е М. С 0.071 0.074 0.054	0.025 0.100 0.100 0.058 0.058 0.030 0.100	0.077 0.047 0.032 0.100 0.100	0.100 0.058 0.039
HC • 089 • 045	.031 .089 .079 .079 .045 .045 .031 .031	.065 .015 .031 .089	• 045 • 045
PFE NJ 2550 0 2550 0 2550 0 2550 0	2550 0 1125 0 1125 0 1125 0 125 0 125 0 125 0 125 0 120 0	100 0 100 0 100 0 350 0	050 0
Y (51 1 0-0 1 0-0 3 0-0	3 0.0 1 0.0 1 0.0 2 0.0 2 0.0 1 0.0	3 0.0 6 0.0 1 0.0	3 0.0 6 0.0 3 0.0
DATA TEKH- ENEKG N- 0.61 0.52 0.41 0.27	0.18 0.61 0.52 0.41 0.27 0.18 0.61	0.41 0.27 0.18 0.51 0.51	0.27 0.27 0.18
РЕРЕ Ни 0.034 0.024 0.024 0.027	0.012 0.034 0.029 0.024 0.024 0.012 0.012 0.039	0.024 0.017 0.012 0.012 0.034 0.029	0 • 02 4 0 • 01 7 0 • 01 2
PR34C4 51N1 51N1 5000 5000	-5000 -5000 -5000 -5000 -5000	• 5000 • 5000 • 5000	• 5000
A AP NM. 5 IEFF (015 0 015 0 015 0	015 0 015 0 015 0 015 0 015 0 015 0	0 510 0 510 0 510	015 0
р м п п п п п п п п п п п п п п п п п п п	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	· · · · · · · · · · · · · · · · · · ·	0 0
Н Н Н Н Н Н Н Н Н Н Н Н Н Н Н Н Н Н Н	1.0 1.0 1.0 1.0 1.0 1.0 1.0	0.1	0.1
cu 4./5 6.0 6.0 4.0	1.0 6.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7	0 • 4 • 0 • 4 • 0	A •0 2.0 1.0

ş

A2.7

•

-

	1015. P35.								3.993					166-2	195.354	1.621				1.555	202-1
	JUNP F + M.								4.477					4.579	1.808	0-743	•			1-994	0-299
	E4ERG4 CHANGE	• 3 4 8	E.	E.	E.	E.	1 P E .	• I P E •	-0 • 0 00	E.	E.	• 1 P E •	IPE.	-0°000	-0°00	000 • 0-	. 196 .	• 3 4 E •	.196.	-0.003	-0.001
	NERGY	TEST P	ST PIF	ald 1S	114 TS	ST PIP	TEST P	1 1 2 3 1	0°093	ST PIP	ST PIP	TEST P	TEST P	660°0	0.062	640-0	TEST P	TEST P	TEST P	0.067	0.045
15.	ENER GY E UPJUNP 0	SHED IN	HC IN TE	HC IN TE	HC IN TE	HC IN TE	SHED IN	SHED IN	C 6 0 ° 0	HC IN TE	HC IN TE	SHED IN	SHEO IN	0.095	0.062	E+0*0	SHED IN	SHED IN	SHED IN	0.070	0.046
M RESJL	DEPTH Change M.	ESTABLE	AS HHC	AS HNC	AS HNC	AS HNC	ESTABLE	ESTABLI	0°002	AS HNC	AS HNC	ESTABLE	ESTABLE	0.017	0°003	0.001	ESTABLE	ESTABLI	ESTABLE	0.023	0.011
PLJCKA	UUMN UEPTH M.	E FLOM	3518LE	32519LE)\$ \$ { \$ F \$ F	3551BLE	E FLOM	5 FLON	0.063	35518LE	378187E	FLOH	: FLOH	0.074	0.04.7	U • 032	FLON	E FLOW	FLON	J. 058	250 C
TA AND	UPJU4P 05PTH M.	11 80K	MP INP(MP IMP	NP INP(MP INPO	LL BOR	LL BORE	0.062	MP INP(MP INP(LL BORE	LL BORG	0.057	0.044	0.031	LL BORE	LL BOR	LL BOR	0.035	0.025
IPE DA	EN TRY F + M N +	, FU	UL) P	n r	nr	Fυ	۴u	12.216) DL	ິດເ	FU	۶	112.216	4 . 983	1 2.016	۶U	Fυ	FU	4.983	2.016
TEST	ENERCI ENERCI								0 4 5					0.45	EC •0 •	1 0.21	e.			5 0°33	10.01
	ENTRY DEPTH M.	-							3-022					0.022	0.016	0.011				0.016	10.01
	N . N K	0.100	0.071	0.054	0-036	0.025	0 - 1 0 0	0.100	0.068	0*044	0 0 0 30	0.100	0.100	0.074	0-041	.0.032	0.100	0.100	0.100	0.058	96020
	U .	0.089	0.079	0.065	0 * 0 + 2	0-031	0.089	0.079	0 • 065	0°045	160.0	0 - 089	0.079	0.065	0 ° 042	160.0	0.069	0.079	0.065	0 • 0 4 2	10.031
	SLOPE	0 °0250	0°0250	0 • 0 5 2 0	0 • 0 5 5 0	0 ° 0 5 2 0	0.0125	0-0125	0.0125	0.0125	0.0125	0 * 0 1 0 0	0 * 01 00	0.0100	00100	0.0100	0 ° 0 0 2 0	0 • 0 0 5 0	0 - 00 5 0	0 • 0 0 5 0	0.0350
DATA	TERM. ENERGY M.	0.772	0.655	0.518	0.345	0°229	0.772	0.655	0.518	0.345	0.229	0.772	0.655	0.510	0.345	0.229	0.772	0.655	0.518	0.345	0.229
H PIPE	N +	0.031	0.027	0.022	0.016	0.011	0.031	0.027	0 • 022	0.016	0.011	0.031	0.027	0.022	0.016	0.011	0.031	0.027	0 • 022	0.016	0-011
PPRUAC	SLOPE (SIN)	0.7070	0-7070	0.7070	0-7070	0 - 20 70	0.7070	0.707.0	0-1010	0-7070	0-1010	0-7070	0.7070	0.7070	0.7070	0~1010	0.7070	0.7070	0.7070	0 * 70 7 0	0-7070
ATA A	MANN. C D E F F	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.915	0°015	0.015	0.015	0.015	0.015	0.015	0 • 015	0-015	0.015
O NONN	DIA. M.	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
00	d. L/S	9°0	0 • Q	0 • 4	2 - 0	1.0	8 • 0	6 • 0	4 • 0	2 • 0	1 • O	5 ° C	0 • Q	4 • 0	2 • 0	1.0	0-0	6 ° 0	4 • 0	2.0	1.0

A2.8

9

ø

1

	÷								\$ \$ \$					140	113	651				(()	561
									77 3.					79 3.	08 2.	43. T.				94 2.	99 1.
	LUB F+R								4-4					4+5	1.8	0-2				1.9	2.0
	AERG	P	•	•	•	•	P E •	P : •	0 • 0 0		•	PE.	PE.	0 • 0 0 0	0000	00 * 0	PE.	PE .	P.E.e	00 003	0 • 001
	N GV	ST PI	3414	PIPE	3414	PIPE	I IS	I IS	- 660	PIPE	3414	14 1S	I JIS	- 540	062 -	- 640	ST PI	IT IS	I IS	- 190	
	ENE DOM	IN TE	1651	TEST	1651	TEST	IN TE	IN TE	.0	TEST	1651	IN TE	IN TE	• 0 •	•0	• 0 •	IN TE	IN TE	IN TE	•0	• 0 •
· 2 •	P JUM	HED	tC IN	IC IN	IC IN	IC IN	HED	HED	60-0	IC IN	IC IN	HED	HED	0.09	0.06	\$0°0	HED	HED	HED	20-0	0 - 0 4
ESUL	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	ABL15	HNNH	H-J-C-H	HICH	HNCF	ABLIS	ABLIS	600	HANH	HNCH	ABLIS	ABLIS	017	£ 0 0	100	ABLES	ABLIS	ABLIS	620	610
RAMR	DEP 1 CHA	N EST	LE AS	LE AS	LE AS	LE AS	K EST	H EST	3 0°	LE AS	LE AS	H EST	N EST	• 0 •	1 0.	2 0.	A EST	M EST	A EST	d 0.	• 0•
1236	14:0 14:0	E FLO	61520	91550	61550	93518	E FLO	E FLO	0° 0	12258	91220	FLO	FLD	0-01	40*0	3.03	E FLO	FL0	E FLO	0.05	E0 ° C
AND	-JU4P 6PTH N.	IAC6	I Hol	IMPI	INPI	INP.	80K	BOR	•062	INP.	IMP	BORI	BOR	1 50.	• • • •	.031	BURI	808	BORE	.035	• 025
DAT	N N	FULL	HUF	JUN	JH AF	HUF	FULL	FULI	440	JUNE .	HUR	FULL	FULL	446 0	459 0	148 0	FULL	FULL	FULL	459 0	148 0
PIPE									.519.					5913.	39 5.	242.				39 5.	2 4 2 •
TEST	ENT &								0					0	•	0				0	•
	4725 6654 14								0.321					0-021	0.015	0+01]				0.015	110.0
	N.H.N.	.100	•071	• 0 •	•036	• 025	.100	•100	• 0 6 8	• • • •	•030	•100	.100	• 0 7 4	-047	• 0 j 2	.100	•100	•100	• 058	• 6 3 4
	υ •	089 0	0 670	065 0	0 4 2 0	0 160	0 6 8 0	0 620	0 6 0	0 4 5 0	0310	089 0	0 620	0 \$ 90	045 0	0 1 0	0 6:90	0 6 0	055 0	0 45 0	0 160
	TE	•0 0	0 0.	•0 0	•0 0	•0 0	• 0 5	• 0 5	• 0 5	5 0 -	5 0 °	•0 00	• 0 00	•0 0	0 0	• 0 00	0 0	• 0	0 0 0	•0 0	• 0 0 9
	14153	0.029	0.02	0.02	0.02	0.02	0.013	0.012	0.013	0.012	0.012	0.010	0.010	0.010	0.010	0.010	00 * 00	0.005	0.03	00 * 0	0 00
ATA	RM. ERGY M.	• 8 8 3	• 753	665.	• 395	• 262	. 683	• 753	• 593	•395	• 262	• 883	• 753	• 593	• 395	•262	• 883	• 753	• 593	• 395	. 262
0 341	₩ ₩	0 000	026 0	021 0	015 0	0 11 0	030 0	0 920	0510	015 0	0 110	030 0	026 0	021 0	015 0	011 0	0 000	026 0	0510	015 0	0 1 1 0
ACH P	IE	50 0°	50 0.	60 ⁰ .	50 0•	50 0°	60 0°	50 0°	\$0 0°	50 0°	50 0°	50 0°	60 0.	50 0°	°0 09	50 0.	50 U.	50 0°	50 0°	50 0°	•0 04
VPPK0	1510	0.86	0-86	0.85	0.86	0.864	0.860	0.866	0.86	0 • 86 (0.86	0.66	0.86	0.86	0.86/	0 • 86 (0.86	0.86	0.86	0.86	0 8 8
TA	ANN	.015	.015	• 015	• 015	• 015	.615	-015	• 015	.015	• 015	•015	•015	• 015	\$10°	• 015	• 015	• 015	.015	• 015	•015
NON DA	. • • •	.10 0	.10 0	.10 0	• 10 0	.10 0	.10 0	.10 0	.10 0	.10 0	.10 0	. 10 0	• 10 0	.10 0	.10 0	.10 0	• 10 0	.10 0	• 10 9	• 10 0	. 10 0
COMM	.0.	C.O 0	6 0 0	0 0 .	2 0 0	1.0 0	5. 0 0	0 0 9	4.0 0	2.0 0	1.0 0	0 0 0	0 0 • 9	• • 0	2.0 0	1.0 0	8.0 0	6 0 0	••0	2.0 0	1.0 0
	ت_		_					-		·					-			-			

A2.9

.

.

.

.

TEST PIPE DATA AND PROJRAM RESULTS.	EATAV ENTAV ENTAV UPJUMP DUMA DEPIM EMERGV EMERGV JUMP 1,14"	DEPTH ENEKGY F+M DEPTH JEPTH CHANGE UPJUNP DOWN CNANGE F+M. ⊅JS. M. M. N. M. M. M. M.	FULL BORE FLOW ESTABLISHED IM TEST PIPE.	JUMP IMPOSSIBLE AS MNCHC IN TEST PIPE.	JUMP IMPOSSIBLE AS MN <mc in="" pipe.<="" test="" th=""><th>JUMP IMPOSSIBLE AS HN<mc in="" pipe.<="" test="" th=""><th>JUMP IMPOSSIBLE AS MN<mc in="" pipe.<="" test="" th=""><th>FULL BORE FLOM ESTABLISMED IN TEST PIPE.</th><th>FULL BURE FLOW ESTABLISHED IN TEST PIPE.</th><th>0.023 0.6313.907 0.062 J.J68 0.005 0.093 0.093 -0.033 4.477 3.531</th><th>JUMP IMPOSSIBLE AS ANCHC IN TEST PIPE.</th><th>JUMP IMPOSSIBLE AS MMCHC IN TEST PIPE.</th><th>FULL BORE FLOM ESTARLISHED IN TEST PIPE.</th><th>FULL BORE FLOM ESTABLISHED IN TEST PIPE.</th><th>0-020 0-6313-907 0-057 J.074 0-017 0-095 0-095 -0-000 4-579 3-338</th><th>0-015 0-39 5.459 0.044 J.047 0.003 0.062 0.062 -0.006 1.808 2.443</th><th>0.010 "0.27 2.296 0.031 0.032 0.001 0.043 0.043 -0.000 0.743 1.73</th><th>FULL BORE FLOW ESTABLISHED IM TEST PIPE.</th><th>FULL BORE FLOW ESTABLISHED IN TEST PIPE.</th><th>FULL BORE FLOW ESTABLISHED IN TEST PIPE.</th><th>0-015 0-39 5-459 0-035 0-058 0-023 0-070 0-067 -0-003 1-994 1-650</th><th>0.010 0.27 2.296 0.025 0.039 0.013 0.046 0.045 -0.001 0.799 1.175</th></mc></th></mc></th></mc>	JUMP IMPOSSIBLE AS HN <mc in="" pipe.<="" test="" th=""><th>JUMP IMPOSSIBLE AS MN<mc in="" pipe.<="" test="" th=""><th>FULL BORE FLOM ESTABLISMED IN TEST PIPE.</th><th>FULL BURE FLOW ESTABLISHED IN TEST PIPE.</th><th>0.023 0.6313.907 0.062 J.J68 0.005 0.093 0.093 -0.033 4.477 3.531</th><th>JUMP IMPOSSIBLE AS ANCHC IN TEST PIPE.</th><th>JUMP IMPOSSIBLE AS MMCHC IN TEST PIPE.</th><th>FULL BORE FLOM ESTARLISHED IN TEST PIPE.</th><th>FULL BORE FLOM ESTABLISHED IN TEST PIPE.</th><th>0-020 0-6313-907 0-057 J.074 0-017 0-095 0-095 -0-000 4-579 3-338</th><th>0-015 0-39 5.459 0.044 J.047 0.003 0.062 0.062 -0.006 1.808 2.443</th><th>0.010 "0.27 2.296 0.031 0.032 0.001 0.043 0.043 -0.000 0.743 1.73</th><th>FULL BORE FLOW ESTABLISHED IM TEST PIPE.</th><th>FULL BORE FLOW ESTABLISHED IN TEST PIPE.</th><th>FULL BORE FLOW ESTABLISHED IN TEST PIPE.</th><th>0-015 0-39 5-459 0-035 0-058 0-023 0-070 0-067 -0-003 1-994 1-650</th><th>0.010 0.27 2.296 0.025 0.039 0.013 0.046 0.045 -0.001 0.799 1.175</th></mc></th></mc>	JUMP IMPOSSIBLE AS MN <mc in="" pipe.<="" test="" th=""><th>FULL BORE FLOM ESTABLISMED IN TEST PIPE.</th><th>FULL BURE FLOW ESTABLISHED IN TEST PIPE.</th><th>0.023 0.6313.907 0.062 J.J68 0.005 0.093 0.093 -0.033 4.477 3.531</th><th>JUMP IMPOSSIBLE AS ANCHC IN TEST PIPE.</th><th>JUMP IMPOSSIBLE AS MMCHC IN TEST PIPE.</th><th>FULL BORE FLOM ESTARLISHED IN TEST PIPE.</th><th>FULL BORE FLOM ESTABLISHED IN TEST PIPE.</th><th>0-020 0-6313-907 0-057 J.074 0-017 0-095 0-095 -0-000 4-579 3-338</th><th>0-015 0-39 5.459 0.044 J.047 0.003 0.062 0.062 -0.006 1.808 2.443</th><th>0.010 "0.27 2.296 0.031 0.032 0.001 0.043 0.043 -0.000 0.743 1.73</th><th>FULL BORE FLOW ESTABLISHED IM TEST PIPE.</th><th>FULL BORE FLOW ESTABLISHED IN TEST PIPE.</th><th>FULL BORE FLOW ESTABLISHED IN TEST PIPE.</th><th>0-015 0-39 5-459 0-035 0-058 0-023 0-070 0-067 -0-003 1-994 1-650</th><th>0.010 0.27 2.296 0.025 0.039 0.013 0.046 0.045 -0.001 0.799 1.175</th></mc>	FULL BORE FLOM ESTABLISMED IN TEST PIPE.	FULL BURE FLOW ESTABLISHED IN TEST PIPE.	0.023 0.6313.907 0.062 J.J68 0.005 0.093 0.093 -0.033 4.477 3.531	JUMP IMPOSSIBLE AS ANCHC IN TEST PIPE.	JUMP IMPOSSIBLE AS MMCHC IN TEST PIPE.	FULL BORE FLOM ESTARLISHED IN TEST PIPE.	FULL BORE FLOM ESTABLISHED IN TEST PIPE.	0-020 0-6313-907 0-057 J.074 0-017 0-095 0-095 -0-000 4-579 3-338	0-015 0-39 5.459 0.044 J.047 0.003 0.062 0.062 -0.006 1.808 2.443	0.010 "0.27 2.296 0.031 0.032 0.001 0.043 0.043 -0.000 0.743 1.73	FULL BORE FLOW ESTABLISHED IM TEST PIPE.	FULL BORE FLOW ESTABLISHED IN TEST PIPE.	FULL BORE FLOW ESTABLISHED IN TEST PIPE.	0-015 0-39 5-459 0-035 0-058 0-023 0-070 0-067 -0-003 1-994 1-650	0.010 0.27 2.296 0.025 0.039 0.013 0.046 0.045 -0.001 0.799 1.175
	HC HN	м. м.	0 0-089 0-100	0.079 0.071	0.0.065 0.054	0 0.045 0.036	0 0.031 0.025	5 0°089 0°100	5 0°079 0°100	5 0.065 0.068	5 0.045 0.044	5 0°031 0°030	0 0.089 0.100	0 0.079 0.100	0 0.065 0.074	0 0.045 0.047	0 0-031 0-032	0.089 0.100	0 0 • 0 7 9 0 • 100	0 0.065 0.100	0 0.045 0.058	0 0°031 0°036
LPROACH PIPE DATA	SLOPE HN TERM. SLOPE	ksim) n. Energy (sim) n.	0.9659 0.029 0.952 0.025	0.9659 0.025 0.810 0.025	0.9659 0.020 0.639 0.025	0.9659 0.015 0.426 0.025	0.9659 0.010 0.282 0.025	0.9659 0.029 0.952 0.012	0.9659 0.025 0.810 0.012	0.9659 0.020 0.639 0.012	0.9659 0.015 0.426 0.012	0*9659 0*010 0*282 0*012	0*9659 0*029 0*952 0*010	0*9659 0*025 0*810 0*010	0.9659 0.020 0.639 0.010	0.9659 0.015 0.426 0.010	0-9659 0.010 0.282 0.010	0.9659 0.029 0.952 0.005	0-9659 0-025 0-810 0-005	0.9659 0.020 0.639 0.005	0-9659 0-015 0-426 0-005	0.9659 0.010 0.282 0.005
COMON DATA A	0. DIA. MAMN.	L/S M. COEFF	6.0 0.10 0.015	6.0 0.10 0.015	+•0 0.10 0.015	2.0 0.10 0.015	1.0 0.10 0.015	8.0 0.10 0.015	6.0 0.10 0.015	4.0 0.10 0.015	2.0 0.10 0.015	1.0 G.10 0.015	8.0 0.10 0.015	6.0 0.10 0.015	4.0 0.10 0.015	2.0 0.10 0.015	1.0 0.10 0.015	8.0 0.10 0.015	6.0 0.10 0.015	4.0 0.10 0.015	2.0 0.10 0.015	1.0 0.10 0.015

Ł

								-					~	m	~			,	1	\$
+504								3.63					3.08	2. 18	1.73				1.69	1.13
ANUL +H+								124-4					4-579	1-608	0- 743				1-994	662-0
LERGY .	• 3						۰.3	000-0			٤.	e.	000 * 0	0000-0	000-0	÷.	• 	е.	003	100.0
10 . 20	1 919	PIPE.	. 3 4 1 4	PIPE.	P19E.	1 11	114 1	- 66	P1PE.	PIPE.	T PIP	I PIP	95 -(62 -(1 3 -(114	114 1	I P I	67 -(42 - C
ENER	TES	EST	EST	EST :	EST	TES	I TES	0-0	EST	EST	TES	TES	0-0	0 • 0	0 • 0	TES	TES	I TES	0.0	0 • 0
PJUNP	HED IN	C IN T	C IN T	C IN T	C IN I	HED IN	NI O3H	60.03	C IN 1	C IN 1	HED IN	HED IN	560°0	0.062	0-043	HED IN	HED IN	HED IN	0.069	0.046
PTH E ANGE U M.	TABLIS	HNNH S	HANH S	H NH S	H NH S	FABLES	TABL [S	-005	HNNH S	H>NH S	TABL 15	FABL I S	-017	E 00 -	100-	I AB_I S	TABLIS	TABLES	.023	613
U CH	H ES	LE A	LE A	-E A	с Р.	H ES	M ES	9 P	LEA	LEA	N ES	H ES	•	7 0	s م	# ES	H ES	# ES	8	Ó ŕ
JEPT JEPT H.	E FLO	81550	8) 2 4 6	0,519	81550	E FLJ	E FLO	0•00	01220	05518	E FLO	E FLO	0.07	0-04	0°ť	E FLO	с. - Ц	E FLO	0°0	U.U3
PJUNP DEPTH N.	L BORE	P IMP(IM IMP	IP INP	IP IMP(L BORE	L BORE	0.062	IP IMP(P IAP(L BORE	L BURE	0.057	0-044	0.031	L BORE	L JOKE	L 80R	0.035	0.025
7.8 Y C	FUL	10r	L U L	H NF	JUL	FUL	FUL	106.	JUL	10F	FUL	FUL	- 907	.728	. 296	FUL	FUL	FUL	.728	• 246
RY EN KGY F •								.6313					.6313	• 43 5	. 27 2				•43 5	. 27 2
A ENT								20 0					20 0	14 0	10 0				14 0	10 0
ENTR DEPT N.						-		0.0		-	_		0-0	0.0	0.0	_		-	0.0	0.0
H .H	0-100	0-071	0-054	0.036	0.025	0-100	0.100	0.068	0-044	0.030	0-100	0.100	0.074	0-047	2 6 9 - 0	0-100	0 - 1 0 0	0.100	0.058	9.039
HC HC	0.089	0.079	0-065	0.045	0.031	460°0	0.079	0 - 065	0+0+5	0.031	0.089	0.079	0 - 065	0-045	0.031	0 - 089	0-079	6 0 0 6 5	0+0	160.0
OP E [N]	0520	0520	0520	0550	0520	0125	0125	0125	0125	0125	0100	0010	0100	0100	0100	0350	0050	0500	0050	0 5 0 0
Y 15	3 0 •	7 0.	4 0+	6 C.	8 0.	·0 ·	-0	4 0 4	6 0.	8 0.	e 0.	7 0.	4 0.	0.0	3 0.	8 0.	-0 2	+ 0-	16 0.	8 0.
TERM. ENERG	0.97	0.32	0.65	0+ 43	0.28	16.0	0.82	0- 65	0-43	0-28	0.97	0- 82	0 - 65	6 • •	0.28	0.97	0.82	0- 55	0.43	0.26
I I	0.029	0.025	0-020	0.014	0.010	0.029	0-025	0-020	0-014	0.010	0.029	0.025	0~070	0-0.14	0.010	0.029	0.025	0~070	\$10°0	0 * 01 0
SIN)	• • • • •	0000.	0000	0000	0000	0000	0000	.0000	.0000	0000	0000	0000	• 00 00	0000	0000	C:000-	0000	0000-	.0000	0000
HN. S	1 510	115 1.	115 1.	15 1.	1 510	115 1.	1 510	115 1.	1 510	1. 210	115 1.	112 1	115 1	15 1	115 1.	115 1.	115 1	112 1	1 510	1 510
COL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0-0	0.0	0.0	0.0	0.0	0.0	0.0	0 0
01A.	0.1(0-10	0.10	0.10	0.10	0-10	0.10	0-10	0.10	0-10	0.10	0-10	0.10	0-10	0.10	0-10	0.10	0-10	0.10	0.1(
0. L/S	3.0	6 • 0	•••	0 • 2	1.0	0=0	6.0	0 * ý	2.0	1.0	0 - 0	6.0	4 * 0	2.0	1.0	8.0	6 . 0	9 - 0	2.0	1 - 0

•

TEST PIPE DATA AND PROGRAM RESULTS.

COMMON DATA APPROACH PIPE DATA

A2.11

•

-

.



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

M KESULIS. DEPTH ENERGY ENERGY ENERCY JURP JUMP CHANGE UPJUMP DUMN CHANGL FARA PJS. M. M. M. M. M.	AS HNCHC IN TEST PIPE.	AS MNCHC IN TEST PIPE.	AS HNCHC IN TEST PIPE.	0.004 0.115 0.115 0.000 9.885 1.972	0.000 0.098 0.098 0.000 6.795 2.033	AS HMCHC IN TEST PIPE.	AS HNCHC IN TEST PIPE.	AS HMCHC BN TEST PIPE.	3.027 0.120 0.119 -D.COIIO.284 0.853	0.018 0.101 0.100 0.000 4.473 0.927	0.012 0.080 0.040 0.000 4.107 0.852	0.007 0.055 0.055 0.000 1.692 0.571	0.006 0.038 0.038 0.000 0.706 0.321							
TEST PTPE DATA AND PRJGRAM TRY ENTRY UPJURP JJAN T TH ENERGY FOM DEPTH JEPTH (10 Mo Mo Mo	JUNP LAPJSSIBLE	JUPPER AND AND	JUNP INPOSSIBLE	JUNP INPOSIBLE	JUMP INPJSSIBLE	JUNP INPOSSIBLE	JUMP INPUSSIBLE	JUNP INPOSSIBLE	JUMP INPOSSIBLE	JURP IRPOSSIBLE	059 0.1411.436 0.030 0.040	051 0-12 7-894 0-071 0-071	JUNP INPOSSIBLE	JUMP INPOSSIBLE	JUNP INPUSSIBLE	.059 0.1411.436 0.070 0.096	051 0.12 7.894 0.062 0.080	690°0 150°0 802°4 60°0 140	.029 0.06 1.932 0.036 0.044	021 0-04 0-791 0-025 J-031
A • SLUPE HC HN EVI • SLUPE HC HN EVI	36 0°0250 0°032 0°064	18 0-0250 0-071 0-C55	95 0°0250 0°051 0°044	165 0-0250 0-040 0-031	44 0-0150 0-028 0-022	36 0-0125 0-082 0-079	18 0.0125 0.071 0.067	95 0.0125 0.057 0.053	65 0-0125 0-040 0-037	44 0-0125 0-028 0-026	38 0-0100 0-082 0-084 0-	18 0.0400 U.O71 0.071 0.	95 0.0100 0.057 0.057	62 0*0100 0*0*A 0*038	44 0°0100 0°028 0°028	38 0-0066 0-082 0-096 0-	16 0-0056 J-071 0-030 D-	95 0.0066 3.051 0.063 0.	65 0-0066 0-040 0-044 B-	44 0.0066 0.024 0.031 U.
COMMON DATA APPROACH PIPL FAT J. Día. Mann. Slúpe hn terp L/S m. cueff (Sin) m. Eném	8.0 0.15 0.015 0.0343 0.059 0.1	1°0 0°12 0°015 0°0349 0°050 0°1	4.0 0.15 0.015 0.0349 0.041 C.0	2.0 0.15 0.015 0.0343 0.029 C.C	1.0 0.15 0.015 0.0349 0.021 0.0	8.0 0.15 0.015 0.0347 0.059 0.1	6.0 0.15 0.015 0.0349 0.050 0.1	4.0 0.15 0.015 0.0347 0.041 0.6	2.0 0.15 0.015 0.0347 0.029 0.C	1.0 0.15 0.015 0.0347 0.021 0.C	8.0 0.15 0.015 0.0347 0.059 P.I	6.0 0.15 0.015 0.0349 0.050 0.1	4.0 0.15 0.015 0.0347 0.041 0.0	2.0 0.15 0.015 0.0349 0.029 0.0	1.0 0.15 0.015 0.0349 0.021 0.C	8.0 0.15 0.015 0.0349 0.059 C.1	6.0 0.15 0.015 0.0347 0.050 0.1	4.0 0.15 0.015 0.0347 0.041 0.6	2.0 0.15 0.015 0.0347 0.029 0.6	1.0 0.15 0.015 0.0349 0.021 0.0

PROGRAM RESULTS BASED UN TERMINAL CONDITIONS IN THE APPRUACH PIPE AND NORMAL FLUW DEPIH DUNNSTREAP OF THE JUMP IN THE TEST PIPE.

LTS	ENERCY E UPJUMP D M.	0-130 0-1	0-106 0-10	0-063 0-062	0-057 0-056	0-040 0-039	STAS SALE TERES	TEST PEPE ENTR	TEST PUPE ENTR	0-663 0-059 -	TTEST PLPE ENTR	ISHED IN TEST PI	E TEST PIPE ENTR	TTEST PLPE ENTR	TEST PLPE ENTR	TTEST PIPE ENTR	ISHED IN TEST PI	ISHED IN TEST PI	TTEST PLPE ENTR
AND PRUGAAM RESU	JAP JOWN DEFTH IH DEPTH CHANGE	302 J.107 0.045	160-0 180-0 140	0+7 0-069 0-021	114 J. U47 0.013	010-0 680-0 470	ROANED AT LEO A	DKG4NED AT L=D A	DADANED AT L-0 A	0.053 0.023	DKD4MED AT L=0 A	JORE FLOM ESTABL	ADANED AT L=0 A	ADANED AT L=D A	DADANED AF L=0 A	DROAMED AT L=0 A	JURE FLOM ESTABL	JURE FLOA ESTABL	DRUANED AT L=0 A
EST PIPE UATA A	NEAV ENTRY UPJU Neagy F+M DEPI Me Ne Me	0-1411-430 0-0	0.12 7.894 0.C	0-09 +-708 0-0	0-06 1-932 0-0	0-04 0-791 0-0	G ANNE	AMNE	1 AMR	0-06 1-932 0-0	0 ANNE	FULL B	3 ANNE	3 AMUE	JUHP D	0 AMUL	FULL B	FULL	0 JANOE
Ŀ	HN FWTRY E M. DEPTH E M.	2 0-101 J-059	1 0-087 0-051	10-00-0000	0 0-047 0-029	4 0-033 4-024	2 0.132	10-101	1 0.077	0.0-053 0-029	7E0-0 8	2 0-150	1 0.112	7 0.084	0.057	¢ 0-039	2 0-150	1 0-150	2 0-096
	Y (SIN) M.	8 0-0050 0-08	8 0.0050 0.07	0-0050 0-05	5 0-0050 0-04	4 0.0050 0.020	8 0.0050 0.08	8 0-0050 0-01	5 0-0050 0-05	5 8-0050 0-04	4 0-0050 0-021	e 0-0025 0-08	8 0-0025 0-07	5 0-0025 0-05	5 0-0025 0-04	4 0-0025 0-02	8 0-0017 0-09	£ 0-0417 0-07	5 0-0017 0-05
JACH PIPE CATA	PE HN TERF.	349 0°059 0°13	349 0-050 0-11	349 0 .0+1 0.09	349 0-029 0-06	149 0-021 C-C4	149 0.059 0.13	11-0 050-6 648	349 0-041 0-09	344 0-029 0-0¢	44 0-07I 0-04	349 0-059 0-13	344 0.050 0.11	349 0-041 0-09	343 0-028 0-0¢	349 0-021 0-04	141 0-059 0-13	11-0 050 0-11	59°0 140°0 646
TA APPRI	- MANN- SLOI COEFF (SI	5 0-015 0-0	5 0-015 0-0	5 0-015 0-0	5 0-015 0-0	5 0-015 0-0	5 0-015 0-0	5 0-015 0-0	5 0-015 0-0	5 0-015 0-0	5 0-015 0-0	5 0-015 0-0	5 0-015 0-0	0-0 510-0 5	5 0-015 0-0	5 0-015 0-0	15 0-015 0-0	5 0-015 0-0.	15 0.015 0.0

FESE PIPE DATA ANG PAJGAAN RESULIS. Niky entry upjump jjan defim erekgy energy jump jump Engegy fom defim jefia change upjump down charge for. Pjs. Mo no mo mo mo mo mo mo mo fo no mo	JUMP EMPJSSIALE AS MNCHC IN TEST PIPE.	JUMP INPUSSIBLE AS HNCHC IN TEST PIPE.	JUMP IMPOSSIBLE AS MNCMC IN TEST PIPE. Jump impossible as MNCMC in test pipe.	JUMP IMPOSSIBLE AS MNCHC IN TEST PIPE. Jump Impossible as mnchc in test pipe.	JUMP IMPJSSIBLE AS MNCHC IN TEST PIPE.	JUNP INPOSSIBLE AS MNCHC IN TEST PIPE.	JUMP INPUSSIBLE AS HNCHC IN TEST PIPE. 0.1813-607 0.040 0.084 0.004 0.115 0.115 0.000 9.685 3.033	0.15 9.388 0.071 0.071 0.000 0.096 0.098 0.000 6.795 2.913	JUMP LAPUSSIBLE AS MNCHC IN TEST PIPE.	JUMP IMPJSSIALE AS MNCHC IN TEST PIPE.	JUMP IMPUSSIBLE AS MNCHC IM TEST PIPE.	0.1813.007 0.070 0.096 0.027 0.120 0.119 -0.0C11C.284 1.835	0.15 9.300 0.062 0.380 0.018 C.101 0.100 0.0CC C.573 1.734	J.12 5.636 0.051 0.063 0.012 0.680 0.080 0.060 4.107 1.513	0.08 2.245 0.036 0.044 0.007 0.055 0.055 0.006 1.692 0.984	3.05 0.914 0.025 0.331 0.006 0.038 0.038 0.000 0.306 0.576
COMMON DATA APPRUACH PTPF EATE Q. Dia. Mann. Slope Hu TFRP. Slope HC Hn Evtry B L/S M. Cueff ISINI M. Tenebey ISINI N. P. DEPTH I N. M.	8.0 0.15 0.015 0.0699 0.049 0.180 0.0250 0.032 0.064 6.0 0.15 0.015 0.0699 0.042 0.153 0.0750 0.021 0.055	4.0 0.15 0.015 0.0699 0.034 0.122 0.0250 0.057 0.044	2.0 0.15 0.015 0.0699 3.024 0.083 0.0250 3.043 0.541 1.0 0.15 0.015 0.0699 3.017 0.056 0.0250 3.024 0.022	8.0 0.15 0.015 0.0698 0.049 0.160 0.0125 0.032 0.079 6.0 0.15 0.015 0.0698 0.042 0.153 0.0125 0.071 0.067	4.0 0.15 0.015 0.0699 3.034 0.122 0.0125 0.057 0.053	2.0 0.15 0.015 0.0699 J.024 0.083 0.0125 0.04J 0.037	1.0 0.15 0.015 0.0699 0.017 0.056 0.0125 0.028 0.026 8.0 0.15 0.015 0.0698 0.044 0.180 0.0100 0.032 0.084 0.044	6.0 0.15 0.015 0.0698 0.042 0.153 0.0100 0.071 0.071 0.043	4.0 0.15 0.015 0.6693 0.034 0.122 0.0100 0.057 0.057	2.0 0.15 0.015 0.0699 0.024 0.083 0.0400 0.040 0.039	1.0 0.15 0.015 0.00499 0.017 0.056 0.0100 0.028 0.028	8.0 0.15 0.015 0.0699 0.049 0.180 0.0000 0.082 0.090 0.049	6.0 0.15 0.015 0.0099 0.042 0.153 0.0066 0.071 0.030 0.043	4.0 0.15 0.015 0.0491 0.034 0.122 0.0066 0.057 0.063 0.034	2.0 0.15 0.015 0.0591 3.024 0.083 0.0066 0.040 0.044 0.025	1.0 0.15 0.015 0.0499 3.017 0.056 0.0066 J.028 0.631 3.018

PRUGRAM RESULTS BASED OV TERMINAL CONCITIONS IN THE APPROACH PEPE AND NORMAL FLUM BEPTH DOWNSTREAP OF THE JUMP IN THE LEST PIPE.

-

A3.4

PRUGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLUM UEPTH DUNNSTREAP OF THE JUNP IN THE LEST PIPE.

APPROACH PIPE CATA COMMUN DATA

IFSE PEPE DATA AND PRUGRAM "ESULTS.

* , 2C 4 4HDr CHANGE F+h. ż JUNP ENEFCE ENERGY UDAN DEPTH ENERGY ENERGY DEPTH CHANGE UPJUMP DOWN ÷ ż DEPTH ENTRY ENTRY UPJUMP DEPTH ENERGY F+M DEPTH Ľ ż ÷ ž į OH: TERP. SLOPE FREACY (SIN) -Z . SLOPE CUEFF MANN. 01 A. **...** 0. L/S

3.0 0.15 0.015 0.1045 0.044 0.219 0.0125 0.082 0.079 4.0 0.15 0.015 0.1045 0.031 0.148 0.0125 0.057 0.053 2.0 0.15 0.015 0.1045 0.022 0.100 0.0125 0.040 0.037 0.064 0-044 2.0 0.15 0.015 0.1045 0.022 0.100 0.0250 0.040 0.031 0.067 1.0 0.15 0.015 0.1045 0.016 0.067 0.0125 0.028 0.026 0-055 0-022 8.0 0.15 0.015 0.1045 0.044 0.219 0.0250 J.082 4.0 0.15 0.015 0.1045 0.031 0.148 0.0250 0.057 1.0 0.15 0.015 0.1045 0.016 C.067 0.0250 U.02d 6.0 0.15 0.015 0.1045 0.038 0.186 0.0125 0.071 6.0 0.15 0.015 0.1045 0.038 0.186 0.0250 0.074

JUMP IMPOSSIBLE AS HNCHC IN JEST PIPE. 4.0 0.15 0.015 0.1045 0.038 0.186 0.0100 0.071 0.071 0.03 8.0 0.15 0.015 0.1045 0.044 0.219 0.0100 0.032 0.044 0.044 2-0 0-15 0-015 0-1045 0-022 0-100 0-0100 0-040 0-039 +•0 0.15 0-015 0-1045 0-031 0-148 0-0100 0-057 0-057

JUMP IMP ISSIBLE AS HNCHC IN TEST PIPE. 21PE. IMPOSSIBLE AS MNCHC IN TEST PIPE. PIPE. JUMP IMPOSSIBLE AS MNCHC IN TEST PIPE. IAPUSSIBLE AS HNCHC IN TEST PIPE. BUMP INPOSSIBLE AS HNCHC IN TEST PIPE. JUMP IMPOSSIBLE AS MNCHC IN TEST PIPE. AS HNCHC IN TEST PIPE. JUMP INPUSSIBLE AS MNCHC IN TEST PIPE. IMPUSSIBLE AS HNCHC IN TEST IMPUSSIBLE AS HNCHC IN TEST SUMP IMPUSSIBLE SUMP JUNP **SURP** JUHP

0-000 9-685 3-565 3.388 0.000 6.795 JUMP INPOSSIBLE AS HNCHC IN TEST PIPE. Ó.098 0-004 0-115 0-115 0-096 0.000 0-1810-681 0-071 0-071 0.2215.472 0.041 0.084

0.119 -0.00110.284 2.338 0.000 6.973 2.189 1.813 4.107 0.000 SUMP IMPOSSIBLE AS HNCHC IN TEST PIPE. 0.100 0-080 0-120 0.080 0.101 0.027 0.018 0.012 0-1810-641 0-062 0-080 0-2215-472 0-070 0-096 0-14 6-271 0-052 0-063 8.0 0.15 0.015 0.1045 0.044 0.219 0.0066 U.082 0.096 0.044 6.0 0.15 0.015 0.1045 0.038 0.166 0.0066 U.071 0.080 0.03b 4.0 0.15 0.015 0.1045 0.031 C.148 0.0066 0.057 0.063 0.031 1.0 0.15 0.015 0.1045 0.016 0.067 0.0100 0.028 0.028

0.000 1.692 1.199 7.000 0.706 J.737

0.055

0.055

0.007

0-10 2-555 0-036 0-044

0.036

0.038

0.006

0.06 1.015 0.025 U.031

1.0 0.15 0.015 0.1045 0.016 0.067 0.0066 0.024 0.031 0.016

2.0 0.15 0.015 0.1045 0.022 0.100 0.0046 0.040 0.044 0.022

	404P 205+ 8-	1.157	1.234	161.1	0.745	U. 42 b		0.517	0-630	0.448	9.534			0.253	0.239	960-ŋ					
	JUNP F+h+ N+	1.008	7.313	4.665	1.750	0 € 2 3 0		8-309	4-212	1.906	662.0			5.193	2.670	0.659					
	ENEPGY Change M.	-0-0051	-0-002	100-0-	-0-001	-0-001	۲ ۳ -	-0-013	-0-002	+00 °0-	E00 °0-	IPE.	• A 2	-0-015	-0-0Cb	<00.0	iPE.	IPE.	۲V	. W .	R
	NEKCY I	0.125 -	0.103 -	0.082	0.056	- 650-0	PE ENTI	0.112 -	0.087	. 650-0	0-041	TEST P	PE ENTI	0.092	0-062 -	0.043	IESE PI	TEST P	PE ENTI	PE ENTI	PE ENTI
\$	NE4 GY E Pjump D M.	0€7*0	0.106	690-0	0.057	0+0-0	TEST PS	0.125	\$6J-0	644.0	0-644	HED IN	TEST PI	0-103	020-0	6+0-0	HED IN	HEE IN	TEST PI	TEST PI	16 15 11
kE SUL T	PTH E Hange W	0.045	160.0	0.021	610.0	010.0	10 VI	0.052	0.036	0.023	0.016	STABLES	18 0=1	2+0-0	0.029	0-020	STABLIS	STABLIS	L=0 AE	L=0 AF	L=0 AF
2206285	DAN CI Depta Ci a.	. 107	097	690-0	240-0	EE0-0	ED AT 1	101-0	110-0	0.053	160-0	FLON E	LED AT 1	.084	1 2 2 0 - 0	039 (FLUM E	FLON E	VED AT 1	HED AF	VED AT
A AND	FJUMP J	0.002	0.057 (0-047 (0-034 (0-024 0	P DH040	0-048 (0-041	0.010	0-021	L BURE	P DKGW	0-047	0.027	0.019	L JURE	L BURE	P 0404	P DADA	IP UKDAI
176 DAT	ENTKY U F + M D N +	100-61	9.344	5 • 636	2.265	0.946	AUG	9-368	5.636	2.285	0.914	FUL	MAL	5.636	2.245	0.914	FUL	FUL	2018	HUL	TUL
d 1531	ENTRY ENTRY 1.	0.19]	J.15	0.12	0°0	0°05		0.15	0.12	0.08	0-05			0.12	∂•08	0.05					
	ЕЧТКҮ DLPTH М.	840°0 4	1 0-043	0°034	¢20-0 1	3 4.018	0	1 0-043	1 0.034	¢20°0 €	7 0.015	0	~	4E0-0 4	¢20-07	9 0.014	0	0	J.		
	HN.	2 0.107	1 0.04	0-040	0-041	à 0-033	2 0-132	1 0-101	1 0.073	0 0.05	8 0-03	2 0.150	1 0.11	1 0-UB	0 0-05	9-03-0 P	2 0-15(1 0.150	0.090	v 0.06	d 0-04
	HC N.	0 0-09,	0 4.07	0 0-05	0 0-04	0 0-02	0 0-08	0 0-01	0 0-05	0 0-04	0 0.02	5 0.08	5 0.07	5 0.05	5 0-04	5 4.02	7 0.08	7 0.07	7 0.05	1 0.04	7 0.02
	SLOPE	0-405	0-005	0-005	0°002	¢00°0 (0.005	200°0	6005	0.005	0.005	0-002	0-012	0.002	0.002	0.002	100-01	100-01	10.001	0.04	6 0.0UL
DATA	I Tekk Enekov P.	9 C. 1 5C	2 0.153	0.122	• 0°083	0.056	9 0.180	2 0-153	0.122	0.063	0.056	9 0-180	2 0°153	0.122	0.083	0.056	9 0.180	2 D.153	0.122	4 6.C83	7 0.054
CH PIPE	HN H	\$ 0=04	9 0 .04	9 0 0 034	\$ 0°074	9 0°01	9 0-04	9 0-04	9 0 • 034	9 0.02	10.0 8	9 0-04	9 0-045	9 0°03	3 0-02	0°01	9 0°04	* 0 • 0 *	9 0°03	A 0.02	40°0 6
APPRUA	SLOPE (SIN)	0.069	0.063	0.069	0.069	0.069	0.069	0-069	0.069	0.069	0-069	0.069	0.069	0-069	0-069	0-069	0.069	0-069	0.063	0.069	6 0.069
DATA	CCEFF	0.015	0-015	5 0-015	0.015	0.015	5 0-015	0-015	0-015	5 0 .015	5 0.015	5 0-015	5 0.015	0.015	0.015	5 0-015	5 0-015	5 0.015	5 0.015	5 0-01	5 0.015
COMNUN	- DIA	•0 0.1	.0 0.1	.0 0.1	.0 0.1	•0 0.1	.0 0.1	.0 0.1	•0 0-1	•0 0•F	-0 0-1	.0 0.1	.0 0.1	.0 0.1	.0 0.1	•0 0-1	•0 0.1	.0 0.1	.0 0.1	.0 0.1	0 0. I
	2	60	9	*	2	-	æ	0	÷	2	-	60	4		2	4	50	4	4	2	1

	5. 	(99	635	424	653	553	444	356	626	640	351		387	534	408	217			030	611	992
		08 I.	13 1.	65 L.	0 C.	30 0.	0 j.	ο υ .	12 0.	06 0.	95 0.		11 6.	эз ù.	10 0.	9 v.			99 0.	36 J.	54 V.
	LUN F+R	11-04	7.31	4+2	1.7	0-7	13-b(6.3(4-21	1° %	0.74		9-51	5.19	2.61	0.5			6•1°	2+31	0.44
	ENEPCY Change P.	-6-005	-0-002	-0-004	-0-001	-0-001	-0-032	-0-013	-0-007	+00-0-	-0-003	· FE .	-0-031	-0-015	-0-009	-0 - 0-	IPE.	• 341	-0-040	-0-015	-0-013
	ENERGY JUHN M.	0.125	0.103	0-042	0 - 056	660.0	0-144	0.112	240-0	0°059	0+0+1	TEST P	0.121	0-042	0.062	0+043	TEST P	TEST P	0.101	0.067	940-0
S.	NEK CV	0.130	C.106	0.683	0-057	0-040	0.181	0.125	0-094	0.063	0-044	HEB EN	0.152	0.107	0-020	0-649	HEL IN	HEL IN	0-141	0.686	0-059
SESUL T	EPTH HANGE C M.	0 - 0 4 5	160-0	0.021	0-013	010-0	0.083	0.052	0.036	620°0	0.016	STABLES	0.070	1+0-0	6-029	0-020	STABLIS	STABLES	0.064	0-039	0.027
RUGRAF	DAN C	-107	150-1	£ 90 - 0	1+0-0	££0.0	•132	101-0	120-0	e 50 • 6	.037	FLOA E	.112	• 0.9 •	1 50 - 1	fe0*	FLUA E	FLOA E	• 090	6 00 -	• • • •
CNA A	FIUNP FPIN	0.062	1 50.0	2+0=0	0.034	0*074	0-049	0-0-8	0-041	0.030	0-021	L BURE	0-042 (260-0	0-027	610-0	L JURE	L BURG	210-0	0-024	0-017 (
IPE UAT	ENTRY L	15-472	100-641	112-9	2.555	4.015	15-472	100.661	112.0	2.555	1.015	FUL	10.661	6.271	2.555	1.015	FUL	FUL	6.271	\$\$ <u>5</u> \$	1.015
SEST F	ENTRY ENERGY 3.	0.22	0.16	1 0.14	0.10	a J.06	0.22	0.18	1 0.14	0.10	0.06		0.16	0.14	2 0.10	0-06			1 0.14	2 0.10	0-06
	ENTRY DEPTH M.	1 0-0 V	7 0-03	9 0-03	1 0.02	3 U. 01	2 0-04	0.036	1 0-031	3 0-02	1 0-010	0	2 0-03	1 0-03I	7 0-02	9 3-010		0	6 U-03	3 0-02	0.01
	2 * H E	01-0 2	0.04	1 0.06	0-04	5 0°03	2 0.13	1 0.10	10-07	0.05	0-03	2 0-15	1 0.11	0.08	0.05	s 0-03	2 0.15	1 0.15	0°04	0.06	3 0-04
	н Н С	0 0•08.	0 0-07	0 0-05	0 0-04	0 0-020	0 0-08	0.0-07	0-05	0 0-04	0 0-021	5 0-08	2 0-07	5 0-05	5 0-040	5 U.02	7 0-08	7 0-07	7 0°05	1 0-04	7 0.02
	SLIPE (SIN)	ĉ	0-005	0.005	0.005	0.005	0.005	0-005	0-005	0.005	0.005	0.002	0.002	0.002	0.002	0.042	0.001	0.001	0.001	106*0	0-001
CATA	VERE. EREFCY E.	0.215	0.186	0.148	0.100	0.667	0.219	0.166	1 C-148	0.100	0.067	0.219	0.186	0.146	0-100	0-063	0.219	8 0.184	1 6.146	2 6.160	6 0. C 6 7
1 P 1 P 8	X ·	0-04	0-034	160-0	0.02	0-010	0-044	0-038	160-0	0.023	0-016	0-04	0-036	0.031	0-02	0.010	0.04	10.03	E0*0	0 .02	0.010
APPRUAC	SLOPE (SIN)	0-1045	0-1045	0-1045	0-1045	0-1045	0-1045	0-1045	0.1045	0-1045	0+1045	0-1045	0-1045	0-1045	0-1045	0.1045	0-1045	0-1045	0-1045	0.1045	0-1045
DATA	MANN. CUEFF	0-015	0.015	0-015	0-015	0.015	0.015	0.015	0.015	0-015	0.015	0-015	0-015	0-015	0.615	0-015	0.015	0-015	0-015	0.015	0.015
NUME	DI A.	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.25	0.15	0.15	0.15	0.15	0.15	0-15	0.15	0.15	0.15	0.45	0.15	0.15
CO	a.	8.0	6.0	4 .0	2.0	1.0	8.0	6.0	4 = 0	2.0	1.0	8.0	6.0	••0	2.0	1.0	0-0	6.0	4.0	2.0	1.0

PRUCRAN RESULTS BASED ON FERMINAL LEPENTIONS IN THE APPAGAGA PIPE AND NORMAL FLUM WERTH GENNSTREAP OF THE AUMP IN THE REST PIPE.

× 3.858 4.127 0-120 0-119 -0.00410.484 2.883 2.653 2.193 1.412 0.932 4202 P 35. 9.085 0.CGL 0.706 0.000 6.795 å -0.01 6.573 0-000 4-107 0.066 1.692 ENERGE JURP Change F+P. 0-000 ENERGY ENERGY **.**. PIPE. AS HNCHC IN TEST PIPE. AS HNCHC IN TEST PIPE. HNCHC IN TEST PIPE. AS HNCHC IN TEST PIPE. AS HNCHC IN TEST PIPE. AS HNCHC IN TEST PIPE. JUMP IMPOSSIBLE AS MNCHC IN TEST PIPE. IN TEST PIPE JUMP ITPJSSIBLE AS HNCHC IN TEST PIPE. HM<PC IN TEST PIPE HNCHC IN TEST PIPE HNCHC IN TEST PIPE 0.115 0.115 0-098 0.100 DOWN 0.080 0-055 0.038 r, HNCHC IN TEST 0.098 ENES CY UPJUMP 0.101 0.000 0-055 0.C38 ÷. TEST PIPE DATA AND PRUGRAM NESULTS. AS HNCHC 0.004 000000 JOAN DEPTH CHANGE 0.027 0.018 0.006 0.007 0.012 Ê AS **A** 5 AS AS JURP LAP JSSIBLE AS JUMP INPOSSIBLE JUNP INPOSSIBLE JUMP INPOSSIBLE JUMP LAP JSSIBLF JUMP INPOSSIBLE JURP LAPUSSIBLE **LAPUSSIBLE** INP JSSEALE JURP INPASSIBLE JUMP INP. JSSIBLE 0.2818.103 0.041 0.084 0.2412.499 0.071 0.071 0.2819.103 0.070 0.096 0-08 1-221 0-025 0-031 0-2412-499 0-062 3-080 0.19 7.361 0.051 3.363 0.12 2.919 0.016 J.044 ÷ ANDEAN THEY THAN DEPIH Ê ANUL JURP ANTHA YANA HIGO 2 Ľ 1.0 0.15 0.015 0.1735 0.014 0.067 0.0046 0.024 0.031 0.014 2-0 0-15 0-615 0-1735 0-026 C-131 0-0066 0-040 0-044 0-02U 4.0 0.15 0.015 0.1736 0.033 0.246 0.0100 0.071 0.071 0.034 0-1736 0-039 0-296 0-0066 0-082 0-096 0-039 8.0 0.15 0.015 0.1736 0.039 0.290 0.0100 0.082 0.084 0.033 0-1735 0-027 0-195 0-0066 0-057 0-063 0-028 6.0 0.15 0.015 0.1735 0.033 0.246 0.00466 U.071 0.080 0.034 0.031 0-007 0.053 0.131 0.0125 0.040 0.037 1.0 0.15 0.015 0.1735 0.014 0.067 0.0125 0.028 0.626 Z.0 0.15 0.015 0.1736 0.020 0.131 0.0100 0.040 0.039 1.0 0.15 0.015 0.1736 0.014 0.067 0.0100 U.026 0.028 0.055 0-044 0.15 0.015 0.1736 0.014 0.087 0.0250 0.024 0.022 0.079 1 <0-0 0-06 2.1 720-0 0010 0-19 0-027 0-195 0-0100 0-057 0-1736 0-039 0-290 0-0250 0-042 0-0250 0-040 0.0250 0.057 0.15 0.015 0.1735 0.039 0.290 0.0125 0.082 6.0 0.15 0.015 0.1735 0.033 0.246 0.0250 0.671 0-074 0.15 0.015 0.1736 0.027 0.195 0.0125 0.057 л. Н 0-246 0-0125 SL'JZE I SENB TERP. ENEPGY 0.15 0.015 0.1735 0.027 0.195 0.131 DAIA ż PIPE 0-15 0-015 0-1736 0-020 0.1736 0.033 0-15 0-015 0-1736 0-020 2 - E APPKJACH SLOPE (SIN) NANN. CCEFF 0.15 0-015 0.15 0.015 4.0 0.15 0.015 0.15 0.015 DATA DIA. COMMON 8.0 8.0 **0**•**4 6.**0 1.0 8.0 0-4 2.0 ••• 2.0 ч. L/S

THE JUPP IN THE TEST PIPE.

APPROACH PIPE AND NUMBER FLUM UFPIH DUMNSTALAP TO APPROACH

PROGRAM RESULTS BASED ON TERMINAL CUNCITIONS IN THE

414		ым? 35. М.	• 12 •		- 192	. 151	.745	186.	614-	• 292	. 857	• 553		. 835	968 •	• 613	• 4 3 6			• 389	322	.222
1 4 5 1		7 4 4 + 2 4 4	008 2	513 2	. 665 1	1 0 52 .	1 062.	. 660 (309 1	712 1	906 0	195 0		511 U	0 661.	020	• 6 5 9 J			199 0	386 0	584 0
JHE N		202 °	11600	002 7.	007 4	004 1.	0 100	CITEO.	013 6.	003 4.	004 1.	0 EOO		031 9.	015 5.	0.08 2.	0 5 0			046 6.	015 2.	013 0.
1. 4.4.0		K ENEI Chai	-0-	-0- E	2 -0-	6 -0.	-0-6	+ -D -	2 -0-(2 -0-1	-0- 6	-0-1	PIPE	-0-1	2 -0-(2 -0.	9 -0- 6	P 1 P E	PIPE	- 0- I	-0- 2	6 -0-1
F 3HI		ENERC DCHN M.	0.12	0.10	0 ° 0	¢0*0	0.03	0.14	0.11	0.06	0°05	0-04	TEST	0.12	60 * 0	0-06	+0=0	TEST	TEST	0.10	0.06	+0 - 0
30 403	15.	enek gy L P Ju M P M -	C.130	0.106	0.083	0-057	0+0-0	0-181	0.125	0-094	0°063	0-644	SHED IN	0.152	0.107	0-010	0-040	SHED IN	SHEE IN	0.141	0.086	0.059
Lt. NSTK	N 4ESUL	DEP TH CHANGE N.	0.045	160.0	0.021	0.013	0.010	680.0	0.052	0.036	0-023	0.016	ESIABLI	0.070	0.047	0.029	0-020	ESTABL	ESTABLE	0.064	0.039	0.027
Pldan .	PRJG4A	0.004N 96PTA A.	101-0	0.037	0.069	1+0-0 1	660-0 4	261.0	101-0	1 0.077	6 0 • 0 5 3	0.037	KE FLOW	0.112	1 3.084	1 0.057	0.039	LO4	KE FLOA	0.395	0.063	10-044
1 111	TA AN	uPJUM DEPTH M.	0.00	¢0•0	0.04	0-03	0.02	0-04	0-0-1	0-04	0-03	0-02	LL 831	9-04	0-03	0.02	0-01	LL bui	16 91	0-03	0-02	0-04
NUNHA	LP E DA	1 1 X 1 X 1 X 1 X 1 X 1 X 1 X 1 X 1 X 1	18-103	12.499	1.361	2.919	1-221	601-81	12.499	1.361	2.919	1-221	FU	12.499	7.361	2.919	1.221	FU	FU	7.361	2.919	1.224
(NF J	ld 153	NTXY R NEXGY 1.	0.28	0.241	0.19	0.12	0.08	0.281	0+24]	0.19	0.12	0.08		0-241	0.19	0.12	0.08			0.19	0.12	0.08
212 HD	F	A A A A A A A A A A A A A A A A A A A	0.039	• 0 3 4	0= 02 h	0-020	0-01+	660.0	• 6 0 • 0	0.020	0- 020	+10-0		0-034	02 g	0-020	0-014			0•02H	6 • 02 0	0.014
1912101		E E E E E E E E E E E E E E E E E E E	101-0	.087	.069	140-0	ee0-0	.132	101-	110-0	£ \$0*	160-0	• 150	1112	+80-0	1 50-0	960°	.150	.150	.096	.063	++ () = (
THE		нс М.	.082	120-	• 057 (.040	• 023	.082	.071 (.057 (• 0+0	• 024	• 082 (• 071 (• 057 (.040	.028	.082	.071 (.057 (.040	• 020
al Solt		LUPE STNJ	• 0500 u	• 0150 0	0 0400	.0050 0	• 0 0 ÷ 0 0 •	.0050 0	-0050 U	• 0020 n	.0050 0	. 0300-	-0025 0	•0025 U	.0025 0	•0025 0	0 4200-1	0.117 0	0 2100-0	0.1100-0	. 100.0	0 2100-0
L CONCIL	DATA	TEAT - S Enefey (h.	0.296 0	0.246 0	0.195 0	0.131 0	0.067 0	0-290 0	0.246 0	0.195 0	0.131 0	0.087 0	0-290 0	0.246 0	0.195 0	0.131 0	0-087 0	0-290	0.246 0	0*195 (0.131 (0.667 0
RHINE	PIPE	Z .	6E0°0	0.033	120.0	0.020	0.014	0.039	0.033	0.027	0-020	0.014	0-039	0.033	0.027	0-020	0.014	960-0	0.033	0.027	0*050	0.014
ED UN TE	APPRUAC	SLOPE	0.1735	\$E1195	0.1736	\$E21.0	0.1735	0-1735	0.1736	0-1736	9611-0	\$61130	0.1736	\$E11.0	9621-0	91736	0.4735	0.1735	0.1735	¢E1136	0.1735	0-1735
S BASI	ATA	MANN. CGEFF	0.015	0-015	0-015	0-015	0-015	0-015	0-015	0-015	0-015	0.015	0-015	0.015	0-015	0.015	0.615	0.015	0.015	0.015	0-015	0.015
ESULT	0 NOW	01 A.	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.45	0.15	0.15	0.15	0.15	0.45	0.15	0.15	0.15	0.15	0.15
RUGRAN F	COF	:5	8 .0	6.0	••	2.0	1.0	ð.6	6.0	4.0	2.0	1.0	0.6	6.0	0*4	2.0	1.0	8.0	6.0	4 ° 0	2.0	1.0

A3.9

•

TEST PIPE DATA AND PRUGRAM dESULTS. Emt≺v entky upjump John Lepth Energy Energy Jump Jump Energy Fom Depth Jepth Change Upjump Down Changl Fom. PJS. Mo Mo M	JUMP INPISSIALE AS HNCHC IN TEST PIPE.	JUMP IMP35518LE AS MACHE IN 1534 FIFE.	JUMP INPUSSIBLE AS HNCHE IN TEST FIFE. Jump Impussible as Hnche in test pipe.	JUMP IMPJSSIBLE AS HNCHC IN TEST PIPE. Jump impjssible as hnchc in test pipe.	JUMP IMPUSSIBLE AS MNCHC IN TEST PIPE. JUMP IMPUSSIBLE AS HNCHC IN TEST PIPE.	JUMP EAPUSSIBLE AS HNCHC IN TEST PIPE.	0.4322.5545 0.0d1 3.084 0.003 0.115 0.115 0.000 9.885 4.753 3.3615.666 0.071 0.371 0.000 0.098 0.098 0.000 6.795 4.395	JUMP IMPLISSIBLE AS HNCHC IN TEST PIPE. Jump Implissible as hnchc in test pipe.	JURP IMPUSSIBLE AS HNCHC IN TEST PIPE.	0.4322.534 0.070 0.090 0.027 0.120 0.19 -0.00110.284 3.532 0.3615.666 0.062 0.080 0.018 0.101 0.100 0.000 6.973 3.184	0.29 9.341 0.052 0.063 0.012 0.680 0.080 0.000 4.107 2.631 0.18 3.621 0.036 0.044 0.007 0.055 0.055 0.001 1.692 1.693	0-13 1-541 0-025 0-031 0-006 C-638 0-036 0-006 0-206 1-094
COMMON DATA APPKUACH PLPI DATA Q. Dia. Maan. Slope mn tekp. Slupe hC hn futry i L/S m. cueff (Sin) m. energy (Sin) m. p. depth e m.	8.0 0.15 0.015 0.3402 0.033 0.437 0.0250 0.082 0.064	4.0 0.15 0.015 0.3402 0.023 0.292 0.0250 0.057 0.057 0.044	1.0 0.15 0.015 0.3402 0.012 0.129 0.0250 0.024 0.0222 1.0 0.15 0.015 0.3402 0.012 0.129 0.029 0.0250 0.028	8.0 0.15 0.015 0.3402 0.033 0.437 0.0125 0.082 0.079 6.0 0.15 0.015 0.3402 0.028 0.370 0.0125 0.071 0.067	4.0 0.15 0.015 0.3402 0.023 0.292 0.0125 0.057 0.053 2.0 0.15 0.015 0.3432 0.017 0.195 0.0125 0.040 0.037	1.0 0.15 0.015 0.3402 0.012 0.129 0.0125 0.028 0.026	8.0 0.15 0.015 0.3402 0.033 0.437 0.0100 0.082 0.044 0.033 6.0 0.15 0.015 0.340? 0.028 0.370 0.0100 0.071 0.071 0.028	4.0 0.15 0.015 0.3402 0.023 0.292 0.0100 0.057 0.057 2.05 2.0 0.15 0.15 0.015 0.017 0.017 0.195 0.195 0.0100 0.040 0.019	1.0 0.15 0.015 0.3402 0.012 0.129 0.0100 0.028 0.028	4.0 0.15 0.015 0.3402 0.028 0.370 0.0066 0.037 0.080 0.033 0.028	4.0 0.15 0.015 0.3402 0.023 0.292 0.0066 0.057 0.063 0.023 2.0 0.15 0.015 0.3402 0.017 0.195 0.0066 0.040 0.054 0.017	1.0 0.15 0.015 0.3402 0.012 0.129 0.0066 0.024 0.631 0.012

PRUGRAM RESULTS BASED UN TERMINAL CONDITING IN THE APPRUACH PIPE AND NUKMAL FLUW UEPTH BUMASIKE PE OF THE JUMP IN THE TEST PIPE.

HE JUMP IN THE TEST PIPE.	NERUY ENERGY JUNP JUMP UMN CHANGE F+M. POS. M. P. N. M.	0.125 -0.00511.008 2.833	0.103 -0.002 7.313 2.659	0-062 -0-001 4-265 2-236 0-056 -0-001 1-750 1-436	0-039 -0-001 0-730 0-936	0-144 -0-03713-660 1-536	0.112 -0.013 8.309 1.948	0-047 -0-007 4-712 1.732	0-059 -0-004 1-906 1-133	0-041 -0-063 0-795 0-743	IESI PIPE.	6.121 -0.034 9.514 i.357	0.092 -0.015 5.193 1.332	0.062 -0.00b 2.070 U.836	0-043 -0-005 0-659 4-593	TEST PIPE.	TEST PIPE.	0-101 -0-040 6-199 U.826	0.067 -0.019 2.386 ú.534	0.046 -0.013 0.984 0.413
demostikkale uf ti	ALTH ENERGY EI Havge upjemp of M. M.	0-045 0-130 (0.031 0.106 (0.021 0.083 0 0.013 0.057 (0-010 0-040	0.083 0.181 (0.052 0.125 (0-036 0-694 (0.023 0.063 (0.016 0.044	STABLISHEE IN 1	0-070 0-152	0.047 0.107 (0-029 0-070	0.020 0.049 (STABLISHED IN 1	STABLISHED IN 1	0-064 0-141 (0.039 0.086 0	0-027 0-659 (
E AND NUKMAL FLUW UEPTH E	WIRY ENTRY UPJUMP JOAN L Velop Fon Depth Jepth C M. M. M. M.	0.4322.584 0.002 J.107	0.3615-666 0.07 0.087	0.29 9.341 0.047 3.069 0.18 3.021 0.034 0.047	EEC.C \$20.0 145-1 E1.0	0.4322.584 0.049 J.132	0.3615.666 0.048 0.101	0.29 4.341 0.041 0.077	0-18 3-621 0-010 0-053	1.0.0 120-0 1+5+1 E1-0	FULL BURE FLOW E	0.3615-666 0.042 0.112	0.29 9.341 0.017 0.084	0-19 3-621 0-027 3-057	0-13 1-541 0-019 0-039	FULL BURE FLOW E	FULL BURE FLOW E	0.29 9.341 0.032 U.096	0-18 3-621 0-024 U-063	3-13 1-541 0-017 0-044
RUGRAM RESULTS BASED ON FERMINAL CCRLITTINS IN THE APPRUACE PLA COMMON DATA APPROACH PIPE EATA	Q. DIA. MANN. SLOPE HN TFRP. SLIPF HC HN FNIRY E L/S M. CGEFF (SIN) M. FNEFGY (SIN) M. M. DLPTH E M. M.	8.0 0.15 0.015 0.3402 0.033 C.437 0.0050 0.082 0.107 0.033	6.0 0.15 0.015 0.3402 9.028 0.376 0.1350 0.071 0.087 0.028	4.0 0.15 0.015 0.3402 0.023 0.492 0.0050 0.057 0.669 0.023 2.0 0.15 0.015 0.3402 0.017 0.195 0.0050 0.040 0.647 0.017	1.0 0.15 0.015 0.3402 0.012 0.129 0.0050 0.028 0.033 0.012	8.0 0.15 0.015 0.3402 0.013 0.437 0.0050 0.082 0.132 0.033	6.0 0.15 0.015 0.3402 0.026 0.370 0.0050 0.071 0.101 0.028	4.0 0.15 0.015 0.3402 0.023 0.292 0.0050 0.057 0.077 0.023	2.0 0.15 0.015 0.3482 0.017 0.195 0.0050 0.040 0.053 0.017	1.0 0.15 0.015 0.3402 0.012 0.129 0.0050 0.020 0.037 0.012	8.0 0.15 0.015 0.3402 0.033 0.437 0.0025 0.082 0.150	6.0 0.15 0.015 0.3402 0.026 0.370 0.0025 U.071 0.112 U.02b	4.0 0.15 0.015 0.3402 J.023 0.292 0.0025 0.057 0.084 0.023	2.0 0.15 0.015 0.3402 0.012 0.195 0.0025 0.040 0.057 0.017	1.0 0.15 0.015 0.3402 0.012 0.129 0.0025 0.020 0.039 0.012	8.0 0.15 0.615 0.3402 0.033 6.437 0.0017 0.082 0.150	6.0 0.15 U.015 0.3402 J.028 0.370 0.0617 U.071 0.150	4.0 0.15 0.015 0.3402 0.023 0.242 0.0017 0.057 0.096 0.023	2.0 0.15 0.015 0.3402 0.017 0.195 0.0017 0.040 0.063 0.017	1.0 0.15 0.015 0.34A2 0.012 0.129 0.0017 0.028 0.044 0.012

TESE PIPE WATA AND PROGRAM RESULTS.	ENTAY ENTAY UPJUAP JUAN DEPTH ENERGY ENERGY ENERCY JUMP JUMP I ENERGY FAM DEPTH DEPTH CHINGE UPJUMP DGWN CHARGE FAM. PDS. No. No. Mo. Mo. Mo. Mo. Mo. Mo. Po. No. Mo.	JUMP LAPJSSIBLE AS HNCHC IN TEST FIPE.	JUMP IMPJSSIBLE AS HNCHC IN FEST PIPE.	JUMP IMPOSSIBLE AS HNCHC IN TEST PIPE.	JUMP LMP ISSIBLE AS MNCHC IN TEST PIPE.	JUMP LAPJSSIBLE AS HNCHC IN TEST PIPE.	JUMP IMPJSSIALE AS MNCHC IN TEST FIPE.	JUMP IMPUSSIBLE AS HNCHC IN TEST PIPE.	JUMP INPUSSIBLE AS HNCHC IN TEST FIPE.	JUMP IMPOSSIBLE AS MNCHC IN TEST PIPE.	JURP INPUSSIBLE AS HNCHC IN TEST PIPE.	0 0.5525.739 0.041 0.084 0.003 0.115 0.115 0.000 9.685 5.072	6 0.4517.550 0.071 J.071 0.000 0.698 0.098 0.000 6.795 4.623	JUMP INPISSIBLE AS HNCHC IN TEST FIPE.	JUMP INPUSSIBLE AS HNCHC IN TEST PIPE.	JUMP IMPJSSIBLE AS MNCHC IM TEST PIPE.	0.5525.739 0.070 3.096 0.027 0.120 0.119 -0.00110.284 3.813	114.5 0.4517.550 0.052 0.030 0.018 C.101 0.100 0.000 4.573 3.411	2 0-3510-248 0-052 0-063 0-012 0-080 0-080 0-000 4-107 2-777	6 0-22 4-111 0-016 J-044 0-007 0-055 0-055 0-060 1-692 1-826	1 0.15 1.6648 0.025 0.031 0.006 C.636 0.038 0.C60 0.706 1.155
	11111 11111 11111 11111 11111 11111 1111	064	055	644	160	022	620	067	053	260	026	044 0-03	071 0-02	057	039	028	0.46 0-03	080 0-02	063 0.02	044 0-01	031 0-01
	U .	0 3 0.	074 0.	057 0.	040 0.	028 0.	082 0.	071 0.	057 0.	340 0+	024 0.	092 0.	071 0.	057 0.	040 0-	028 0.	082 0.	071 0.	057 0.	040 0*	028 0.
	SLOZE H (SIN) A	0.0250 0.	0.0250 0.	0.0250 0.	0.0250 0.	0-0250 J-	0.0125 0.	0.0125 0.	0.0125 0.	0-0125 0-	0.0125 0.	•0 001C=0	-0 0010°0	0-0100 0-	0.0100 v.	•0 00TC•0	0-0066 0-	0-0066 0-	n-0066 0-	0.0466 0.	0 00000 0°
DATA	TEKE Enefon F.	0 6.561	6 C-475	1 0.374	5 0.246	1 6.164	0.561	b 0.475	1 0-374	5 0-248	L C. 164	0.561	6 0.475	1 0.374	5 C.246	1 0.164	0.561	6 0.475	1 0-374	5 0-248	0.16
CH PIPE	Р т Ц Ш	0.030	0-024	0.021	0.01	10-0 6	0.030	0.020	1 0-021	10-0 0	0-011	0.030	0-026	0-021	:to-o c	10-0 0	0 0 0 C	0-020	0-021	0.01	10-0 0
APPAGA	SLUPE	0.500	0-500	0-500	0-500	0-500	0-200	0-500	0-500	0.500	0-500	0.500	0-500	0-500	0-500	0-500	0-500	0-500	0-500	0.500	0*200
DATA	MANN. CDEFF	0-015	0.015	0-015	0.015	0.015	0.015	0-015	0-015	0-015	0-015	0-015	0-015	0-015	0-015	0-015	0-015	0-015	0-015	0-015	0.015
COMMON	Q. DIA. L/S M.	8-0 0-15	6.0 0.15	4.0 0.15	2.0 0.15	1.0 0.15	8.0 0.15	6.0 0.15	4.0 0.15	2.0 0.15	1.0 0.15	8.0 0.15	6.0 0.15	4-0 0-15	2.0 0.15	1.0 0.15	8.0 0.15	6.0 0.15	4.0 0.15	2.0 0.15	1.0 0.15

PRUGRAM RESULTS BASED BY TERMINAL CONDITING IN THE APPRUACH PLAF AND NUKRAL FLUW DEPTH CONNSTREAM OF SHE JUMP IN THE TEST PLPE.

• T e I e		ия? Э5.	461.	168.	1353	125.	266	906	.179	683	. 254	.836		585	478	910	• 6 5 4			126.	. 725	(1)
1231		7 A . Z	08 3	13 618	2 65 2	1 052	130 .	090	2 605	112 1	906 1.	195 3.		11 1	193 1.	010 F.	59 0			0 661	186 3	984 0
1 F.F.			1110	2 7.	1 4-1	1 1.	1 0.	1713.1	3 8	-+ 2	4 I-9	13 0° 1		1 9.	5 5.1	b 2.	5 0 s			t 6.	4 2.	G.
N d		ENERC Charc	-0-00	-0-00	-0-00	-0-00	-0-00	-0-03	-0-01	-0-00	-0-00	-0-00	3 P.E. •	-0-03	-0-01	-0-00	-0.00	Lis Mas	3 P.E -	-0-04	-0-01	-6.01
		> 	•125	erl.	-002	• 050	650.	-144	.112	290.	• 059	1+0*	ESI P	121-	-042	-052	- 0+3	EST P	EST P	101-	-067	• 0 • 6
OF TH			306	06 U	93 0	3 65	0 0	88 0	25 0	94 0	0 69	••	IN I	52 0	0 10	0 02	0 69	EN I	2 11 2	•1 0	96 0	59 0
LE AP	15.	iaran 19943	f.1.	0-11	0-0	0-0	0-0	0.10	0.1	0-0	0-0	0-0	SHEE	0+1	0-11	0-0	0-0	SHED	SHEL	0.1	0-0	0-0
	R E SUL	P TH TANGE H.	.045	160.0	120.0	.013	.010	.083	.052	960-0	620-0	.016	TABLE	010-0	1+0-0	•029	.020	TABLE	IABLI	• 9 9 •	•039	027
FH DC	UGABH	L CP	107 6	197 6	0 6 90	147 0	133 0	3 261	101 0	111 0	9 650	3 7 60	04 ES	112 6	944	121	9 660	.04 ES	04 65	96 0	063 6	944
. 05P	0 PRO		2 0+1	7 0.0	7 3.6	4 J=0	4 0-0	9 0.1	8 0.1	1 0 · 0	0.0-0	1 0.0	Rë FL	2 3-1	7 0-0	7 0-0	9.0.6	RE FL	Rč FL	2 0.0	4 J. C	7 0.0
r flu	TA AN	UP3UA DEPTH	0.40	c0=0	U = U*	0.03	0.02	0 • 0 •	0=0+	0-04	0-03	0-02	LL BU	0-04	6.0.0	0-02	0.04	LL 40	LL BU	60°0	0.02	0-01
CREAL	E DA	× = + Z	657.1	• 550	•240		. 6668	· 739	045-	•248		-688	FUI	.550	•24R	. 114	•686	FUI	FUI	•248	• 111	•646
A GNA	414 1	KY EN KGY E	•5525	• + 5 13	.3510	• 22 •	.15 L	•5525	• +513	.3510	• 22•	.15 1		• • 517	.3510	• 22 •	.15 4			.3510	• 22•	.151
5410	1ES		0 0	0 9	2 0	16 0	11 0	0 0	6 0	0 2	16 0	11 0		6 0	2 0	6 0	11 0			2 0	16 0	11 0
			1.1	~	~~	-		1.1	1.4	~~~					r s	_					-	0
NCH		ЕчТР 06Р1	0=0	0.0	0.0	0.0	0-0	0.0	0°0	0.0	0.0	0-0	-	0-0	0.0	0-0	0.0			0-0	0 0 0	5
APPRUACH		HN FAIR DEPT	0-107 0-0	0-047 0-0	0.009 0.6	0.047 0.0	0-033 0-0	0-132 0-0	0-101 0-0	0-077 0-0	0-053 0-0	0-037 0-0	0-150	0-112 0-0	0-084 0-0	0-057 0-0	0-039 0-0	0 - 1 5 0	0-150	0-096 0-0	0-063 0-0	0-044 0-
THE APPRUACH		HC HN EVIE N. DEPT	-082 0-107 0-0	011 0-047 0-0	•057 0•009 0•E	•0+0 0•0+1 0•0	•05b 0•033 0•0	.082 0.132 0.0	•071 0•101 0•0	.057 0.077 0.6	.040 0.053 0.(.024 0.037 0.0	•095 0•150	-071 0-112 0-C	-057 0-084 0-0	•0+0 0-024 0+0-	.028 0.039 0.0	•042 0•150	•071 0-150	•057 0•096 0•0	•044 0•063 0•0	-02d 0-044 U
NS IN THE APPRUACH		AL HA EVIE	0-0 201-0 70-0 040	150 0-071 0-047 0-0	150 J.057 0.009 0.E	150 0-040 0-042 0-0	J5U U.O26 0.033 0.0	0+0 0-082 0-132 0+0	050 0.071 0.101 0.0	350 0.057 0.077 0.0	350 0.040 0.053 0.(150 0.028 0.037 0.0	J25 0.042 0.150	025 0-071 0-112 0-0	225 0-057 0-084 0-0	025 V.040 0.057 0.0	J25 J.028 0.039 0.0	017 0-042 0-150	017 U. 071 0.150	017 V.057 0.096 0.0	017 0.044 0.063 0.0	U17 0-024 0-044 0-
LITERNS IN THE APPRUACH		SLOPE HC HN EVIE I (SIN) H. P. DEPT	0-0100 0-087 0-101 0-0	0-0020 0-011 0-041 0-0	1 0.0050 J.057 0.009 0.E	0 • 0 0 2 0 • 0 + 0 • 0 • 0 • 0 • 0	1 0-0454 4-026 0-033 0-0	1 0-0050 0-082 0-132 0-0	0.0050 0.071 0.101 0.0	+ 0.0050 0.057 0.077 0.0	0 • 0 0 2 0 • 0 • 0 • 0 • 0 • 0 • 0	1 0-0350 0-024 0-037 0-0	1 0-0025 0-082 0-150	5 0-0025 0-071 0-112 0-C	• 0-0025 0-057 0-084 0-0	3 0-0025 V-040 0-057 0-0	6 0-0025 J-028 0-039 0-0	1 0.0017 0.042 0.150	5 0-0017 U-071 0-150	• 0-0017 v-057 0-096 0-0	8 0-0017 0-044 0-063 0-0	4 0.0017 0.024 0.044 U.
. LINEITIANS IN THE APPRUACH	DATA	TEPP. SLUPE MC HN ENTR Neecy (Sin) M. M. M. Dept M	0-541 0-0050 0-082 0-107 0-0	0-475 0-0050 0-071 0-047 0-0	0.374 0.0050 J.057 0.009 0.E	P.246 0.0050 0.040 0.047 0.0	0.164 0.0050 0.028 0.033 0.0	0.561 0.0050 0.082 0.132 0.0	0.475 0.0050 0.071 0.101 0.0	0.374 0.0050 0.051 0.077 0.0	0.248 0.9050 0.040 0.053 0.(0.164 0.0350 0.028 0.037 0.0	0.561 0.0025 0.082 0.150	0.475 0.0025 0.071 0.112 0.0	0.374 0.0025 0.057 0.084 0.0	0.248 0.0025 v.040 0.057 0.0	0.164 0.0025 0.028 0.039 0.0	0.561 0.0017 0.042 0.150	0.475 0.0017 U. 071 0.150	0.374 0.0017 U.057 0.096 0.0	C.248 0.0017 0.044 0.063 0.0	0.164 0.0017 0.024 0.044 0.
MENEL GENEITEANS IN THE APPRUACH	PIP6 BATA	MN TEPP. SLUPE MC HN ENTR M. FALEGY (SIN) M. P. DEPT M. M.	.030 0*561 0*0050 0*082 0*107 0*0	+026 0.475 0.0050 0.011 0.047 0.0	021 0.374 0.0050 J.057 0.009 0.E	.015 P.248 0.0050 0.040 0.047 0.0	•011 0-164 0-0050 0-028 0-033 0-0	-030 6.561 0.0050 0.082 0.132 0.0	•026 0.475 0.0050 U.071 0.101 U.0	021 0.374 J.0050 J.057 0.077 D.	1.015 0.248 0.9050 0.040 0.053 0.0	011 0.164 0.0350 0.024 0.037 0.0	030 0.561 0.0025 0.042 0.150	-026 0.475 0.0025 0.071 0.112 0.C	-021 0-374 0-0025 0-057 0-084 0-0	1.015 0.248 0.0025 J.040 0.057 0.0	.011 0.164 0.0025 0.028 0.039 0.0	1.030 0.561 0.0017 0.042 0.150	-026 0.475 0.0017 U.071 0.150	1.021 0.374 0.0017 0.057 0.096 0.C	•.015 E.248 0.0017 0.044 0.063 0.0	1.011 0.164 0.0017 0.024 0.044 U.
A FERMINEL LINEITIANS IN THE APPRUACH	UACH PIP4 DAIA	PE MN TEPP. SLOPE MC HN EVIF N) M. ENEECY (SIN) M. M. M. DEPT M. M. M.	000 0°030 0°241 0°0020 0°082 0°101 0°0	300 0-026 0-475 0-0050 0-071 0-047 0-0	007 0-021 0-374 0-0050 J-057 0-059 0-E	001 0.015 P.248 0.0050 0.040 0.047 0.0	000 0.011 0.164 0.0050 0.028 0.033 0.0	001 0-030 6-561 0-0050 0-082 0-132 0-0	001 0.026 0.475 0.0050 U.071 0.101 U.O	003 0.021 0.374 J.0050 J.057 0.077 D.(000 0-015 0-248 0-0050 0-040 0-053 0-0	007 0.011 0.164 0.0150 0.028 0.037 0.0	001 0-030 0-561 0-0025 U-042 0-150	000 0.026 0.475 0.0025 0.071 0.112 0.C	000 0.021 0.374 0.0025 0.057 0.084 0.0	000 0.015 0.248 0.0025 V.040 0.057 0.0	000 0-011 0-164 0-0025 0-028 0-039 0-0	000 0-030 0-561 0-0017 0-042 0-150	003 3-026 0-475 0-0017 J-071 0-150	000 0-021 0-374 0-0017 0-057 0-096 0-C	000 9.015 E.248 0.0017 0.044 0.063 0.0	003 0.011 0.164 0.0017 0.020 0.044 0.
SED WY FERMINEL GINEITIANS IN THE APPRUACH	APPRUACH PIP4 DATA	 SLUPE MN TEPP. SLUPE MC HN EVIE FOLDTE MC HN EVIE FOLDTE MC HN EVIE FOLDTE MC HN MC HN MC MC MC MC Me Mc MC	5 0*5009 0*030 0*541 0*0050 0*085 0*107 0*0	5 0.5300 0.026 0.475 0.0050 0.071 0.047 0.0	5 0-5007 0-021 0-374 0-0050 J-057 0-009 0-E	5 0-5007 0-015 0-248 0-0450 0-040 0-047 0-0	5 0.5000 0.011 0.164 0.0050 0.026 0.033 0.0	5 0.5007 0.030 6.561 0.0050 0.082 0.132 0.0	5 0.5007 0.026 0.475 0.0050 U.071 0.101 U.0	5 0-5003 0-021 0-374 0-0050 0-057 0-077 0-6	5 0.5007 0.015 0.248 0.9050 0.040 0.053 0.0	5 0.5007 0.011 0.164 0.0350 0.024 0.037 0.0	5 0.5007 0.030 0.561 0.0025 0.042 0.150	5 0.5000 0.026 0.475 0.0025 0.071 0.112 0.0	5 0-5000 0-021 0-374 0-0025 0-057 0-084 0-0	5 0.5000 0.015 0.248 0.0025 J.040 0.057 0.0	5 0-5000 0-011 0-164 0-0025 0-028 0-039 0-0	5 0.5000 0.030 0.561 0.0017 0.042 0.150	5 0.5007 J.026 C.475 0.0017 J.071 0.150	5 0.5007 0.021 0.374 0.0017 0.057 0.096 0.C	5 0-5000 9-015 E-248 0-0017 0-040 0-063 0-0	5 0-5003 0-011 0-164 0-0017 0-024 0-044 0-
TS BASED WY FERMINEL LINELLING IN THE APPRUACH	IATA APPRUACH PIP4 DATA	NAAN. SLUPE MN TEPP. SLUPE MC HN EVIF Cueff (SIN) M. FNEECY (SIN) M. P. DEPT M. M.	0-015 0-5009 0-030 0-541 9-0450 0-082 0-107 0-0	0-015 0-5000 0-026 0-475 0-0050 0-011 0-041 0-0	0.015 0.5007 0.021 0.374 0.0050 J.057 0.009 0.E	0-015 0-5007 0-015 0-248 0-0450 0-040 0-041 0-0	0.015 0.5000 0.011 0.164 0.0050 0.028 0.033 0.0	0.015 0.5007 0.030 6.561 0.0050 0.082 0.132 0.0	0.015 0.5007 0.026 0.475 0.0050 0.071 0.101 0.0	0.015 0.5003 0.021 0.374 J.0050 U.057 0.077 0.6	0.015 0.5000 0.015 0.248 0.0050 0.040 0.053 0.0	0-015 0-5007 0-011 0-164 0-0150 0-028 0-037 0-0	0.015 0.5007 0.030 0.561 0.0025 0.042 0.150	0-015 0-5000 0-026 0-475 0-0025 0-071 0-112 0-0	0-015 0-5000 0-021 0-374 0-0025 0-057 0-084 0-0	0-015 0-5000 0-015 0-248 0-0025 V-040 0-057 0-0	0-015 0-5000 0-011 0-164 0-0025 0-028 0-039 0-0	0-015 0-5000 0-030 0-541 0-00117 0-045 0-150	0-015 0-5003 3-026 C-475 0-0017 0-071 0-150	0.015 0.5007 0.021 0.374 0.0017 0.057 0.096 0.0	0.015 0.5000 0.015 C.248 0.0017 0.044 0.063 0.0	0-015 0-5003 0-011 0-164 0-0017 0-020 0-044 0-
ESULTS BASED BY FERMINEL CINEITIANS IN THE APPRUACH	MUN DATA APPRUACH PIPE DATA	DIA. NAAN. SLUPE HN TEPP. SLUPE MC HN ENFR H. CUEFF (SIN) M. FNEECY (SIN) M. M. M. DEPT M	0.15 0.015 0.5009 0.030 0.561 0.0050 0.082 0.107 0.0	0.15 0.015 0.5300 0.026 0.475 0.0050 0.071 0.047 0.0	0.15 0.015 0.5007 0.021 0.374 0.0050 J.057 0.009 0.E	0.15 0.015 0.5007 0.015 0.248 0.0050 0.040 0.047 0.0	0.15 0.015 0.5000 0.011 0.164 0.0050 0.026 0.033 0.0	0.15 0.015 0.5007 0.030 0.561 0.0050 0.082 0.132 0.0	0.15 0.015 0.5007 0.026 0.475 0.0050 0.071 0.101 U.O	0.15 0.015 0.5003 0.021 0.374 J.0050 U.057 0.077 0.6	0.15 0.015 0.5007 0.015 0.248 0.9050 0.040 0.053 0.0	0.15 0.015 0.5007 0.011 0.164 0.0350 0.024 0.037 0.0	0.15 0.015 0.5007 0.030 0.561 0.0025 0.042 0.150	0.15 0.015 0.5000 J.026 0.475 0.0025 J.071 0.112 D.C	0.15 0.015 0.5000 0.021 0.374 0.0125 0.057 0.084 0.0	0.15 0.015 0.5000 0.015 0.248 0.0025 V.040 0.057 0.0	0.15 0.015 0.5000 0.011 0.164 0.0025 0.024 0.039 0.0	0.15 0.015 0.5000 0.030 0.561 0.0017 0.042 0.150	0.15 0.015 0.5007 J.026 C.475 0.0017 J.071 0.150	0.15 0.015 0.5007 0.021 0.374 0.0017 0.057 0.096 0.C	0.15 0.015 0.5000 7.015 E.248 0.9017 0.044 0.063 0.0	0.15 0.015 0.5003 0.011 0.164 0.0017 0.024 0.044 0.
SRAM RESULTS BASED WY TERMINEL GINEITIANS IN THE APPRUACH	COMMUN DATA APPRUACH PIP6 DATA	Q. DIA. MANN. SLUPE HN TEPT. SLUFE HC HN EVIF L/s H. Cueff (Sin) M. Fneecy (Sin) M. M. M. M. M. M.	8.0 0.15 0.015 0.5009 0.030 0.561 0.0050 0.082 0.107 0.0	6.0 0.15 0.015 0.5300 0.026 0.475 0.0050 0.071 0.047 0.0	4.0 0.15 0.015 0.5047 0.021 0.374 0.0050 J.057 0.009 0.E	2.0 0.15 0.015 0.5007 0.015 0.248 0.0050 0.040 0.047 0.0	1.0 0.15 0.015 0.5000 0.011 0.164 0.0050 0.026 0.033 0.0	8.0 0.15 0.015 0.5007 0.030 0.561 0.0050 0.082 0.132 0.0	6.0 0.15 0.015 0.5007 0.026 0.475 0.0050 0.071 0.101 0.0	4.0 0.15 0.015 0.5003 0.021 0.374 J.0050 U.057 0.077 0.6	2.0 0.15 0.015 0.5009 0.015 0.248 0.9050 0.040 0.053 0.0	1.0 0.15 0.015 0.5009 0.011 0.164 0.0150 0.028 0.037 0.0	8.0 0.15 0.015 0.5007 0.030 0.561 0.0025 0.042 0.150	6.0 0.15 0.015 0.5000 0.026 0.475 0.0025 0.071 0.112 0.0	4.0 0.15 0.015 0.5000 0.021 0.374 0.0125 0.057 0.084 0.0	2.0 0.15 0.015 0.5000 0.015 0.248 0.0025 V.040 0.057 0.0	1.0 0.15 0.015 0.5000 0.011 0.164 0.0025 0.024 0.039 0.0	8.0 0.15 0.015 0.5000 0.030 0.561 0.0017 0.042 0.150	6.0 0.15 0.015 0.5003 3.026 0.475 0.0017 J.071 0.150	4.0 0.15 0.015 0.5007 0.021 0.374 0.0017 0.057 0.096 0.0	2.0 0.15 0.015 0.5000 9.015 E.248 0.0017 0.044 0.063 0.0	1.0 0.15 0.015 0.5003 0.011 0.164 0.0017 0.024 0.044 0.

.

TESE PIPE DATA AND PRJGAAM KESULTS。 Zytay Entry upjump joan ûffth Enekgy Enepêy Enifês juhp jjap Evergy f⇔m dêpth jepth change upjimp dûnn change f+h° pjs. M° N°	JUMP IMPJSSIBLE AS MNCHC IN TEST PIPE. Jump Impjssible as Mnchc in test pipe.	JUMP INFUSSIBLE AS MACHE IN TEST FIFE. JUMP IMPUSSIBLE AS MACHE IN TEST PIPE. JUMP IMPUSSIBLE AS MACHE IN TEST PIPE. JUMP IMPUSSIBLE AS MACHE IN TEST PIPE.	JUMP IMPJSSIBLE AS HNCHC IN VEST PIPE. JUMP IMPDSSIBLE AS HNCHC IN VEST PIPE. 0.6728-695 0.041 0.384 0.003 0.115 0.115 0.006 9.685 5.333 0.5719-900 0.071 0.071 0.000 0.098 0.098 0.006 6.795 4.845 SUMP IMPUSSIBLE AS HNCHC IN TEST PIPE.	JUMP IMPUDSFIBLE AS MMCHC IM TEST PIPE JUMP IMP03551BLE AS HMCHC IM TEST PIPE Oubling Oubling Oubling Oubling Oubling Oubling So So Oubling Oubling Oubling Oubling Oubling Oubling Su Su
COMMUN DATA APPROACH PIPE EATA Q. DIA. MANN. SLOPE HN TEKP., SLOPE HC HN FWTRY L L/S M. CUEFF ISINI M. ENEKGY (SINI M. M. M. M.	d.0 0.15 0.015 0.7079 0.027 0.705 0.0250 0.082 0.064 6.0 0.15 0.615 0.7079 0.024 0.597 0.0250 0.071 0.655 4.0 0.15 0.015 0.7079 0.019 0.469 0.0250 0.057 0.044	1:0.0.15 0.015 0.010 0.010 0.010 0.010 0.0250 0.0252 1.0 0.15 0.015 0.7079 0.010 0.205 0.0250 0.0252 8.0 0.15 0.015 0.7079 0.027 0.7055 0.082 0.0579 8.0 0.15 0.015 0.7079 0.027 0.7055 0.0125 0.057 8.0 0.15 0.015 0.7079 0.0274 0.5977 0.0125 0.0125 0.057 6.0 0.15 0.015 0.0279 0.024 0.5977 0.0125 0.057 0.057 4.0 0.15 0.015 0.019 0.469 0.0125 0.057 0.053	2.0 0.15 0.015 0.7070 0.014 0.310 0.0125 0.0537 0.0537 1.0 0.15 0.015 0.7077 0.310 0.205 0.0125 0.024 0.026 8.0 0.15 0.015 0.7077 0.327 0.705 0.0100 0.082 0.0144 0.028 6.0 0.15 0.7077 0.024 0.577 0.5797 0.0100 0.082 0.0144 0.028 4.0 0.15 0.0107 0.577 0.5749 0.5107 0.024 0.024	Z.0 0.15 0.015 0.7070 0.0114 0.310 0.0100 0.0010 0.039 1.0 0.15 0.015 0.7077 0.0100 0.205 0.0100 0.028 0.028 1.0 0.15 0.015 0.7077 0.010 0.205 0.0106 0.028 0.028 8.0 0.15 0.015 0.7077 0.027 0.205 0.0106 0.0058 0.028 8.0 0.15 0.015 0.7077 0.024 0.5076 0.0106 0.0053 0.0058 4.0 0.15 0.015 0.7077 0.019 0.0056 0.0053 0.019 2.0 0.15 0.016 0.0166 0.0166 0.0649 0.0633 0.019 2.0 0.15 0.0166 0.0166 0.0449 0.0166 0.031 0.014 1.0 0.15 0.0166 0.0166 0.023 0.014 0.014 0.014

PRUGRAM RESULTS BASED UN FERMINAL CONDITIONS IN THE APPROACH PIPE AND NORMAL FLUN DEPTH BONNSTREAP OF THE JUPP IN THE LEST PIPE.

			\$	2		Q	10	~		ç	đ	Q.			10	Ŧ	Ģ			~	-	~
		425°	3.35	3.12	2 - 53	1.73	1.05	61.2	2.43	60-7	1,33	Ú. 85		4.83	1 • 6 3	I.15	0.71			1 - 1 8	0.86	0.53
		4 • Z	r08	313	597	250	730	660	909	712	906	295		511	661	010	659			199	386	495
		J. J.	-11-	2 2.	4	4 4.	•••	.513	8	4	1			6	5.	0 2.	0				2.	0.
		NE P G	00 - 0	0-00	0 • 00	0-00	0-00	0-03	0-01	0.00	0-00-	0-00	۴.	0-03	0.01	0.00	0.00	PE.	P.E	0-040	0.01	0-01
		шо Ж.	- 52	63 -	82 -	- 95	- 66	- ++	12 -	- 28	- 65		Id I	- 12	- 26	62 -		IdI	14 1	- 10	- 29	- 94
		ENER DGMN	0.1	0.1	0-0	0.0	0.0	0.1	0.1	0.0	0.0	0 * 0	TES	0.1	0-0	0-0	0.0	TES	TES	0.1	0-0	0*0
		A P P	OET	106	683	150	040	181	125	460	063	440	1	152	107	020	640	E IN	E IN	141	686	650
	115.	ENE	•	•	•	•	•	•	•	•	0	•	ISHE	•	-	•	•	E SHE	I SHE	•0	•0	•0
	RESU	PTH ANGE	-045	160.	.021	E10*	.010	.083	.052	.036	.023	.016	IA6L	.070	240-	.029	.020	TABL	TABL	• 0 6 4	• 0 39	.027
	KAR	20 	2	17 0	6	1		2	1	2 8		2 0	IN ES	2	4	2 0	6	H ES	IN ES	9	3 0	9
	PRJC	104 104 104	0=10	0=0	0-06	0-0	0-03	0.13	0.10	0.01	0°	0-03	FLO	0+11	0-09	0.05	0-03	FLO	FLG	0.09	0 • 00	3=04
	DNA	LUA?	•005	140.	-0-7	+10-	• 07 4	940-	.0+8	Ún l	.030	120	808	.042	250.	120.	.019	BURE	6 UR	•032	• 70 •	1017
	DATA	V UP	95 0.	0 00	57 0.	38 0.	61 0	95 0.	0 00	57 0	38 0.	51 0.	-ULL	0 00	0.29	38 0.	61 O.	FULL	FULL	0 25	30 0.	64 0.
	I P E	¥ # # # 7 4 9	28.6	19.9	11.9	4+7	1 - U	28.6	19-9	11-9	4+7	1 = C	-	19 - 91	11-9	1.7	1.0	-	-	11.9	2 * 5	1 = Ŭ
	SI P	TAV ERGY 4.	0.67	12.0	14.0	0.29	0.18	1 9-0	15-0	14-0	0.29	0.18		0.57	0.47	0.29	0.18			0.47	0.29	0.18
	ΤE	H E	20	54	19	1	10	2 19	54	56	4	10		54	19	1.4	10			16	14	10
		ENTR DEPT M.	0-0	0 • 0	0-0	0-0	0.0	0-0	0.0	0 • 0	u. 0	0 • 0		() • ()	0.0	0 -0	0.0			0.0	0-0	0-0
		Z + X K	101-1	1.087	• 0 • 0	-043	EE0*	.132	.101	.077	• 053	.037	-150	.112	-084	-057	•634	.150	•150	•096	•003	++0-
		() .	82 0	17. 0	0 150	140 0	24 0	9.2 0	71 0	157 0	0 040	23 0	82 0	171 0	121 0	40 0	120 0	982 0	171 0	57 0	40 0	124 0
		ΞĽ	0.0	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0.0	0.0	0-0	0.0	0.0	0-0
		UNE INE	0020	0020	0050	0050	0050	0050	0.050	0.050	00150	0.50	0025	0025	0.025	0025	0u25	0012	0012	0012	0013	100.
	4	64 C	0.50	0 26	69 0.	10 0.	0 5 0.	05 0.	0 26	69 0.	10 0.	0 50	05 0.	0 26	69 0.	10 0.	05 0.	02 0	0 26	69 0	10 0.	05 0.
	DAT	TEFF ENER F.	0.7	0.5	C.4	0.3	0.2(0.7	0.5	0.4	0.31	0.20	0.7	0.5	0-4	0.3	0.2	0.7	0-5	0.4	0.3	0.2
	34 I d	Z +	• 327	• 024	610-	•10-	.010	-027	•024	610-	-014	.010	- 027	• 20 •	610.	-014	• 010	• 027	• 024	•10	•014	.010
	ACH	ω.	10 01	10 0	0 62	0 61	7.7 0	70 0	20 0	20 0	20 0	10 01	70 0	0 62	20 0	0 62	70 0	70 0	70 0	20 0	10 0	70 0
	PPK3	SLUP SLUP	0- 20	0-20	02-0	02-0	070	070	0.20	070	02-0	02-0	0.7.0	0-10	0**0	0.20	0-10	0.20	0-10	02*0	0-10	0.70
	<	INN.	015	015	015	615	015	015	015	015	615	015	015	015	015	015	015	015	015	015	615	015
	DAT		5 0	5 0-	5 0.	5 0.	5 0.	5 0.	5 0.	5 0.	5 0.	5 0.	5 0.	5 0.	5 0.	5 0.	5 0.	5 0.	5 0 -	5 0.	5 0.	5 0.
	NUM	DI A	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	CO	0. L/S	8.0	6.0	4.0	2.0	1.0	8.0	6.0	4 • 0	2.0	1.0	8.0	6.0	4.0	2.0	1.0	8.0	6.0	4 • C	2.0	1 ° 0

PROCRAM RESULTS BASED UN TERMINAL LINLITIDAS IN THE APPROACH PLAS AND NURMAL FLUM WEREH DOWNSTREAT OF THE JUMP IN THE RESULTS BASED UN TERMINAL LINLITIDAS IN THE APPROACH PLAS AND NURMAL FLUM WEREH DOWNSTREAT OF THE JUMP IN THE REST PLACE.

TEST PIPE WATA AND PRJGRAM RESULTS.	r ENTAY ENTRY UPJUMP JOAN DEPTH EREKGY ENER'Y ENERGY JUMP JJ97 1 ENERGY FOR DEPTH CHANGE UPJUMP DOWN CHANGE FOR. 235. M. N. M. M. M. M. M. M. M. M. M. Y. Y.	JUMP IMPJSSIBLE AS MNCHC IN TEST PIPE.	JUMP IMPOSSIBLE AS HNCHE IN TEST PIPE.	JUMP LIPISSIBLE AS MNCHC IN TEST PIPE.	JUMP IMPOSSIBLE AS HNCHC IN TEST PIPE.	JUMP INPOSSIBLE AS MNCHC IN TEST PIPE.	JUMP INPOSSIBLE AS HNCHE IN TEST PIPE.	JUMP EMPOSSIBLE AS MMCHE IN TEST PIPE.	JUMP ERPOSSIBLE AS MNCHC IN TEST PIPE.	JUMP IMPUSSIBLE AS HMCHC IN TEST PIPE.	JUMP IMPJSSIBLE AS MNCMC IN TEST PIPE.	26 0.7831.030 0.041 0.084 0.003 0.115 0.115 0.000 9.685 5.455	23 0-6320-815 0-071 0-071 0-071 0-000 0-098 0-098 0-000 6-795 4-919	JURP IMPOSSIBLE AS HNCHC IN TEST PIPE.	JUMP IMPOSSIBLE AS HNCHE IN TEST PIPE.	JUMP IMPUSSIBLE AS HNCHC IN FEST PIPE.	26 0.7831.030 0.070 0.095 0.027 0.120 0.119 -0.00110.284 4.19	23 0-6320-815 0-002 0-030 0-018 0-101 0-100 -0-001 6-973 3-712	19 0-5212-645 0-0>2 0-063 0-012 0-080 0-060 0-000 4-107 3-052	13 0-34 5-120 0-036 0-044 0-007 0-055 0-055 0-000 1-692 2-323	10 0-22 2-071 0-025 0-031 0-006 0-638 0-038 0-000 0-706 1-277
COMMUN DATA APPRJACH PIPE DATA	3. DIA. MANN. SLOPE HN TEKK. SLOPI HC HA ENIPY L/S N. CGEFF ISIN) M. ENERGY ISIN) M. H. DIPTE P. M.	8.0 0.15 0.015 0.8660 0.026 0.608 0.0250 0.082 0.664	6.0 0.15 0.015 0.8667 0.023 0.483 0.0250 0.071 0.655	4.0 0.15 0.015 0.86667 7.019 0.536 0.0250 0.057 0.044	2.0 0.15 0.015 0.8667 0.013 0.355 0.0250 0.040 0.631	1.0 0.15 0.015 0.8667 0.010 0.234 0.0250 0.024 0.022	8.0 D.15 0.015 0.8669 0.026 0.608 0.0125 0.082 0.079	6.0 0.15 0.015 0.8664 0.023 0.683 0.0125 0.071 0.067	4.0 0.15 0.015 0.8667 0.019 0.536 0.0125 U.057 0.053	2.0 0.15 0.015 0.8669 0.013 0.355 0.0125 0.040 0.037	1.0 0.15 0.015 0.8660 0.010 0.234 0.0125 0.028 0.026	8.0 0.15 0.015 0.8561 0.026 0.808 0.0100 0.082 0.084 0.02	6.0 0.15 0.015 0.8669 0.023 0.683 0.0100 0.071 0.071 0.02	4.0 0.15 0.015 0.8669 0.019 0.536 0.0100 U.057 0.057	2.0 0.15 0.015 0.8660 0.01B 0.355 0.0100 0.040 0.039	1.0 0.15 0.015 0.8669 0.010 0.234 0.0100 0.024 0.028	8.0 0.15 0.015 0.86667 0.026 0.808 0.0066 0.032 0.046 0.02	6.0 0.15 0.015 0.8669 0.023 0.683 0.0066 0.071 0.080 0.02	4.0 0.15 0.015 0.8667 0.019 C.536 0.0066 0.057 0.063 U.01	2.0 0.15 0.015 0.8667 0.013 0.355 0.7066 0.040 0.044 0.01	1.0 0.15 0.015 0.8567 0.010 0.234 0.0066 0.024 0.031 0.01

PRUGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPROACH PLPF AND NUMMAL FLUM USPIH DOWNSTAFAP OF THE JUMP IN THE TEST PIPS.

	04P 35.	615.	•195	÷ 65 5	.772	611.	. 277	• 472	.156	• 455	• 926		• 8 7 4	• 751	• 218	.775			• 252	• 35 •	
	7 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	.008 3	e 616.	• 265 2	. 750 1	. 730 1	. 660 4	\$ 605-	.712 2	1,905-	- 795 0		1 114.	• 193 1	.070 1	• 659 U			. 199 1	.386 b	
	R CK J	. 00511	005 7	100	1 100.	0 100.	E17E0.	8 610.	. 007 4	. 004	0 600 .	•	6 160.	015 5	009 2	0 \$00.		•	040 6	019 2	
	CHI	25 -0-	0- 60	12 -0-	56 -0-	99 -0-	-0- +4	12 -0.	17 -0-	9-6	-0- 14	FIPE	-0-12	2 -0-	-0- 20	-0- 54	PIPE	1414	0- 10	-0- 29	
	ENERG DOWN	0.12	0-10	0 • 0	0 • 0	0.0	0-14	0.11	0-0	0-0	0-0	N TESI	0.12	0.03	0.06	0-04	N TESI	N TESI	0.10	0-06	
15.	ENEK CV UP JURP	0-130	0.106	0-083	0-057	0-040	0-101	0.125	0-094	0-063	0-644	SHED E	0.152	0-107	0-070	0-649	SHEE II	SHED T	0.141	0.086	
I LE SUL	LEFTH CHANGE M.	0•045	160.0	0.021	0.013	0.010	0.033	0.052	0.036	0.023	0.016	STABLE	0.070	2+0-0	0.029	0-020	STABLE	STABLE	0.064	0.039	
PRUGRAN	104N 1040	0-107	180-0	063	2+0-0	££0°¢	0.132	101-0	110.0	0.053	160-0	FLON E	0.112	0.084	1 20.057	0.039	FLON E	FLON E	0.036	0.063	
ONA A	PJUNP EP IN P.	0.062	1 40 -0	1+0-0	410-0	0-024	0-049	0+0+0	140-0	0.030	0.021	L BURE	0-042	160-0	120-0	670-0	L BURE	L BURE	260-0	0-024	
PE DAT	N TKY C F+H N+	1.030	0-815	2+645	5.120	720-2	1-030	0.815	2+645	5.120	2.071	Fut	0-815	2+645	5.120	2.071	FUL	FUL	2+645	5.120	
FST PL	NTAV E Nëagy M.	0.783	0.632	0.521	0.34	0.22	0.783	0.632	0.521	0.34	0.22		0.632	0.521	9*34	0.22			0.521	0.34	
1	NTRY F EPTH E M.	0-026	0-023	610-0	610°0	0-010	0-020	0.023	610-0	0.013	0-010		0.023	0.019	0.013	0.010			0-019	010-0	
	H #	0.107	0.647	0.069	0+0+7	0-033	0.132	0.101	0-077	0-053	160-0	0 • 1 5 0	0-112	0.044	0.057	0.039	0-150	0.150	0.096	0.063	
	н С ж	0.082	0-071	150.0	0+0-0	0-028	0.082	0.071	0.057	0+0+0	0.028	0.082	0-071	0.057	0+0+0	0-024	U-082	0.071	0-057	0+0-0	
	SEUPE	0-0050	0.0050	0 - 00 - 0	0.0050	0.0050	0-0350	0.0050	0 \$ 0 0 5 0	0 \$ 0 0 • 0	0 \$ 00 \$ 0	0.0025	0.0025	0-0425	0.0025	0.0025	100-0	0.0017	0-0017	0.0017	
DATA	EKF. NERGY H.	0-808	0.683	0.536	0.355 (0.234	0.608	0.683 (0.536	0.355 (0.234	C.806	0.683	0.536	0.355	0.234	0-606	0.483	0.536	0.355	
P IPE	N .	0.026	0.023	610.0	£10°0	0.010	0.026	0.023	0.019	0.013	0.010	0-026	0.023	610.0	0.013	0.010	0.026	0.023	0.019	0.013	
PPKJACH	SLOPE	0.8660	0.8660	0.8667	0-8650	0.8667	0.8667	0.8663	0-6660	0.8660	0-6663	0-8660	0.8667	0.8669	0.8660	0.8669	0-8660	0-8560	0-8560	0-8663	
ATA A	MANN. COEFF	610 •0	0.015	0+015	0.015	0-015	0.015	0.015	0*015	0-015	0.015	0.015	0.015	0.015	0.015	0-015	0.015	0.015	0.015	0.015	
J NOWN	DIA. M.	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	
COP	u. L/S	8.0	6.0	••0	2.0	1.0	ð.6	6.0	4.0	2.0	1.0	8.0	6 • 0	4.0	2.0	1.0	0-0	6.0	4 ° 0	2.0	

TFST PIPE DATA AND PRDG4AM KESULTS. Entry upjump jown defth entigy Energy Entrgy jump energy F+M depth jepth change upjump down change F+F. PDS. M. M.	JUMP EMPOSSIBLE AS HNCHC IN TEST PIPE. Jump Empossible as Hnchc in test pipe. Jump Empossible as Hnchc in test pipe.	JUMP IMPOSSIBLE AS MWCHC IN TEST PIPE. Jump impossible as mwchc in test pipe. Jump impossible as mwchc in test pipe.	JUMP IMPJSSIBLE AS MNCHC IN TEST PIPE. Junp impjssible as mnchc im test pipe. Jump impussible as mnchc im test pipe.	JUMP IMPOSSIBLE AS HNCHC IN TEST PIPE. 0.8532.330 0.041 0.084 0.003 0.115 0.115 0.000 9.885 5.531 0.6921.807 0.071 0.071 0.000 0.098 0.098 0.050 6.795 4.992	JUMP IMPOSSIBLE AS MNCHC IN TEST PIPE. Jump Impossible as Mnchc im test pipe. Jump Impossible as Mnchc in test pipe.	0.6921.807 0.0476 0.027 0.027 0.129 0.119 0.0110.284 5.254 0.6921.807 0.052 0.083 0.018 0.101 0.100 -0.073 3.785 0.5212.645 0.036 0.012 0.569 0.055 0.057 0.569 3.785 0.34 5.120 0.036 0.007 0.555 0.055 0.001 1.692 2.023 0.322 2.071 0.025 0.038 0.006 0.6538 0.038 0.038 0.2016 1.277
COMMON DATA APPRUACH PIPE DATA Q. Dia. Mann. Slope HN Terp. Slupe HC HN Entry e L/S H. Coeff (Sine M. Enercy (Sine M. M. M. M.	3.0 0.15 0.015 0.9659 0.025 0.671 0.0250 0.032 0.064 6.0 0.15 0.015 0.9657 0.022 0.735 0.0250 0.071 0.055	2.0 0.15 0.015 0.9659 0.013 0.381 0.0250 0.040 0.031 1.0 0.15 0.015 0.9659 0.009 0.251 0.0250 0.028 0.022 8.0 0.15 0.015 0.9657 0.025 C.871 0.0125 0.082 0.078	6.0 0.15 0.015 0.9657 0.022 0.735 0.0125 0.071 0.067 4.0 0.15 0.015 0.9659 0.012 0.578 0.0125 0.057 0.053 2.0 0.15 0.015 0.9659 0.013 0.381 0.0125 0.040 0.037	1.0 0.15 0.015 0.9659 0.009 0.251 0.0125 0.028 0.026 9.0 0.15 0.015 0.9657 0.025 0.671 0.0100 0.032 0.084 0.025 6.0 0.15 0.015 0.9657 0.022 0.735 0.9100 0.071 0.071 0.022	4.0 0.15 0.015 0.9657 0.018 0.578 0.0100 0.057 0.057 0.057 2.0 2.0 0.15 0.015 0.9657 0.013 0.381 0.0100 0.028 0.038 1.0 1.0 0.15 0.015 0.9657 0.009 0.251 0.0100 0.028 0.028 0.028	0.0015 0.9059 0.0022 0.0135 0.9059 0.022 0.0135 0.9059 0.022 0.735 0.0166 0.034 0.022 0.735 0.0 0.15 0.015 0.9059 0.022 0.735 0.0066 0.071 0.0340 0.022 0.0 0.15 0.9059 0.018 0.576 0.0066 0.057 0.013 0.013 0.0066 0.040 0.014 0.013 2.0 0.15 0.9059 0.013 0.361 0.0066 0.040 0.044 0.013 1.0 0.15 0.015 0.9059 0.0096 0.0066 0.024 0.031 0.011

PRJGRAM RESULTS BASED ON TERMINAL CONDITIONS IN THE APPRUACH PIPE AND NORMAL FLOW DEPTH DUMNSTREAP OF THE JUMP IN THE TEST RIPE.

-

Icst Place -0-006 2-670 1-218 r 3+534 3 • 259 2 • 6 5 5 1.772 -0-001 0-730 1.119 2.355 2.543 2.156 0-059 -0-004 1-906 1-455 u-92b 0.775 0-101 -0-040 6-199 1-252 0.924 1.951 1.751 0.984 0.531 SHUL P35. -0.002 7.313 4.265 -0.001 1.750 0-144 -0-03713-660 -0.013 8.309 -0.007 4.712 0.795 9.511 5.193 -0.005 0.659 -0.019 2.386 -0-00511.008 Feñ. ż JUNP ENERGY ENERGY ENERGY UPJUMP DOWN CHANGE E00-0--0-001 160-0--0-015 -0-013 . FULL DURE FLOW ESTABLISHED IN TEST PIPL. PIPE. FULL BURE FLOW ESTABLISHED IN VEST PIPL. 0.039 0.103 0.056 0.042 640-0 0.067 0+0+0 0.041 0.121 0.062 0.125 0.062 0.112 0.087 FULL BORE FLOW ESTABLISHED IN TEST ċ 0.057 ++0-0 1+1-0 C. C86 0-010 0.649 6.683.0 0.107 0.059 0.106 0+0-0 0.063 0-130 0.101 0.125 0-694 0.152 -FEST PIPE DATA AND PROGRAM RESULTS. 0-020 0.027 DEP TH CHANGE 0.013 0.029 0.064 0.039 010-0 0.016 010-0 240-0 0.045 160.0 0.036 0.021 0.083 0.052 0.023 ż 0.22 2.071 0.019 0.039 0.063 DEPTH 0-22 2-071 0-017 3-044 0.063 0.34 5-120 0-014 J-047 0-34 5-120 0-030 0-053 0.037 0.5212-645 0-037 0-084 0.057 0-107 0-087 6E0.0 0.101 0.077 0.6921-807 0-J+2 0-112 0.096 0.8532.330 0.049 0.132 ÷ 0.6921-807 0.057 0.5212-645 0.047 0-6921-807 0-048 0-22 2-071 0-024 0-22 2-071 0-021 0.34 5.120 0.024 UPJUNP 0.062 0.5212-645 0.041 0.34 5.120 0.027 0-5212-645 0-032 ÷ 0.8532.330 ENTAY ENTRY ENTRY ENTRY ENTRY DEPTH ENERGY FOR ž -1.0 0.15 0.015 0.9659 0.009 0.251 0.0025 0.026 0.039 0.01U 0.15 U.015 0.9657 0.013 0.381 0.0050 0.040 0.047 0.013 0.381 0.0017 0.040 0.063 0.013 0.15 0.015 0.9659 0.009 0.251 0.0017 0.028 0.044 0.010 6.0 0.15 0.015 0.9653 0.022 0.735 0.0050 0.071 0.087 0.022 0-9657 9.016 0.578 0.0050 0.057 0.069 0.019 0-010 8.0 0.15 0.015 0.9659 0.025 0.671 0.0050 0.032 0.132 0.025 0.010 0.15 0.015 0.9659 0.016 0.576 0.0025 0.057 0.084 0.019 0.013 0.019 0.025 0.022 0.15 0.015 0.9657 0.018 0.578 0.0050 0.057 0.077 0.019 0.013 0-024 ÷ 0-025 0-671 0-0050 0-092 0-107 1.0 0.15 0.015 0.9659 0.009 0.251 0.0050 0.026 0.033 0-0025 0-071 0-112 0.361 0.0025 0.040 0.057 0.0017 0.057 0.096 6.0 0.15 0.015 0.9659 0.022 C.735 0.0050 0.071 0.101 9-013 0-381 0-0050 0-040 0-053 1.0 0.15 0.015 0.9653 0.009 0.251 0.0050 0.028 0.037 0.9659 0.022 0.735 0.0017 0.071 0.150 3.0 0.15 0.015 0.9659 0.025 0.671 0.0025 0.082 0.150 8.0 0.15 0.015 0.9659 0.025 0.871 0.0017 0.062 0.150 Z -IN THE HC HC SLOPE (NIS) TEAP. **361.0** 0.15 0.015 0.9659 0.016 0.578 APPRUACH PIPE CATA FE 2MINAL 0.015 0.9659 0.013 2.0 0.15 0.015 0.9657 0.019 6.0 0.15 0.015 0.9659 0.022 N N N 0.9659 0.15 0.015 0.9659 SLUPE 0.15 0.015 0.015 0.015 MANN. CGEFF COMMUN DATA 0.15 0.15 0.15 DI A. +-0 2.0 8.0 ••• 2.0 4.0 **6.0** 4-0 2.0 1.0 0. L/S

N.

JUMP

THE

UFPTH DUENSTREAP OF

IND NURBAL FLUK

APPRUACH PLPC

LUCALITY

BASED UN

RESULTS

PRUGRAM

3.259 2.234 0.926 0-101 -0-040 6-199 1-325 ÷ 2.356 -0.013 8.309 2.543 1.465 1.21H 0.775 0.924 3.534 2 . 735 -0-001 1-750 1-772 1.113 9.511 1.951 **1.833** 166.0 **dhnr** PJS. 0-039 -0-001 0-730 0-144 -0.03713-660 0-046 -0-013 0-984 0-103 -0-002 7-313 4.712 0.795 -0.00b 2.070 0-043 -0-005 0-059 -0.00511.008 4.265 1.906 -0.015 5.193 2.586 ż F+h. JUNP 0-059 -0-004 -0-003 -0.019 CHANGE -0+001 ENEFCI -0-002 0.121 -0.031 a, PIPE. PIPE. FULL BORE FLOW ESTABLISHED IN TEST PIPE. 0-092 ENERGY ENERGY UPJUMP DGMN 0.125 0°056 0.041 0.067 0.062 0.112 0.087 0.062 ESTABLESHED IN TEST FULL BURE FLOM ESTABLISHED IN TEST -0-044 0.020 0.049 C.181 0.063 01.07 C.C59 0.057 0+0-0 0-152 0-070 0.086 G.106 0.083 0.125 0.694 0-141 0.130 i, FEST PIPE DATA AND PRUGRAM RESULTS. DEPTH CHANGE 0.016 0.013 0.010.0 0.023 0~047 0°029 0.064 0.039 0.027 0°036 0.070 0.045 0.031 0.021 0.033 0.052 ė 0-22 2-071 0-019 0-039 0.34 5.120 0.024 0.063 0-22 2-071 0-017 0-044 UDAN 0°053 0.6921.807 0.057 0.087 0.5813.406 0.047 J.069 0-5813-406 0-037 0-084 0.34 5.120 0.027 0.057 0-34 5-120 0-034 3-047 0.22 2.071 0.024 0.033 0.22 2.071 0.021 0.037 FULL BURE FLOA 0-5813-406 0-032 3-096 0.107 0.077 0-6921-807 0-042 0-112 0.8532.330 0.049 0.132 0.6921.807 0.048 0.101 ź 0-5813-406 0-041 0.34 5-120 0-030 0.6532.330 0.462 **UPJURP** DEPIN £ ENTLY ENTRY ENERGY FAM ż 1.0 0.15 0.015 1.0000 0.009 0.257 0.0017 0.020 0.044 0.010 0-025 0-892 0-0350 0-032 0-107 0-025 0.15 0.015 1.0009 0.013 0.390 0.0050 0.040 0.053 0.013 0.010 1.0 0.15 0.015 1.0000 0.009 0.257 0.0025 U.024 0.039 0.010 0.0050 0.040 0.047 0.013 0.0050 0.028 0.033 0.010 0.0054 0.082 0.132 0.025 0.0050 U.057 0.077 0.018 4.0 0.15 0.015 1.0000 0.018 0.591 0.0025 0.057 0.084 0.018 0.015 1.0007 0.018 0.591 0.0017 0.057 0.096 0.018 0.013 6.0 0.15 0.015 1.0003 0.022 0.752 0.0050 0.071 0.087 3.022 0.15 0.015 1.0000 0.022 0.752 0.0050 0.071 0.101 0.022 0.15 0.015 1.0000 0.022 0.752 0.0025 0.071 0.112 0.022 0.15 0.015 1.0000 0.013 0.396 0.0425 0.040 0.057 0.013 ENTRY Depth 0-0050 0-057 0-069 0-018 ť 0.015 1.0000 0.009 0.257 0.0050 0.028 0.037 0.015 1.0003 0.013 0.390 0.0017 0.040 0.065 3.0 0.15 0.015 1.0000 0.025 0.852 0.0025 0.082 0.150 0.752 0.0017 0.071 0.150 8.0 0.15 0.015 1.0000 0.025 6.892 0.0017 0.082 0.150 12 HC M. SLOPE (VISI TERP. FNERCY 2.0 0.15 0.015 1.0000 0.013 0.390 0-015 1-0007 0-018 0-591 0.591 0.009 0.257 8.0 0.15 0.015 1.0000 0.025 0.892 APPRUACH PIPE DATA a, 0.015 1.0003 0.018 0.022 Z . 0-015 1-0003 0.015 1.0000 0.015 1.0000 SLUPE MANN. C CEFF DATA 0.15 0.15 2.0 0.15 0.15 0.15 01 A. 0.15 0.15 0.15 COMMUN 2°0 **0°**9 4 ° 0 0.9 0.4 1.0 2.0 6.0 0.4 8.0 1.0 0. L/S

*"/lc

JUMP IN THE TEST

DF THE

FLUN DEPTH DUNNSTREAP

TERMINAL CONCITIONS IN THE APPENDACH PIPE AND NURMAL

PROGRAM RESULTS BASED UN

PROGRAM RESULTS BASED GN TERMINAL COADIFITNS IN THE APPAUACH PIPE AND NURMAL FLUM DEPTH DUMNSTREAP OF THE JUMP IN THE TEST PIPE.

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

	4140 415.									(< 2 - 0	3-522				0.555	0.470				61C.C	
	JUAP F + M - N -									1-449	0-755				2-009	622.0				2-474	605 0
	FRE PGV CMANGE M.	R Y .	۲۰.	•	•		۲۰.	۶¥ .	1 P E •	C 0 0 ° 0-	-0 ° 0 6 G	۰ ۲۵	۲.	IPE.	-0-001	000 - 0-	۲۰.	۲۰.	1 P.E .	-0-010	¢00°0-
	MEA GY 1 DVN 0 M.	PE ENTI	PE ENTI	ST PIPI	ST PIP	ST PIPI	PE ENTI	PE ENTI	IEST PI	- 640-0	- 0+0-0	PE ENTE	PE ENTI	TEST P	0.065	- 040-0	PE ENTS	PE ENTI	FEST PI	0.076 -	- 640 • U
5.	MERCY EI PJUMP DI M.	TEST PL	TEST PLI	C IN TE:	C IN TE	C IN TE	TEST PI	TEST PLI	HED IM 1	0.064 (0+0-0	TEST PLI	TEST PI	HED IN	0.066 (0+0-0	TEST PII	TEST PI	HED IN 1	0.089 (0.050
H KESULT	DEPTH E Change u M.	L=0 AT	1V 0=7	AS HNCH	AS HNCH	AS HNCH	L=0 AT	1V 0=7.	STABLIS	U. 010	0.004	L=U AF	L=0 AT	STABLIS	0.010	6.00s	L=0 AT	L=0 AT	STABLIS	0 • 0 4 4	0.023
182024		NED AT	NEU AT	SIGLE	SIBLE	Stale	NED AT	NEJ AT	FLON E	1.047	J. 02 B	NEJ AT	NEÙ AT	FLOA E	0°051	0.030	NEO AT	NED AT	FLUH E	.950-0	40. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
UNA AT	UPJUMP UEPTH M.	MP UAGH	MP 0904	MP LAPU	MP IMPO	NP INPO	MP URUW	MP UZON	LL BURE	160.0	0.025	HP UKOM	NP DRUM	LL BORE	0, 033	0.023	1P URUH	MP URUN	LL BURE	0.023	0.016
IPE DA	ENTRY F + N N •	2	n	U.	00	Uf	n r	U.	Ful	2 .497	U • 944	105	in r	FU.	2.497	646 ° 0	in r) N	FUI	144.5	0.944
TEST P	ENERGY Energy M.									0.09	0-00				6:0°0	0.06				0.09	0.06
	ENTRY DEPTM M.									0.023	0°014				0-023	U. UL4	•			U.023	U=014
	Z • I I	0-0 75	0-675	0.062	0.036	0.022	0.075	0.075	0.075	0-047	0.028	0-075	0.675	0-075	0.051	0.030	0.075	0.075	0.075	0.068	0.039
	U +	ولأه . ٥	610°0	0 • 066	0.012	0.026	0.075	0°075	0.066	0.042	0-026	0.075	6.00.0	0°066	0+042	0.026	610.0	610°0	0.066	0.042	0 - 026
	SLUPE (SIN)	0 < 20 • 0	0 < 7 0 • 0	0°02 50	0 < 7 0 • 0	0 < 20 • 0	0.0125	0.0125	0-0125	0-0125	0-0125	00100	0010-0	00100	0.0100	0-0100	0 < 0 0 • 0	0 \$ 0 0 • 0	0 • 0 0 5 0	0469-0	0 < 0 0 • 0
DATA	LER. NERGY H.	0.178	0.133	0-104	0.067 (0 043	0.178	0.133	0-104	0-067	0.043	0.178	0.133	0.104	0.067	0+043	0.178	0-133	0.104	0.067	
1 P 1 P E	HN T M. E	0.075	0.075	0.054	0.032	0 ° 0 5 0	0.075	0°075	0°054	0.032	0 ~ 0 2 0	0.075	510°0	0.054	0.032	0.020	0.075	0°075	0.054	\$60.0	0-020
PPR0AC-	SLOPE (SIN)	0.0349	0-034-	0.0344	0.0349	0°0344	0.0349	0.0349	0.0349	6.460-0	0.0349	0.0349	0-0349	0.0349	0.0344	f-4 E O * O	0-0349	0-0349	0.0349	0.0349	0-0349
ATA A	MANN. COEFF	0.015	0.015	0°015	0.015	0.015	0.015	0.015	0-015	0.015	0-015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
O NCHH	01A. H.	0.07	0.07	0.07	0.07	0.07	0.07	0.07	20.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
000	0°.	0 • 0	0 • Q	4 ° 0	0 • 7 .	1.0	0-0	0.0	4.0	2 • 0	L • 0	0-0	0-0	4+0	2.0	1 ° 0	d • 0	6 • 0	4.0	2 • 0	L.0
											4	A4.2									ŧ.

EST PIPE DATA AND PLICAM RESULTS.	NIAY ENTRY UPJUNP UJAN DEPTH ENERGY ENERGY ENERGY JUNP 1JAP Nergy Fam depta Jepta Change Upjunp Dumn Caange Fam. P35. M. N. M.	JUMP URUMMED AT L=0 AT TEST PIPE ENTRY.	JUMP URUMAED AT L=0 AT TEST PIPE ENTRY.	JUMP IMPOSSIBLE AS HNCHC IN TEST PIPE.	JUMP IMPOSSIBLE AS HNCHC IN TEST PIPE.	JUMP IMPO,SIBLE AS HNCHC IN TEST PIPF.	JUMP UROWALD AT L=O AT TEST PLPE EMTRY.	JUMP URUWNED AF L-U AT TEST PIPE EMERY.	FULL BURE FLOM ESTABLISHED IN TEST PIPE.	0.10 2.717 0.037 J. 347 0.010 0.064 0.063 -0.00 1.949 3.915	U.07 1.0099 0.025 J.023 0.004 0.040 0.040 -0.005 0.725 4.725	JUMP DAUWNED AT L-U AT TEST PIPE ENTRY.	JUMP DROWNED AT L=0 AF TEST PIPE ENTRY.	FULL BORE FLOM ESTABLISHED IN TEST PIPE.	3-10 2-717 0.033 4.051 0-018 0.066 0.065 -0.001 2.004 3.71	0.07 1.089 0.023 4.330 0.005 0.040 0.040 -0.000 0.779 0.577	JUMP UNDANED AT LOO AT TEST PIPE ENTRY.	JUMP URUMMED AT LOU AT TEST PIPE ENTRY.		FULL BURE FLJM ESTABLISHIU IN TEST PIPE.	0.10 2.717 U.U23 J.J53 0.U44 0.089 0.076 -0.014 2.474 U.151	612.4 902.0 400.0- 200.0 040.0 040.0 400.0 400.0 400.0 400.0
CONTON DATA APPRUACH FIFE DATA	J. DIA. MANN. SLOPE MN TEFR. SLOPE MC MN EATRY E L/s n. cgfff (sin) n. fnercy (sim) m. m. dlpff e m.	3.0 0.07 0.015 0.0048 0.072 0.165 J.U250 0.075 0.U75	5.0 0.07 0.015 0.0644 0.057 0.158 0.0250 0.075 0.075	4.0 0.07 0.015 0.0598 0.041 0.126 0.0250 U.066 0.062	2.0 0.07 0.015 0.0694 0.025 0.083 0.0250 0.042 0.034	1.0 0.07 0.015 0.0698 0.015 0.054 0.0250 0.026 0.022	8.0 0.07 0.015 0.0678 0.072 0.185 0.0125 U.075 0.075	6.0 0.07 0.015 0.0693 0.057 6.15E 0.0125 0.075 0.075	4.0 0.07 0.015 0.0678 0.041 0.126 0.0125 0.066 0.075	2.0 0.07 0.015 0.0094 0.025 0.683 0.0125 0.042 0.047 0.021	1.0 0.07 0.015 0.0578 0.015 0.054 0.0125 0.026 0.028 V.013	8.0 0.07 0.015 0.0048 0.072 0.185 0.0100 0.075 0.075	6.0 9.07 0.015 0.U698 0.057 0.158 0.0100 0.075 0.U75	4.0 0.07 0.015 0.0673 0.041 0.126 0.0100 0.066 0.075	2.0 0.07 0.015 0.0599 0.025 0.083 0.0100 0.042 0.051 0.021	1.0 0.07 0.015 0.0598 0.015 0.054 0.0100 0.026 0.030 0.013	4.0 0.07 0.015 0.0698 0.072 0.185 0.0150 0.075 0.075	. **0 0*01 0*012 0*0499 0*021 0*128 0*0020 N*012 0*12		4.0 0.07 0.015 0.0693 0.041 0.126 0.0050 0.066 0.015	2.0 0.07 0.015 0.0693 0.025 0.083 0.030 0.042 0.045	1.0 0.07 U.015 0.0544 U.015 0.054 9.0450 U.026 0.019 3.013

٦

	GV ENEFSY JUMP JJ49 CMANG: F+N. PJ5. • 4. N. 4.	ENTRY .	ENTRY.	P1P6.	P1P6.	P1PE.	EN FRY.	ENTRY.	T PIPE.	66.1 744.1 600.0- Ed	10 -0.003 0.755 0.931	cMTRT.	ENTRY.	r pipe.	5 -6.001 2.009 0.030	10 -0.00; 0.779 0.553	ENTRY.	ENTRY.		16 -0.014 2.474).275	10 -0. (05 0.909 U. 23)
	LUP DOWN	T PIPE	57 PIPE	IN TEST	IN TEST	IN TEST	ST PIPE	T PIPE) IN TES	0.0	0*0 0*0	T PIPE	3414 1S	IN TES	0•0 990	0*0 0*0	ST PIPE	ST PIPE	IN TES	0.0 0.0	50 U+0
534 TS.	TH ENE 466 UPJ	D AT TE	AT TES	MNCHC	HNCHC	HNCHC	AT TES	AF TES	1945178V	0.0	03 0.0	AF TES	AF TES	VBLI SHE	0.0 0.C	09 0.0	AT TES	AT TES	I BH I SHEI	0.0 0.0	23 0-0
GRAM KI	TH CHAC	AT L=(AT L=0	BLE AS	BLE AS	BLE AS	AT L=0	4T L.	0M EST/	47 0-0	23 U•(AT L.	AT L=(OH ESTA	51 0.0	3.0 0.0	AT L=C	AT L.	04 ESTA	5d 0.0	
AND PRO	UHP JJ4 IH JEP	URUMNE J	LAUMMED	1 MP 0 > 51	1400351	1400251	UA OMNE D	UKUMME J	øJRE FL	0.0 710	U25 J.O	U ROMAE J	UR OMMË D	dUKE FL	u]] u.O	u22 u.0	DROMNED	URUMMED	DAE FL	U23 J.O	0160
E DATA	TRY UPJ • M UEP N• M•	JUNP	ANUL	JH UL	JUMP	JUNP	JUNP	JU HP	FULL	.927 0.	.170 0.	JURP	AMUL	FULL	• 927 0	.170 0.	AMUL	JU HP	FULL	.427 0.	.170 0.
414 JS3.	NTRV EN Nergy F M.									0.12 2	0.03 1				0.12 2	1 80.0				0.12 2	0.081
10	ENTRY E ULPTH E M.									610°C	0.012				010-0	J.012				610.0	J. 01 2
	Z • I L	0*0 75	0-075	0.062	0.036	0.022	0.075	0-075	0.075	0-047	0-028	0°075	0°075	0°075	0.051	0°030	0.075	0.075	0.075	0.068	0.039
	н С И е	0.075	0.075	0 • 066	0 • 042	0 - 02 5	¢10•0	0.075	0•000	0.042	U• 02 6	0.075	¢10•0	0.066	0-042	0.026	0-075	0.075	0.066	0 • 0 4 2	0 • 05 6
	\$L3PE (\$14)	0° 07 20	0°0250	0 * 0 7 2 0	0°0,250	0 ° 07 2 0	0.0125	0°0125	0.0125	0.0125	0.0125	0°0100	0°0100	0.0100	00100	0010-0	0.0050	0 4 CO * O	0,00,0	0 • 00 • 0	0.00.00
DATA	TLAM. ENLRGY N.	0.218	0.187	0.150	0.099	0.064	0.218	0.187	0.150	0.099	0.064	0.218	0.187	0•150	0.099	0.064	0.210	0.187	0.150	660 *0	0.064
H PIPE	HA A.	0 • 00]	0*0+6	0.036	0.022	0.013	0.061	0*0*0	0 • 036	0.022	0.013	0.061	0 • 0 + 6	0.036	0.022	0.013	0.061	0 * 0 4 8	0.030	0.022	0.013
APPRUAC	5LOPE (51N)	0.1045	0.1045	0.1015	0.1045	0-1045	0 - 10 - 5	0+10+5	0.1045	0.1045	0.1045	0.1045	0.1045	0.1045	0.1045	0.1045	0.1045	0-1045	0 • 1045	0.1045	0.1047
DATA	COFFF	0.015	0.015	0.015	0.015	0°015	0.015	0.015	0°015	\$10°0	0.015	0°015	0.015	\$10.0	0.015	0.015	0.015	0.015	0.015	¢10°0	0.015
NCHN	014. M.	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
C O	J.	8°0	6 • 0	9 • 0	2.0	1 - 0	0.0	¢•0	9 - 4	2 • 0	1.0	d • 0	0 • ¢	0 • •	2°0	1.0	3 • O	6 • 0	4.0	2.0	1.0

.

•

.

A4.4
										6611	166.				: 30 P	. 713					986.	
		•								1 614	765 0.				6 600	779 3.				+1+ 3.	0 604	
										0 2.	0.0				1 2.6					4 2.	•0 •	
	ENFRG C44NS N.	۳۴.	RY .	£.	Е.	E.	RY.	• Y =	LPE.	-0-00	-0-00	R Y +	£Ч	LPE .	-0 * 00	-0-00	R.K	R.Y.+	.1PE -	-0+01	CO • 9-	
	NEKGY NND N.	IPE ENT	PE ENT	ST PLP	ST PIP	ST PLP	PE ENT	PE ENT	TEST P	0.063	0*0*0	PE ENT	PE ENT	1651 P	0 • 065	0+0+0	PE ENT	PE LNT	TEST P	0.076	\$+0 •0	
	A C C C C C C C C C C C C C C C C C C C	FST PI	EST PI	IN TE	IN TE	IN TE	EST PI	EST PI	ED IN	• • • •	040-	EST PI	EST PI	ED IN	•066	-040	EST PI	EST PI	ED IN	• 0 9 4	0\$0	
1-13	E UP	AT T(AT TA	INCHC	IN CHC	HVANC	AT TI	AT T	ILI SH	0	0.6	AF TI	AF TI	ILI SHI	8 0	.0 80	AT TI	AT TI	HS IT	4 0	0	
T KES	DEPTH Chang A.	1=0	L=0	AS H	AS H	AS H	L=0	L=0	ESTAB	0.01	0°*0	۲=0	L=0	ESTAB	0-01	000	L=0	L=0	ESTAB	0 . 04	0.02	
<)6 KA		ÉD AT	TA Ca	SIBLE	SIBLE	51865	ED AT	ED AT	FLOA	140.	• 029	ED AT	TA CS	۲ 0 4	.051	.033	ED AT	ED AT	FLON	.063	160.	
		MUYO	MMUP	CO4H1	LAP 05	SOJE	NUMU	NMONC	JURE	L 750	125 J.	RUMNI	KHUYI	ORE I	U 510	0 6 20	RUMM	INHU YO	SORE 1	0 620	n 210	
AIA	UPJN	UHP .	UNP L	UNP	AND	UMP	AH N	UNP 1	חרר	2 0.4	1 0.1	UHP	UMP L	חרר	د ٥.٥	7 0.0	UMP 1	UMP 1	ענר ג	.0 2		
	EN TRY F + N N.	7	7		7	7	1	9	4	3.20	1 . 30	7	-	ч.	J • 28	1 • 30	.	.		3.28	4.30	
TESE	ENTAY ENEAGY A.									0.15	0.03				0.15	0.09				0.15	0.09	
	4724 6974 7.									0-017	0.011				3.017	0.011	•			0.017	0.011	
	N . D M	.075	-075	•062	•036	• 0 2 2	•075	• 0 7 5	• 0 7 5	- 047	.029	•075	•075	.075	.051	.030	•0 75	\$20*	•075	.068	• • • • • •	
	υ.	0 520	0 5 0	0 490	0 7 0	026 0	0 510	0 520	0 990	0 7 0	0 970	0 2 5 Q	0 520	0 000	0 2 0	026 0	0 520	0 520	0 9 9 0	0 7 4 0	026_0	
	IE	0 0.	50 U.	\$0 0°	·0 09	• 0 0 •	25 0.	25 0.	25 0.	\$ 0.	25 0.	•0 00	• 0 00	•0 00	• 0 00	• 0 00	50 U.	50 0.	50 U.	50 0.	50 0.	
	11153	0.025	0-02	, 20.0	0.02	0.029	10-0	0.01	0-015	0.012	0.012	0.010	0.010	0.010	0.040	0*070	0.00	0.00	0.60	0.00	0.00	
DATA	EKM. NEKGY N.	0.284	0.244	0.195	0-129	0.082	0.264	0.244	0.195	0.129	0.062	0.284	0.244	0.195	0.129	0.082	0-284	0.244	0.145	0.129	0-082	
		040.	-040	.030	. 018	.011	.050	• 0 • 0	• 030	.018	1 10-	.050	040	010	.018	.011	• 0 5 0	.040	.030	• 018		
1404		736 0.	736 0	1 0 0	736 0.	736 C.	736 0.	736 0	0 962	736 0.	736 0.	0 914	736 0.	736 0.	735 0	736 0	0 912	136 0	735 0	736 0	135 0	
APPRI	2101	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0-1	0.1	0.1	0.1	0.1	0.1	0.1	0 .1	0.1	5 0.1	0.1	
ATA	COFF	0.015	0.015	0.015	0.015	0.015	0.615	0 - 015	0.015	0.615	0.015	0.015	0.015	0-015	\$10.0	0.015	0.015	0.019	0.015	0.01	0.01	
NON	01A.	0.07	0.07	0.07	0.07	0.07	10.07	10.07	20.07	20-07	0.07	20-07	10.01	0.07	0.07	10.01	10.01	10.07	0.07	0.67	0.07	
100	0. L/S	d.0	0 • Q	••0	2.0	1.0	d. 0	0 ° 9	4.0	2.0	4.0	3.0	0.0	6.4	2.0	1.0	0 • 0	\$•0		0 * 2	1.0	
												A4	.5									

•

-

CO	NUMP	DATA	APPROAC	1 PIPE	UATA				T	EST P11	PE DAT	A AND	RJGŁAH	RESJL	15.				
0. L/S	0 [A .	NANN. COFFF	5L0PE (51M)	N N N	TERM. ENERGY M.	SLOVE	0 • F	MM. Er	NTRV E	МТКҮ Е! Меабу б М.	2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		104M 0	EPTH Mange M.	ENEKGY UPJJMP M.	EMERGY Dawn M.	6 2 6 7 6 4 C 4 6 7 C : 4 • 5 •	4съ т.т.	1140 15.
8° 0	0.07	0.015	0.3402	0.036	0 0 4 3 0	0 \$ 70 * 0	0.075 (510°C			H NP	P URUM	at at	L.O AT	4 1231	IPE ENI	rit v.		
0.0	0.07	0.015	0.3402	0.031	0.368	0,20.0	v.075 (0.675			E O F	P UKUMr	VC D AT	L • 0 AT	1537 P	BPE ENT	вч.		
••	0.07	0.015	0.3402	0.023	0.292	0 \$ 20 * 0	0.066	0.062			NUL	P INPU	Slace	AS HNC	HC IN I	EST PII	٤.		
2.0	0.07	0.015	0.3402	0.014	0.190	0\$70*0	0.042	0.036			NUL	P INPO	SIBLE	AS HNC	HC IN T	EST PLI	۰. ۲		
1.0	0.07	0.015	0.3402	0 • 009	0.119	0 - 05 50	0.026	0.022			HUL	P INPUS	SIBLE	AS HNCI	HC IN T	EST P.10	۴.		
0 • 0	0.07	0.015	0.3492	0.038	0.430	0.0125	0.075	0.075			H UL	P UKOW	iEO AT	L=0 AT	TEST P	IPE ÉNI	IR V.		
0 • 0	0.07	0.015	0.3492	0.031	0.368	0.0125	0.075 (0°075			NUL	P URUM	IED AT	L=0 AT	1 1 2 3 L	IPE ENT	1R Y .		
••0	0.07	0.015	2046.0	0.023	0.292	0.0125	0.066 (510.0			FUL	L JURE	FLON E	STABLI	SHED IN	TEST P	8 PE .		
2.0	0.07	0.015	0.34.92	0.014	0.190	0°0125	0.042 (0.047	\$10°¢	0.20	3.920	. 110-0	140.	0.010	0°064	0.063	(JO • 0-	1.949	1.414
1.0	0.07	0.015	0.3402	0.009	0.119	0°0125	0.026	0.28 C	£00°0	0.13	c 5 5 • 1	0.625	• 05 5	600°9	0+0-0	0+0-0	C J O * O -	0.705	1-323
0.0	0.07	0.015	2046.0	0.038	00430	0°10°0	0.075 (0°075			N NF	P URUWS	IEO AT	L=0 AT	165T P	IPE ENT	RY.		
6.0	0.07	0.015	2046.0	0.031	0.368	0.0100	0.075 (0.075			JUH	P URUM	iëD AT	L=0 AT	TEST P	IPE ENT	RY.		
4.0	0.07	0.015	0+34.92	0.023	0.292	0.0100	0.066	0.075			FUL	L' BORE	FLON E	STABLES	SHED - IN	TEST			
2.0	20*0	0.015	0.3402	0.014	0.190	00100	0.042	0.051 (014	0*50	3.920	0.033 (• 051	0.018	0.066	0.065	160-0-	2.009	1.231
1 • 0	0.07	0.015	0.3492	0.009	0.119	0.0100	0.026	0.030 4	eco*r	0.13	L • 5 5 5		r{0°1	00.00	0+0-0	0*0*0	-0-003	6119	0.975
0.0	0.07	0.015	0*3405	0 ° 0 38	0-430	0.0050	0.075 (0.075			NUL	P UKUW	te Cat	L=0 AT	TEST P	IPE ENT	RV.		
6.0	0.07	0.015	0.3402	0.031	0.368	0 \$ 0 0 \$ 0	0.075	0.075	•		NUL	P UROW	IA CH	L.O AF	1658 P	IPE ENT	IRV.		
••0	0.07	0.015	0.3402	0.023	0.292	0 \$ 0 0 \$ 0	0.066 (0.075			FUL	L BURE	FLOH E	STABLE	SHED IN	-1531-	1 PE .		
2 • 0	0.07	0.015	0.3402	0.014	0.190	0.0050	U.042 (0.068	0.1.0	0-20	3.920	0.424	. 063	0 - 044	0.089	0.076	• 10 ° 0-	2.474	465-0
1.0	0.07	0.015	20+5-0	0.009	0.119	040.0	0.026	0.030	f00 *f	0.13	466.1	0.017	1.031	0.023	0 \$ 0 \$ 0	0.045	-0.00-	6.05 * 0	U.51J

									1.52)	1-234				1.31!	666+C				U+ 742	
101 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1									1.949	0.705		ł,	•	2.009	0.779				2.474	
FN: PC	RY.	IRY -	f.	·F.	• ;	RY.+	RY.	111.	-0-090	C00 * 0-	R.Y	RY.	. 141.	100 * 0-	-0-065	. R.Y	P.Y.+	. 191	-0-014	
A SA PAGA	IPE ENT	IPE ENT	ICST PIP	114 T23	LEST PLP	IPE EN	IPE ENT	1 16 51 9	0.063	6+0-9	IPE ENT	IPE ENT	1. TEST 1	0.065	0+0 = 0	IPE ENT	IPE ENT	1 TEST #	0.076	
ENFRGY UPJUNP N.	TEST 1	T 121	HC IN 1	HC IN 1	HC IN 1	TEST	TEST I	SHED IN	0.064	0+0-0	TEST .	TEST	SHEJ IN	0.066	0+0-0	TEST	TEST	SHED IN	0.069	
DEPTH Change A.	[F=0 4]	1 L=0 A1	AS HNG	E AS HN	AS HNG	1 F 0 41	[[=0 A]	ESTABLE	0.010	00 003	L=0 41	1 L=0 A	ESTABL	0.014	0.008	1 -0 A	L=0 A1	ESTABL	• • 0 • 0	
1 - F	MNED A	IN CANNE	0,518LE	0251816	0,51816	IN CONN	HNED AT	16 FL04	1+0-0	0.023	WNE U AT	IMMED AT	16 FL34	J.J51.	U.033	IN (JA	MNGD AT	E FLOM	J. 965	
UFJUN UEPIH M.	NUMP UK	NUMP UAL	IUNP IN	IUNP IN	INT ANUI	UNP UN	INN UK	יטרר אטנ	10 0.031	14 0.U2	IUMP UK	IUMP UKI	ULL BUR	10 0.03	11 0.02	NUMP URC	UMP URL	חרר גיוו	10 0.024	
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	·		·					-	56 4 39	16 1.73	•	-		56+4 22	16 1.73		•	ų.,	56.4.65	
ENTK ENTK M.									د ٥.	\$ 0.				2 0 -	30.				2 0.	
E4 FRY Of P 1 4									10-0	0 - 0			•	0.01	9.00	•			0.01	
ž ř	0.075	0-015	0.052	0.036	0 • 02 2	0.075	0.075	610-0	0-047	0-029	0-075	0.075	0-015	0.071	0 * 0 3 0	0-075	0.075	0-075	0.668	
U ·	0.075	0.075	0 • 066	240.0	0.026	0.075	0.075	0°000	0 • 0 4 Z	0.026	0.075	0.075	0.066	240-0	0.026	0.075	610-0	0.066	U-042	1 0.21
1 SL D*E	0 4 7 0 * 0	0\$ 70*0	0 < 20 * 0	0 * 0 7 2 0	0.0250	0.04 25	0-0125	0-0125	0.0425	0.0125	0°10°0	0 * 0 1 0 0	0.0100	0.0100	0.0400	0\$ 0 0 2 0	0.00050	0.0150	0.0050	0.000
TERM. ENEPGY M.	3 0.555	674-0 7	0 0.373	3 6.239	6 0.149	3 0.555	1 0.473	0.373	9 0.239	3 0.149	3 0.555	7 0.473	616.0 0	3 0. 239	8 0.149	3 0.555	E24.0 7	0 0.373	3 0.239	
N .	0.03	0.02	0-02	0.01	0.001	0.03	0.02	0.020	10.0	0.001	.0.03	0°0	0.020	0.01	00.00	0.03	0.02	0.020	10.0	
SLOPE (SJN)	0.5070	0.5000	0 • 20 10	0.000	0005-0	0.000	0,02.0	0.5000	0.5000	0.000	0.5000	0.5000	0.5000	0.05.00	0.5000	0-2000	0.5370	0.5070	0.5000	00000
COEFF	u.015	0.015	U-015	0.015	0.015	0.015	0.015	0.015	\$10-0	0.015	0.015	0.015	0.015	0.615	0.015	0.015	0.015	¢10°0	¢10°0	410 0
A.01A.	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
	0.1	0.0	0-4	2.0	1.0	0 • 0	6.0	0 **	2.0	1.0	0 • 0	6.0	0 • 4	2.0	1.0	0 • Q	6.0	4 • 0	2.0	•

.

TEST PIPE UATA AND PAJGAAM RESULTS.

COMMON DATA APPROAC.4 PIPE DATA

•••••••••••••••••••••••••••••••••••••••									115	147						392				629	9 4 5
									49 L.	65 L.					09 l.	79 0.		•		74 3.	09 3.
2 + L 7 - L									1.5	0.7	•				2.0	0.7				2.4	4°0
10 4 4 F	• 1	۰.	•	•	•	۰,	۲.	•	0.00	00010	۲.	۲.	•		0° 001	00-00	۲.	۴.	PE .	0.014	\$0.00
ш () 2	ENTR	ENTR	3414	PIPE	9 I P E	EMTR	ENTR	14 1	- [9]	- 040	EMTP	ENTP	-		- 59		ENTR	ENTR	T PI	16 -	- 540
LOWN	3414	919	TEST	1657	TEST	PIPE	P 1 P E	N TES	0•0	0.0	9196	P 1 P E	N TES		0 • 0	0*0	PIPE	PIPE	N TES	0.0	0-0
45 84 Y	FEST	TEST	N I	Z.	N I	TEST	1657	IEC I	0.064	0+0-0	1151	rest	IFO I		•066	040-0	TEST	TEST	1 03	.089	0\$0*0
E CF	AF	AT 1	HN < HC	нлкн	HN VH	AT 1	AT 1	8118	10	03	AL 1	AT 1	BLISH		16 0	90	AE 1	AT' I	96159	**	2.7 0
DEPT Chan	L • 0	1=0	A5	AS	AS	L=0	۲•0	ESTA	0•0	0.0	n•1	1=1	ESTA		0*0	0°0	L=0	۱.	ESTA	0.0	0.0
474 474	EJ AT	ED Al	SIBLE	SIBLE	51866	ė0 al	IA Cà	FLOM	240-	• 05 6	L) AT	ėD Al	FL04		.051	•030	60 A1	E0 41	FLOM	• 0 • 4	.034
	ראנוא ט	איטאט	i MP U S	IAP DS	(UJH)	URDHN	NHOND	BORE	C 1CO	0 6 2 0	URUMN	UXOMN	BORE		U EEO	022 W	URUMN	URUWN	BJRE	u { 20	UL7 J
	AND	UMP (AND	JHD	AND	UNP	UMP	חרר	•0 0	~ 0 •(UMP	6 11 0	חרר י		0.0	2 0.6	AND	UNP	חרר	0 0	< 0°
FNTRY F +M N +	ر	•	•	7	~	•	•		4 . B7	1 • 9 L		7	4		4-87	1.91	-	7	<u>u</u>	4 . B 7	1.91
ENTRY ENEAGY M.									0.31	0.19					0.31	0.19				0.31	0.19
1 . 1									.011	.007					.011	* 00 5				.011	.001
ΨO X.	075	520	062	036	0 2 2	075	520	075	047 0	028 0	075	075	520		0.51.0	0 00	075	520	520	069 0	6
τε	* 0 *	°0 5	6 0°	2 0.	• 0	-0 S	5 0°	6 0 •	2 0	• 0 •	2 0 °	°0 S	÷ 0 •		2 0-1	•0	-0 5	5 0.	6 0 •	· 0 ·	0 20
С + К	0 * 01	u • 01	0 • 00	0 • 04	0 • 05	0.07	0.07	0• 00	0 - 04	0•02	0.07	0 • 01	0 • 0		0 * 0	0 • 05	0.07	0.07	0.04	0 * 0	0=0-
011	06 20	0520	0520	0550	0520	0125	0125	0125	0125	0125	0100	0100	0100		0100	0100	0400	09.00	0 4 0 0	0150	<u>סרוס</u>
• 5 1 67 15	010	95 0 e	66 O.	97 0.	03 0.	0 1 0	95 0.	66 O.	97 0.	83 0.	010	95 0.	66 O.		97 0.	83 O.	010.	45 O.	66 0.	97 0.	
TERN Ener M =	0 . 7	· 0 • 5	0.4	0.2	0 • 1	0.7	0.5	0 • 4	0.2	0.1	0 • 7	6°0	4 • 0		0.2	0.1	0.1	0.5	9 0.4	1 0.2	1.1
N .	0.029	0 • 024	0.016	0.011	0 • 00 1	570 * 0	0.024	0.016	0.011	0 • 001	0•029	0.024	0.016		0.011	0 • 001	0.029	0.024	0.016	0.011	0.00
096 [N]	070	7070	7070	010	1070	7070	7070	1070	7070	0101	1070	7070	7070		7070	1070	0101	010	1070	7070	0101
- SLI	2 0 °	5 0°	5 0.2	5 0 -	5 0.7	5 0.	5 0.	5 0°	5 0.	5 0.5	5 0.	5 0.	5 0.3		5 0 -1	5 0.5	5 0°	5 0.5	5 0.	5 0°	2 0
COFF	0 .01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	10.01	0.01	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01
01A. M.	0.07	10.07	0.07	10.07	0.07	0.07	10.07	0.07	0.07	0.07	0.07	0.07	0.07		0.07	0.07	0.07	0.07	0.07	0.07	0.07
3.	8.0	0 ° ¢	0 • •	2.°0	1.0	0°9	0 • 0	0 * 4	2.0	1.0	9 • 0	¢ • 0	••		2.0	1.0	0 ° P	6.0	••	2.0	1.0
-														0							

ì

TEST PIPE DATA AND PRISAAN RESULTS.

2

COMMON DATA APPROACH PIPE DATA

A4.8

٠

•

EST PIPE VATA AND PAJGAAM KESULTS. Niay Entry Upjump Juma depth Enfact Energy Enfred Jump Jump Nergy Fom Uepth Jepta Change Upjump Jumm Caange Fom, pjs. M. N. M. M. M. M. M. M. M. N. N. M.	JUMP URUMMEU AI L=0 AT TEST PIPE EMTPY. JUMP URUMMED AT L=0 AT TEST PIPE EMTPY. JUMP URUMMED AT L=0 AT TEST PIPE. JUMP IMPUSSIBLE AS MMCMC IN TEST PIPE. JUMP IMPUSSIBLE AS MMCMC IN TEST PIPE. JUMP URUMMED AT L=0 AT TEST PIPE EMTPY. JUMP URUMMED AT L=0 AT TEST PIPE EMTPY. JUMP DRUMMED AT L=0 AT TEST PIPE EMTPY. JUMP DRUMMED AT L=0 AT TEST PIPE EMTPY. JUMP DRUMMED AT L=0 AT TEST PIPE EMTPY. FULL BORE FLDM ESTABLISHED IN TEST PIPE. JUMP DRUMMED AT L=0 AT TEST PIPE EMTPY. JUMP DRUMED AT L=0 AT TEST PIPE EMTRY. JUMP DRUMED AT L=0 AT TEST PIPE EMTRY. FULL BURE FLDM ESTABLISHED IN TEST PIPE. JUMP DRUMMED AT L=0 AT TEST PIPE EMTRY. JUMP DRUMMED AT L=0 AT TEST PIPE.	0.35 5.142 0.024 0.053 0.044 0.089 0.076 -6.614 2.474 3.874 0.21 2.032 0.017 0.034 4.323 0.350 0.045 -6.065 0.409 0.555
COMMON DATA APPRJACH PIPE DATA J. DIA. MANN. SLOPE HN TEKN. SLOPE MC HN E4TRY E L/S M. CUEFF ISIN) M. ENLAGY ISIA) M. M. OFPTA E M. M.		2.0 0.07 0.015 0.8550 0.011 0.337 0.0050 0.042 0.058 0.010 1.0 0.07 0.015 0.8550 0.007 0.207 0.0350 0.026 0.019 0.007

••••									191	191				173	335				106	(15
									1 61	5 1.				9 1.	9 1.					۰ ۵
10 - 1 1 - 1 11 1 - 1 1 -									1.9.	0 • 7:				2.0(0 . 7				2.4	0. 41
20 20 20 20 20 20 20 20 20 20 20 20 20 2	•					•			(10.	• • • •	•		÷.	.001	.003	•			.01.	• 00 •
U U U U	NTRV.	NTRV.	1 P E .	1 P E .	1 P E •	NER.	NTPT.	919	9 - C	0-0	NTRY.	NTRY.	414	5	0-0	NTRY.	NTRY.	6 1 6	9-0-9	2-0-
CONRRG CONRRG	PIPE E	PIPE E	TEST P	IEST P	1127	9 3414	PIPE E	N 1657	0•00	₩0°0	3 3414	9 3484	N TEST	0 • 00	0°0	3 3414	3 3474	N TEST	0.07	¢0*0
ENERGY UPJUMP M.	TEST	TEST	HC IN	IC IN	IC IN	TEST	TEST	SHED II	0.064	0 • 7 • 0	TEST (TEST (SHED II	0.066	0+0+0	TE S T	TEST (SHED LI	0.089	0 \$ 0 \$ 0
EPTM HANGE	L.O. AT	L=0 AT	AS MMCI	AS MACI	AS HNCI	L=0 AT	L=O AT	STABLE	0.010	0.003	L=0 AF	L=0 AT	STABLE	0.018	0-008	L=0 AT	L-U AF	STABLE:	0.044	0.423
	AT.	AT	9LE	BLE	5	AT	A T	Ŭ H	24	5 4	AT	AT	94	51	CE	AF	AT .	9 10	F q	~
1) 1) 2) 2) 2) 2) 2)	MAE J	MNE Û	12 < 0	12<0	15 40	MNE D	MNE O	E FL	C • 0	0 • 0	MAE 3	MMED	E FL	0.0	0.0	M NE D	(JNH	E FL	0.0	0.0
UPJUMP 06014 4.	MP DRU	nP 440	ANJ AN	ant an	MP I MP	MP UKU	HP UXU	LL BUR	/fn=0.	¢ 2Ŋ * O	MP DRU	MP UXU	16 404	0.013	0.023	MP UKO	MP UKU	LL BUR	0°024	0.017
ТКҮ • М • И •	nr	זר	nr	J.	nr	חר	JL	fυ	•356	• 0 9 4	UL.	n r	Fu	• 356	60°	. r	J.	۴u	• 350	÷ 0 +
Y EN GY F									37.5	23 2				37.5	232				37 5	2 23 2
ENTA Enta A.									•	•				•	•				••	.0
* 7 * * * * * *									0.010	0.00				0.010	000 .006				0.013	0.00
2 2 2	075	520	062	036	022	075	075	075	047	020	0 7 S	075	075	051	000	075	015	075	064	034
ΤĽ	5 0.	5 0°	6 0.	2 0 .	• 0 •	> 0.	÷0 \$	• 0	2 0.	• 0 •	• 0 ·	5 0.	6 0.	2 0.	6 0°	5 0.	~ 0°	6 O.	2 0°	6 0.
U · H	0.07	0.07	0 • 06	0 • 04	U • 02	0.07	u . 07	0 • 00	0°04	0 • 02	0.07	0.07	0 • 00	0.04	0 • 02	0.07	0.07	0.06	0 ° 04	0 • 02
4	1250	250	1250	057(2 50	125	\$210	125	125	125	0010	001	001	100	100	050	050	050	050	0 5 0
r (S1	0.0	3 9.0	1 0.6	0.0	1 0.0	9 °°C	9 0 • 0	0.0	0 0	0.01	0-0	3 0.0	0-0	0.0	1 0.0	0 0	0.0	1 0.0	0 0.0	1 0.6
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	0. 66	0.73	0.571	0•360	0.22	0.66	0.73	0.57	0• 36(0.221	0.86	0.73	0.571)• 36(0.22	.86	0.73	0-57	0• 36(0.22
	026	021	016	010	900	970	170	010	010	900	970	021	016	010	900	026	021	016	010	006
. II.	9 0.	9 0.	2 0°	9 0 .	9 0.	9 0.	9 0.	*0	4 0 •	9 0.	9 0.	3 0.	9 0.	9 U.	9 0.	9 0.	4 0°	J 0.	9 0°	9 0.
LOPE	.965	• 45 5	• 965	- 96 S	- 465	. 96 5	• 96 5	• 96 5	• 96 5	• 46 5	-965	• 45 5	• 465	• 96 •	• 965	• 96 S	• 965	.965	.965	• 41 5
- LL - LL	0 510	115 0	15 0	115 0	0 510	115 0	0 510	115 0	0 510	0 510	115 0	115 0	115 0	0 510	15 0	0 510	0 510	115 0	015 0	015 0
C OF	1 0.6	2 0.6	2 0.6	2 0.6	2 0.4	7 0.6	7 0.(7 0.6	7 0.4	7 0-6	2 0.4	7 0.6	1 0.4	7 0.6	7 0.6	7 0.6	7 0.4	7 0.4	7 0.(7 0 .4
01A.	0 • 0	0-01	0.02	0.0	0-0	0.01	0=0	0.01	0.01	0-0	0.0	0.01	0.01	0.0	0=0	0.0	0 • 0	0-0	0-0	0-0
0. L/S	0 • 0	6 • 0	9 • 0	2.0	1.0	3 ° 0	0 • 0	4 = 0	2.0	1.0	d. 0	6 • 0	4 - 0	2.0	1.0	8.0	6 • 0	0 • 4	2 • 0	1.0

TEST PIPE DATA AND PRJGAM RESULTS.

COMMJM DATA APPROACH PIPE DATA

-

A4.10

•

504									1.59	1.13				L. 98.	10.1				16 °C	0.57
101 101 101									1.949	0.765				2-609	0.779				2.474	606°0
ADAUNA ADAMA	PE LHTRY.	PE ENTRY.	ST PIPE.	ST PIPE.	ST PIPE.	PE ENTRY.	PE ENTRY.	TEST PIPL.	0.063 -0.003	0*0+0 -0*000	PE ENTRY.	PE ENTRY.	TEST PIPE 41	0.065 -0.001	C00*0- 040*0	PE ENTRY.	PE ENTRY.	TEST PIPE.	0.076 -0.CI+	0°045 -0-005
H ENFAGY E	AT TEST PI	AT TEST PI	HNCHC IN TE	HNCHC IN TE	HNAMC IN TE	AF TEST PI	AT TEST PI	ISLESHED IN	10 0.064	0+0-0 00	AT TEST PI	AT TEST PI	BLISHED IN	115 0-066	040-0-90	AT TEST PI	AT TEST PI	BLT SHED IN	944 0°389	0\$0*0 €20
	WHED AT L-0	HINED AT L-0	USSIBLE AS	UNSTOLE AS	OSSIBLE AS	HNED AT L=0	MNCD AT L=0	LE FLOH ESTA	U.047 0.0	0.020 U.0	DANED AT L=0	INNED AT L-0	LE FLOM ESTA	0-0150-0	0.0 660.0 0	HAED AT L=0	HNEJ AT L=0	LE FLOW ESTA	J. J. 543 0.0	0+0 +EC+0
4 TRY UPJUAP F+M UEFI4 N. M.	JUNP URD	JUMP DRO	AND INP	AMI AMUL	AMD IMP	JUMP URD	UND UND	FULL BOH	160.0 114.6	2.121 0.625	JUMP URC	JUMP UKU	FULL BUR	[[0*0]]+*g	2.121 0.023	JAMP URU	JUNP UNC	FULL BUH	5.411 0.U24	2 • 1 2 1 0 • U 1 7
ENTRY E ENCRGY M.									0.38	62-0				0.38	0.23				0.38	0.23
×I.									10	000				(10	900				013	\$00
ENTRY Depth M.	\$	2	2	9	2	5	5	5	7 0.013	8 0.00	5	15	5	(10.01)	10 0-000	5	5	5	.8 0-013	00.00
HN ENTRY M. DEPTH M.	0.075	0.075	0.062	0.036	0.022	0.075	9.015	0.075	0-047 0-013	0.028 3.006	0.075	610.0	0.075	C10.0 1 CU.O	0.030 0.006	0.075	0.075	0.075	0.068 0.013	0.034 0.005
HC HN ENTRY A. H. DEPTH	0.015 0.075	0.075 0.075	0.066 0.062	0.042 0.036	0.026 0.022	0.075 0.075	0.075 9.075	0.066 0.075	U. 042 0.047 0.013	0.026 0.028 3.006	U.075 0.U75	0.075 0.075	0.066 0.075	0.042 0.051 0.013	0.026 0.030 0.006	0.075 0.075	0.075 0.075	0.066 0.075	U.042 0.068 0.013	0.026 U.U.J. 0.005
SLOPE HC HN ENTRY (SIN) M. M. DLPTH H.	0.0250 0.015 0.075	0.0250 0.075 0.075	0.0250 0.066 0.062	0°0250 0°042 0°036	0.0250 0.026 0.022	0.0125 0.075 0.075	0.0125 4.075 9.075	0.0125 0.066 0.075	0.0125 0.042 0.047 0.013	0.0125 0.026 0.028 3.006	0.0100 0.075 0.075	0.0100 0.075 0.075	0.0100 0.066 0.075	0.0100 0.042 0.041 0.013	0.0100 0.026 0.030 0.006	0.0350 0.075 0.075	0.0050 0.075 0.075	0.0050 0.066 0.075	0.0050 0.042 0.068 0.013	0°030 0°030 0°030 0°030 0°00
TERM. SLOPE HC HN ENTRY Enlpgy (Sin) M. M. Depth M.	6 0.879 0.0250 0.075 0.075	1 0-750 0-0250 0-075 0-075	\$ 0.584 0.0250 0.065 0.062	0 0° 366 0°0250 0°045 0°036	6 U.225 0.0250 0.026 0.022	6 0.890 0.0125 0.075 0.U75	1 0.750 0.0125 0.075 9.075	6 0.584 0.0125 0.066 0.075	0 0.368 0.0125 0.042 0.047 0.013	6 0.226 0.0125 0.026 0.028 3.006	6 0.890 0.0100 0.075 0.075	1 0.750 0.0100 0.075 0.075	6 0.584 0.0100 0.066 0.075	0 0.368 0.0100 0.042 0.051 0.013	¢ 0.22¢ 0.0100 0.026 0.030 0.006	6 0.890 0.0350 0.075 0.075	1 0.750 0.0050 0.075 0.075	6 0.584 0.0050 0.066 0.075	0 0.368 0.0050 0.042 0.068 0.013	6 0.226 7.0350 0.026 0.03% 0.305
HN TEKM. SLOPE HC HN ENTRY M. ENLPGY (SIN) M. M. DEPTH M. M.	0.026 0.879 0.0250 0.015 0.075	0.021 0.750 0.0250 0.075 0.075	0.016 0.584 0.0250 0.066 0.062	0.010 0.368 0.0250 0.042 0.036	0.006 U.225 0.0250 0.026 0.022	0.026 0.890 0.0125 0.075 0.075	0.021 0.750 0.0125 0.075 9.075	0.016 0.584 0.0125 0.066 0.075	0.010 0.368 0.0125 U.042 0.047 0.013	0.006 0.226 0.0125 0.026 0.028 3.006	0.026 0.890 0.0100 0.075 0.075	0-021 0-750 0-0100 0-075 0-075	0.016 0.584 0.0100 0.066 0.075	0.010 0.368 0.0100 0.042 0.051 0.013	0.006 0.226 0.0100 0.026 0.030 0.006	0.026 0.890 0.0350 0.075 0.075	0.021 0.750 0.0050 0.075 0.075	0.016 0.584 0.0050 0.066 0.075	0.010 0.368 0.0050 U.042 0.068 0.013	U.OJE 0.226 0.0350 0.026 0.039 0.305
SLOPE - HN TEKH. SLOPE HC HN ENTRY (SIN) M. ENLPCY (SIN) M. M. DEPTH M.	1.0030 0.026 0.833 0.0250 0.015 0.075	1.0000 0.021 0.750 0.0250 0.075 0.075	1.0000 0.016 0.584 0.0250 0.066 0.062	1.0000 0.010 0.368 0.0250 0.042 0.036	1.0000 0.006 U.225 0.0250 0.026 0.022	1.0000 0.026 0.890 0.0125 0.075 0.075	1.0000 0.021 0.750 0.0125 U.075 9.075	1.0070 0.016 0.584 0.0125 0.066 0.075	1.0000 0.010 0.368 0.0125 U.042 0.047 0.013	1.0000 0.006 0.226 0.0125 0.026 0.028 3.00	1.0000 0.026 0.890 0.0100 0.075 0.075	1.0000 0.021 0.750 0.0100 0.075 0.075	1.0000 0.016 0.584 0.0100 0.066 0.075	1.0000 0.010 0.368 0.0100 0.042 0.010 0.013	1.0030 0.006 0.226 0.0100 0.026 0.030 0.006	1.0000 0.026 0.890 0.0350 0.075 0.075	1.0000 0.021 0.750 0.0050 0.075 0.075	1.0000 0.016 0.584 0.0050 0.066 0.075	1.0070 0.010 0.368 0.0050 0.042 0.068 0.013	1.0070 0.036 0.226 7.0350 0.026 0.039 0.305
MANN. SLOPE - HN TEKM. SLOPE HC HN ENTRY Cofff (SIN) M. Emlygy (SIN) M. M. Depth M.	U.015 1.0030 0.026 0.833 0.0250 0.015 0.075	0.015 1.0000 0.021 0.750 0.0250 0.075 0.075	0.015 1.0000 0.016 0.584 0.0250 0.066 0.062	0.015 1.0000 0.010 0.368 0.0250 0.042 0.036	0.015 1.0000 0.006 0.225 0.0250 0.026 0.022	0.015 1.0070 0.026 0.890 0.0125 0.075 0.075	0.015 1.0000 0.021 0.750 0.0125 0.075 9.075	0.015 1.0070 0.016 0.584 0.0125 0.066 0.075	0.015 1.0000 0.010 0.368 0.0125 U.042 0.047 0.013	0.015 1.0000 0.006 0.226 0.0125 0.026 0.028 3.006	U.015 1.0000 0.026 0.890 0.0100 U.075 0.075	U.015 1.0000 0.021 0.750 0.0100 0.075 0.075	0.015 1.0000 0.016 0.584 0.0100 0.066 0.075	0.015 1.0000 0.010 0.368 0.0100 0.042 0.051 0.013	0.015 1.0030 0.006 0.226 0.0100 0.026 0.030 0.006	0.015 1.0000 0.026 0.890 0.0350 0.075 0.075	0.015 1.0000 0.021 0.750 0.0050 0.075 0.075	0.015 1.0000 0.016 0.584 0.0050 0.066 0.075	0.015 1.0070 0.010 0.368 0.0050 0.042 0.068 0.013	0.015 1.0070 V.046 V.226 7.VJ50 0.026 V.U39 0.305
OI A. MANN. SLOPE HN TEKM. SLOPE HC HN ENTRY M. COFFF (SIN) M. ENLPGY (SIN) M. M. DEPTH M. M.	0.07 U.015 1.U030 0.026 0.879 0.0250 0.015 0.075	0.07 0.015 1.0000 0.021 0.750 0.0250 0.075 0.075	0.U7 0.015 1.0000 0.016 0.584 0.0250 0.066 0.062	0.07 9.015 1.0030 0.010 0.368 0.0250 0.042 0.036	0.07 0.015 1.0000 0.006 U.22£ 0.0250 0.026 0.022	0.07 0.015 1.0070 0.026 0.890 0.0125 0.075 0.175	0.07 0.015 1.0000 0.021 0.750 0.0125 4.075 9.075	0.07 0.015 1.0070 0.016 0.584 0.0125 0.066 0.075	0.07 0.015 1.0000 0.010 0.368 0.0125 0.042 0.047 0.013	0.07 0.015 1.0000 0.006 0.226 0.0125 0.026 0.028 3.006	0.07 0.015 1.0000 0.026 0.890 0.0100 0.075 0.075	0.07 U.015 1.0000 0.021 0.750 0.0100 0.075 0.075	0.07 0.015 1.0000 0.016 0.584 0.0100 0.066 0.075	0-07 0-015 1-0000 0-010 0-368 0-0100 0-042 0-013	0.U7 0.015 1.U03U 0.COE 0.226 0.01U0 0.026 0.030 0.006	0.07 0.015 1.0000 0.026 0.890 0.0350 0.075 0.075	0.07 0.015 1.0000 0.021 0.750 0.0050 0.075 0.075	0.07 0.015 1.0000 0.016 0.584 0.0050 0.066 0.075	0.07 0.015 1.0990 0.010 0.368 0.0050 0.042 0.068 0.013	0.07 0.015 1.0070 V.046 V.276 A.VJ50 0.026 V.VJ9 0.305

A4.11

1. 10

.

.

TEST PIPE UNTA AND PAUSAAM AESULTS.

COMMON DATA APPKUACH PIPE DATA

•

,

e



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

	C.	MMM M	0 T A	19946	14.64 01	DE D	4 7 A					TEST PIP	E DATA	AND	A.JG&AI	I RESUL	15.					
		O I A	COFFE	SLGP	H H		KA. F. SCY	SLOPE	л с Н	E . E E	ENT&Y (Depth (m.	ENTRY EN Energy F M.	17.8 V UP • M UE N •	PI-		JEPTH Change M.	ENERGY UPJUHI M.	ENERGI DOWN	/ ENEPG Clang M.	и JUNP Г.н.	10 10 10 10	• •
	• •	0 0.10	0.015	0.03	149 0.6	068 0	.138	0 < 2 0 • 0	0.087	0.076			Jun	IMPO.	51865	AS HNC	HC IN	TEST P.	ipe.			
	6 • (0 0.10	0-015	0.03	149 0.0	0 550	.116	0 • 0 5 2 0	0.072	0.062			JUMP	INPO:	518LE	AS HN	HC IN	TEST P	. 341			
	4 - 6	0 0.10	0-015	0.03	149 U.(040	060 *	0°70°0	0.055 (0+0+0			ANUL	INPO:	SIBLE	AS HN	HC IN	TEST P.	1 P E •			
	2.	0 0.10	0.015	0.03	149 0.6	25 0	.058	0.0250	0.034	0.028			140 î	INPO.	SIBLE	AS HN	CHC IN	TEST P	IPE.			
	1 • (0 0-10	0.015	0 • 0 3	149 0.6	115 0	.037	0°0550	0.022	0.017			JUMP	IHPO:	SIBLE	AS HNC	HC IN	TEST P	1 P E .			
•	9 • 9	0 0.10	0.015	0.03	144 0.(0 890	9E1 -	0.0125	0.087	0.100			FULL	BORE	FL04 (STABLE	SHEU	N TEST	• 1 P E •			
	۰ °	0 0•10	0-015	0.03	149 0.6	55 0	. 116	0.0125	0.072	0.041	0+0	0.16 9	. 827 0	.003	.081	0.019	0.10	0.10	00-0- 6	0 7.67	5 1-3	33
	4° (0 0.10	0.015	0.03	0.0	040	050 .	0.0125	0.055 (0.059	0.030	0.12 5	.767 0	0 0 \$0 *0	.054	0.009	96-0	0.08	-0.00	9 4-42	5 1.2	23
	2•(0 0.10	C.015	0.03	149 0.4	0.25 0	• 058	0.0125	0.034	0.036	0.019	0+09 2	.307 0	. 550-0	.036	0.002	0.05	0*02	2 -0.00	0 1.74	5 1.0	-
	1.(0 0.10	0.015	0.03	149 0.0	015 C	.037	0-0125	0.022	0.022	0.012	0°05 U	- 612 0	• 022 (•022	0°00°	0-03	0 03	3 -0.00	0 0.67	2 0.7	3
A		0 0.10	0.015	0.0	49 0.4	068 0	.130	00100	0.087	0-100			FULL	BORE	FLOM 1	STABLE	SHED	IN TEST	• 34 I d			
5.2																						
	6.1	0 0.10	0.015	0.03	149 0.(0 5 5 0	.116	001000	0.072	0.089	0+0-0	0.16 4	.827 0	• 050 •	• 00 •	0.033	0.114	0.11	2 -0.00	i 7.93	9 0 - 9	72
	4 = (0 0*10	0.015	0-03	149 0.6	0 0 0	• 060	0.0100	0 ~ 60 ° 0	0.065	0.030	0.12 5	.767 0	. 046	÷065	610.0	0.00	0.08	00 - 0- 1	1 4.52	6 n 3	6
	٤.(0 0.10	0.015	0.00	149 0.6	325' 0	.558	0 0 1 0 0	+E0 *0	0.034	v.014	0.08 2	· 10E.	. 160.	FE0-4	0.008	0-052	0*05	2 -0° CU	\$L•1 C	12 . 6 8	9
	I • (0 0.10	0.015	0-03	147 0.4	015 0	• 037	0.0100	0.022	0.024	0.012	n ¢0°0	. 917 0	.020 .	•024	0.004	E 0*0	0.03	-0-00	0.69	2 0.5	-
	9°0	0 0.10	\$10°0 (0.03	149 0.	066 0	1.138	0.0050	0.087	0.100			FULL	BORE	FL04 (STABLE	SHED	N TEST	P3PE.			
	••	0 0.10	0.015	0.03	144 0.	0 2 4 0	.116	0 * 00 \$ 0	0.072	0.1.00			FULL	BORE	FLUM (STABLE	SHEU	IN TEST	PIPE.			
	*	0 0.10	0.015	0.03	349 0.	040	040 .	0.0050	0-055	0.085	0:030	0.12 5	.767 0	. [[0.	< 90 • 1	0°052	0.10	0°0	t -6.01	3 5.42	7 0.1	3
	2.	0 0.10	0.015	0.0	349 0.	025 0	.050	0 - 0 - 50	0.034	0.0.0	0.014	0.08 Z	. 307 0	. 023	U\$0.1	0.027	0.06	140-0	00-0- 6	4 2.01	5 0.2	4
	1.	0 0.10	0.015	0-01	0 .41	015 0	1037	0406-0	0.022	000000	0-012	0.05 0	.917 0		030	0.015	C.03(0.03	00-0- 0	2 0.27	5 4.2	17

- · ·

								_					_						-		
	-504							1-521	1-524	1.23	0.933		1 - 2 5 3	1.236	0-944	J. 63 b			0 . 39j	0-412	60E . U
								7.675	4.425	1.745	0.692		964.7	4-526	1.766	0-697			5.427	2-015	0.775
	ENF PGY CHANG: M.	f.	Ę.	f.,	E.	E.	.341	500 -0-	-0.00	-0.000	-0-00	1 PE .	-0-005	-0.001	-0.000	-0-000	1 P.E .	1 P E .	-0-013	-0-00+	-0- 602
	EMERGY DUMN M.	EST PIP	EST PIP	EST P1P	EST PIP	EST PLP	1651 P	0.109	0.003	260.0	C C O * O	1651 P	0.112	0.084	0*052	0.033	TEST P	TEST P	0.096	0.056	0.036
15.	ENFRCY UPJUMP M.	HC IN T	HC IN T	HC IN T	HC IN T	HC IN T	SHED IN	0.109	0.063	0.052	660.0	SHED IN	0-114	0.085	0.052	0.033	SHED IN	NE C 3HS	0.109	0.062	0.038
H RESUL	DEPTH Change M.	AS HNC	AS HNC	AS HNC	AS HNC	AS HNC	ESTABLE	0.019	0.009	0.002	000 • 0	ESTABLE	f €0 •0	0.019	0.008	0.004	ESTABLE	ESTABLE	0.052	0.027	0°015
PROGRA	004M 06PTH 3.	3181840	JA SIALE	JSIBLE	3781846	37818LE	FL04	180-0	0.5 J	0.036	u. 022	FLOM	J.084	0.365	J.039	1-024	FL04	FL04	085 V	0¢0°0	0.030
ITA AND	UPJUAP UEPIH M.	MP IMP	MP INP	MP INP	HP INP	INP INP	11 804	0.063	0.050	0.033	0.022	ILL BORE	0-057	0-040	0.031	0*050	ILL BOR	ILL BORI	660.0	0.023	0-015
PIPE DI	EN TRY Y F + M N •	L	n e	7	n r	n r	Fu	1+1-010	\$ \$ 3 24	LE2.5 9	4 - 00-	FU	1.7.018	4-324	2.533	\$ 1 .004	FU	Fu	• 26 • 9 4	2.533	1.004
TEST	ENTRY ENERG M.							0-1	0-1-	0-0	0 - 0		0-11	0.14	0 • 0	0.0	•		0.1	0 0	0.0
	ENTRY DEPTH M.							0-036	0.027	0-01	0.011		0.036	0.023	0.017	0-011			0.027	0.017	0.011
	N .	0.078	0-062	0-040	0.028	0.017	0.100	0.081	0.059	0.036	0.022	0.100	0.089	0.065	0.039	0-024	0.100	0°100	0.085	0.050	0.010
	U ·	0.087	0 • 072	0 • 05 5	U.034	0 • 02 2	0.087	0.072	0.055	0-034	U • 022	0-087	0.072	0-055	4E0 * 0	U.022	0.087	0.072	0.055	0 ° 034	0.022
	SLOPE	0 \$ 70 * 0	0 - 02 50	0 \$ 7 0 * 0	0\$70.0	0420.0	0-0125	0.0125	0-0125	0.0125	0-0125	0.0100	00100	0-0100	0°100	0.0100	0.0050	0 • 0 0 5 0	, 0 • 00 5 0	0 \$ 00 \$ 0	0 - 00 5 0
DATA	TERM. ENERGY M.	0.172	0.145	0.114	0-073	0.046	0.172	0.145	0-114	0.073	0.046	0.172	0-145	0.114	0.073	0.046	0.172	0.145	0-114	0.073	0-040
I PIPE	N	0.052	0.042	0.032	610.0	0.012	0.052	0.042	0-012	0.019	0.012	0.052	0.042	0-032	0.019	0.012	0.052	0.042	0.032	0.019	0.012
PPROAC	SLUPE	86.40.0	0.0698	0 • 00 • 0	0.0694	0.0098	0.0698	0.0678	₽£.40°0	0.0694	0.05 Jd	0.0535	0-06 JU	0.0645	0.0099	0.0694	0-06-98	0.0695	0 • 00 4 8	0.0698	0.0048
DATA A	MANN. COEFF	\$10.0	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0°015	0.015	0.015	\$10.0	0.015	0.015	0.015	0.015	0.015	0.015	0.015
NONN	рі А. И.	0 * 1 0	0.10	0.10	0.10	0*10	0.10	0.10	0.10	0.10	0.10	0.10	0 * 10	0.10	0.10	0.10	01-0	0.10	0.10	0.10	0.10
00		d • 0	6 • 0	0 • •	2 • 0	1.0	d - 0	0.0	4 - 0	2.0	1.0	3.0	6 • 0	•••	2.0	1.0	d • 0	6.0	4 • 0	2.0	1.0

.

A5.3

•

P05.							1.95	1+ 73	1.31	C4-C		1.40	1.30	1-05	0-201
2							7.675	4-425	1-745	0.092		7.439	4-526	1.766	190-0
ENE BCY Change R.	E.		, L	بب	Ę.	1	-0.003	-0-606	00°n-	-0.00	IPE.	-0•005	-0.001	-0-000	-0-000
ENERGY DOWN N.	EST PIP	EST PIP	EST PIP	EST PIP	EST PIP	TEST P	0.109	0.063	2 <0 ≈ U	0.033	TEST P	0.112	0.084	0 • 052	0.033
ENEKGY UPJUMP M.	HC IN I	HC IN T	HC IN T	HC IN T	HC IN T	ShEU IN	0.109	0.083	0.052	0.033	SHED IN	0.114	0.085	0.052	0-033
UEPTM CHANGE M.	AS HNC	AS HN<	AS HNK	AS HNS	AS HNC	E STABL	0°014	0.009	0°005	00000	ESTABLE	0.033	0.019	0.008	0-004
0043 06713 1.	0, 51 BL E	0, 51 BLÉ	Ossidue	U > 5 1 8 L E	U>513LE	E FLOW	V.081	V.054	J.036	J.022	E FL04	J.044	0 • 0 6 >	010.0	0.024
UPJUAP DEPIM R	URP INF	UMP IMP	UNP LEP	UNP INP	UHP IRP	164 116	(0.06)	U 60 • 0 1	1 0-034	9 0.022	111 408	1 0.057	1 0.046	0.631	0.020
ENTRY 7 F + M N •	<u> </u>	ī		ĩ	1	1	19*111	6 6 84	0 2.73.	6 1.07	F	111.61	6 6 . 84	0 2 • 73	6 1.07
ENTRY FNERC							2 0 2	4 0.1	5 U.1	0-0		2 0 2	4 0.1	5 0 . 1	0 0 0
ENTRY Deptm M.	5 ^	~	-0			0	0-03	3 0.02	10	10.01	0	0°1 (5 0.02	0.01	0-01
Σ. I.E	10.07	2 0.06	0-040	0.021	0.01	01.0	0.04	0.05	0.03/	0.02	0.100	0.08	0.06	0.03	0-024
H C	0-047	0-072	0.055	0.034	U = 022	0 • 083	0.072	0•055	¢(0°0	0 • 02 2	U = 087	570.0	U.055	0.034	0 022
SLOPE (SIN)	0570°0	0 < 7 0 ° 0	0 * 0 7 2 0	0520-0	0.0250	0.0125	0.0125	0.0125	0°0125	0.0125	0°100	0 * 0 * 0 0	0.0100	0°10°0	0-0100
TERM. ENERGY N.	0.206	0.175	0.137	0.687	0.054	0.206	6.175	0.137	U. 087	0.054	0.206	0.175	0.137	0.087	0-054
I t	0.045	0.036	0.027	0.017	0.011	0 - 0 - 5	0.036	0.027	0.017	0.013	0.045	0.036	1 20 . 0	0.017	0.011
51 0°5 15 14)	0.1045	0°1045	0.1945	0.2045	0.1345	0.1045	0.1045	0.1345	0.1045	0.1045	0.1045	0.1045	0-1045	0-1045	0-1045
MANN. Cueff	0.015	0.015	0.015	0.015	0.015	9.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
01A. M.	0.10	0.10	0•10	0.10	0.10	0.10	0•10	0.10	0.10	0.10	0-10	0.10	0.10	0.40	0.10
13.	9-0	6.0	0 • 4	2.0	1.0	3 ° 0	0 • Q	6.4	2 • 0	4.0	8 • 0	6.0	0 · 4	2.0	1.0

TEST PIPE DATA AND PROGRAM RESULTS.

COMMON DATA APPRUACH PIPE DATA

A5.4

0.036 -0.002 0.175 3.357

0.038

0.058 -0.004 2.015 0.513

0.10 2.733 0.023 0.050 0.027 0.062

1.0 0.10 0.015 0.1045 0.011 0.054 0.0050 0.022 0.030 0.010 0.06 1.074 0.015 J.030 0.015

••0 0-10 0-015 0-1045 0-027 0-137 0-0450 0-055 0-085 0-024 2-0 0-10 0-015 0-1045 0-017 0-067 0-0450 0-034 0-050 0-015

\$.0 0.10 0.015 0.1045 0.045 0.206 0.0050 0.087 0.100 6.0 0.10 0.015 0.1045 0.036 0.175 0.0050 0.072 0.100 0-109 0.096 -0.013 5.427 0.552

0.052

0.16 6.841 0.033 0.08>

FULL BORE FLOW ESTABLISMED IN TEST PIPE. Full boke flow establismed in test pipf.

	4MUR 905.							161-2	1.930	1.453			- 283	1.619	1.137	. 783			161-0	0.555	64.0
	4							1.675	1-425	1.745	.692		1.439	.526	. 166	169.0			5.427	510-5	\$11.0
	EPCY Ange						е Ц	. 000 -	. 100.	000-	. 600	بد بد	200 -	• 100*	. 00.	0000	f.	•	- 613	+ 00 -	.00.
	N L .	P1PE.	PIPE.	PIPE.	. 3414	P1PE .	414 1	9- 60	143 -0	52 -0	U- EE	414 I.	12 -0	84 -0	52 -0	- EE	414 1	414 1	0- 94	0- 84	36 -0
	ENER DOWN	1651	TEST	1651	TEST	1 2 3 1	N TES	0-1	0.0	0-0	0-0	N TES	0.1	0-0	0-0	0 • 0	N TES	N TES	0.0	0.0	0.0
TS.	ENEK GY UPJUMF M.	HC IN	HC IN	HC IN	HC IN	HC IN	SHEU I	0.104	0.083	0-052	0.033	SHED	0-114	0.085	0.052	0.033	SHED I	SHED I	0.109	0.062	9E0*0
RE SUL	EP TH HANGE H.	AS HNC	AS HNC	AS HNC	AS HNC	AS HNS	STABLE	0.019	400-0	0.002	000-0	STABLE	0.033	0.019	0.004	+00*0	STABLE	STABLE	0.052	0.027	610
ROGRAH	NNU N. U	STOLE	51866	SIBLE	SIBLE	SIBLE	FLON E	100.	• 50 •	•036	.022	FLOH E	•089	• 0 6 5	€E0•	• 0 2 4	FLON E	FLOM E	« PO •	. 350	.01,
AND P	1114	INPO	CO AN I	INPOS	IHPO.	INPO	bORE	. 630.	- 050 J	0 4 E O .	.022 U	BUKE	U 1 CO.	040	U 100.	. 620 0	BORE	BORE	U [[0.	. 023 J	u <10.
DATA	N UP	JUHP	AHUL	AHUL	JUHP	JUNE	FULL	111 0	0 669	0 4 90	204 0	FULL	114 0.	0.466	0. 490	204 0	FULL	FULL	0 669	0 4 0	204 0
PIPE	F ENT GY F •							.613.	03	13 3.	00 1 .		. 613.	20 7-	13 3.	08 1.			20 7.		06 1.
TEST	ENTR ENER M.							6 O	0.1	3 0.1	.0		0	- 0 • 1	3 0.1	9 0 6			1 0	3 0.	
	ЕМТRY 06ртн М.							0-02	0 . 02	0.01	00°C		0.028	J • 02	0.01	00 • 0			0 02	0.01	C0 • n
	H H	0.078	0.062	0-040	0-028	0.017	0-100	0.081	0.059	0.036	0 • 0 22	0 • 1 0 0	0.089	0.065	0.039	0.024	0.100	0.100	0.085	0 * 0 > 0	0.0.0
	нс Н.	0.087	0 • 072	0.055	0.034	0.022	U.087	0.072	< 50 ° 0	0.034	0.022	0.087	0.072	\$\$0.0	0.034	0 • 022	0.087	0.072	u . 055	• [0 • 0	0 . 022
	SIN	.0250	• 05 50	• 0520	• 0520	0570-	.0125	•0125	.0125	• 0125	• 0125	• 0 100	.0100	• 00100	• 0100	• 0100	.00.50	0500-	• 0 0 2 0 0	• 00050	0560.
ATA	KM. ERGY M.	. 271 0	229 0	.176 0	113 0	. 070 0	. 271 0	.229 0	. 178 0	0 611.	. 070 0	.271 0	. 229 0	. 178 3	. 113 0	.070 0	. 271 0	.229 0	.178 0	.113 0	.070
IPE U		0 260	30 0.	0 620	14 0	0 60	0 2 6	30 0	0 620	14 0	0 60	0 15	130 0.	0.53 0.	14 0.	0 600	0 210	0 00	0 23	14 0	0 400
CH A	Ĩŕ	¢ 0.0	6 0°C	6 0°C	0.0	6 0°0	0.0	0-0 9	6 0°0	0.0	6 0°0	0.0	6 0°C	6 0°C	0-0 9	6 0°C	6 0.G	0.0	0.0	6 0°C	\$ 0°C
FFROA	SLUPE (SIN)	0 - 173	611.0	6.173	6.173	6.173	611.0	6.17.9	611.0	611.0	611-0	0.173	6.173	611.0	0.173	0.173	611.0	0.173	611.0	6.173	611.0
ATA A	HANN.	015	\$10°0	• 015	.015	.015	.015	• 015	\$10.0	\$10.0	015 ·	-015	\$10.0	\$10.5	015	015	\$10.0	\$10-0	\$10.0	015	\$10.0
NON DI	DI A. 1	0.10 6	0.10	0.10 0	0.10 4	0.10 0	0.10 0	0.10 0	0.10 0	0.10 0	0-10	0.10 0	0-10	0.10 0	0-10 0	0.10	0-10 0	0.10 0	0.10	0.10	0.10 0
COM	L/ 0.	0°9	0 • 0	4.0	2.0	1.0	b. 0	6.0	4.0	2.0	1.0	d.0	0.0	4.0	2.0	1.0	8.0	0.0	4.0	2.0 (1.0

.

A5.5

-

-

•

								\$\$\$.3	C+2+2	1.546			2-133	1. 312	ć16 • 1	0.335			010.1	166.0	166.0
								-675	-425	.745	.692		\$65.	•526	• 755	160.			124-1	.015	\$115
	1 4 5 4 4 4 7 5 4 7 6 6 4 7 6 6 4						•	.005	. 000 -	• 000	• • • • •	ۍ ه	1 200.	• 100 •	. 660 1	• • • • •	•	f. •	.013 5	•00•	. 202 .
	2 U U U	196.	1 P E .	• 3 d 1	. 34 1	1 P E •	414	0- 6	3 - C	2 -6	0- E	919	2 =0	- 4	2 -0) - 0	919	414	9 - 0	ڊ - ر	ر ان
	EMERG DUNN H.	rest p	TEST P	Tést P	TEST P	rest p	N TEST	0.10	0.08	0°05	0 * 03	1631	0.41	0°0	¢0 ° 0	0.03	I TEST	N TEST	0.04	¢0 • 0	(0 ° 0)
TS.	E NF R C Y UP J L N P N •	HC I N	HC IN	HC IN	HC IN	HC IN	SHED I	0.109	0.083	0.052	0.033	SHED I	0-114	0.085	0-052	EE 0 * 0	SHED I	SHED 1	0.109	0.062	0.030
I AESUL	DEPTH Diange N.	AS HAS	AS HNC	AS HNC	AS HNC	AS HNC	STABLI	0.019	600.0	0 • 00 5	000°0	STABLE	0.033	610.0	0000	\$00*0	STABLE	STABLE	0 • 0 5 2	U = 0 2 7	¢10.J
RJGZAP	NNDO FIGO	SIBLE	SIGLE	513-6	SIBLE	SIDLE	FLON E	18C .	• 90 • 1	010	220-0	FL04 8	• 08 •	c \$6 • 1	+ 2 0 - 1	+20-	FLOH E	FL04 6	< 0 q >	C 5 0 * 1	06.0.00
4 CINA	4507 E	1440	IMPO)	INPU)	INPO.	I HPU)	8086	. 6 0 . 0	- 0 čU - (r 460*	. 220.	63RE	L 13U.	• 040 ·	. 031	020°	BURE .	HJRE .	5 6 E U	C (20-	, לוט.
UA TA	×ו 20	4 n of	Jun	JUR	JUN	JUN	FUL	2 062	240 0	651 0	120 0	FULL	140 0	240.0	651 0	420 C	f ULL	FULL	240 0	0 1 4 9	420 0
PlPE	N N N							615.	• e - 8	0	1 1.		612.	* * 6	5	1 1.			۰ ۲	4 3.	14.
1 E S I	ENTRY ENCRO M.							0•3	0 • 2	0-1	0.1		0 3	0.2	1°0	0.1			2.0	J. L	9.1
	E4784 U5974							0 • 023	0.013	0.011	0.007		U= 02 3	0.015	u.011	10.031			0.013	0.011	100.0
	Z + I E	0.079	0 • 4 6 2	0-040	0.028	0-017	0.100	0.001	6 5 0 ° 0	0.036	0.022	0.100	0°084	0°065	0.039	0-024	0°100	0.100	0.085	0 \$ 0 * 0	0.010
	HC HC	0 . 087	U.072	u 。055	0.034	0 • 022	0.057	0.072	0°055	4 E O • V	0.022	0.087	0°072	0°055	0-034	0.022	0.087	U • 0 72	5 G O O O	0.034	U. 022
	SL0"E	0 * 0 7 2 0	0°0°0	0 ~ 0 5 20	0 < 7 0 ° 0	0°0250	0.0125	\$210-0	¢210°0	0.0125	0.0125	00100	0°100	00100	0010-0	001000	0 \$ 0 0 0 0	0 - 00 - 0	0 \$ 0 0 \$ 0	0510.0	0;r0°u
DA TA	lera. Energy a.	0. 408	0.342	0.263	0.164	0.100	0-408	245.0	0.263	0.164	0.109	0.408	0.342	692.0	0.164	0.100	0.408	0.342	0.263	0.164	6.100
PIPE	X ·	6 70 ° (• 70 • 0	0.018	• 012	2002	620.0	0-924	010.0	.012	.003	.029	•20•0	.018	• 012	100.00	620-0	\$ 70 ° 0	0.018	0.012	00.00
PR0404	LOPE	3402 (3402 (3402	34.92	3402	3402 (3402	3492 0	3402 (3402	3402 0	3402 0	3402 0	2492 0	2046	34 02 (3492	3472 0	3492	34.92
AP	N. L.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0	15 0.	15 0
DATA	CCE	0-0 (0 • 0	0.0	0.0	0.0	0-0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NCHE	м. М	0-10	0.16	0•10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0. 10	0.10	0.10	0.10	0. 10	0.10	0.14	0.1(
00	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	d • 0	0 ° 9	9 • 0	2.0	1.0	0.0	0 • 0	0 • 4	2.0	å.0	8.9	6 • 0	•••	C • 2	1.0	4.0	9 • 6	0 • 4	2 • 0	1.0

A5.6

.

.

æ

								. 250	165.	. 735	143		186.	e e o .	151.	246.			\$63.	126.	• • • • •
	4 . 5 5							.675 2	.4 25 2.	.1 5+2 .	. 692 1.		2 626.	.526 2.	.766 1.	. 697 0.			.4 27 1.	. c 510.	. 175 U
	FFCF L						£.	.000 2	÷ 6.0.	.000 1	0 000 .	•	.002 7.	. 101 .	. 600 1	0 000 -	•	•	.013 5	.064 2	.002.0
	A S	• 14 14	• 3414	P1PE .	PIPE.	• 34 14	414 1	0- 60	B3 -6	52 -0.	0- 20	414 1	12 -0	0- 99	0- 24	- CE	414 1	T PIP	J- 960)- 950	- 10
	P DUWN	TEST	TEST	TEST	16.51	T E S T	IN TES	9 0.1	0.0	2 4.0	0.0	IN TES	4 0-1	5 0.0	2 0.0	3 0.0	IN TES	IN TES	9 0 0	2 0.0	0.0
15.	ENFA G UPJUM N	HC IN	HC IN	4 24	HC IN	HC IN	SHED	0.10	0.08	0°05	0.03	C 3HS	0.11	0.06	0.05	0.03	CEHES	SHED	0.10	0.06	0.03
M AESUL	OLPTH Changè n.	AS HNC	AS HHC	AS HNC	AS HHC	AS HHC	ESTABLI	0.014	0. J04	0.002	000*0	ESTABLE	U.033	0.019	V.008	\$00°0	ESTABLE	ESTABLE	0.052	0.027	¢10°0
P43644	044 1671 1.	זטוגנוי	0, 51 à LE	3787660	0,51816	3161260	€ FL04	J.0041	4 c 0 . L	J.036	J20.U	E FLOH	U.044	J.065	48C*r	0.324	E FLJ4	₩074 3	J.085	U 4 C • C	CE0°r
ATA ANU	UP JUHP DEPIH N.	AP1 AND	UNP LHP	UMP LAP	UNP LHP	UNP INP	ULL 808	60.063	040.0 %	1 0.034	6 0.022	טרר מטג	0.057	7 0.046	160.01	0.020	ULL 80K	חרר מיזא	1 0.013	1 0.023	0.015
PIPE 3	ENTRY Y F + M	Ĩ	2	-	ň	ī	Ĩ	12.115	66.018	2 4.07	1.50	ŭ	517.71	510.33	2 4.07	3 1.58	F	Ĩ	10.13	2 4.07	3 1.50
TE ST	ENTAY ENEAG N.							4.0 1	0.3	0.2	1.0		1 0.4	0.3	0.2	0.1			b 0.3	0.2	0.1
	E4147 ULP14 N.	æ	~	Q	e	2	0	1 0.02	9 0.010	6 0.010	2 0.00	0	9 0.021	5 0.01 (9 0.01:	4 0.03	0	0	5 0.01	10.0 0	0 0 . 00
	N K	7 0.07	0.06	+0°0 9	0.02	0.01	0.10	0.68	<0.0	0.03	0.02	0.10	0.08	0.06	0.03	0.02	01.0	0.10	0.08	¢0°0 4	0.03
	HC H.	0.04	0.072	0 • 055	0.034	0.022	0.087	0.072	0 • 05 5	0.034	0.022	0.087	0.072	0 • 0 5 5	0.034	U= 024	0.047	U.072	0.055	0.034	6 • 022
	(> 1 >) (> 1 >)	0 < 20 * 0	0 - 0 2 50	0.0250	0 * 0 5 20	0.0250	0.0125	0.0125	0.0125	0.0125	0.0125	0 * 0 * 0 0	0.010.0	0.10.0	0.10.0	0.100	0 \$ 0 0 * 0	0 < 0 0 * 0	0.0050	0410.0	0,00,0
DATA	TERM. ENERGY M.	0.521	464-0	0.333	0.206	0.125	0.521	454-0	0.333	0.206	0.125	124.0	0.434	0.333	0.206	0.125	. 0.521	464-0	0.333	0.206	0.125
H P L P	N .	0.026	0-021	0.010	0*010	0* 003	0.026	0.021	0.016	0*010	0 * 00 1	U. 026	0.021	0.016	0.010	00 * 0	0.020	0.021	0.016	0.010	0 • 0 0
APPRIAC	SLOPE (SIN)	0 ~ 20 7 0	0.5000	0.5000	0.000	0.5000	0.5000	0.5007	0.5093	0.5073	0005-0	0 • 2000	0.5000	0.5000	0.000	0.5000	0.5070	0.5000	0.5000	0.0000	0.5073
ATA	MANN. COFFF	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	\$10*0	3.015	0.015	0.015	0 • 015	0.015	\$10.0
MUNN C	01 A.	0.10	0-10	0.10	0* 10	0.10	0.10	0.10	0*10	0*10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
C O	0.	9 . 0	0	4 • 0	2 . 0	1.0	8.0	6 • 0	4 = 0	2.0	1 • 0	3.0	6 • 0	4 • 0	2.0	1.0	d. 0	0.0	4 . 0	2.0	1.0

A5.7

.

.

•

•

A5.8

.

.

.

.

-

									-	~	2		~		1	0			2		2
	101							3• 31	2.5	1-3	1.21		2 . 5	2 • 2	1.51	10.1			1-1		0 • S
								520	52	45	26		39	56	99	61			23	15	52
	5							7.6	-	3 + 2	0.6		7.5	6 • 6	1 - 7	0.6			5-4	2.1	0-1
	10 40 0 00 0 2 4							000	000	C 00	C00	•	200	001	000	900		•	610	004	209
			E.	•	e u		166	•••	-0-	-0-	-0-	343	•0-	-0-	•0-	-0-	1	: d 1	-0-	-0 -	-0-
	****	I	-	PIP	919	PIP	51 P	109	6 90	240	650	1	112	084	052	650	51 P	1	940	0 - 0	016
	E NEI	ES T	E 5 T	EST	153	EST	16	•0	• 0	•••	•0	TE	•	•0	•0	•0	IE	TE	0	• 0	6.
	110	Z	E E	N	z	z	N I N	60	6.9	250	33	IN	-	69	52	33	N.	N II	60	62	36
15.	LPJL	101	HC 1	L DH	Ч Ч	Ļ	SHED	0.1	0.0	0.0	0.0	SHFD	0.1	0-0	0-0	0.0	SHE	SHED	0.1	0-0	0-0
SUL	w TU •	NH N	NH	NH	NH	INH	BLI	19	60	02	00	BLL	33	61	50	*0	8.1	BLE	25	21	15
A K	HAN HAN	A S	AS	AS	AS	AS	STA	0 - 0	0 • 0	0.0	0.0	STA	0 • 0	0 • 0	0 • 0	0 • 0	STA	S TA	0 • 0	0 • 0	0 • 0
GAP		BLE	BLE	θ⊾€	9 ° E	βιĒ	3 10	16		36	22	9 40		· • •	33	54	10		C p	20	11
C 2 4	T L T	154	1550	1551	15 51	154	1	0 * 0	0.0	0.0	0-0	j.	C • 7	·	0 • 0	0-0	FLI	FL	J = 0	0.0	U.)
140		NPO	INPO	U A B O	I MP 0	Udhi	J RE	103	000	1	220	JURE	151	940	160	070	JORE	JAE	513	523	c1 0
TA .	1 4 E 4 U 0 0	e. E	4	L	d H	du	L.	0	0.1	0.	0.1	LL.	0.	0-0	0.	0.0	LL LL		0.0	•0	••0
0	×I.	20	2	D.L.	D.L	20	Fu	999	200	744	458	F U	966	206	784	854	FU	FU	208	104	.854
	Z IL							320-	312	+	. F.		320.	12.	•	3 4.			112.	•	
21	N N N N							0-6	0-46	0.31	0.1/		0.6	••0	0• 3(0.1(0-41	0.3	J. L
1 E								~	m.				~	m.	3	5			0	'n	2
								0.01	0.01	0 • 0	00 ° 0		0.01	u-01	00 • 0	0•00			10-0	0.03	n•0(
	9	36	62	•	\$8	11	00	19	59	36	22	00	60	65	39	24	00	00	62	20	30
	H H	0 • 0	0 • 0	0.0	0•0	0-0	0.1	0-0	0.0	0.0	0.0	0.1	0.0	0 • 0	0.0	0.0	0.1	0.1	0.0	0 • 0	0 • 0
	U •	087	072	ç ç 0	460	022	087	072	650	034	022	087	072	055	034	022	087	072	0 55	034	022
	II	•••	•••	•0	•	•	•	•	• 0	•0	•0	•0	•0	0	•0	•0	• 0	•0	•	•	• • •
	14)	0520	0 5 20	0520	05 50	0420	01.25	125	1125	125	5710	100	0110	0010	0010	100	050	0 2 0 0	0 5 00	050	0 ° L C
	35	0.0	0.0	0-0	0.0	••	0 • 0	0-0	0.0	0*0	0.0	0.0	0*0	0.0	0.0	0.0	0*0	0.0	0-0	0.0	0.0
17.4	- CA	243	615	468	287	172	243	615	468	282	172	243	615	468	282	172	243	615	468	287	172
E DI	U U U	1 0.	0.0	3 0.	•) 6	° 0•	.0 1	8 0.	3 0.	• 0 •	5 0 .	••	.0	3 0.	9 0.	5 0°	.0	5 0.	0	9 0	• •
	Z ·	- 05	10-	• 01	• 00	• 00	• 05	-01	-01	00	• 00	• 02	• 01	• 01	00-	00-	-02	-01	• 01	00 -	00 *
ACH		50 0	50 0	50 0	0 09	0 0	0 0	0 09	0 0	0 0	0 09	0 0	0 0	0 0	0 0	0 09	0 0	0 09	0 09	0 0 9	0 09
P KO	NI S	• 99	.85	• 99	• 866	• 99	. 866	• 66 (• 666	• 66	- 86	• 66 6	.866	• 85 6	• 866	- 86	. 86	. 86 (.866	• 90	• 86
A	• LL 2	15 0	5 0	5 0	5 0	0 51	15 0	15 0	5 0	15 0	5 0	5 0	5 0	15 0	15 0	15 0	15 0	15 0	15 0	5 0	0 51
	CUEL	0.01	10-0	0.01	0.01	0-01	0.01	0.01	0.01	0-01	0.01	0.01	0.01	0-01	0-01	0.01	0.01	0.01	0-01	0.01	0.01
O NC	•	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
DMM	Q E	0 0	• •	•••	• •	.0	• 0	.0 0	0 0	•0 (• 0 0	• 0 0	-0 0	• 0 0	• 0 0	.0 0	.0 0	.0 0	.0 0	0.	0 0
u	۲.۷	10	6.	*	2.	1.(d.	6.0	4	2.0	1.0	8.0	6.0	••	2.0	L. (d. (\$ • C	+	2.0	4.

f

.

.

.

.

A5.9

.

APPRJAC + PIPE DATA DATA NCHHOD

đ

8

REST PIPE DATA AND PRISAM RESULTS.

"CHLL P.05. JUNP F + h ż ENERUY CHANGE ÷ ENERGY ENERGY ŕ UPJJMP DOWN ŕ DEPTH CHANGE 004N JEPT4 ŕ 9 PJUMP UEPIN ÷ ENTRY ENTRY USPT4 ENERGY F+M ž ENTAV ÷ X . U H 12141 SLDPE TERM. Enlrgy ŝ Z . SLUPE (SIN) NANN. COEFF DIA. ÷ دی. ۲

0.10 0.015 0.9659 0.017 0.661 0.0125 0.072 0.081 0.017 0.10 0.015 0.4659 0.013 0.501 0.0125 0.055 0.059 0.013 0°10 0°015 0°4552 0°020 0°797 0°0250 0°087 0°078 0.034 0.028 0.046 0.022 0.017 0°10 9.015 0.4559 0.020 0.797 0.0125 0.087 0.100 0.062 0-0250 0.055 0-072 0.4657.0.012 0.661 0.0250 0.307 0.0250 0.184 0.0250 0.10 0.015 0.9659 0.013 0.501 0.10 0.015 0.4659 0.008 0.4659 0.005 0.0 0.10 U.015 0.10 0.015 4° 0 2°0 1.0 9.0 •• • 9.4 **J**•0

FULL BOKE FLOW ESTABLISMED IN TEST PIPL. PIPE. PIPES PIPE. PIPE. PIPE. JUMP INPUSSIOLE AS MMCHC IN TEST JUMP LAPUSSIALE AS MMCHC IN TEST IN TEST JUMP IMPUSSIBLE AS MMCMC IN TEST JUMP IMPUSSIBLE AS MNCHC IN TEST JUMP IMPOSSIBLE AS MMCHC

0-109 -0-003 7-675 3-373 -6.003 1.745 1.373 -0.060 4.425 2.524 0.692 1.222 -0.002 PIPE. 0.003 2<0.0 0.033 FULL BORF FLU4 ESTABLISHED IN TEST 0.033 0.109 0.083 0.052 0.004 00000 0.014 6.002 V°5112.62U 0.04U 0.054 0.6821.734 0.063 U.041 4.941 0.034 U.035 0.19 1.915 0.422 J-022 0.32 0.10 0.015 0.9554 0.005 0.184 0.0125 0.022 0.022 J.035 U.OL25 U.034 O.U36 U.033 0°10 0.015 0.4659 0.020 0.797 0.0100 0.087 0.100

0.10 0.015 0.9654 0.008 0.307

2.0 1.0 0.0 0.0 •••

0-112 -0.002 7.439 2.534 4.526 2.232 -0-003 0-697 L.J22 -0.003 1.766 1.634 0.044 -0.001 PIP: 0.033 0°052 FULL BURE FLOA ESTABLISHED IN TEST 0.114 0.085 2 \$ 0 * 0 0.033 0.004 0.033 0.019 00.00 0.6821.738 0.077 J. J.44 0.32 4.943 0.011 J.034 0.5112.62U 0.U46 J.065 0.19 1.915 0.020 J.J24 0.10 0.015 0.4654 0.017 0.661 0.0100 0.072 0.069 0.017

0.046 -0.013 5.427 1.455 PIPE. ESTABLISHED IN TEST 0.109 FULL BURE FLOA 0.5112-62U 0.U3J J.095 0.10 0.015 0.4654 0.013 0.501 0.0050 0.055 0.005 0.011 0-10 0-015 0-4-5+ 0-013 0-501 0-0100 0-055 0-065 U-013 9.10 0.015 0.4557 0.008 0.307 0.0100 0.035 0.039 0.038 9.10 0.015 0.4654 0.005 0.184 0.0100 0.022 0.024 3.035 0°10 0°015 0°4553 0°020 0°797 0°0050 0°087 0°100 0.4659 0.017 0.661 0.0350 0.072 0.100 0.19 0.015

0.058 -0.004 2.615 1.357 U.U36 -U.OG 0. 775 U.541

29 C . 0

0.027

Lic. L (20.0 649.4 58.6

0.052

0.038

0.015

U10.0 C10.0 C10.1 91.0

1.0 0.10 0.015 0.4454 0.005 0.184 0.0050 0.622 0.030 0.005

0.10 0.015 0.4454 0.008 0.307 0.0150 0.034 0.050 U.008

1.0 **0**•0 0-0 0.4 2.0

0-2

A5.10

							3-035	\$1535	1.370	1.225		£ c 2 - 3	:. 303	1.507	636-1			1.157	1.353	0-684
							1.675	4-425	1.745	0.692		964.1	• • 526	1.766	1 240.0			5-427	2.015	0.775
	•	•	•	•	•	PE .	C00 *0	0.000	0.060	0.002	P: •	0.002	0.054.4	0-00-0	0.000	P.E	ود در ه	0.013	400-9	0.002
LU V L	T PIPE	T PIPE	T PIPE	T PIPE	T PIPE	1 IS J.	- 601-	- 600-	- 250-	- 660-	ESE PT	. 112 -	- 980-	- 250-	- 650-	14 153.	14 153.	- 960-	- 050 -	- 910-1
JUNP DO	IN TES	IN TES	IN TES	IN TES	IN TES	D IN 1	0 601	0 690	052 0	0 66 0.	T NI O	114 0	.065 0	052 0	0 660.	ED IN T	T NI O	109 0	062 0	0 860.
GE UP	HNAHC	HNCHC	HNCHC	ни с нс	HNCHC	INS I TON	19 0.	0 600	0 700	0 000	INS I TO N	.0	0 410	0 9 0.	0 + 0	ABLE SHE	VBL I SHI	0.52 0.	0.120	015 0.
TH CHAT	BLE AS	SLE AS	LE AS	SLE AS	BLE AS	04 ESTA	31 0.0		9.0.0	.2 0.6	NH ESTA	0-6	55 0°C	33 0.0	• 0 • 6	A EST	DH EST	5> 0•0	0.0	0.0
	15:04	IPUS SI	10036	1005566	10001	JRE FL	53 U.O	50 ~ 0 0 g	0.0.40	22 0.02	DRE FL	1 J.00	10 n 01	31 0.0	0 °r 0;	OKE FLO	JRE FLI	13 J.04	23 0.03	15 U.O
DEPT	I JUNE	JUNP 1	JUMP L	JUNP 1	I ANDE	FULL B	74 0-01	50 0 °0	91 0°0	34 0-0	FULL N	19 0.U	n=0- 95	0.0 16	34 0.0	FULL B	FULL B	0.0 00	0-0 16	34 0.0
GY F M						-	921.9	5212.7	32 4.9	19 1.9	-	\$ 921 .9	5212.7	9.4 56	19 1.9	-		5212.7	9-4-56	19 1.9
							16 0.	13 0-	.0 80	•0 \$0		15 0.	13 0-0	03 0.	05 0.			13 0.	08 0.	0 40
OF PT	78	52	•	50	11	00	91 0.0	59 0.0	36 0.0(22 V.0	00	89 6.0	65 0.0	39 0.01	24 0.0	00	00	85 V.O	0 0 0 0	30 U.0
- -	0-0 29	12 0.0	55 0-0	3+ 0-0	22 0.0	87 0.1	72 0.01	55 0.0	3+ 0-0	22 0.0	87 0.10	12 0.0	55 0.0	34 0.0	22 0.0	87 0.1	72 0.1	55 0.0	34 0.0'	22 0.0
	0.0 00	50 0.0	50 0 ° 0	50 0°0	0 0 0 9	25,0.00	25 0.0	25 0.0	5 0.0	25 0 • 0	0 0.00	0.0.00	0 0 00	0 0 0 00	0 0 00	0 0 09	0.0 03	50 U.O	50 0.0	50 0.03
Y (514	6 0 • 0 2	6 0°02	2 0.02	3 0.02	0 0 °0 4	9 0.012	9 0-01	2 0.01	3 0.012	8 0.01	0.010	0.010	2 7.010	3 0.01(8 0-010	0.00	0.00	2 0.00	0.00	8 0.00
ENEKG M.	0 0.81	7 0.67	3 0.51	8 0. 31	5 0.18	0 0.61	7 0.67	3 0-51	8 0.31	5 0-10	0 0.61	7 0-67	3 0.51.	8 0.31	5 0.18	0 0. 61	7 0.67	15-0 6	8 0.31	5 0.18
ź	0 0.02	0 0.01	0 0.01	00 0 0	0 0.00	0 0 C	0 0.01	0 0.01	00.00	0 0 00	0 0 0 0	0 0.01	10.0 0	0 0.00	00 0 00	0 0.02	10.0 0	0 0.04	0 0 0 0	0 0 0 0
(115)	1.000	1-007	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.003	1.000	1.003	1.673	1.000	1.000	1-000
CUEFF	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0:015	0.015	0.015	0.015	0-015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
	0 0.10	0 0- 10	0 0.10	0 0.10	0 0.10	0 0.10	0 0.10	01-0 0	0 0.10	0 0.10	0 0.10	0 0-10	0 0.10	0 0.10	0 0.10	0 0.10	0 0.10	0 0.10	0 0.10	0 0.10
L/S	- 9	•		2.		•	•	*	~~~	•	9	.0		۶.	1.	•	°.		2.	1.1

-

.

.

.

.

TEST PIPE DATA AND PAJGRAM RESULTS.

COMMON DATA APPRUACA PIPE DATA

.

.

.



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

	• • • • •						2.517					1.003		1-633	1.132		0.517	1 99 -0	0.671	0.596	< C + - O	1.232
	2 · · · · · · · · · · · · · · · · · · ·						.670					.746		. 620		. 525 .	.005	. 137	+26-	- 412		• • • 5 2
	4 5 5 5 5 6 6 6 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7						000					600		000	000 3	000	000	11200	1 400	0634	100	100
	V ENE Cha	1 P E .	. 34 I	1 P E •	1 P F .	I P E .	9 - 0.	1 P E .	1 P E .	1 P E .	1 P E .	• 0- 0		2 -0-	3 =0.	9 = 0.	5 -0°	• 0 - 0	• 0 - 0	• 0- 9	2 -0.	¢ -0•
	ENERC UOMN A.	E 57 P	EST P	e s r P	EST P	4 15 3	0.09	EST P	EST P	4 15 3	4 153.	0.10		0.04	0°00	0.03	0.02	0.44	0.09	90 * 0	•0•0	0.02
•	A C C C C C C C C C C C C C C C C C C C	L N I	IN I	IN I	I NI	I N I	640.	IN I	I NI	1 IN 8	IN I	• 1 00		.082	690.0	6E0°	•029	.110	•00•	.010	646*	120.0
SUL T	M E	HNCH	HNCH)H > NH	MNCHO)H > NH	00	H NH	HVAN)H > NH	HNCH	12 0		0 2 0	0 0	02 0	01 0	64	37 0	26 6	15 0	60
AN 4E	DE PT CHAN	E AS	E AS	E AS	E AS	E AS	0 • 0	E AS	E AS	E AS	E AS	0 • 0		0 • 0	0 • 0	0 • 0	0 • 0	0 * 0	0 • 0	0.0	0 ° 0	0°0
P.K.164	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	لهاكد	155106	213 c	.518.	SIBL	J.067	» 51 BL	* 5 f B L	» \$13L	18155	J.072		J • 05 d	J = 044	1.00.0	1.010	4 E C + F	J.076	o¢0•€	+ 6 6 • 6	25C • L
UNA .		IMPO	INPO	IMPO	1480	AMPO	• 066	LMPU	DANI	IMPU	INPO			160.	C+n*)	• 055	.016	\$ \$ 0 * 2	•U34	. 030	020-0	• 012
DATA	××. • 90	Ju nf	JUHP	Jung	JUNG	JURP	933 0	9 M DF	JUNE	JUNE	ANDL	933 0		830 0	160 0	0 45 0	807 0	933 0	830 0	160 0	0 4 4 0	607 0
919	4 E A T G 4 F 4						1512.					1912.		12 8.	10 5.	06 2.	• 0 • 0	1512.	42 3.	10 >.	05 2.	ບ ຈູ ບ •
1631	ENTA Enta A.						¢ 0•					¢ 0°		9 0	2 0.	• 0 •	, 0.	6 0.	بر 0•	2 0.	• 0 •	۰
	ЕЧГ К D е р т -1 М -						0 0 3					0.03		0 - 0 2	U = 0 2	0.01	00°r	0.03	U • 0 2	20.0	0.01	0°°°
	e e	0°052	0.042	0 • 0 32	0.020	E10*0	0.067	0.054	0 • 0 • 0	0°025	0.016	0.072		0.058	0*0*4	0.027	0.017	0°044	0.076	0 - 056	0-034	0.022
	U • T E	• 00 •	<\$0°	.042	• 020	110.0	• 0 • 0	\$\$0°	.042	•026	011000	• 0 0 6		< 6 0 • 0	240.0	020	110.	• 0 6 6	< 50° (042	• 020	110.0
	40	5 50 3	0 0 5 7 (12 50 4	250 0	2 50 (125 0	125 0	125 0	125 0	125 0	0010		100 0	100 0	100 0	0001	020	0 050	020 0	0 050	0.50
_	V (SL	5 0°(5 0.6	3 0°C	0 0 9	9 0 6	5 0°C	5 0.6	3 0 0	0 0 9	0 0 6	5 0°(5 0°0	3 0°C	0 0	9 0 6	5 0.0	5 3.0	3 0 0	6 0°C	0.0
DATA	TEKM. ENERC M.	0.11	0.09	0 * 0 1	0.04	0° 05	0.11	0.09	0.07	0.04	0.02	0.11	1	0.09	0.07	0 • U 4	0 • 02	0.11	0.09	0.01	0 0 0	0=02
PIPE	Ĩi	0.046	810.0	0 • 02 8	0.018	0.012	0.040	0.038	0.028	0.010	0.012	0 • 0 • 6		0.038	0.028	0.018	0.012	0 • 0 • 6	0.038	0.028	0 * 01 8	0.012
ROACH	00 E	0349	0149	6460	0349	0349	6 4 E O	0349	69 60	6450	0149	6460		0349	6460	0349	0349	0349	6410	****	6410	6960
APP	N. SL	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.		15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.
DATA	• MAN COF	5 0.0	5 0.0	5 0.0	5 0.0	2 0 0	5 0.0	5 0.0	5 0.0	5 0.0	0.0	0 0 6		5 0.0	5 0.0	5 0.0	5 0.0	\$ 0.0	0°0 \$	0.0 6	5 0.0	0°0 5
NCNNO	019 M.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	1 00	0.1
C	3.	8.0	6.0	4 • C	2.0	1.0	6 ° 0	6.0	••0	2 . 0	1.0	8.0	;	6 • C	4.0	2.0	1.0	ð. (6 • C		2.0	L.G

-

	•													"	•	3.4	(15		11	6	ć O
							3.)					2.2	2.)	1.5	1.)	9 · 5	(• 1	t . c		0.3	0.5	6 - N
	4 						9.670					9 . 7 4 6	6.620	3.646	1.525	0.605	1.037	7.374		4-212	1.015	0.652
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1						.000					.000	C C O • 1	. 063	.000	(10.	.0071	\$ 7 0 *		£00 *	.004	150 -
		1 PF.	1 PE -	1 P E •	1 P E •		0- 6	1 P E .	1 P.E.	IPE.	196.	9- 0	2 -0	0- E	ŋ- 6	0- s	0-0	0- 0		0-	- 2	9 - 0
	E NERG DUMM	EST P	4 123	EST P	121	4 1 2 3.	0.04	EST P	4 123.	4 1 S 3	EST P	0.10	0.08	0 • 0	0.03	u • 02	0.11	60.09		0 • 0	0 • 0 ♦	0.02
	HF 4 6 Y	I IN I	I NI DI	C IN T	I WI J	I HI DI	660.0	I IN D	I HI J	IC IN T	I NI J	00100	0.062	0.063	0.039	0.025	0.116	\$50.0		0.010	0.043	0.027
KE SJL	H TH	S HHC	ANH S	S HNC	S HHCP	S HNC	• 000	S HACE	S HH C	S HHC	S HNC	* 015	100 .	•00•	• 005	100*	• 0 • 0	160.		• 0 2 6	• 01 >	£00°
HAH	L CH	9 T S T	ILE A	JLE A	ILE A	1.E A	10	s i	L.E.A	3 LE A	1-E A	12 0	19	•	1 0	1 0		9		0	•	0
6 * 4		0.510	1510	1 \$ < 0	12 . U	1240	JJ	11500	1510	12 40	JS ST:	J.9	.C. r	u= 3 +	5C.L	10.0	·(•r	[(i • c		i (• r	C • r	5(°f
OFA A	-104P	411	110	41	411	d F. T	0.006	911	411	911	140	1 00 0	150.0	0.0.0	\$20.0	0100	\$\$0.0	biu • i		060.0	020.0	0.012
UATA	>> × × •	Pur	hur	INUL	HOF	unr	446	INUL	MUL	HUL	JU NF	344	740 (100	142	1 1 1	344 0	140 (200	147	9 (99
3414	1 - X						614.					814.	5 4 •	۰c ا	1 2.	4 U •	. • 16	5 9.		1 5 •	1 2 .	+ 0 +
1531	ЕМТ & Y Емб 4 с И •						0.1					0.1	0 • 1	0.1	0 • 0	0 0	0. 1	0.1		9.1	0.0	0 * 0
	CEPTA CEPTA						166.0					160.0	0.326	0.020	0.012	0.033	160.6	0.326		0.323	0.212	0.001
	I .	0. 05 2	0.042	0.032	0°0'0	0.013	0.007	+ < 0 * 0	0+1-0	0.025	910.0	0.012	0.058	0.044	0.027	0.017	0.094	0.076		0.056	0.034	0°0 22
•	0. I T	. 066	. 055	- 042	• 026	110.1	• 000	• 055	240.0	.026	.017	• 000	• 055	\$\$0*0	.026	1000	• 046	450 *		240*1	• 020	110.0
	w	250 0	2 50 0	0 0 ¢ 2	50 0	0 052	125 0	125-0	125 0	125 0	125 0	000	00 0	100 0	000	100 0	0 050	150 0		0.050	0 0 4 0	0 050
	151	0 • 0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0 • 01	0 * 0	0 • 0	0.01	0 • 01	0.0	0.0	0.0		0.0	0.0	0 • 0
CATA	TERM. ENEKCY H.	0.146	0.123	0.074	0.058	960.0	0.148	0.123	0.094	C.058	0.036	0.148	0.123	0.094	G. U58	0.035	0.148	C\$1.0		0* 044	0.050	0.036
PIPE	Z +	960 . 0	0 : 0 3 0	0.023	0.014	0.009	0.035	0:030	6 2 0 • 0	\$10.0	0.009	0.036	0:030	0,• 023	0.014	0.009	0.036	0:010		6 20 . 0	0.614	600.0
PPUAC	51.0PE 15.14)	06 9 3	\$690°	PL 90 * (P6.90*	H € 90 * 1	P6 90 * (00.00	96 90 .0	. 66 9 8	8640.0	.0698	.0698	. 06 98	• 0648	.06 JA	.0698	.0698		6440°0	0.06 #3	0.0698
	N N O	015 0	015 0	015 0	015 0	015 0	015 0	015 0	015 0	015 0	015 0	015 0	015 0	5 610	015 0	015 0	0 510	015 0		015 (610	015
DAT	4 D 1 U	5 0.	5 0.	5 0.	5 0°	5 0.6	2 0.	5 C.	5 0.	5 0.	5 O.	5 0.	5 U.	5 0.	5 0.	5 0.	5 0.	5 0.		s 0.	\$ 0.	5 0.
NONE	о! A н.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.1
C 0	0°.	0 • 0	· 6 • 0	4 • 0	2.0	1.0	6 • 0	0.0	9 • 0	2.0	1.0	8.0	6 • 0	4.0	2 • 0	1.0	d. U	0. ¢		••	2.0	1.0
								•											•			

TEST PIPE DATA AND PAJSHAM NESJLTS.

. A6.3

	• • • • •			•			3.254					2.525	st2.2	1.793	1.123	0.533	1.273	1.155	e 5 8 ° C	0.544	u. 353
							9.670					9+2+6	6.620	3.640	1.525	0.605	1. 437	+26-1	4.412	1.645	0.652
	11.4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	٠	•	•	•	•	-0.066	•	•	•		900 • 0.	C 00 *0.	C 00 ° 0.	COQ *0.	(00 • 0.	0.0071	\$00 * 0.	·U. 003	100.0	100.01
	HEAGY E	51 P1P6	ST PIPE	ST PIPE	ST PIPE	ST PIPE	- 660 - 0	51 9195	1 11	114 19	1 116	- 100 -	- 082 -	. 063 -	- 660-0	.025 -	- 110 -	- 060-0	. 068 -	- 240-0	- 020
•	22 22 22 24 24 24 24 24 24 24 24 24 24 2	IN TE	IN TE	IN TE	IN TE	EN TE	660.	IN TE	IN TE	IN TES	IN TES	.100	.062 (.063	.039	.025 (.118	+60.	.070	543	057
51-15	H E E E E E	HNCHC	HNCHC	HNCHC	никнс	HACHC	0 00	HNCHC	HNCHC	HNCHC	HNCHC	1.2 0.	0 10	0	0 7 0	0 10	4.4 0.	37 0.	26 0.	15 0.	5.0
LAN LE	06 PT 0 ANN N	E AS	LE AS	E AS	E AS	.E AS	1 0.0	E AS	.E AS	E AS	.E AS	0.0	0-0	0 • 0	0.0	0 • 0	0-0	0.0	0.0	0.0	0.0
PR06	1691. 1691.	01210	035181	055181	151556	1915 (1)	J. 05	1612 40	161250	0 2 5 E B 1	055181	1.074	3.056	1-0+	0+32	110.6	3.044	0.076	0.05 e	1.03	J. 02
TA AND	UEPIN UEPIN M.	NP INP	MP INP	AP I AP	NP INP	MP INP	0 • 00	MP INF	MP IMP	MP INP	MP INP	0.061	0.051	0*0*0	0 • 07 5	0.016	0.0+5	0.034	0.010	0-020	0.012
IPE UA	N 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1) L	nr	n r	nr	٦r	15.578	n r	nr.	nr	D.L.	15.570	00.030	6 . 1 4 L	2.424	449 a G	15.570	U . 6 3 U	6.142	2 . 424	944
IESE P	NTAV NE4GV M.						0.21					0.21	0.17	0.13	0.05	3°02	0.21	0.17	0.13	0.09	50.0
-	4147 6 9 1 4 7 .						0.020					0.025	0, 023	610°0	110.0	0.007	0.029	U.023	3.016	110°0	100 .
	M N N N N N N N N N N N N N N N N N N N	0.052	0.042	0.032	0.420	610.0	0.067	0°054	0+0-0	0.025	0.016	0.072	0.058	0.044	0.027	0.017	\$60°0	0.076	0.056	0.034	0.022
,	H H H	0 • 06 6	0-055	0 • 042	U • 026	0.017	0 • 0 • 6	0.055	0-042	0.026	0.017	0 • 066	0°055	0°042	0.026	0.017	0 • 0 • 5	¢ \$ 0 ° 0	0+042	0.026	0.017
	SIND	0420	°0520	•0550	0520.	• 05 50	•0125	•0125	•0125	• 01 2 5	•0425	.0100	• 0 1 0 0	•0100	.0100	0010	0360.	.0050	• 3050	0560.	0000
1 T A	RGY C	0 621	140 0	0 611	0 690	042 0	0 621.	148 0	0 611.	0 6 9 0	042 0	179 0	143 0	0 611	0.9 0.	042 0	179 0	148 0	0 611	0 6 9 0	045 0
IPE DI		0 100	0.26 0	0 0 2 0	0 [10	0 8 00	0 100	026 0	0 070	0 610	0 900	0 100	026 0.	070 0	0 610	0 0 00	0 110	0 9 70	0 0 0	0 6 10	0 900
JACH F	u -	045 0	045 0.	045 0	0 4 2 0	045 0	045 0	0 45 0	045 0	045 0	0 4 2 0	045 0	0 4 5 0	045 0	045 0	045 0	0450	045 0	045 0	345 0.	0.510
APPR	1. SLO	5 0.1	5 0.1	5 0.1	5 0.1	5 0.1	5 0.1	5 0.1	5 0.1	5 0.1	5 0.1	5 0.1	5 0-1	5 0.1	5 0.1	5 0.1	5 0.1	5 0.1	5 0.1	5 0.1	5 0.1
DATA	CUEF	0.01	0.01	0.01	0.01	10.0	10-01	10.0	10.0	10.0	10.0	0.01	10-01	0.01	0.01	0.01	0.01	10.0	0.01	10.0	0.01
NCHH	DIA. M.	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0-15	0.15	0.15	0-15	0-15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
50	ء. د / ۲	0 • 9	6 • 0	••0	2.0	1.0	8 • 0	6 • 0	••0	2.0	1.0	6 • 0	b • 0	4 . 0	2 • 0	1.0	9 • 0	••0	0 • 4	2.0	l • 0

N. N.<	N. N.<		SLOPE	I 1	TEAM.	SLDPE	24	1	ENTRY	ENTAV ENTR Fneagy 200	V UPJUA	PHON 41	DEPTH CHANGE	ENFACY	ENERGY		- June	145
0.233 0.005 0.002 0.002 0.002 0.002 0.002 0.002 0.002 0.002 0.002 0.003 <th< td=""><td>0.233 0.0050 0.005 0.002 0.003 <t< td=""><td>•</td><td>• Ľ</td><td></td><td></td><td></td><td>•</td><td>•</td><td></td><td></td><td>•</td><td></td><td>. M.</td><td>*W</td><td>• 1</td><td></td><td></td><td></td></t<></td></th<>	0.233 0.0050 0.005 0.002 0.003 <t< td=""><td>•</td><td>• Ľ</td><td></td><td></td><td></td><td>•</td><td>•</td><td></td><td></td><td>•</td><td></td><td>. M.</td><td>*W</td><td>• 1</td><td></td><td></td><td></td></t<>	•	• Ľ				•	•			•		. M.	*W	• 1			
0.2231 0.0250 0.005 0.002 <	0.2231 0.0250 0.005 <																	
0.193 0.0250 0.012 <t< td=""><td>0.0193 0.00250 0.0012</td><td>0.1776 0.026</td><td>0.026</td><td></td><td>0.234</td><td>0 5 2 0 ° C</td><td>0.066</td><td>2 < 0 • 0</td><td></td><td></td><td>PI ANUL</td><td>100560-0</td><td>AS HNC</td><td>HC IN I</td><td>414 T23</td><td>E.</td><td></td><td></td></t<>	0.0193 0.00250 0.0012	0.1776 0.026	0.026		0.234	0 5 2 0 ° C	0.066	2 < 0 • 0			PI ANUL	100560-0	AS HNC	HC IN I	414 T23	E.		
0.1140 0.0125 0.0132 JUMP 1M0151616 5 MMCHC IM FET FEC 0.0039 0.0259 0.012 0.020 JUMP IMPD351316 5 MMCHC IM FES PEE 0.0034 0.0259 0.011 JUMP IMPD351361 5 MMCHC IM FES PEE 0.0134 0.0125 0.013 0.013 JUMP IMPD351816 AS MMCHC IM FES PEE 0.115 0.012 0.012 0.013 JUMP IMPD35184 AS MMCHC IM FES PEE 0.115 0.012 0.012 0.012 JUMP IMPD35184 AS MMCHC IM FES PEE 0.0125 0.012 0.012 JUMP IMPD35184 AS MMCHC IM FES PEE 0.0125 0.012 0.012 JUMP IMPD35184 AS MMCHC IM FES PEE <	0.1146 0.0123 0.0123 0.012	0.1736 0.022	0.022		0.193	0 . 02 56	<50.0	0+0+2			JURP IN	1035646	AS HNC	HC IN I	651 P1P	• 2		
0.003 0.002.0 0.020 <	0.0000 0.0020 0.020 0.020 0.021 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.020 0.000 <	0.1736 0.017	0.017		6.146	0 * 0 5 0 (0+0+2	0.032			PI JUNF	1-01 22U4	AS HNC	HC IN I	EST PIP	۴.		
0.0054 0.0017<	0.0054 0.0017 0.011 0.011 0.012 <	0.1735 0.011	0.011		0.089	0 * 0 5 0 1	0.026	0.020			JUMP IN	12351341	AS HAC	HC IN T	EST PIP	ų.		
0.233 0.0012 0.005 0.407 0.407 0.409 0.409 0.409 0.409 0.401 <t< td=""><td>0.233 0.001 0.003 0.003 0.001 0.003 <th< td=""><td>0.1735 0.007</td><td>0.007</td><td>-</td><td>0.054</td><td>0.0250</td><td>110-0</td><td>610.0</td><td></td><td></td><td>JURP IN</td><td>POSIBLE</td><td>AS HNC</td><td>HC IN T</td><td>EST PIP</td><td>е</td><td></td><td></td></th<></td></t<>	0.233 0.001 0.003 0.003 0.001 0.003 <th< td=""><td>0.1735 0.007</td><td>0.007</td><td>-</td><td>0.054</td><td>0.0250</td><td>110-0</td><td>610.0</td><td></td><td></td><td>JURP IN</td><td>POSIBLE</td><td>AS HNC</td><td>HC IN T</td><td>EST PIP</td><td>е</td><td></td><td></td></th<>	0.1735 0.007	0.007	-	0.054	0.0250	110-0	610.0			JURP IN	POSIBLE	AS HNC	HC IN T	EST PIP	е		
0.193 0.0125 0.055 JUNF 14PD3518L A MACH< IEST FIFe. 0.114 0.0125 0.045 JUNF 14PD3518L A MACH<	0.112 0.0125 0.0125 0.0125 0.0125 0.0125 0.0125 0.014 0.0125 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.014 0.015 0.014 0.015 0.016 0.015 0.016	0-1736 0-026	0.026		0.234	0.0125	¢ 0 0 0 0	0.067	0.025	0.2617.5	82 0.06	100.0 0	0.000	660°0	0.049	-0.003	9.070	1.532
0.0146 0.0125 0.0142 0.0142 0.0142 0.0145 0.0145 0.0145 0.0146 0.0146 0.0146 0.0146 0.0146 0.0146 0.0146 0.0146 0.0146 0.0106 0.0102 0.0002 0.0102 0.0102 0.0012 0.0102 0.0012 0.0102 0.0012 0.0102 0.0012 0.0102 0.0012 0.0102 0.0012 0.0012 0.0102 0.0012	0.0146 0.0125	0.1736 0.022	0.022		0.193	0.0125 (0.055	0.654			FI JUNF	1005186	AS HNC	HC IN I	EST PIP	۴		
0.0059 0.0125 0.0125 0.0125 0.0125 0.012 0.012 0.012 0.012 0.012 0.012 0.012 0.012 0.010 0.003 0.010 0.003 0.012 0.010 0.003 0.010 0.003 0.010 0.003 0.012 0.010 0.010 0.003 0.012 0.010 0.010 0.003 0.012 0.010 0.010 0.003 0.010 0.003 0.012 0.010 0.010 0.003 0.012 0.010	0.0050 0.0125 0.0125 0.012 0.0125 0.012 0.012 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.000	0.1736 0.017	0.017		0.146	0.0125 0	0.042	0*0*0			TI JUNF	POS SIde	AS HNS	HC IN T	414 T23	F.		
0.0054 0.0117 0.0117 0.0117 0.0117 0.0117 0.0117 0.0117 0.0117 0.0117 0.0117 0.0110 0.0100 0.0100 0.0100 0.0100 0.0100 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0111 0.0111 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0101 0.0111 0.0111 0.0111 0.0111 0.0111 0.0101 0.0101 0.0101 0.01111 0.0111 0.01111	0.0054 0.0125 0.017 0.015 0.015 0.012 0.0100 0.0000 0.0000 0.0000 0.0100 0.0100 0.0000 0.0000 0.0100 0.0000 0.0000 0.0100 0.0000 0.0000 0.0000 0.0000	0.1736 0.011	0.011		0.089	0.0125	0.020	0.025			JUNP IN	كماكدلام	AS HNC	HC IN T	EST P1P	۴.		
0.2234 0.010 0.005 0.012 0.2011 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.101 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111 <	0.2334 0.0100 0.0056 0.012 0.2011	0.1736 0.007	0.007		0.054	0 01 25	210.0	0.016			FI ANUL	PO> 51811	AS Hec	HC IN T	EST P1P	е. •		
7 0.107 0.0107 0.007	0.103 0.010 0.0103 0.003 <t< td=""><td>0.1736 0.020</td><td>0.020</td><td>-0</td><td>0.234</td><td>0.040.0</td><td>0 • 066</td><td>0.072</td><td>0-025</td><td>0.2017.5</td><td>82 0.06</td><td>1 9.372</td><td>0.012</td><td>0.100</td><td>0.100</td><td>-6-003</td><td>9-240</td><td>126-</td></t<>	0.1736 0.020	0.020	-0	0.234	0.040.0	0 • 066	0.072	0-025	0.2017.5	82 0.06	1 9.372	0.012	0.100	0.100	-6-003	9-240	126-
7 0.0146 0.010 0.010 0.004 0.	0.146 0.001 0.004 <td< td=""><td>0.1736 0.02</td><td>0 • 05</td><td>N</td><td>£61°0</td><td>0.0160</td><td>0.055</td><td>0.058</td><td>0.021</td><td>0.2111.9</td><td>74 0.05</td><td>1.0.354</td><td>0.007</td><td>0.082</td><td>0.062</td><td>()0-0-</td><td>6.120</td><td>129-3</td></td<>	0.1736 0.02	0 • 05	N	£61°0	0.0160	0.055	0.058	0.021	0.2111.9	74 0.05	1.0.354	0.007	0.082	0.062	()0-0-	6.120	129-3
1 0.089 0.0100 0.021 0.010 0.	0.089 0.0100 0.027 0.010 0.10 2.10	0-1716 0.01	10.0		0.146	0.0100	240-0	440-0	0.016	J.16 6.9	+1 0.04	**0** 0	\$00°0	0.063	0.003	-0.00	3.016 1	126
7 0.4054 0.4010 0.4017 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4001 0.4011	7 0.4054 0.401 0.401 0.405 0.401 0.405 0.401 0.405 0.401 0.405 0.401 0.405 0.401 0.405 0.401 0.405 0.401 0.405 0.401 0.405 0.401 0.405 0.401 0.405 0.401 0.405 0.401 0.	0.1776 0.01	0.01	-	0.089	001000	0.026	0.027	C10°0	0.10 2.7	14.0.02	120.1 0	0.002	0.034	660.0	C 0 0 ° 0-	1.525 1	ś£2*:
0.234 0.0150 0.066 0.094 U.2017.584 0.044 U.0314 0.113 U.00111.0031 U.00111.0031 U.00111.0031 U.00111.0031 U.00111.0031 U.001111.0031 U.0011111.0031 U.011111.0031 U.011111.0031 U.01111111 U.011111111 U.011111111 U.011111111 U.011111111 U.011111111 U.0111111111 U.0111111111 U.0111111111 U.0111111111 U.0111111111111111111111111111111111111	0.234 0.0150 0.066 0.094 0.2617.584 0.045 0.045 0.115 0.00111.0031 1.011 10.113 0.114 0.055 0.076 0.015 0.016 0.015 0.015 0.015 1.011 1.141 10.114 0.105 0.015 0.016 0.016 0.111.977 0.111.977 1.011 1.011 1.011 0.015 0.015 0.015 1.011 1.011 1.011 0.012 0.012 0.012 0.012 0.011 0.011 1.011 1.011 0.012 0.012 0.012 0.013 0.011 0.011 1.011 1.011 0.012 0.012 0.012 0.011 0.011 0.011 1.011 1.011 1.011 0.012 0.011 0.011 0.011 0.011 1.011 1.011 1.011 1.011 1.011 0.011 0.011 0.011 0.011 0.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1.011 1	0-1736 0.00	0.00	-	0.054	0010-0	110.0	0.017	J. 007	0.1 00.0	10.0 00	110 · n 4	100*0	¢20°0	0.025		0.605	167.0
2 0.193 0.0050 0.055 0.076 0.011 0.191 0.1111 0.11111 0.11111 0.11111 0.11111 0.11111 0.111111 0.11111	0.193 0.0050 U.055 0.076 U.0111.977 0.0111.977 0.0111.977 0.0111.977 1.114 1 0.105 0.056 U.015 0.016 U.015 0.111.977 0.011 0.012 0.012 0.012 0.012 1.114 1 0.105 0.015 0.016 0.16 0.111 0.111 0.111 0.012 0.012 0.012 0.012 1.114 1 0.016 0.016 0.16 0.111 0.111 0.111 0.012 0.012 0.012 0.012 0.012 0.011 1.0111 0.01111 0.0111 0.0111	0.1736 0.02	0.02	-0	0 • 234	0510-0	0.066	\$60°0	U.025	0.2617.5	84 0.04	+60°F 50	640.0	0.118	C11°0	1 100 . U-	1.037	• j 3 2
7 6-146 0-015 0-056 0-016 0-16 0-047 0-010 0-012 0-016 0-012 4-212 1-146 r 0-069 0-0150 0-014 0-010 0-10 2-714 0-012 1-014 0-014 0-016 1-056 5-712 1-146 r 0-069 0-0150 0-016 0-10 2-714 0-012 1-056 1-056 5-712 1-146 r 0-054 0-0150 0-010 0-10 2-714 0-012 0-011 1-056 5-712 1-146 r 0-054 0-0150 0-102 0-102 0-101 0-152 0-412 0-412 0-412 0-412 2-713	7 6.146 0.054 0.056 0.056 0.056 0.016 0.16	0.1736 0.02	0 • 02	N	0.193	0.0050	0.055	0.076	U. 021	0.2111.9	10.0 41	010 .L 8	0.037	467-0	0.040	<0.00-	1.116.1	114-1
r 0.069 0.0050 0.026 0.034 0.010 0.10 2.714 0.020 J.334 0.015 0.043 0.042 -0.001 1.645 5.715 7 0.054 0.0350 0.017 0.022 0.037 J.UA 1.050 0.012 J.322 0.004 0.027 0.026 -6.001 6.652 0.413	: 0.089 U.DU50 0.026 0.014 0.010 0.10 2.714 0.U20 J.JJ4 0.015 0.U43 0.042 -0.001 1.645 5.72 1 0.054 0.0750 U.017 0.022 U.037 J.UA I.050 U.ULZ J.JZ2 U.U04 0.027 0.026 -C.DDL G.L52 0.413	0.1736 0.01	0.01	~	6.146	0 . 0 . 0	240-0	0.056	0.016	0.16 0.9	10.0 14	CC0.0 00	0.026	0.070	0.068	-0-003	4-212 1	
7 0.054 0.0350 U.017 0.022 U.037 J.UA 1.050 U.ULZ J.322 U.UO4 0.027 0.026 -6.001 G.652 0.413	0.054 0.0350 U.017 0.022 U.037 J.UA 1.050 U.ULZ J.322 U.UOY 0.027 0.026 -6.001 G.L52 0.413	0.1730 0.01	10-01	ànt	0.069	0.00.0	0.026	0.034	010.0	0.10 2.7	14 0.02	+ 6 C * C 0	0.015	0-043	0-042	-0.001	1.645	
		0.1735 0.00	0.00	~	0.054	0 * 0 0 * 0	210 * 0	0.022	10.03	0.1 40.6	10.0 00	220°r 7.	U-00-	0.027	0.026	-6.001	6.652 (614.0

•

-

1

1

_

.

TEST PIPE DATA AND PRICHAM RESULTS.

COMMON DATA APPROACH PIPE DATA

	194						3.734					9.223	2+132	102.5	1/1-1	122-0	1.372	1.725	\$16.1		(69.0
	4 * *						.670					-746	. 620	949-1	• 525	. 605	.637	+16.	.212	. 645	. 552 (
							000					6 00.	. 603	.001	1 000.	0 000	00711	1 500	• 600	1 100.	0 100
	C I I	• 3 4 8 •	1. P.E.	196.	I PF.	• 3 4 3 •	0- 64	.1	.341	.176.	. 34 1	0- 00	12 -0.	0- 6	·C- 61	2 -0	-0- []	0- 0	0-0	- 2	ie - 6.
	EMERC ODMN M.	Test P	153	1 13 31	LEST .	TEST P	0 • 0	1651 1	TEST P	TEST P	IEST I	0.10	0 • 0	0 • 0	0 * 0	0-02	0.11	0 0	0-06	0 * 0	0 • 05
S.	MFRGY PJUMP M.	C IN 1	C IN 1	I IN J	I W D	C IN 1	0.099	IC IN 1	C 1N 1	I I I J	IC IN 1	0•100	0.082	690.0	0.039	0.025	0.116	\$60°0	0.010	0.043	0.627
LUC31	PTM E Ange L M.	S HNCH	ANN S	S HNCP	NWCH	ANH S	• 000	S HWCP	S HNCH	S MNCE	ANNA 2	• 012	100.	+00+	• 005	100 .	6 * 0 *	166.	• 02 6	\$10*	600*
NA AQ	10 10 10 10 10 10	3-E A	BLEA	d_E A	BLE A	BLE A	67 G	BLE A	8.E A	BLEA	BLE A	72 0	5 a 0	3	27 0	17 0	3 4	75 0	56 (34 (2 2 0
CH1 C	5 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	P US S I	PU>51	PUS 21	P0551	P0> \$1	6 3.0	P0, 51	P0>51	P 05 5 I	12209	1 0.0	1 3.0	0 . 0	6 J.O	6 J 0	5 u • 0	0 . 0	0	0 3.0	2 3.3
TA AN	06914 06914	NP IN	11 11	NP IN		NP IN	0.66	MP 4 M	NP IN		NI dH	0.06	ς ∩ • 0	0 - U 4	0.02	0.01	• • • •	0.03	0.03	0.02	0.01
E UA	A M A A A A A A A A A A A A A A A A A A	U.		5	U.	U.C.	161-1	30	30	5	n	161.1	1.340	.204	.223	\$\$2*	161.	.340	.284	.22.	c+2 • 1
14 15	TRT EN Ergy F M.						0.3721					1216.0	0.301	F E2.0	0.14	1 90 . 0	1276.0	0.3014	0.23 H	0.14	1 60.0
TE	2.X U U V U V U V U V U V U V U V U V U V U						620					630	110	013	5 C O	< C 0	Các	210		\$00	< 0.0
	6 4 0 5 4	52	42	32	20	61	67 O.	40	0	25	16	12 0.	58 D.	44 34	27 0.	17 0.	94 0.	76 0.	50 0.	34 0.	1 23
	A P	n•0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	U•0	0.0	0.0	0.0	0.0	0.0
,	5 · F	6 • 0 6 1	0 • 0 5	0 • 0 4 5	0 - 02(0.010	U = 060	0.055	0 • 0 •	0.020	0.01	0 • 001	0 • 05	0 • 0 4 9	0 • 05 (0.01	0 • 0 • 0	U • 055	U = 04	0.026	0.01
	SLOPE	0 4 7 0 • 0	0 < 7 0 * 0	0\$20*0	0.0250	0 * 0 7 2 0	9.0125	0.0125	0.0125	0.0125	0.0125	0 0 1 0 0	0.010.0	0010°0	0-0100	0.0100	0 < 0 0 * 0	0500.0	0 • 3 0 5 0	0510.0	0.0.50
DATA	TEAM. In FGY M.	0.345	0.283	0.212	0.120	0.076	0+345	0.283	0.212	0.120	0°016	0°345	0.283	0.212	0.128	0.076	0.345	0.263	0.212	0.128	0.076
P 1 P E	N N N	0.021	0.018	0.014	0000	0.006	0.021	0.018	0.014	00000	0.006	0.021	0.018	0.014	0.009	0.006	0.021	0.018	+10-0	600 * 0	0.046
HDACH	0P 6	3402	3402	3492	3402	3402	3402	3402	3402	3402	3402	3402	3405	3402	3402	3402	3402	3402	3402	3402	2046.
API	N° SI	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.	15 0.
DATA	C UF	5 0.0	0.0	0 0 0	0 • 0	0.0	5 0.0	5 0.0	0.0	5 0 ÷ 0	0 • 0	0 0 0	0 • 0	0 • 0	5 0.0	0°0 §	0.0	5 0.0	5 0°0	5 0 • 0	0°0 §
NOHM	01A.	0.1	0.1	0.1	0.1	. 0. 1	0.1	0.1	0.1	0.1	0.1	0.1:	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
CC	J.	6.0	6 • U		2.0	1.0	6.0	6 • 0	4 ° 0	2 • 0	1.0	6.0	0 • 0	•	2.0	L • C	0 • 0	6 • 6	••	2.0	1.0

	1116 						161.1 0					5 3. 42	0 2.35	\$ 2.8.325	5 1. 11	18.6 3	121.2 7	1.33	61.1 5	5 32	
	цсл. К.Н.						9.67					9.74	6.62	3. 64	1.52	0.00	11-63	7.37	4.21	1.64	
	ME B G f 4 A M G I M •	٠		•		•	(00.0.			•	•	000 *0.	co0°0.	000.0	(00.0.	(00.)	1200-0	¢0√•0.	6.00.3	100 * 9.	
	KN KN A.	1 P1PE	T PIPE	T PIPE	T PIPE	T PIPE	- 660-	1 P1PE	3414 I.	T PEPE	T PIPE	- 100 -	- 280 -	• 063 -	- 039 -	• 025 -	- 110 -	- 040 -	- 990 -	- 240 -	
	AGY EN	IN TES	IN TES	IN TES	IN TES	IN TES	0 650	IN TES	IN TES	IN TES	IN TES	0 001	0 82 0	0 6 3 0	0 66 0	025 0	0 011	0 440	0 20 0	0 640	
JLT5.	EME UPJ	1C NC	14 HC	ACHC	SHO	4ChC	• 0	1 <hc< td=""><td>44 HC</td><td>JHY</td><td>1 < HC</td><td>2 0°</td><td>• 0 •</td><td>0</td><td>•0</td><td>L. 0.</td><td>•0</td><td>• 0</td><td>• 0</td><td>• 0</td><td></td></hc<>	44 HC	JHY	1 < HC	2 0°	• 0 •	0	•0	L. 0.	•0	• 0	• 0	• 0	
M NESI	DEPTH Change M.	AS HE	AS HA	AS HE	AS HI	AS HI	0.000	AS HI	AS HI	AS HI	AS HI	0.01	0.00	0.004	0 • 00 5	6.001	0.04	0.03	0 - 02 6	0.015	
435KA	104M 069TA	SldLe	510-E	31915	SIBLE	Slalé	1.00.0	si ta LE	şlare	SIBLE	SIBLE	.012	1.353	••0••	120.0	111.0	+ec.	010.0	940.0	*EC*I	
1 0 M		1400	LAPO	1400	I NP 0	DAHI	. 066	IAP0	INPO	IMPU	I HPU:	. 100.	. 150.	0 * 0	. 020	. 016	. 640.	010	. 010.	. 020	
DAFA	AV UP	AMUL	ANOF	JUNE	JH NF	ANUL	0 619	JUNP	Anut	AHUL	AH DE	19 0	0 020	36 0	0 790	340 0.	519 0.	0 070	236 0	9 7 9	
P1P6	N N N N N N N N N N N N N N N N N N N						. 626		·			523.0	1716.(9 - E - B	17 3.1	0 1.	523.0	1716.		1 3.5	
1531	ENTAT ENEAC						0.					0.4	0•3	0.2	0.1	0.1	0.4	0 •]	0 • 5	0.1	
	R4TAT DcPT4 M.						0.014					0.016	0.015	0 • 01 8	10°03	00°r	0.043	0.015	0.012	0.001	
	I.	2 د 0 • 0	0.042	260.0	0-0-0	0.013	0.067	• < 0 • 0	0+0+0	0.025	0.016	0.072	850.0	0.044	0.427	0.017	0 • U 4 4	0.076	360.0	0.034	
	14C	0.066	0 • 05 S	0.042	0.026	0.017	0.066	0.055	0.042	0+026.	110.0	0066	\$ \$ 0 ° 0	240.0	0.026	110 -0	0.066	¢ ¢ 0 • 0	2+0-0	0.026	
	0°E	0520	0520	0250	0550	0550 (0125 (0125 4	9125	0125 (6210	0100	0100	0010	0010	0100	0 0 5 C 0	0.050 (0510	0 0 5 0 (
•	cv (SL	35 0.0	56 0.0	66 0.	0 0 0 3	95 0.	35 0.	56 0.	\$ \$ 0 •	60 0.	95 0.1	35 0 °	56 0.	66 0.	ro 0°	95 0°	35 0.	56 0.	66 0.	0 0 v	
E DAT	TERM ENER	¢ • 0	E •0 \$	2 0.2	5 0. I.	0.0	4.0	0.3	2 0.2	8 0.1	0 • 0	\$ · 0	5 0.3	0.2	0.1	0.0	4 -0 6	0 . 3	2 0.2	0.1	
	N .	0.01	0.04	0.01	0 * 00	0.00	0.019	0 * 01	0.01	0 * 0 01	00 * 0	0.01	0 • 01	0.01	0.00	0 • 00	0.01	0.01	0.01	0 . 0 1	
PROAC	LOPS SIN)	. 5000	• 5000	• 5000	• 5000	• 5000	.5000	0005.	0005.	• 5000	• 5000	. 5000	• • • 000	• 5000		. 5000	00.05-	• • • • • •	0606.	• • • 0 0 0	
A AP	NN. S LFF	0 510	0 510	015 6	0 510	0 510	0 510	015 0	0 510	0 15 0	015 0	015 0	0 510	0 510	0 \$10	0 410	015 0	015 0	0 <10	0 510	
1 DAT	A. MA CU	5 0.	12 0.1	5 0.1	5 0.4	5 0.4	15 0.1	5 0.0	.0 51	15 0.	15 0.	15 0.	15 0.	•0 51	•0 51	15 0.	.0 .	15 3.	15 0.	15 0 .	
OMMO	10	0 0.1	0 0.1	0 0.1	0 0.1	0 0.1	0 0-1	0 0.1	0 0.1	0 0.1	0 0.1	0 0.1	0 0.1	0 0.1	0 0.	0 0.1	0 0.1	0 0.1	0 0.1	0 0.1	
ų		9	• •		2.	-	10		•	~~		ер •	•		\$	I.,	4	•	+	٠,	

							4 · 34 >					3.531	3•33 j	2.422	1.427	158.0	2.337	116.5	1.533	0.370	0.553
	4 7 7						¥.670					9+2+6	6. 62 Û	3.646	1.525	0.605	1.037	+26-2	4.412	1.645	0.652
		۳	۴.	•	E e	۴. •	COO ° 0-	E e	E.	° u	f.	900.0-	- U. O O G	-U • 00 J	-0.003	-0.003	-0.0071	-0 - 00 5	-0.003	-0.001	-0.061
	EMERGY UUMN M.	EST P19	EST P19	614 153	EST PLP	114 T23	0 • 0 99	EST P1P	EST 219	EST PIP	EST PLP	0.100	0 . 0 42	0.063	660.0	0.025	0.110	0.090	0.068	240-0	0.026
15.	ENFLCV UPJUMP N.	HC IN T	HC IN 7	HC IN T	HC IN T	HC IN 1	0.099	HC IN T	HC IN I	hC IN T	HC IN T	0.100	0.062	0°0¢3	0.039	0.025	0.418	0°040	0.070	0.043	0.027
M 465UL	DEPIM Change M.	AS MMC	AS HMC	AS MMC	AS HMC	AS MMC	00000	AS MMC	AS MNC	AS HNC	AS MMC	0.012	0.007	00 • 00 •	0.002	U. 001	0.049	0.037	0.026	0.015	0°008
P 43 34 A	1043 1677 4.	0,513.6	U S I B L E	0, 51 dLE	0551816	USSIDLE	J. J67	0.519.6	USSIALE	3> 518 L E	JJSIBLE	U.012	U = 0 5 3	1+0+F	J = 021	11C.L	4 C * C	010.0	0 ÷ 0 • •	4E0°r	1°322
ATA ANU	UPJUMP UEPIM M.	AM1 AMU	URP INP	UMP INP	UMP INP	UMP IMP	J 0.060	UMP INP	AFI AMU	UMP IMP	UNP INP	3 0.061	liu.0 L	0+0-0 4	0 - 0 - 02 6	4 0.Ulb	2+0.0 L	860.0 E	5 U.JU	020.0 0	9 0.012
PIPE 0	T ENTRY Ty F +M No			راب	7		626.22	-	đ,	Ĩ	4	620 •22	+2-215	12.014	50°7°03	12 1 .51	626.22	+2-2751	1410.21	46° F 0	15-1 - 21
test	E E E E E E E E E E E E E E E E E E E						6 0.5					6 0°5	• 0 •	L 0. 3	7 0 2	• 0•1	6 0°5	4 O. 4	1 0.3	1 0.2	• 0.1
	ENT 27 De PT 4 N •	~	~	2	0	~	1 0.01		0	5	Q	2 0.01	10-0 8	10.0 4	7 0.03	7 0.00	4 0.01	0.01	4 0.01	4 0.00	co.u <
	H H H	0°05	• 0• 0 •	0.03	0.02	0.01	0.06	0.05	0.04	0.02	0.01	0.07	c0°0	\$ 0 ° 0	0.02	10.0	0°0 .	10.0	¢0°0	0.03	0.02
	33	0 • 066	0 • 0 5 5	0 • 0 4 5	0 • 026	0.017	0.060	0 • 055	0 • 0 4 2	0 • 02 6	0.00	U.066	U • 0 5 5	0 • 0 • 2	0.026	0.017	0.066	0 • 055	0 • 0 • 7	U . 026	0.017
	1514) 1514)	0 * 0 7 2 0	0 • 0 5 2 0	0 * 0 7 20	0 • 0 < 2 0	0 • 0 5 20	0.0125	0.0125	0.012S	0°0125	0.0125	0.0100	0 * 0 7 00	0.0100	0.0100	0.010	0<0.00	0500-0	0 \$ C 0 * 0	0510-0	0400-0
DATA	TERM. EMERGY M.	96539	664.0	0.327	0.195	0.115	0.539	4E 4 ° 0	0.327	0.195	0.115	6E \$ °0	0.439	0.327	0.195	0.115	0.539	964.0	0.327	0.195	0.115
I PIPE	H . N	0.017	0.014	0.011	0.007	\$00°0	0.017	0.014	0.011	0.007	0.045	0.017	0.014	0.011	0.007	0°002	0.017	0.014	0.011	0.007	00.00
PPRUAC	SLUPE	0.707.0	0 • 70 7 0	0.7070	0 * 70 7 0	0 • 7070	0 * 20 7 0	0.7070	0.7070	0.7070	0.7070	0.7070	0.7070	0.707.0	0.7070	0.7070	0.7070	0.7070	0.1010	0.707.0	0.1010
ATA A	MANN. COEFF	0.015	0.015	0.015	6.015	510° 0	\$10 * 0	0.015	0.015	\$10°0	0°015	0.015	0.015	\$10°0	0.015	0.015	0.015	\$10°0	0.015	0.015	0.015
NCHHO	01 A. M.	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
00	J.	0 • 0	6 • Q	0	2.0	1.0	9 * 8	6 • C	9 • 6	2 • (1.0	d • C	6 ° C	9.6	2.0	1.0	9.0	þ. (••	2.0	1.0
	n			~		e.			9			A 6	• 8		p.	-		-			

•												-		-					-	-	~
												3.575	3.157	111.2	1.527	0.3×4	2.423	2.353	1.51)	1.33	0.571
	104 7 . 7 . 7 . 7						9.070					9.746	6.620	3.045	2-525	0. 605	1.037	1.374	4.212	1.015	0.452
		•		•	•		-0.002		°.	•	Ľ.	-0.000	C 90 - 0-	-0.603	cc0 * 0-	-0-003	-0.0071	·0.00.	-0°003	-0.001	-0.001
	A SARA	ST PIP	ST PIP	ST PIP	ST PLP	ST PIP	0.049	ST PIP	ST PIP	ST PIP	ST PIP	0.100	0.032	0.063	0.039	0.025	0-110	060 • 0	0.068	U=042	0-026
5.	PJUMP (C IN TE	C IN TE	C IN TI	C IN TE	C IN TE	660.0	C IN T	C IN TE	C IN TE	C IN TE	0.100	0.082	0.063	660.0	0.025	0.110	+60.0	0.070	0.043	0.027
Kë SJL T	EP TH E HA46E U M.	AS HNCH	AS HNCH	AS MNCH	AS HMCH	AS HNCH	000-0	AS HNCH	AS HNCH	AS MNCH	AS HMCH	0.012	0.007	0.004	0.002	100.00	6 4 0 • 0	1 2 0 . 0	0 • 0 5 \$	0.015	0.00
A JUKAN	C P L C	51815	SIGLE	ild LE	STALE	31010	100.	31816	510.6	SIGLE	SIBLE	510.0	\$ 5 C • P	*****	1.327	111.0	véc .	0110	950.0	+10.4	1.322
A AND	JPJUAP JEPTH	0461 46	CdH1 dt	0441 41	CAMI AN	0411 41	0.065	0411 41	ITPU	1P 14P0	AP INPO	0.061	1<0.0	0,040	0.020	0.016	0.045	0.038	010.0	0 • 02 0	0.012
IPE DAT	ENTRY 1 F + M L	1) 1	1 U F	10r	1 U E	4 U F	27.865	10F	100	1 n f	i n r	27.865	18.86/	13.840	4.186	1.609	27.865	10.057	10.0440	4.130	1.604
TEST P	ENTAY ENEAGY A.						0.63					6 0.63	0.51	0.38	0.23	0.13	0.63	0.51	0.19	0.23	0.13
	E4T2V D6PFH M.						0.015					9.919	0.013	0.013	0.000	0 • 0 0	0.01	0.311	0.013	0.000	0.000
	I F	0.052	0-042	0.032	0-020	0.013	0.067	+ 5 N * 0	0+0-0	0.025	0.016	0.072	0.058	0 • 0 + +	0.027	0.017	0 . U 4 4	0.076	0.056	0.034	0.022
	ЧЧ ЧЧ	0 • 066	¢\$0°0	0 • 0 4 2	0.026	0.017	0 • 06 W	¢ \$ 0 * 0	2+0 - 0	0.026	0.017	0.006	0°055	0+0+2	U.026	0.017	0.066	0°055	0 • 042	0.026	210.0
	514) (514)	0 \$ 7 0 * 0	0 * 0 7 9 0	0 • 3 5 5 0	0 \$ 70 * 0	0 • 07 5 0	\$210.0	\$210.0	0.0125	0.0125	0.0125	0.0100	0.0100	0.0100	0.0100	0010.0	0<10.0	0 \$ 0 0 \$ 0	0500.0	0.0050	0516.0
OATA	TEK M. ENERGY N.	0.611	0.498	0.369	0. 220	0.130	0.611	0.498	696.0	0.220	0.130	0.611	0.498	0.369	C. 220	0.130	0.611	0.498	0.369	0.220	061.0
I P L P F	I I	0.016	0.013	0.010	0.007	0.004	0.016	0.013	0.010	0 • 007	00000	0.016	C 10 * 0	0.010	0.007	0000	0.010	0 • 01 3	0.010	0.007	\$00*0
P P RO A C H	SLUPE (SIN)	0 * 99 * 0	0.4660	0 • 86 60	0.6660	0 • 86 60	0.8560	0.8650	0.8660	0.8660	0.866J	0.8660	0.8660	0 - 94 40	0.8663	0.8460	0.8660	0.8460	0.8663	0.8660	0.8553
ATA A	MANN. COEFF	0.015	0.015	0 • 015	0 ° 015	0.015	0.015	0.015	0.015	0.015	0°015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
NUMP	01A.	0.15	0 . 15	0.15	0.15	0.15	0 • 15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
CO	4. L/S	8°0	6.0	4.0	2 . 0	1.0	d. 0	6 • 9	4 = 0	2.0	1.0	8 ° 0	6 • 0	0 • 4	2.0	1.0	0.0	\$°0	0 • 4	2.0	1.0
				•																	

A6.9 _

.

.

h

-

-

_

	14° 35.						. 52.9			٠		• 7 2 5	. []]	.534	. 513			121.	1 2 2 2 .	. 323	• 535
							670 9					146 3	6203	5 0 2	525 1	605 U	137 2	374 2	212 1	645 L	652 V
	3 • ¥											6	9 ¢•	3 3.		» 0°	711.	\$ 7.	3 4.		1 0.
	ENFRG Clanc R.	e e	۰ يو	f .	e e	E .	-0.00	و بو	ε.	• 54	е.	-0.00	-0*03	-0 • 00	-0•00	-0.00	-0.60	-0.00	-0.00	-0° 00	-0.00
	2 2 C	919	414	-	919	9.24	660	414	4	4		100	042	600	460	025	110	040	000	240	026
	E M C	76.57	TEST	1651	1651	1 E S 1	0	TE S T	TEST	1231	1651	•	•	•0	•	•	•0	•0	•	••	•
TS.	ENFRGY UPJURP M.	MC IN	HC IN	MC 14	HC IN	HC IN	00039	HC IN	MC IN	HC IN	MC IN	0.100	0.082	0 • 0 6 3	0.039	0.025	0.110	0.094	0.070	0-043	0.027
4ESJ-	PTH ANGE A.	S HNK	S HNK	S HNC	S HNC	S MM S	.000	S HAC	S MM S	S MN C	S HNC	• 012	100°	• 00 •	• 0 0 2	.001	•0•0	100.	• 3 2 6	• 015	f00*
4 A M	1 64	~E A	LE A	LE A	LE A	LE A	1 0	LE A	E A	LE A	۳. A	<i>د</i> ٥	9	•	2	0 1	•	0	0	•	ہ م
223	0.04 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	فاكدل	05513	6] \$ «O	91550	3.510	J.06	12510	91550	0 2 5 1 4	01550	4°01	1• 35	€C°r	J.02	1.01	€ C ● C .	10°C	1-35	1°03	5 C • L
CNA		INP	446	1 MP	AMP	IAP	• 00 0	INPU	1 HP	I AP	975	.061	• U j l	. 40	. 42 6	. 416	c 4 D •	• • 38	.010	20	12
DATA	Y UP UE	JUNG	JUNP	JUNP	4un	AN UL	20 0	JU NP	ANUL	SH UL	JUNP	20 0	92 0	0 20	23 -0	54 0	26 0	0 76	0 10	23 0	9 65
3 6 1	FNTA For						2 8 - 8.					28 . 8.	4.61	11.2	6 • 9	k • 6	28.6	14.4	11.2	6 • 9	1.0
51 P	7 × V 6 × G V 4 •						0.67					0.67.	0.54	0 • • 0	0.24	0.14	0.67	0 • 5 •	0 • • 0	0 . 2 4	0.14
-	Z Z						-														
16	TAY EN						015					\$10 °(012	C10*(0.006	0000	¢10 • ſ	210.0	c10 • r	\$00 *0	\$C0°0
1 E	N ENTAV EN DEPTA EN	2¢0	042	25 0	070	610	U67 J. 015 (• 5 •	0 • 0	025	016.	072 0.015	058 0.012	C10*0 440	027 0.336	017 0.0QN	094 U.015	21C°N 920	056 0.013	034 V. 005	\$CU°C 220
1 E	MN ENEZY EN M. DÉPT4 En 4.	0°0,02	5 0.042	2 0.032	0.020	0.013	6 0°U67 J°015	\$ 0.U54	0.040	5 0°025	7 0.016	\$ 0°075 0°015	5 0.058 0.012	2 0.044 U.013	¢ 0°027 0°336	1 0.017 0.00°	¢ 0.094 U.015	\$ 0.076 V.JI2	2 0.056 0.013	6 0°034 U.005	*CU.C 220.0 1
1E	MC MN EMERY EN M. M. DÉPE4 Em 4.	0.066 0.052	0.055 0.042	U.042 0.032	0°070 0°070	0.017 0.013	U. 066 0. U67 J. 015	0.055 0.U54	0.042 0.040	0.026 0.025	0.017 0.016	0.065 0.672 U.015	0.055 0.058 0.012	0.042 0.044 0.013	0.020 0.027 0.036	0.017 0.017 0.00%	0.066 0.094 u.015	0.055 0.076 V.JIL	0.012 0.056 0.013	0.026 0.034 U.005	U.017 0.022 J.UJ.
°.	DPE MC MM ENTRY EN 141 M. M. DEPT4 Em 4.	0250 0°060 0°052	0250 0.055 0.042	0250 V.O42 0.V32	0250 0°026 0°020	0250 0.017 0.013	0125 U.OG& O.UA7 J.015 (0125 0.055 0.USA	0125 0.042 0.040	0125 0.026 0.025	0125 0.017 0.016	0100 0.000 0.072 0.015	0100 0°055 0°058 0°015	C100 0 % 0 % 0 % 0 % 0 % 0 % 0 % 0 % 0 %	0100 0.020 0.027 0.036	0100 0.017 0.017 0.00%	0050 0.066 0.094 u.015	3150 V.055 0.076 V.312	JU50 0.042 0.056 U.013	U350 0.026 0.U34 U.005	0.150 U.017 0.022 J.UJ.
LE .	SLOPE MC MM ENFRYEN V (SIV) M. M. DÉPLIEM	4 0°0150 0°0¢¢ 0°032	2 0.0250 0.055 0.042	5 0.0250 V.042 0.VJ2	\$ 0°0720 0°070 0°070	8 0.0250 0.01% 0.013	4 0.0125 U.066 0.U67 J.015	2 0.0125 0.055 0.054	5 0.0125 0.042 0.040	5 0.0125 0.026 0.025	8 0.0125 0.017 0.016	4 0.0100 0.060 0.672 U.015	2 0.0100 0.055 0.058 0.012	5 0.0100 0.042 0.044 U.011	5 0.0100 0.020 0.027 0.036	0 0 0 11 0 0 0 11 0 0 0 1 0 0 0 0 0 0 0	4 0°0050 0°066 0°094 0°015	2 0.3150 V.055 0.V76 V.312	\$ 0.3U50 0.012 0.05h U.013	5 0.0350 0.026 0.034 U.005	6 0.0150 0.017 0.022 J.U)
UATA . TE	TERM. SLOPE MC MM ENTRY EN Energy (Siv) M. M. Dépta Em M.	0°654 0°0750 0°060 0°052	0.532 0.0250 0.055 0.042	0.395 0.0250 V.042 0.VJ2	0°535 0°0720 0°070 0°070	0.138 0.0250 0.017 0.013	0.654 0.0125 0.066 0.067 3.015	0.532 0.0125 0.055 0.U54	0.395 8.0125 0.042 0.040	0.235 0.0125 0.026 0.025	0-138 0.0115 0.01% 0.01¢	0.454 0.0100 0.066 0.072 0.015	0.532 0.0100 0.055 0.058 0.012	0.395 0.0100 0.042 0.044 U.013	0.235 0.0100 0.020 0.027 0.036	0,138 0.0100 0.017 0.017 0.00%	0.654 0.0050 0.066 0.094 0.015	0.532 0.9150 0.055 0.076 V.912	0.395 0.3450 0.042 0.056 0.013	0.235 0.UJ50 0.026 0.UJ4 U.005	0.136 0.0350 V.017 0.022 J.U.
PIPE DATA . TE	MM TERM. SLOPE MC MM EMFRYEN M. Energy (Slu) M. M. Deptien M.).015 0.654 0.0150 0.060 0.052	013 0.532 0.0250 0.055 0.042	1.010 0.395 0.0250 U.042 0.U32	.0000 0.235 0.0250 0.020 0.020	1.004 0.138 0.0250 0.017 0.013	1.015 0.654 0.0125 U.066 0.U67 J.015 (•013 0•532 0•U125 0•055 0•U54	0.010 0.395 0.0125 0.042 0.040	1°006 0°235 0°0125 0°026 0°025	004 0.138 0.0125 0.017 0.016	.015 0.454 0.0100 0.000 0.672 0.015	.013 0.532 0.0100 0.055 0.058 0.012	0.010 0.395 0.0100 0.042 0.044 0.013	006 0.235 0.0100 0.026 0.027 0.036	0004 04138 0.0100 0.017 0.017 0.00%	1.015 0.694 0.0050 0.066 0.094 0.015	1.013 0.532 0.0150 0.055 0.078 0.012	1.010 0.395 0.3U50 0.042 0.05h U.013	.000 0.235 0.0350 0.026 0.034 U.005	1.004 0.136 0.0150 0.017 0.022 J.UJ.
JACH PIPE DATA . TE	PE MN TERM. SLOPE MC MN ENTRY EN 4) M. Energy (Siv) M. M. Depta Em 4. M.	554 0.015 0.654 0.0250 0.060 0.052	+59 0.013 0.532 0.0250 0.055 0.042	59 0.010 0.395 0.0250 ⊍.042 0.U32	.59 0.006 0.235 0.0250 0.026 0.020	59 0.004 0.138 0.0250 0.017 0.013	.59 0.015 0.654 0.0125 U.066 0.U67 J.015 (•59 0.013 0.532 0.0125 0.055 0.U54	•59 0.016 0.395 0.0125 0.042 0.040	59 0.006 0.235 0.0125 0.026 0.025	59 0.004 0.138 0.0125 0.017 0.016	• • • • • • • • • • • • • • • • • • •	54 0.013 0.532 0.0100 0.055 0.058 0.012	59 0.010 0.395 0.0100 0.042 0.044 0.013	•59 0.006 0.235 0.0100 0.026 0.027 0.036	559 0.0004 0.138 0.0100 0.017 0.017 0.00%	•59 0.015 0.654 0.0050 0.066 0.094 0.015	554 0.013 0.532 0.0150 0.055 0.076 0.012	.59 0.010 0.395 0.3050 0.042 0.056 U.013	554 0.000 0.235 0.0050 0.026 0.034 ∪.005	\$\$ 0.004 0.136 0.0150 0.017 0.022 J.UJ.
APPROAC4 PIPE DATA . TE	SLUPE MN TERM. SLOPE MC MN ENTRY EN (SIM) M. ENERGY (SIM) M. M. DEPTA EM M.	0.9654 0.015 0.654 0.0250 0.060 0.052	0°\$\$\$\$ 0°013 0°235 0°0250 0°055 0°045	0.9659 0.010 0.395 0.0250 0.042 0.032	0°3659 0°006 0°535 0°0720 0°070 0°070	0.4657 0.004 0.138 0.0250 0.017 0.013	0.4459 0.015 0.654 0.0125 U.066 0.U67 J.015	0.9659 0.013 0.532 0.0125 0.055 0.U54	0°3659 0°016 0°395 0°0125 0°045 0°140	0.4659 0.006 0.235 0.0125 0.026 0.025	0.4659 0.004 0.138 0.0125 0.017 0.016	0.9654 0.015 0.454 0.0100 0.066 0.672 0.015	0.465% 0.013 0.532 0.0100 0.055 0.058 0.012	0.9659 0.010 0.395 0.0100 0.042 0.044 0.013	0.9459 0.000 0.235 0.0100 0.020 0.027 0.036	0.4659 0.004 0,138 0.0100 0.017 0.017 0.00%	0.4659 0.015 0.654 0.0050 0.066 0.094 N.015	0.4654 0.013 0.532 0.3150 U.055 0.U76 U.312	0.9559 0.010 0.395 0.3450 0.042 0.056 U.013	0.9654 0.006 0.235 0.0350 0.026 0.034 0.005	0.9553 0.004 0.136 0.3J50 0.017 0.022 J.UJ.
TA APPROAC4 PIPE DATA	IANN. SLUPF. MN TERM. SLOPE MC MN EMFRYEN .Deff Isimi m. Enérgy (slui m. m. déftiem m.	.015 0.9654 0.015 0.654 0.0150 0.060 0.052	.015 0.9459 0.013 0.532 0.0250 0.055 0.042	.015 0.9659 0.010 0.395 0.0250 0.042 0.032	•015 0.9659 0.0006 0.235 0.0250 0.026 0.020	.015 0.4657 0.004 0.138 0.0250 0.017 0.013	.015 0.4659 0.015 0.654 0.0125 0.066 0.067 J.015	•015 0.9659 0.013 0.532 0.0125 0.055 0.U54	.015 0.9659 0.016 0.395 0.0125 0.042 0.040	.015 0.9659 0.006 0.235 0.0125 0.026 0.025	.015 0.4659 0.004 0.138 0.0125 0.017 0.016	.015 0.9654 0.015 0.654 0.0100 0.066 0.672 0.015	•015 0°4654 0°013 0°532 0°0100 0°055 0°058 0°015	.015 0.9659 0.010 0.395 0.0100 0.042 0.044 0.013	.015 0.9459 0.000 0.235 0.0100 0.020 0.027 0.036	.015 0.4659 0.004 0.138 0.0100 0.017 0.017 0.00%	•015 0.4659 0.015 0.654 0.0050 0.066 0.094 u.015	0.015 0.4654 0.013 0.532 0.3150 0.055 0.076 0.315	•015 0.9559 0.010 0.395 0.3U50 0.042 0.05h U.013	0.015 0.9654 0.006 0.235 0.0350 0.026 0.034 0.005	.015 0.9653 0.004 0.138 0.0J50 0.017 0.022 J.UJ.
IN DATA APPROAC4 PIPE DATA	IA. MANN. SLUPF MN TERM. SLO ^d é mc mm Emfry En Coeff (Sim) m. Enérgy (Sim) m. m. dépt- em m.	15 0.015 0.9654 0.015 0.654 0.0250 0.066 0.052	LS 0.015 0.9659 0.013 0.532 0.0250 0.055 0.042	15 0.015 0.9659 0.010 0.395 0.0250 0.042 0.032	15 0.015 0.9659 0.000 0.235 0.0150 0.016 0.020	15 0.015 0.4657 0.004 0.138 0.0150 0.017 0.013	15 0.015 0.4659 0.015 0.654 0.0125 U.Occ 0.Uc7 J.015	15 0.015 0.9659 0.013 0.532 0.0125 0.055 0.U54	15 0.015 0.9659 0.01C 0.395 0.0125 0.042 0.040	15 0°015 0°4659 0°106 0°235 0°0125 0°026 0°025	15 0.015 0.4659 0.004 0.138 0.0125 0.017 0.016	15 0.015 0.9659 0.015 0.454 0.0100 0.066 0.072 0.015	15 0.015 0.4659 0.013 0.532 0.0100 0.055 0.058 0.012	15 0°015 0°9659 0°010 0°395 0°0100 0°045 0°044 0°013	15 0.015 0.9659 0.006 0.235 0.0100 0.026 0.027 0.036	15 0.015 0.4659 0.004 0.138 0.0100 0.017 0.017 0.00%	.15 0.015 0.9659 0.015 0.654 0.0050 0.066 0.094 u.015	15 0.015 0.4654 0.013 0.532 0.0150 V.055 0.U76 V.012	15 0.015 0.9559 0.010 0.395 0.3050 0.042 0.054 0.013	15 0.015 0.9654 0.006 0.235 0.0050 0.026 0.034 0.005	15 0.015 0.9053 0.004 0.136 0.0150 0.017 0.022 J.UJ.
COMMIN DATA APPROACH PIPE DATA .	DIA, MANN, SLUPE MN TERM, SLOPE MC MM ENTRY EN 5 m. Coeff (Sim) m. Energy (Sim) m. m. dept4 Em 5.	0 0.15 0.015 0.9654 0.015 0.654 0.0250 0.060 0.052	0 0°15 0°015 0°3459 0°013 0°532 0°0250 0°055 0°042	0 0.15 0.015 0.9659 0.010 0.395 0.0250 0.042 0.032	0 0°15 0°015 0°3659 0°006 0°235 0°0250 0°026 0°020	0 0.15 0.015 0.4657 0.004 0.138 0.0250 0.017 0.013	0 0.15 0.015 0.4659 0.015 0.654 0.0125 0.066 0.067 3.015	0 0.15 0.015 0.9659 0.013 0.532 0.0125 0.055 0.054	0 0°15 0°015 0°3459 0°016 0°345 0°0155 0°045 0°140	0 0.15 0.015 0.9659 0.006 0.235 0.0125 0.026 0.025	0 0.15 0.015 0.4659 0.004 0.138 0.0125 0.017 0.016	0 0.15 0.015 0.9654 0.015 0.454 0.0100 0.066 0.672 0.015	0 0.15 0.015 0.4654 0.013 0.532 0.0100 0.055 0.058 0.012	0 0.15 0.015 0.9659 0.010 0.395 0.0100 0.045 0.044 0.013	0 0.15 0.015 0.9559 0.006 0.235 0.0100 0.026 0.027 0.036	0 0.15 0.015 0.4659 0.004 0,138 0.0100 0.017 0.017 0.00%	0 0.15 0.015 0.4659 0.015 0.654 0.0050 0.066 0.094 0.015	0 0.15 0.015 0.4654 0.013 0.532 0.3350 0.055 0.076 0.315	0 0.15 0.015 0.9559 0.010 0.395 0.3050 0.042 0.054 0.013	0 0.15 0.015 0.9654 0.006 0.235 0.0350 0.026 0.034 0.005	0 0.15 0.015 0.9053 0.004 0.136 0.0350 0.017 0.022 J.UJ.

٠

e

.

.

.

a

.

.

.

A6.10 e 9

.

•

8

Ð

+

COMMUN DATA APPHILACE PIPE DATA

ŧ

ſ

ſ

f

t

•

f

TEST PIPE UNIN AND PAJSAAM NESJUTS.

0.063 -0.002 3.646 2.51) 211.2 0.063 -0.003 4.212 1.575 0.100 -0.003 9.746 3.739 1.517 0.333 -0.005 7.374 2.131 1.123 0.024 -0.031 0.652 0.533 0.099 0.049 -0.001 9.670 4.472 -0.000 6.620 3.234 215. 1 140 ÷ -0.000 1.525 -0.000 0.635 163-11 50.0--6-031 1-645 4577 F+h. ż FNEPCI CHANG: ÷ JUMP [APUSSIBLE AS MNCHC [M TEST PIPE. PIPE. PIPE. JUMP 14PULSIJLE AS MACHE IN TEST PIPE. JUMP IMPOSSIBLE AS MNCHC IN TEST PIPE. JUMP [MPD>S[BLE AS MACHE [N TEST PIPE. JUHP [MPUSSIBLE AS MNCHC IN TEST PIPE. JUMP IMPUSSIBLE AS MNCHC IN TEST PIPE JUMP [MPUSJIJLE AS MNCHC IN TEST PIPE 0.042 0.639 9-025 060.0 ENERGY ENERGY 0.110 0.042 NHUU ANULAU ÷ JUMP IMPOSSIBLE AS MNCHC IN TEST JUNP IMPOSSIBLE AS MNCHE IN TEST 0.100 6+0-0 0.062 0.063 9CC.0 0.025 0.110 0°094 120.0 0.070.0 JEPTA CHANGE 0.6824.124 0.UA6 J.757 0.000 0.007 600-0 0.015 0°00*0 0.002 100.0 6.043 160.0 0.026 0.012 0E P TH ŕ 0.6829.128 0.061 J. 3/2 0.15 1.677 0.016 1.01/ 0.15 1.677 U.U12 J.J22 0.4111.329 0.040 J.044 0.25 4.345 0.020 0.34 0.5619.71U 0.U>1 J.U>3 0.25 4.365 0.025 J.027 3. 5824 .120 0.045 J. J44 0.5614.710 0.014 J. J76 c*C.L ULU-0 426.1114.0 **** ť UP JUMP ULPIH ÷ **ENTRY ENTRY ENTRY** DEPT 4 ENERGY F +M ż ť *****.0 0.15 0.015 1.0000 0.010 0.404 0.0100 0.042 0.044 0.039 2.0 0.15 0.015 1.0030 0.006 0.240 0.0100 0.026 0.027 0.000 1.0 0.15 0.015 1.0000 0.004 0.141 0.6150 J.017 0.022 J.005 4.0 0.15 0.015 1.0000 0.015 0.060 0.0100 0.066 0.072 0.015 4.0 0.15 0.015 1.0030 0.015 0.648 0.0250 0.066 0.094 v.015 2.0 0.15 0.015 1.0000 0.006 0.240 0.0050 0.026 0.034 0.006 U. 056 0.067 U. 013 *0 0*15 0*015 1*0000 0*00* 0*141 0*0100 0*015 0*05 0*00 5.0 0.15 0.015 1.0300 0.012 0.544 0.3J50 0.055 0.076 0.012 4.0 0.15 0.015 1.0010 0.016 0.404 0.0150 0.042 0.056 J.03) 6.0 0.15 0.015 1.0000 0.012 0.544 0.0100 0.055 0.058 0.012 ŕ ••0 P.15 0.015 1.0000 0.010 0.404 0.0125 0.042 0.040 d.0 0.15 0.015 1.0000 0.015 0.668 3.0250 0.066 0.052 2.0 0.15 0.015 1.0090 0.00£ 0.240 0.0125 0.026 0.025 1.0070 0.006 6.240 0.0253 0.026 0.020 1.0 0.15 0.015 1.0000 0.004 0.141 0.0250 0.017 0.013 1.0 C.15 0.015 1.CC00 0.004 0.141 0.0125 0.017 0.016 4.0 0.15 0.015 1.0000 0.010 0.404 0.0250 0.042 0.032 5.0 0.15 0.015 1.0000 0.012 0.544 0.3125 U.055 U.U54 0.042 NH R 0.055 U E 4.0 0.15 J.015 1.0000 0.015 0.668 0.0125 6.0 0.15 0.015 1.6000 0.012 0.544 0.0250 TEAP. SLUPE ENERCY (STA) . E I I SLOPE 11121 2.0 0.15 0.015 NNN N COEFF И. 01 A. ۲/۱ ;

A6.11

9

\$

2

L

APPENDIX 7

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

W RATE .	1.0000	2.0000	3°000	4 ° 0000	5°0000	0 ° 00 0	7.0000	8.0000 L/S.	PIPE DÍA. O MÍDTH M.	~
E SLOPE				NORMAL DE	er HT9					
0.0017	0.0435	0°0624	0°0795	0.0956	0.1132	0.1449	0.1434	0.1499	0.1500	
0.0025	0.0394	0.0567	0°0700	C + 80 * 0	0.0976	0 • 1 1 Z I	0.1334	0.1499	0.1560	
0.0033	0.0365	0 • 052 6	0.0056	0.0774	0.0488	0.1006	0.4136	U.1321	0.1500	
0.0050	0.0332	0•047L	0.,585	0.0666	0.0781	0.0874	0.0469	0.1069	0.1500	
	0.0579	8550°0	0.0486	5 4 5 Q = Q	0-0640	0-0709	01110	0 4 4 0 4 3	0.1500	
0.0125	0.0254	E7E0.0	0.0459	0.0534	0.0602	0.0465	0.0727	U.0786	0.1560	
0°0250	0.0223	U.0314	0°0,184	0°0442	0.0500	0 < < 0 • N	٤५८८.0	₽ 4 0 0 4 4	0.1500	
				•	•					
0.0349	0.0206	0.0289	0.0353	0.0408	0.0458	0.0504	0. 4547	0.0586	0.1500	
0°0698	0.0174	0.0244	0.0297	0.0343	0.0383	.0.0421	0-0456	U • N 4 8 8	0.1500	
0.1045	0.0158	· 0 • (- 2 2 1	0°0269	0.0310	0.0347	0.0380	0.0411	0+40	0.1560	
0.1736	0.0140	0°0195	0°0%38	0 • 0274	0.0306	0.0335	0.0361	U.0346	0°1200	
0.3402	0°0120	0.0166	0.0202	0.0232	0°0259	U - 024 3	0.4306	. 9260.0	0.1500	
0.000	0°0109	0.0152	0.0184	0.0211	0.0236	0.025U	0.0278	0.0297	0.1500	
0.7070	0.0101	0.0140	0.0170	0.0195	0.0217	1620.0	U.U.555	U • 0273	0.1560	
0.8000	0.0394	0.0133	0.0162	0.0185	0.0206	6 2 2 0 ° 0	0.0243	0.0259	0°1500	
0.9659	0°0044	0 6 1 0 • 0	0.1157	U.0181	0.0201	0 ~ 0 7 7 0	0.0237	0.0253	U . 1540	
1.0000	0.0073	0.0129	0.0156	0.0179	0.0199	0.0218	0.0235	0 • 0 5 2 0	0.1500	
ITICAL	0.0280	0.0400	0.0493	0.0572	0.0443	0.0707	0.0767	0.0821		

FF.																							
COL	ĕ			0	õ	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	
AND MANNING	PIPE DIA. WIDTH H.			0-150	0-150	0.150	0.150	0.150	0.150	0.150	u • 150		0.150	0.150	0.150	0.150	0.150	0.150	0.150	0 • 150	0.150	0.156	
÷																							
R 0.1500	8-0000 1/5			10.5952	16.5942	13.8604	11.0078	10.2435	9.8852	9° 4054	E7+7.01		11.5125	13.8159	15.5854	16.3234	22.9158	26.1227	29.4151	31.5457	32.7049	33.1944	
EL DIAMETE	7.000			15.7493	13.1413	10.5482	4.ub54	8. 2674	8.2432	146L . B	4.0072		9.7118	11.6299	£96E1.E1	15.4262	19.2324	21.4478	24.7411	26.5538	27.5516	27.4198	
TION CHANN	6 • 0000	×.		15.0117	9.5115	8 . 30 8 7	fele./	6-9724	1467.0	0.8343	7.4453		1086.1	9.5548	10.7741	12.6432	15.7973	14.0141	20.2467	21 . 7516	22.5536	22 • 855 3	
CROSS SEC	5 • 00 00	HAL DEPTH.		8.8620	7.1472	6.3426	5+71-5	5.4457	5.3707	5.4080	5 • 8 4 7 0	•••	6.3174	7.5635	6 ° 2 1 8 3	9.9427	12.4756	14.2320	15.4499	17.1735	17.6022	10.0367	
A CIRCULAR	•• 0000	LUE AT NOR		6.1988	5.1430	4.7119	4.2653	4.1065	4.0332	4.0647	1354.4	•	4.7502	5.6741	6.3860	7.4932	9.3483	10.6593	11.9879	12.8413	11.3386	13.4955	
UE PTAS IN	3.0000	F+H VA		4.1076	3.5124	3.2200	2.+383	2.0366	2.1930	2.0159	3.0707		3.2853	3.4208	4.9071	5.1000	6.4485	7.3248	0+4 2 + 4 0	ded 396	9.1817	4.2905	
AT MORNAL	2.0000			2+3856	2.0697	1.9059	1.7447	1.6923	1.6678	4.6806	1.8266		1.9541	2.3248	2.6122	3.0598	3.8077	4.3266	4.8691	5.2191	5.4112	5.4780	
JES OF FON	1.0000			0.9844	0.8584	1562 0	0.7304	0.7059	16900	0.6980	0.7546		. 0.8036	0.9512	1.0657	1.2452	1.5474	1.7556	1679.1	2.11 64	2.1947	2.2198	
FABULATED VALU	FLOW RATE -		PIPE SLOPE	0.0017	0.0025	0.0033	0.0050	0.0066	0.0100	0.0125	0.0250		0*0349	0.0696	0.1045	0.1736	0.3402	0.5000	0.7070	0.8660	0.9659	1.0000	

. • • • • 5

1.0			CINCULAN						
	000		3.J000	4.0000	5°0000	6 . 0000	7.0000	8.0000 L/S.	PIPE DIA. <mark>Or</mark> WIDTH M.
				N <mark>u</mark> rmal dep	TH N.				
0 • 0	524 0	0999	0.0999	6440.0	6640°0	0 • 0 9 9 9	0°0994	0.0999	0-1000
0.0	168 6	1670.	0.0999	6440.0	0.0499	6490 ° 0	0.0999	0°0449	0.1000
0.0	433	0663	0.0494	6740°0	0.0499	0.000 0	0.0499	0.0999	0.1060
0.0	358 0	0524	0.0692	0.0444	0.499	6.00.0	0.049	0.0999	0.1000
0.0	321 0	0468	0.0599	0.6737	0.0949	6440°0	0°.499	0.0449	0.1000
0.0	254 0	.0434	0.0557	0.0675	0.0418	0.0707 0	0°0409	0°0999	0.1000
					*				
0-0	234 0	E E E O ° 1	0.0414	0.0487	0-0557	0.0626	0.0200	0.0783	6.1000
0-0	196 6	0.0278	0.0344	0.0401	0-0454	0°0504	0.0553	0.0602	0.1000
0.0	178 0	0251	0.0309	0.0359	0-0400	0.0448	0640-0	U.0531	0,0100
0.0	157 0	1.0221	0.0271	0-0314	0.0353	0.0340	0.0424	0.0457	0-1000
0.0	134 0	1.0187	0.0229	0.0264	0.0297	0 0 25 0	0.0353	0.0380	0.1000
0.0	122 6	0210-0	0.0208	0.0240	0.0269	0.0245	0.0320	U.0343	0.1000
0.0	112 6	. 2 510 .1	1010.0	0 * 7 0 0	0.0246	0 * 0 2 7 0	0.0292	0.0313	0 0 1000 1
0 - 0	107 0	6410-1	0.0182	0.0209	0.0234	0.0256	0-0277	0.0297	. 0.01000
0.0	104 0	1-0145	0.0177	0.0204	0.0224	0.0249	012U.0	0.0289	0.1600
0.0	9 (01	1.0144	0.0175	0.0202	0.6225	. 0 • 0 5 4 7	0.4267	0.0286	0 - 1000
0	916		0.0563		262.0	0000	0 4 4 5 6		
•••	676	TCLO			C 71 A * A	7610.0		2400.0	

•

ť
COLFF.	QR																
AND MANNING	PIPE DIA. MIDTH N.		0 - 1000	0-1000	0.1000	0-1000	0 • 1000		0.1000	0 - 1060	0.001.0	0.1000	0.1000	0.1000	0.1000	0.1000	0 • 1 00 0
R 0.1000 M	8-0000 L/S-		11.9940 11.9940	11.9940 11.9940	0466-11	11.9940 11.9940	11.9990		11-9907	16-0513	18.9462	23.8240	27.2308	30.7542	32。9663	34.2663	34.7480
HEL DIAMETE	7.000		10-0840	10-0440	10-0440	10.0440	9.0582		10.1267	13.5908	16.0075	20- 4069	22.9368	29.3695	27.0160	20.002	24.2229
CTION CHAN	6 .000 0	• X •	8 • 4 2 8 7 8 • 4 2 8 7	8 • 4 2 8 7 H • 4 2 0 7	8 . 4287	8 • 4 2 8 7	1.8872		9666 - 9	14.1807	13.1515	16.4949	18.8540	21.2520	22.3261	23.6962	23.9560
R CROSS SE	5.0000	RHAL DEPTH	7.0261	7-0291	7.0201	7.0281	6.2380	•	6.6116 7.8526	8-0645	10-4335	13.0490	14.8881	10.6191	18.0339	10.7102	18.4650
I A CIRCULA	4 ° 000 D	ALUE AT NO	5 • 8 8 2 1 5 • 8 8 2 1	5.8421	5.8821	4.5785	4.6871	•	4.9816 5.0263	6-6778	7.8421	9.8076	11.1868	12.5945	13.5034	14.0281	14.1951
DEPTHS IN	3.0000	F+M V	8055**	4.4408	3.2872	3.1794	3.2447		3.4539	4. 6206	5.4151	6.7653	7.7140	8.0901	6°1199	9.5667	4.7810
M AT NORMAL	2.0000		4°3542 2°6443	2.2964	1.8813	1.8081	1.9333		2.0586	2 - 7435	1 412.6	4.0108	4.5672	+GE1+G	5.5082	5.7202	5.7894
ALUES OF F.	1.0000		1.1524	0.8879	0.7647	0.7424	0-1990		9748.0 .	1.1254	1.3126	1.6337	1.8574	2.0902	2.2383	2 . 32 5 4	2.3531
TABULATED VI	FLOW RATE -	PIPE SLOPE	(SIN) 0.0017 0.0025	0.000	0.0066	0.0100	0.0250		0.0349	0-1045	0.1736	0.3402	0.5000	0.1070	0.8660	0.4659	1.0000

.

0•01S

,

A7.5

ATF = 1.0000 2.0000 3.0000 4.0000 5.0000 7.0000 6.0000 L/011	RATE =									
OFF MORMAL DEPTH N. 017 0.0749 0.0759 0.0759 0.0759 0.0759 0.0759 0.0759 0.0759 0.0759 <td< th=""><th></th><th>1 °0000</th><th>2°0000</th><th>3.0000</th><th>4°0000</th><th>0000°°ς</th><th>6 • 000 J</th><th>7.000</th><th>8.0000 L/S.</th><th>PIPE DIA. OR WIDTH M.</th></td<>		1 °0000	2°0000	3.0000	4°0000	0000°°ς	6 • 000 J	7.000	8.0000 L/S.	PIPE DIA. OR WIDTH M.
017 0.0749 0.0779 <td>LOPE</td> <td></td> <td></td> <td></td> <td>NORMAL DE</td> <td>• N H14</td> <td></td> <td></td> <td></td> <td></td>	LOPE				NORMAL DE	• N H14				
00000 0.00749 0.00750	2100	0.0749	0.0749	0-0749	0.0749	0.0749	0.0749	0.0749	0.0749	0.0750
0.011 0.0525 0.0749 0.0749 0.0749 0.0749 0.0749 0.0749 0.0749 0.0759	0025	0.0590	0.0749	0.0749	0.0749	0.0749	0.0744	0-0749	0.0749	0.0750
01650 0.0154 0.01749 0.01750	6600	0.0525	0.0744	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	0 \$ 2 0 ° 0
0.00115 0.07149 0.0750 0.0750	0 5 0	0.0454	0.0749	0.0749	0.0749	0.0749	0.0744	0.0749	0 • 0 7 • 9	0.0750
0.0167 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01750 0.01750 01125 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01759 0.01750 0149 0.01749 0.01749 0.01749 0.01749 0.01749 0.01759 0.01750 0149 0.01749 0.01749 0.01749 0.01749 0.01749 0.01750 0.01750 0149 0.0172 0.0381 0.0637 0.01749 0.01749 0.01749 0.01750 0.01750 01405 0.0217 0.0395 0.01749 0.01749 0.01749 0.01750 0.01750 01405 0.0172 0.02180 0.01351 0.01749 0.01749 0.01750 0.01750 01700 0.01172 0.01210 0.02750 0.01313 0.01313 0.01313 0.01349 0.01750 010101 0.01112 0.	0066	0.0415	0.0749	0.3749	0.0749	0.0749	0 • 074 Y	0.910.0	0.0749	0°0150
0.0114 0.01749 0.01749 0.01749 0.01749 0.01749 0.01749 0.01750 0.0259 0.01259 0.01749 0.01749 0.01749 0.01749 0.01749 0.01750 0.0259 0.01749 0.01749 0.01749 0.01749 0.01749 0.01750 0.01750 0.01750 0.01759 0.01749 0.01749 0.01749 0.01749 0.01750 0.0259 0.0181 0.0495 0.0551 0.01749 0.01749 0.01750 0.0172 0.0217 0.0195 0.01749 0.01749 0.01749 0.01750 0.0172 0.02147 0.01313 0.01749 0.01749 0.01750 0.01750 0.0172 0.02147 0.01351 0.01749 0.01749 0.01750 0.01750 0.0172 0.0172 0.01250 0.01749 0.01749 0.01750 0.01750 0.0112 0.01210 0.01274 0.01313 0.01496 0.01750 0.01750 0.01112 0.01211 0.01210 0.02231 0.02241 0.01211 0.01260	0100	0.0367	0.0540	0.0749	0.0749	0.0749	U.0749	0.0749	0.0749	0 < 2 0 0
0.0284 0.0422 0.0563 0.0749 0.0749 0.0749 0.0749 0.0749 0.0750 0.0284 0.0284 0.0749 0.0749 0.0749 0.0749 0.0749 0.0750 0.0284 0.0313 0.07495 0.0749 0.0749 0.0749 0.0750 0.0287 0.0313 0.07455 0.0749 0.0749 0.0749 0.0759 0.0289 0.0313 0.07475 0.0749 0.0749 0.0759 0.0750 0.0172 0.0172 0.0749 0.0749 0.0749 0.0759 0.0750 0.0172 0.0172 0.0171 0.01749 0.0749 0.0750 0.0750 0.0172 0.0172 0.0171 0.0244 0.0172 0.0156 0.0750 0.0112 0.0121 0.0121 0.0124 0.0174 0.0136 0.0750 0.0112 0.0121 0.0217 0.0131 0.0126 0.0131 0.0156 0.0156 0.0111 0.01212 0.01220 0.0131 0.0126 0.0131 0.0156 0.0156	0125	0.0344	0.0536	0°0749	0.0749	6.920°0	0 • 0744	0.0744	U.0749	0 • 0 7 5 0
0.0759 0.0381 0.0495 0.05749 0.0749 0.0749 0.0749 0.0759 0.0759 0.0313 0.0495 0.0561 0.0749 0.0749 0.0749 0.0759 0.0759 0.0313 0.0395 0.05416 0.0561 0.0749 0.0749 0.0759 1736 0.0217 0.0313 0.0395 0.03416 0.05412 0.0749 0.0759 1736 0.0175 0.0197 0.01516 0.01516 0.01516 0.0759 0.0170 0.0172 0.01266 0.01212 0.01276 0.01517 0.0157 0.0170 0.01112 0.01211 0.01201 0.02201 0.0251 0.01313 0.01314 0.01112 0.0157 0.01202 0.01202 0.01202 0.01202 0.0126 0.0126 0.01112 0.0157 0.01202 0.01202 0.01202 0.01202 0.0126 0.0126 0.0126 0.01112 0.0157 0.01212 0.01202 0.0122 0.0126 0.0126 0.0126 0.0126 0.01112 0.0157	0520	0.0284	0.0422	0°0563	0.0749	0.0749	0.0749	0.0749	U.0749	0 ° 0 7 5 0
0.0349 0.0259 0.0341 0.0495 0.0537 0.0749 0.0749 0.0749 0.0749 0.0759 0.0313 0.0313 0.0395 0.0541 0.0541 0.0749 0.0749 0.0749 0.0759 0.0495 0.0315 0.0541 0.0541 0.0749 0.0749 0.0749 0.0759 1736 0.0127 0.0245 0.0346 0.05416 0.0482 0.0749 0.0749 0.0759 0.0175 0.0246 0.0335 0.0482 0.0456 0.0749 0.07749 0.07769 0.0172 0.01206 0.01254 0.01335 0.04513 0.01512 0.07769 0.07769 0.0172 0.01206 0.02245 0.02335 0.01312 0.01349 0.0157 0.07769 0.0112 0.01219 0.02210 0.02247 0.01312 0.01349 0.01569 0.07769 0.01112 0.01219 0.01201 0.02219 0.02247 0.01312 0.01369 0.01769 0.01112 0.01194 0.01212 0.01224 0.01212 0.01112 0.017					•	•				
0349 0.0259 0.0341 0.0495 0.0547 0.0549 0.0749 0.0749 0.0749 0.0759 0698 0.0217 0.0313 0.0395 0.0541 0.0541 0.0749 0.0749 0.0759 0698 0.0175 0.0313 0.0345 0.0541 0.0542 0.0749 0.0759 0.0759 1736 0.0197 0.0280 0.0351 0.0346 0.0542 0.0552 0.0556 0.0759 0.0759 0.0759 1736 0.0117 0.0269 0.0358 0.0336 0.0335 0.0335 0.0335 0.0759 0.0759 0.0759 0.0759 1736 0.0112 0.0269 0.02358 0.0336 0.0335 0.01312 0.0159 0.0759 1707 0.0112 0.01210 0.02247 0.01312 0.01394 0.01394 0.0759 1000 0.0112 0.0129 0.02247 0.02347 0.01344 0.01394 0.0759 1010 0.01112 0.0129 0.02247 0.02247 0.01344 0.0136 0.0759 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>										
0.0217 0.0313 0.0395 0.0541 0.0749 0.0749 0.0749 0.0749 0.0749 0.0759 0.0750 1045 0.0175 0.0280 0.0351 0.0446 0.0752 0.0552 0.0546 0.0759 0.0750 1736 0.0172 0.0245 0.01351 0.0446 0.0459 0.0552 0.0569 0.0750 1736 0.0172 0.0245 0.01353 0.0336 0.0332 0.0511 0.0569 0.0750 3402 0.0112 0.0127 0.01313 0.0454 0.0569 0.0750 0.0750 3402 0.0112 0.0127 0.0336 0.03132 0.01313 0.0454 0.0750 3707 0.0112 0.0121 0.02247 0.0313 0.01312 0.0356 0.0750 3659 0.0111 0.0154 0.02241 0.02247 0.01212 0.01256 0.0750 3659 0.01112 0.0154 0.02243 0.02247 0.01313 0.01326 0.01356 0.0750 3659 0.01112 0.0157 0.02243	0349 .	0.0259	0.0381	0-0495	0.0637	0.0749	0.0749	0.0749	U.0749	0.0750
1045 0.0195 0.0280 0.0351 0.0482 0.0552 0.0646 0.0749 0.0759 1736 0.0172 0.0245 0.01365 0.0338 0.0459 0.0549 0.0569 0.0750 3402 0.01172 0.0245 0.0254 0.0274 0.0335 0.0313 0.0459 0.0569 0.0750 3402 0.0112 0.0264 0.0335 0.0333 0.0333 0.0454 0.0569 0.0750 3700 0.0112 0.0167 0.02249 0.03335 0.0333 0.0333 0.0336 0.0356 0.0750 3710 0.0112 0.0167 0.02249 0.0333 0.0313 0.0336 0.0356 0.03750 3700 0.0112 0.0167 0.02241 0.02749 0.0313 0.01312 0.0356 0.03750 3659 0.0111 0.0158 0.0122 0.01279 0.01279 0.01326 0.01326 0.01750 3659 0.01112 0.0158 0.01279 0.02779 0.01312 0.01326 0.01750 0.00750 0.01750 0.01750 <td>0698</td> <td>0.0217</td> <td>0.0313</td> <td>0°0395</td> <td>0.0475</td> <td>0.0561</td> <td>0 • 0744</td> <td>0.0749</td> <td>0.0749</td> <td>0.0750</td>	0698	0.0217	0.0313	0°0395	0.0475	0.0561	0 • 0744	0.0749	0.0749	0.0750
1736 0.0172 0.0245 0.0136 0.0358 0.0459 0.0549 0.0569 0.0750 3402 0.01146 0.07206 0.0254 0.0247 0.0335 0.0313 0.0464 0.03750 5000 0.0112 0.0167 0.0274 0.0335 0.0313 0.0464 0.03760 0.03750 7010 0.0112 0.0167 0.02210 0.02274 0.0313 0.0454 0.0356 0.03750 7070 0.0112 0.0171 0.0210 0.0274 0.0313 0.01310 0.0356 0.03750 7070 0.0112 0.0171 0.02210 0.0274 0.0313 0.01312 0.0356 0.03750 7070 0.0111 0.0124 0.02241 0.02274 0.02247 0.03267 0.03126 0.03750 9659 0.01112 0.0157 0.0122 0.01312 0.01326 0.01750 0.0750 9659 0.0112 0.0157 0.0223 0.0276 0.02779 0.0126 0.0126 0.0750 9659 0.0112 0.0157 0.0223	1045	0.0195	0.0280	0.0351	0-0416	0.0482	.0.0552	0.06%6	0.0749	0.0750
3402 0.0146 0.0206 0.0254 0.0246 0.0336 0.0372 0.0466 0.0544 0.0750 5000 0.0112 0.0167 0.02130 0.0302 0.0313 0.0466 0.0394 0.0750 7070 0.0112 0.0171 0.0210 0.0274 0.0313 0.04316 0.0356 0.0750 7070 0.0112 0.0171 0.0210 0.0274 0.0313 0.01312 0.0356 0.03760 7070 0.0112 0.0164 0.02247 0.0313 0.01312 0.0356 0.03750 7070 0.0111 0.0158 0.0120 0.02247 0.02247 0.01312 0.03316 0.0750 7050 0.01112 0.0157 0.02231 0.0279 0.0279 0.01276 0.0750 7000 0.0112 0.01197 0.0122 0.01276 0.01276 0.01260	1736	0.0172	0.0245	0.0305	0.0358	0.0408	0°0459	0.0511	0.0569	0°0120
5000 0.0112 0.0167 0.0270 0.0302 0.0313 0.0464 0.0344 0.0750 7070 0.0112 0.0171 0.0210 0.0244 0.0274 0.0313 0.01310 0.0356 0.0750 8660 0.0111 0.0120 0.0224 0.0274 0.0313 0.01312 0.0356 0.0756 9659 0.0111 0.0158 0.0129 0.0223 0.0279 0.0279 0.03277 0.03122 0.0356 0.03750 <td< td=""><td>3402</td><td>0.0146</td><td>0.0200</td><td>0.0254</td><td>U = 0246</td><td>0.0336</td><td>5760.0</td><td>0-0408</td><td>U. 0 4 4 4</td><td>0 - 0 7 5 0</td></td<>	3402	0.0146	0.0200	0.0254	U = 0246	0.0336	5760.0	0-0408	U. 0 4 4 4	0 - 0 7 5 0
7070 0.0122 0.0171 0.0210 0.0244 0.0274 0.0313 0.0130 0.0356 0.0376 8660 0.0111 0.0163 0.0120 0.02247 0.0312 0.0312 0.0356 0.0750 9659 0.0111 0.0158 0.01194 0.02231 0.0273 0.0279 0.0312 0.0326 0.03750 9659 0.0111 0.0158 0.01194 0.0223 0.0279 0.0279 0.0376 0.0750 0.0750 0.0756 0	5000	2610.0	0.0167	0.20.0	0.0267	0.0302	6 E E E O • O	0.0364	0.0394	0 < 2 0 0
#660 0.0116 0.0123 0.0231 0.0260 0.0277 0.0312 0.0316 0.0750 9659 0.0111 0.0158 0.01194 0.0275 0.0279 0.0130 0.0326 0.0750 0000 0.0112 0.0157 0.01223 0.0276 0.0326 0.0323 0.0276 0.0326	7070	0.0122	0.0171	0.0210	0.0244	0.0274	6 U E O S U B	0.(1)0	0.0356	0 • 0 2 5 0
9659 0.0111 0.0158 0.0194 0.0225 0.0253 0.0279 0.0103 0.0326 0.0750 0000 0.0112 0.0157 0.0192 0.0223 0.0250 0.0276 0.0300 0.0323 0.0750	4660	0.0116	0.0163	007000	0.0231	0 . 0 2 6 0	0.0247	0.0312	U.0336	. 0520°0
0000 0.0112 0.0157 0.0192 0.0223 0.0250 0.0276 0.0300 0.0323 0.0750	9659	0.0113	0.0158	0.0194	0.0225	0.0253	0.0279	0.0303	U. 0326	0.0750
	0000	0.0112	0.0157	0.0192	0.0223	0.0250	0.0276	0.01300	U.0323	0.0750
	CAL	0.0343	0.0493	0.0602	0.0675	0.0714	0.0732	0.0740	0-0745	

0

.

•

IANNING COLFF.	•E DIA• OK)TH M•			0.0250	0 \$ 20 \$ 0	0.0750	0 ° 0 7 5 0	0<20.0	0 \$ 20 \$ 0	0 \$ 2 0 \$ 0	0.0750		0.0750	0 • 0 7 5 0	0.0750	0 < 0 > 0	0,0750	0.0750	0<20.0	0.0750 1	0 4 2 0 0	
0.0750 M. AND P	0000 L/S. PI			1094	1094	1094	1094	1044	1094	+601	1094		1094	1094	1094	1607	9933	5645	2549	b524	0168	
AMETER	9900 8*0			140 46.1	140 16.	140 16.	140 16.	140 16.	140 16.	140 10.	140 10.		140 10.	140 10.	.422 16.	1919 18.	1471 23.	1491 27.	124 31.	1258 33.0	1510 35.	
CHANNEL DI	0000 7+0			712 12.0	7122 12.7	1712 12.1	7112 12.0	1712 12.0	7712 12.1	1712 12.1	1712 12.1		712 12.1	1712 12.0	1711 13.2	2590 L>.Y	1749 20.3	1902 23.1	1318 26.4	1802 - 28.4	2.02 0119	
S SECTION	000	EPTH. N.		612 9.7	412 9 .7	012 9.7	d12 9.7	1812 4.1	d12 9.7	412 9.7	812 4.1		612 9.7	212 9.7	567 11.1	875 13.2	254 16.7	496 19.2	390 24.7	060 23.3	1047 24.2	
CULAP. CROS	000 5-0	IT NORMAL D		1.2 7.2	2+34 7.2	1439 7.2	2+34 7+2	5 - 7 - 2	1.2 7.2	1.1.2	2.1 9643		1546 7.2	213 7.9	7920 8.9	1967 10.5	E.E1 78+0	903 15.2	1768 17.2	1265 18.5	1520 19.2	
IS IN A CIR	. 000	+H VALUE A		593 5.2	593 5.2	593 5.2	593 5.2	593 5.2	593 5.2	5.2 5.2	5.2		674 5.1	028 6.0	1.04 405	568 7.9	1687 10.0	1981 11:4	125 12.9	076 13.9	1934 14.4	
RRAL DEPT	0000 3° U	u.		1275 3.b	3.6	3.0	c75 3.5	275 3.0	3488 3.6	713 3.0	162 3.4		3-6 416	101 4.2	1276 4.7	1120 5.5	399 6.4	151 7.4	1153 8.4	003 9.5	1220 9.4	
FFA AT M	0000 2-0			3484 2.5	2441 2.4	1537. 2.5	1959 2.5	1359 2.5	1429 2.0	1 TL 1.	3306 2.0		1805 2.1	1383 2.5	1647 2.6	16 06 3.5	1932 4.1	1250 4.7	709 5.3	12 73 5.0	1134 5.5	
VALUES OF	= 1+0			7 1.6	5 1.2	3 1-0	0 0.8	6 0.8	0 0	5 0.1	0.6		9.0.6	0 1-0	5 1.1	6 1.3	2 1.6	0 1.9	0 2.1	0 2.3	9 2.4	
TABULATED	FLOW RATE		LIPE SLOPI	0.001	0.002	0.003	0.0050	0.006	0-010	0-012	0.025		\$*E 0=0	0.0690	0-104	. 0.173	0.340	0.500	0.707	0.8460	0.9655	

.

0.015

.

	TABULATED	MOPPAL FLOW DI	EPTHS FUR	A RECTANGUL	.AR CMANNEL	OF MIDTH	0-1500	M. AND MA	NNING COEFF.	0.0150
	FLOW RATE	. 1.0000	2-0000	3.0000	4 • 000 0	0000°\$	0000	7°00	8.0000 L/S.	PIPE DIA. 00 WIDTH M.
	ALL STAF				NORMAL DE	PTH N.				
	0.0017	0.0310	0.0501	0.0673	0.0836	0.092	0.1145	0-1294	U.1442	0.1560
	0.0025	6.0272	0.0438	0.0585	0.0123	0.0355	0.0964	0.1110	0.12J9	0061.0
	0.0033	0°0248	0.0397	0.0528	0.0652	0.070	0.0084	6640°0	0.1105	0 9 4 1 0
	0.0050	0.0216	0.0344	0°0456	0°0500	0.0060	6¢10°0	0.0449	0.040	0°1500
	0.0346	0°0101	0.0313	0~0413	0°0507	0.0596	u • 068 L	0.0764	U. U844	0.1500
	0.0100	C.0172	0.0272	0°U 358	0.0438	0.0512	< 9 < 0 ° 0	0.0654	0.0723	0.1500
	0.0125	0.0160	0.0252	0.0332	0.0405	0.0474	0 • 0 5 3 9	0.0603	U.0665	0.1500
•	0.0250	0.0128	0.0201	0°0262	0.0314	1160.0	0.0422	0.410	0.0517	0.1560
					•	• • •				
	0.0349	0.0115	0.0180	0.0235	0.0284	1660.0	0.0375	0-0410	0.0459	0.1500
	0.0690	0.0093	0-0144	0.0187	0.0226	0.0262	0.0296	0 ° 7 3 2 9	0°0360	0.1560
	0.1045	0.0092	0.0126	0.0164	0.0198	0.0229	0.0250	0.4287	0°0314	0.1500
A	0.1736	0.0070	0.0100	0°0134	0.0168	0.0194	U . 0218	U • U2 4 2	0.0265	0.1560
7.	0.3402	0.0051	0.0087	0.0112	0.0135	0.0156	0.0175	0.0194	0.0211	0.1540
8	0.5000	0 0 0 0 0 0	0.0077	0°100	0.0114	0.0138	U.0155	0.U171	U.0187	0.1560
	0.7070	0.0045	0.0069	0~0049	0.0107	0.0123	0.0139	0.0153	0.0167	0.1500
	0.8660	2 % 00 % C	0.00.65	0.0084	0.0100	0.0116	0 . 0 1 10	0.0143	U.0156	0.1500
	0.9659	0.0041	0.0063	1800.001	0.0047	0.0112	0.0125	0 • U 1 1 4	U.0151	0.1500
	1.0000	0.0041	0.0062	0 • 0 0 0 0	0.0096	0.0111	0.0124	1610.0	0.0149	0.1560
	CRITICAL DEPTH N.	0•0165	0.0263	0°0 344	0.0417	0.0484	0.0546	0 • 0 • 0 5	U. 0662	

LOW RATE .	1.0000	2.0000	3.0000	0000*	5.3000	6 • 000 0	0000-2	4.0000 L/	5. PI	PE DIA. OR
										DVN N.
			F+M VA	LUE AT NOR	IMAL JEPTH.	х.				
The shore										
10000	0.9207	2105-2	4.2279	6-4147	8-9259	11.7345	14-0474	10.2604		0.1500
0.0025	0.7892	2-0184	3-5425	5.3173	7.3251	9.5547	12.0029	14.6632		0.1560
0.0033	0.7207	1.0297	3.1400	1 692.4	6+54.0	8+9+ R	10.2713	12.6470		0.1500
0.0050	0.6517	1.6450	2.0454	4.2110	5.2275	7.3730	9.1200	4160-11		0.1540
0.0066	0.6239	1.5720	2. 1089	3.9958	5.4072	6 4 5 9 3 5 3	8-2698	10.2994		0.1500
0.0100	0.6053	1.5247	2.6189	3.8465	5+1443	6 • 6202	8 . L+27	9.7962		0.1500
0.0125	0.6050	1.5254	2.6184	3.6407	5.1694	1065.0	0.0926	9.6698		0.1500
0.0250	0.6408	1.6258	2.0432	4.0954	5.5052	1.0010	8.5768	10.2216		0.1500
				•••						
0.0349	0.6761	1.7204	2.4628	4.3460	5.0427	1-4304	4.1025	10.8475		0.1500
0.0698	0.7421	2.0063	3.4666	5.0946	6-8659	0.7504	1661.01	12.8007		0.1500
0.1045	0.6658	2.2267	3. 35 70	5.6661	7.6620	9.7804	12.4030	14.3267		0.1560
. 0.1736	0-9420	2.5640	4.4514	6.5699	0.0710	11.33778	13.4357	16.6408		0.1500
0.3402	1.2009	3.1170	5.4340	0 = 0 3 3 0	10.8606	1416.61	17.4231	20.5037		0.1500
0.5000	1.3438	3.4970	6.1019	9.0329	12.2514	15.6786	14.3262	23.1233		0.1500
0.7070	1.4898	3.8606	6.1769	10.0508	13.6267	17.4673	21->>03	25.8244		0.1500
0.8660	1.58 15	4.1250	7.2102	10.6948	14.5120	16.6237	22.4502	27.5126		0.1500
0.9659	1.6351	4.2658	7.4576	11-0709	15.0256	14.2641	23.7548	24.4472		0.1560
. 0000	1 . 5 . 1	- 300 -	2 - 120		16.1323	10 4030	1111	0100 HC		0.150.0

A7.9

. . . .

	TABULATED NOR	HAL FLOW DE	PTHS FUR	A RECTANGULA	R CHANNEL	UF MIDTH	00100	N. AND MA	NNING COEFF .	0-0150
	FLOW RATE -	1.0000	2.0000	3.0000	0 0 0 0 ° \$	\$ • 0 000	0 000 • 9	1.0300	8-0000 L/S.	PIPE DIA. D MIDTH M.
					NORMAL DEP	PIM N.				
	PIPE SLOPE (SIM)									
	0.0017	0.0100	0.0100	0.0100	0°0100	001000	0.100	0.4400	0.0100	0.0100
	0.0025	0.0100	0.0100	0.4100	0.0100	0.0100	0.10.0	0.0100	0.0100	0°100
	0.0033	0.0100	0.0100	0.0100	0.0100	0.0100	0010 0	0.1100	0.0100	0.0100
	0.0050	0.0100	0.0100	0.0100	0.0100	0.0100	0010.0	0.0100	0.0100	0.0100
	0.0066	00100	0.0100	0.100	0.0100	0.0100	0.0100	0.10.0	0.0100	0°0100
	0.0100	0.0100	0-0100	00100	0.0100	0.0100	0100	0-1100	U.0100	0.0160
	0.0125	0.010.0	0.0100	0.0100	0.0100	0.0100	0.0100	0.1100	U.0100	0.0100
	0.0250	0.0100	0.0100	0.100	0.0100	0.0100	0.0100	0.1100	00100	0°0100
					•••					
	0.0349	00100	0.0100	0.0100	0.0100	0.0100	0.0000	0.0100	0.0100	0.0100
	0.0698	00100	001000	0.0100	0.0100	0.0100	0.0000	0.010.0	U.0100	0.0160
	0.1045	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
	0-1736	0.010.0	0.0100	0.0100	0.0100	0°0100	0.0100	001000	0.0100	0.0100
Δ.	0.3402	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.4100	0.0100	0.0100
7.	0.5000	0°0100	0.0100	0.0100	0.0100	0 * 0 1 0 0	0.0100	0.10.0	0.0100	0.0100
10	0.7070	0.0100	0°0100	0.0100	0.0100	0.0100	0.10.0	0.0100	U.0100	0.0100
)	0.8660	0.010.0	0.0100	0.0100	0.0100	0.0100	0.10.0	0.0100	0.0100	0.0100
	0.9659	0°10°0	0.0100	0.0100	0.0100	0.0100	0.10.0	0.0100	0.0100	0.0100
	1.0000	001000	0.0100	00100	0.010.0	0.0100	0.0100	0.4100	001000	0.0100
										•
	CRITICAL DEPTH M.	0.0100	0.0100	0.0100	0.0100	0.010.0	0.0100	0.0100	0.0100	

. .

PIPE SLOPE	1.0000	2.0000	3.0000	4.0000	5-0000	0000 · ·	7.0000	8.0000 L/S.	PIPE DIA WIDTH M.	8
PIPE SLOPE			F .M VI	LUE AT NO	RAAL DEPTH	. И.				
1 2100 0	1+10-0	40-0440	90.0928	160.1610	250.2491	360 . 3562	490.4436	640-6299	0.01	03
0.0025 1	1+10-0	40.0440	90-0928	160.1610	250.2491	360 . 3562	490.4436	640°6598	10.0	00
0.0033	2+10-0	40-0440	90.0928	160.1610	250.2491	360 . 3502	440.4836	640.6249	0.01	00
0.0050	1+10-0	40-0440	90.0928	160.1610	250.2491	360 . 3562	490.4836	640°6299	10.0	00
0.0066	1+10-0	40.0440	90. J928	160.1610	250.2491	360.3562	490. + 36	640.6249	0.01	00
0.0100	1+10-0	40.0440	90.1928	160.1610	250.2491	360 . 3562	490.4436	640.6299	0.01	00
0.0125 1	0.0147	40.0440	90. 1428	160.1610	250.2491	360.3562	490.4836	640.6299	0.01	00
0.0250 1	0.0147	40.0440	90° 1928	160.1610	250.2491	360 . 3562	440.4436	640.6249	0.01	00
				•						
1 . 640.0	0-0147	40-0440	90.0928	160.1610	250.2491	360 . 3562	490.4436	640 ° 6299	0.01	00
0.0696	0.0147	40-0440	90.0928	160.1610	250.2491	360.3562	440.4836	640° 6299	0.01	00
0.1045	1410-0	40-0440	90.0928	160.1610	250.2491	360.3562	490.4436	640.6299	0.01	00
0.1736 1	0.01 47	40°0440	90.0428	160.1610	250.2491	360.3562	440.4036	640.6299	0.01	00
1 2040-0	0-0147	40.0440	90.0928	160.1610	1642.065	360 . 3562	490.4436	640.6299	0.01	03
0.5000 1	1410-0	40-0440	90.3928	160.1610	2945.065	360.3562	490.4436	640.6299	0.01	00
0.7070 1	0-0147	40.0440	90.0928	160.1610	250.2491	360.3562	490.4836	640.6299	0.01	00
0.8660 1	0.01+7	40.0440	90.0928	160.1610	250.2491	360.3562	440.4436	640.6249	0.01	00
0.9659 1	1+10-0	40.0440	90.0928	160.1610	19+5.065	360 . 3562	490.4836	640.6299	0.01	00
1.0000 1	1.10.0	40.0440	90.0928	160.1610	250.2491	360.3562	410.4836	640.6299	0.01	00

	TABULATED MOI	RMAL FLOW JE	FTHS FUR	A RECTANGUL	.AR CHANNEL	0F MLOTM	0.0750	M. AND MA	.NNING COEFF.	0.0150
	FLOW RATE .	1.0900	2.0000	3.3000	0900*•	5 • 0000	6 • 0000	7.0300	8.0000 L/S.	PIPE DIA. O WIDTH M.
					NOKMAL DE	PTH N.				
	PIPE SLOPE (SIM)									
	0.0017	0.0599	0.0749	0.0749	0.0749	0.0749	0.0749	0.0749	U.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 • 0744	0-0149	0.0749	0 4 2 0 2 5 0
	0.0050	\$6E0*0	0.0677	0.0749	0.0749	0.0749	0.0749	0.0744	0.0749	0 < 0 2 5 0
	0.0066	0.0355	0.0005	0.0749	0.0149	0.0749	0.0744	0.0749	0.0744	0.0750
	0.100	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. 1649	0-0744	6.420°0	0.0749	0.0749	U.0749	0 \$ 2 0 \$ 0
	. 0.0250	0.0219	0.0362	0.0493	0.0619	0.0742	0.0749	0.0749	0.0744	U \$ 1 0 . 0
					•	•••				
	0.0349	0.0195	0.0320	\$E\$0°0	0.0542	0.0648	0.0749	0.0749	0.0749	0 ° 0 3 5 0
	0.0698	0.0154	0.0249	0.0335	0.0415	0.0493	0.0568	0.0042	U.0715	0.0750
	0.1045	0*0T34	0.0216	0.0280	\$\$£0°0	0.0422	0.0445	0.3547	0.0608	0.0750
	0.1736	0.0113	0.0101	0-0240	U.0246	0.0346	004000	0 • 4 4 9	0.0496	0.0750
A	. 2040.0	0.0091	0.0144	0.0190	0.0232	0.0272	1160.0	0.0348	0.0385	0 < 0 1 > 0
7.	0.5000	0.0080	0.0126	0.0166	0.0203	0.0237	0.0270	0.0302	0.0333	0 < 2 0 2 5 0
12	0.7070	0.0072	C110°0	0.0148	0.0180	0.0210	6.0239	0.0267	0.0244	0 ° 0 7 5 0
?	0.8660	0.0067	0.0105	0.0138	0.0168	0.0196	U . 0222	0. 12 4 8	0.0273	0 < 1 0 0
	0.4059	0.0065	0.0102	0.0133	0.0162	0.0108	0.0214	0.0239	0.0262	0.0750
	1.0000	0.0064	0.0101	0. 11 32	0.0160	0.0166	0.0211	0. 42 36	u.0259	0 • C 7 > 0
•	CRETECAL DEPTH N.	0.0263	0.0417	0.0546	0.0662	0.0749	4420°0 .	0.0749	0.0749	

Ĕ																		1.	
PIPE DIA. MIDTH R.		0.0750	0.0750	0 4 2 0 3 9 0	0<10.0	0 \$ 2 0 \$ 5 0	0 \$ 2 0 • 0	0.0750		0.0750	0.0750	0.0750	0.0750	0.0750	0 \$ 20 \$ 0	0.0250	0 < 2 0 * 0 2 > 0	0.0750	0 ~ 0 7 5 0
us.																			
8 • 0000		13.4542	13.4542	13.4542	13.4542	13.4542	13.4542	13-4542		13.4542	13.0130	15.3898	18.0574	22.7159	26.0012	24.3541	31.5306	32.7746	33.1822
7.0000		10.7449	10.7849	10.7849	10.7849	10.7849	10./449	10./849		10.7849	41.0932	19+0.61	15.2020	19.1364	21.1474	24.1510	26.531	21.5429	27.4282
0 0 0 0 • •	• 2	8 4715 4 4715	8.4715	9-4715	8 . 4 7 L 5	C174.8	a.4715	8-4715		0.4715	9.6376	10.7564	12.6012	15.7453	5210° RT	20.2977	21.7577	22.9412	22.8010
\$°0000	AL DEPTH.	6.5140	0.140	6.5140	6.5140	6.5140	0+14.9	6.517 8	:	6.6893	7.6600	6.5617	10.0129	12.5151	14.2643	16.0136	17.1703	17.8220	18-0277
• • 000 0	UE AT NORN	4.9125	4.9125	4.9125	4.9125	4-9125	4.9125	1668.4	•	5.0155	5.7749	6.4516	1.5358	1476.9	10.6758	11.9774	12.0159	13.2981	13-4473
000 C*E	F+M VAL	3.6668	3.6668	3.6668	3.5664	3.5448	3. 3476	3.1278		3.4580	3.4986	4.4670	5.2040	6.4524	7.1232	6.1963	6.7676	9.U859	9-1849
2 - 000 0		2.7771	2.7771	2 + 7 + 3	2.2291	2.0092	1.94bb	1.9549		2.0427	2.3686	2.6419	3.0671	3.7842	4.2771	4.7790	5.1020	5.2815	9125.2
1.0000		1.5415	1.0732	0.90 88	66193	0.7790	0.7649	0.7451		0.4236	0.9543	1.0591	1.2228	1.4477	1.6352	1.8754	1.9994	2.0692	2.0912
RATE -	E SLOPE	2100-0	0.0033	0,0000	0.0066	0.0100	0.0125	0,0200		. 6460-0	0.0698	0.1045	0.1736	0.3402	0.000	0. 7070	0.8660	0.9659	1-0000

.

A7.13

APPENDIX 8

JUMP FORMATION INDICATOR TABLES FOR 0.15 m PIPE DIAMETER FOR A RANGE OF MANNING COEFFICIENTS FROM

0.009 TO 0.018

0 • 01 6 0	31																							
INING COEFF.	PIPE DIA. O MIDTH M.			0.1500	0.1566	0.1506	0.156C	0.1500	0.1500	0.1500	0.1560			0.1500	0.1500	0.1500	0.1560	0.1500	0.1560	0.1500	0.1506	0.1500	0.1560	
1500 M. AND MAN	6.0000 L/S.			0.1499	0.1499	0.1499	0.1271	0°1107	0 • 0 4 8	0.0881	0.0714			0.0649	0.0538	U = 0 4 6 4	0.0424	0.0358	0.0325	0.0298	6 ° 0 2 8 4	U.0276	0.0274	U.0421
ſ E.K. 0.	7-000			0.4499	0°1444	0 . 4 4 99	0.1113	0.0448	0. 4468	0.0411	0.0662			0.0603	0.0501	0.0451	0.0396	0°0335	0.0304	0. 4279	0. 42 66	0.0259	1620.0	0.0767
UF DLAMEI	6 . 000 0			0.1449	0.1499	0.1165	0.0408	0.0449	u • 0 7 4 0	9L70.0	U • 0 6 0 8			0°0555	0.0403	0.0416	U .0367	0160.0	U .0282	0.0259	0.0246	0,20.0.	0.0236	1010.0
DN CAANNEL	5 ° 0 00 0	TH N.		0.1499	0.1121	0.1006	0.0874	0.0802	0.0709	0.0665	0\$<0°0	•		0°0404	0.0421	0.0160	0.0135	0.0203	0.0258	0.0237	0.0225	0.0220	0.0218	0.0643
R055 5ECT1(4°0000	NURMAL DEP		0.1094	0.0448	0.0866	0.0762	0.0703	0.0625	0.0584	0.0484		•	0+0+0	0.0376	0.0340	0.0299	0.0254	0.0231	0.0213	0.0202	0.0147	0.0195	0.0572
CIRCULAR C	000r°€.			0.00000	0620.0	0.0728	0.0646	492 LOO	0. 1535	0.0504	0.3422			0.0387	0.0325	0. J295	0.0260	0.0221	0.J201	0.0185	0.0176	0. J 1 7 2	0.0170	0.0493
THS FOR A	2.0000			U. 0697	0.0625	0.0580	0.0519	0.0482	0.0433	0.0404	0-0343			0.0310	0.0266	U+0242	0.0213	0.0182	0.0166	0.0152	0.0145	0.6142	0.0146	0 • 0 • 0
L FLON DEP	1.0000			0.0479	0.0433	0-0403	0.0363	0.0339	0-0306	0.0289	0.0244			0.0225	0.0140	0.0173	0°0153	0.0130	0.6119	0.0110	0.0105	0.0102	1010.0	0-0290
T/BULATED NDRMA	FLOW RATE =		PIPE SLOPE	0.0017	0-0025	0.0033	0-0050	0-0066	0-0100	0-0125	0.0250			0.0349	0.0698	0-1045	. 0.1736	2040.0	0.5000	0.7070	0.8660	0.9659	1.0000	CRITICAL Depth n.

A8.2

COEFF.	ğ																					
. AND HAMMING	PIPE DIA. (MIDTH M.			0.1560	0.1500	0.1560	0.1566	0.1560	0.1500	0.1500	U.1500		0.1500	0.1560	0.1500	0.1500	0.1500	0.1500	0.1500	0.1540	0.1560	0 • 150 0
R 0.1560 M	8-0000 L/S-			16.5982	16.5982	16.5982	13.1422	11. 3472	10.2006	4°9506	10.1684		10.6423	12.4816	13.9551	16.3096	20.2746	23.0919	22.9891	21.8297	20.9225	24.2493
IEL DIAMETE	7.4000			15.7493	15.7493	15.7493	10.1155	9.6024	8.2061	8.1394	8.0117		9.U154	10. 2224	11.7778	1767.61	17.0065	14.40 45	21.0374	23.4048	26.2432	24. 2419
TION CHANN	0 0 0 0 0 Q	r		12-0137	15.0137	10.0377	6.1512	7.4660	0.4329	601000	7.0368		2 < 0 + 2	8 • 6 4 0 4	9.6644	11.2524	13.9404	15.4100	12.9074	19.1890	14.8442	20-15-5
CR055 SEC	5.0000	MAL DEPTH.		14.3911	9.7352	4564-1	6.2839	5.8291	5.4579	1186.3	5.5738	• •	5.8673	1048.0	7.0462	8.4005	11.0505	LE12.51	14.1396	15.1510	15.7251	15.9137
A CIRCULAR	0000**	LUE AT NOR		7.7482	6.1254	5.3807	4.6410	4.3316	4 • 0 d b 2	4°0379	4.1925	•	4.4097	5.1371	5.736U	6.6785	8.2796	9.4097	10.5419	14.3462	11.7664	11.9240
GEPTHS IN	0000°°E	F .M VA		1969.4	4.0733	3. 6279	9+1 1-6	2.4831	2.4247	2.7945	2.4036		3.0543	3.5540	3.959B	4.6096	5.7122	6.4411	7.440	7.d089	8. 1446	8.1941
AT NORMAL	2.0000			2.8170	2.3649	2.1300	1.6631	1.7754	1.6862	1.6687	1.7319		1.8196	2.1107	1946.5	2.7306	3.3763	3.8312	4.3045	4.6632	6477.4	4.8419
LES OF F+H	1.000			1.1457	0.9169	0.6832	0.7846	0.7405	0.7033	0.6948	0.7166		6.7504	0.8662	0.9603	1.1120	1.3776	1.5574	1.7472	1.0705	1.4332	1.94 35
TABULATED VALL	LOW RATE -		IPE SLUPE (SIN)	0.0017	0.0025	0.0033	0.0050	0.0066	0.0100	0.0125	0°0250		0.0349	0.0698	0.1045	0.1736	0+3402	0.5000	0-7070	0.8660	0.9659	1.0000

٠

10*0

0150								. *				•	· ·		۶			
WING COLFF.	PIPE DIA. OR MIDTH M.		0.1560 0.1506	0-1540	0.1560	0.151.0	0 • 1 5 4 0 0 • 1 5 4 4		0.1500	0.1500	0°1200	0.1500	0099900	0,151.0	0.021.00	0.1500	0 • 15 0 0	
.1500 M. AMU MAN	&.0000 L/S.		U = 1 4 9 9 U = 1 4 9 9	0.1321	U. 0965	U.0843	U = 0 2 8 6 U = 0 6 4 4		0.0548	U = 0 4 6 8	0.0440	0.0386	0.0020	6720.0	U.0259	0.0253	u • 0 2 5 0	0.0621
TER O.	7.0000		0.1499	0-1136	0.0483	0.0776	151v.0 992v.0		0.0547	0.4456	0.0411	0.0361		0. 3255	6+20-0	1120.0	0.0235	0.0767
UF DIAME	6 • 0000		0.1499	0-1006	U = 08U2	0.0709	0 - 0 6 6 5 0 0 - 0 5 5 0		0.0504	U -042 l	0 . 0 3 4 0	0335 0150	0.025A	1620.0	0.0225	0.0220	U • 02 L 8	1 0 0 0 0
ION CHANNEL	5°0000	ТМ и.	0 • 1 1 3 2 0 • 0 9 7 6	0.0888	0.0720	0.0640	0°0502 0°0500	• •	0.0458	0.0303	0.0347	0.0306	0-0250 0	0.0217	0.0206	0.3201	0.0199	6490.0
CRUSS SECTI	4.0000	NORMAL DEP	0.0956 0.0843	0.0774	0.0635	0.0567	U = 0 5 3 4 0 = 0 4 4 5	•	0.0408	0.0343	0.0310	0.0274	0.0211	0.0195	0.0145	0.0181	6/10-0	
CIRCULAR	3.0000		0°0705 0°0709	0.0656	0.0542	0.0486	0.J%59 0.J384		0.0353	0.3297	0. U 2 69	0.0238	0-0202	0.0170	0.0162	0.3157	0. 1156	£640°0
PTHS FOR A	2.0000		U • 0629 0 • 0567	0.0526	0 • 0 • 3 B	0.0344	0.0374		0.0269	0-0244	0.0221	0.0195	0.0100	0.0140	0.0133	0.0130	0.0129	0°0400
AL FLOW DE	1.0000		0.0435	0.0368	0.000	0.0279	0 • 02 64 0 • 02 2 3		0.0206	0.0174	0.0158	0*10*0	0-010-0	0-0101	0.00 36	4600.0	0.0073	0.0280
TABULATED MORN.	FLOW RATE -	PIPE SLOPE	0.0017 0.0017 0.0025	0.0033	0.0060	0.0100	0.0125 0.0250		0*0349	0.0678	0+1045	0.1736	00.5000	0.1070	0.8660	0.9654	1.0000	CRITICAL DEPTH N.

A8.4

•

COEF	NO.			~	•	~	~	0	0		~		•	0	-	0	•	0	0	3	0	0	
AND MANNEML	PIPE DIA. WIDTH M.			0.156(0-150	0.150	0-150	0.150	0.156	0.150	0-1-0		0-150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0-150	
0.1500 M.	8.0000 US.			10.5982	16.5982	13.8604	11.0078	10.2435	9.8852	4.9054	10.7473		11-5125	13.8159	15.5854	18.3234	22.9158	26.1227	24.4151	34.5457	32.7449	\$ \$ 6 T • F E	
EL DIAMETER	1.0000			15-7493	C141.61	10.5482	4.0654	8.5074	4.24.92	8.1347	9.0672		9.7118	11-6249	+461.e1	15.4262	14.6824	21.9478	24.7411	26.5538	27. 2516	8614.75	
TIUN CHANN	6 • 000 U	N.		15.0137	9.5115	7 806 ° 8	7.3133	6.9729	6 . 745 L	6.8343	7 - 4 45 3		7.9401	4 • 5 2 4 B	10.7741	12.6432	15.7473	1410.81	20.2867	21 . 1516	22.5436	22.00553	
CR0SS SEC	5°0000	MAL DEPTH.		8-8620	7.1472	6.3926	5.7245	5.4357	5.3707	5.4080	5.6970	• • •	6.3174	7-5635	8.5103	9.9427	12.4756	14.2320	15.4849	17.1735	17.0022	18.0367	
A CIRCULAR	0000**	LUE AT NOR		6.198A	5.1930	+.7119	4.2653	1.1065	4.0332	4.0647	4.4351	•	4.7502	5.6741	6.3860	7.4932	9.3483	10.6593	11.9879	12.8413	13.3366	13.4955	
DEPTHS IN	3.000	F+M VA		4.1076	3.5129	3.2200	2.4383	2.5366	2.7930	2.3159	3.0707		3.2853	3.4208	4.4071	5.1666	6.4485	7.3240	8.2446	8.5396	9.1817	9.2405	
AT NORMAL	2.0000			2.3856	2.0697	1.9059	1.7497	1.6923	1.6678	1.6808	1.8286		1.9541	2.3248	2.6122	3.0598	3-8077	4.3266	4.8691	5.2191	5.4112	5.4780	
UES OF F+N	1.0000			++R6=0	0.8549	0.7951	0.7304	0.7059	0.6937	0.0480	0.7546		0. 60 36	0.4512	1.0657	1.2452	1-5474	1.7556	1.9737	2.1164	2.1947	2.2198	
TABULATED VAL	- TATE		LPE SLOPE	0.0017	0.0025	0.0033	0.0050	0.0066	0°0100	0.0125	0.0250		0.0349	0.0678	0.1045	0.1736	0.3402	0.5000	0.7070	0.8660	0.9659	1.0000	

.....

Λ8.5

FLOW AFTE 1.0000 2.0000 3.0000 5.0000 5.0000 7.00000 7.0	• 01 2																							
FLOW RATE 1.0000 2.0000 3.0000 5.0000 5.0000 7.0000 8.0000 7.0000 8.0000 7.0000 8.0000 7.0000 8.0000 7.0000 8.0000 7.0000 8.0000 7.0000 8.0000 7.0000 8.0000 7.0000 8.0000 7.0000 8.0000 7.0000 8.0000 7.0000 8.0000 7.0000 8.0000 7.0000 8.0000 1.0000 8.0000 1.0000 8.0000 1.0000 8.0000 1.0000 8.0000 1.0000 8.0000 1.0000 8.0000 1.0000 8.0000 1.0000 8.0000 1.0000 8.0000 1.0000 8.0000 1.0000 8.0000 1.0000 8.0000 1.0000 8.0000 1.0000 8.0000 1.00000 1.0	0 • 44300 • WIW	PIPE DIA. OR MIDTH M.			0.1500	0.1500	0.1560	0.1500	0.1500	0.1500	0.1540	0.1560		0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1540	
TAULARED MORMAL FLOW DEFINE FUR A CIRCULAR CROSS SECTION CANNEL OF DIAMELER 0. 0.0010 2.0000 2.0000 3.0000 4.0000 5.0000 5.0000 7.00000 7.0000 7.0000	WAR UNA .R UUCI	8.0000 L/S.			0.1499	0.1190	U.1055	0.0912	U.0634	4.0736	0.0690	0.0520		U.0521	U.0435	U.0392	0.0346	0.0292	. 0.0266	U.0244	U.•0233	5220°0	0°0225	U.0821
TABULATED MORMAL FLOW DEFTING FUR A CIRCULAR CNDSS SECTION CHANNEL UF DIAME FLOW RATE 1.0000 2.0000 3.0000 5.0000 6.0000 FIFE S.UP 3.0000 3.0000 3.0000 5.0000 6.0000 PIFE S.UP NORMAL DEFTM M. NORMAL DEFTM M. NORMAL DEFTM M. PIFE S.UP 0.00137 0.00557 0.0557 0.00407 0.01093 0.01093 0.00137 0.01727 0.01937 0.01427 0.01473 0.01647 0.01643 0.01762 0.00125 0.01277 0.01291 0.01431 0.01643 0.01643 0.01763 0.00126 0.01277 0.01291 0.01431 0.01643 0.01643 0.01763 0.01209 0.01291 0.01281 0.01433 0.01433 0.01643 0.01643 0.01643 0.01201 0.02791 0.01212 0.01212 0.01433 0.01633 0.01633 0.01203 0.01204 0.01223 0.01212 0.010433 0.01633 0.01633	1ER 0.	7.0000			0.1272	0.1060	0.0954	U.Jd 37	01110	0. 3682	0.1041	16 čU•0		0.0486	0.0406	0.0367	0.0323	0.0274	0. 4249	0. J229	0.0218	0.4212	0.0211	0.0767
FLOW RATE L.00000 Z.00000 J.J0000 4.00000 5.00000 FLOW RATE L.00000 Z.00000 J.J0000 4.00000 5.00000 FIPE SLOW RATE L.00000 Z.00000 J.J0000 4.00000 5.00000 PIPE SLOW RATE L.00000 Z.00000 J.J0000 4.00000 5.00000 PIPE SLOW O.01370 O.0557 O.0447 O.0447 O.04455 O.0017 O.01270 O.01570 O.01517 O.01517 O.04451 O.04455 O.00120 O.02217 O.02121 O.01412 O.04455 O.04455 O.00125 O.02217 O.02141 O.04757 O.04556 O.04455 O.01225 O.02211 O.01412 O.04757 O.02246 O.04756 O.05756 O.01257 O.02246 O.02246 O.02246 O.02740 O.02740 O.02740 O.01257 O.02246 O.02246 O.02740 O.02740 O.02740 O.02740 O.02740	. UF ULAME	0 00 0 • 9			0.1094	0.0948	0.0466	0.0762	0.0703	0.0625	G . 0589	0.0489		0.0449	0.0376	0.0340	0.0299	0.0254	0.0231	0.0213	0.0202	10.0197	0.0145	0.0707
TABULATED MORMAL FLOW DEFINS FUR A CIRCULAR CROSS SECTION FLOW RATE 1.0000 2.0000 3.0000 4.0000 FIFE SLOPE 0.0389 0.0557 0.03647 0.08427 0.0017 0.0017 0.0357 0.0557 0.08427 0.08427 0.0017 0.0017 0.0372 0.0557 0.08427 0.08427 0.0017 0.0017 0.0372 0.05317 0.01519 0.01427 0.01427 0.00125 0.00127 0.01391 0.01481 0.01482 0.0147 0.0147 0.00125 0.01277 0.03333 0.01481 0.01487 0.0147 0.0147 0.0125 0.02177 0.03333 0.01481 0.0147 0.0147 0.0125 0.0126 0.01317 0.01316 0.0127 0.0127 0.0125 0.0126 0.0126 0.0126 0.0127 0.0127 0.0126 0.0126 0.0126 0.0126 0.0127 0.0274 0.01070 0.0126 0.0126	ON CHANNEL	5°0000	TH N.		0.0950	0.0443	0.0774	0.0686	0.0035	0.0567	0.0534	0*0++2	•	0.0408	0.0343	0.0310	0.0274	0.0232	0.0211	0.0175	0.0185	0.0181	0°0119	0.0643
TABULATED MORMAL FLOW DEPTHS FUR A CIRCULAR FLOW RATE 1.0000 2.0000 3.0000 FLOW RATE 1.0000 2.0000 3.0000 PIPE 0.0017 0.00339 0.00557 0.00553 0.00553 0.0017 0.00339 0.00357 0.00553 0.00553 0.00553 0.00553 0.0017 0.00339 0.00177 0.003397 0.00173 0.00482 0.01482 0.00125 0.00127 0.00333 0.00123 0.01333 0.01482 0.01482 0.0125 0.0125 0.01333 0.01333 0.01316 0.01482 0.0125 0.0125 0.0137 0.0137 0.01317 0.01482 0.0125 0.0125 0.0137 0.0137 0.01317 0.01492 0.0125 0.0125 0.0137 0.0137 0.01317 0.013162 0.0126 0.0137 0.0137 0.0137 0.01317 0.013162 0.0133 0.0126 0.0137 0.0137 0.01317 0.013162 0.0133 0.0126 0.01376 0.01376 0.01376	CRUSS SECTI	0000*+	NOKMAL DEI		0.0427	0.0736	0 • 0 6 8 0	0.0605	U.0561	0.0501	0.0474	1960.0		0.0365	0.0307	0.0278	0.0246	0.0204	0.0140	U.0175	0.0167	0.0162	0,0161	0.0572
TABULATED MORMAL FLOW DEPTHS FUR A FLOW RATE = 1.00000 2.00000 FLOW RATE = 0.0017 0.0152 0.00033 0.0127 0.01391 0.00050 0.0277 0.03313 0.00125 0.0277 0.03313 0.00250 0.0277 0.03313 0.01250 0.02317 0.0137 0.01250 0.02319 0.02319 0.01250 0.0157 0.0137 0.01250 0.0126 0.0137 0.1736 0.0126 0.0126 0.1736 0.0143 0.0126 0.1736 0.0143 0.0126 0.1736 0.0143 0.0126 0.1736 0.00143 0.0126 0.1736 0.00164 0.01177 0.17	CIRCULAR (3.000			0.3647	0.0625	0.0580	0.1514	0.0482	0.0433	0°040A	0.3343		0.0316	0.0266	0.0242	0.0213	0.0162	0.0166	0.3152	0.0145	0.0142	0.0140	0*0463
TABULATED MORMAL FLOW DE FLOW RATE = 1.00000 FLOW RATE = 1.00000 FIPE SLOPE 0.03899 0.0017 0.03899 0.00125 0.03899 0.00125 0.03899 0.00125 0.03899 0.00125 0.0377 0.00125 0.00277 0.00125 0.00277 0.00125 0.01257 0.00125 0.0277 0.0125 0.0277 0.0125 0.0125 0.0125 0.0125 0.0125 0.0143 0.0125 0.0143 0.0125 0.0143 0.0125 0.0143 0.125 0.0125 0.126 0.0135 0.126 0.0135 0.126 0.0135 0.126 0.0135 0.1034 0.0103 0.1035 0.0036 0.1036 0.0036 0.1037 0.0036 0.1036 0.0036 0.1035 0.0036 0.1036 0.0036 <	PTHS FUR A	2 • 000 0			0 • 055 7	0.0503	0.0468	0.0.0	10E0.0	0.0352	0 • 0333	0.0281		0.0259	U.0219	0.0198	0.0176	0.0150	0.0137	0.0126	U.0120	0.0117	0.0116	0.040.0
TABULATED MORM FLOW RATE = (SIN) (SIN) (SIN) (SIN) (SIN) (SIN) (SIN) (SIN) (SIN) (SIN) (SIN) (SIN) (SIN) (SIN) (SU) (SU) (SU) (SU) (SU) (SU) (SU) (SU	AL FLOW DE	1.0000			0.0309	0.0352	0.0329	0.0297	0.0277	0.0250	0.0237	0.0201		0.0185	0.0157	0.0143	0.0126	0°0109	0.0078	0.0091	0.0046	0.0084	0.0054	0°0580
	TABULATED MORN	FLOW RATE -		PIPE SLOPE (SIN)	0.0017	0.0025	0.0033	. 0.0050	0.0066	0.0100	0.0125	0°0250		. 6460.0	0.0698	0-1045	0.1736	0.3402	000500	0.7070	0.8660	0.4659	1.0000	CRITICAL Deptm N.

A8.6

COLFF.	8																					
AND HANNING	PIPE DIA. 6 MIDTM M.			0.1560	U.1500	0.1500	0-1500	0.1500	0.1500	6.1500	0.1500		0.1500	0.1500	0°1566	0.1560	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500
R 0.1500 M.	8-0000 L/S-			16.5962	12.2134	10.8991	10.0445	4.87d7	10.0584	10.3270	11.0190		12.8466	15.7753	17.9724	24.2261	26.664b	30.4470	34.3322	36.8767	30.2424	36.7339
EL DIAMETEI	1.000			12.2726	9.4111	0+77-0	8.4016	8.2976	6.4740	8 - 10 4 4	4016.6		10.0594	13.1123	15.1334	17.3740	22.4505	25.2487	2d.d 190	30.4443	32.2200	32+25
TION CHANN	0000°9	ž		9.1971	7.8237	1.2714	1760.0	6 4 9 5 3	5 6 6 9 5 5 2	7.14/3	8 .1927		6 - 914 5	10.9023	100101	14.6512	10.3704	20.9727	21.0475	22.3824	26.3412	26.6917
CR0.55 SEC	5 • U 000	AAL DEPTH.		6.4560	6.0728	5.6901	5.4041	5.3720	5.5059	5.6619	6.4355		7.0616	0-6300	9.7936	11.5725	14.5161	16.5833	18.6726	20.0126	20.07430	21.0390
A CIRCULAN	4.0000	LUE AT NOR		5.0708	6464°4	4.2432	4.0541	4.0350	4.1411	4.2590	4.8776	•••	5.3003	6.4706	7.3513	8 • 6 6 6 V	10.8707	12.3845	13.9651	14-9715	15.5614	15.7412
LE PTHS IN	0000.6	F+N VA		3.4389	3.0421	2.9232	2.3048	2.1943	2.1684	2.9496	3.1716		3.6658	4.4672	5.0639	5.3807	7.4471	8. 2329	9.5141	10.3053	199501	10.4363
AT NORMAL	2.0000			2.0264	1.0317	1.7418	1.6743	1.6665	1.7117	1.7565	2.002H		2.1763	2-644N	3.0063	3.5304	4.4164	5.0367	5.6754	6.0427	6.305 H	6.3932
UES OF F+H	1.0000			0.8436	0.7637	0.7270	0.6477	\$ E 49 ° 0	160200	0.7270	0.8233		0-6911	1.0796	1.2200	1.4366	1.7939	2.0429	2.3000	2.4550	2.5595	2.59.92
TABULATED VAL	FLOW RATE .		FITE SLUFE (SIN)	0.0017	0.0025	0.0033	0.0050	0.0066	0.0100	0.0125	0.0250		640.0	0.0698	0.1045	0.1736	0.3402	0.5000	0.7070	0.8660	0.9659	1.0000

.

,

A8.7

.

•

p

.

0 • 00																							
NING COEFF.	PIPE DIA. OR WIDTH M.			0.1560	0°1500	0.1540	0.1540	0.1560	0.1500	0.1500	0.1500		0.1500	0.1560	0.1500	0.1560	0.1500	0.1560	0.1500	0.1540	0.151.0	0.1540	
LSOO N. AND MAN	6.0000 L/S.			0.1094	U = 0448	U . O 8 6 6	0.0762	0.0703	0.0625	0.0589	0°0489		0.0449	U.0376	0 * 6 0 3 4 0	0.0299	. 0.0254	0.0231	0.0213	0.0202	U.0197	0.0195	0.0421
TER 0.	7-000			0.4988	0.0368	0.0798	001000	U.U651	19ct.0	1+40-0	0.0456		0-4419	0.4351	0.0318	0.4280	0.0238	0.4217	0°1139	0 * 7 0 * 0	0.0145	U.U433	0.0167
L UF DIAME	6 • 0 0 0 0			0.0840	0.0740	U.0728	U = 0646	U.0544	0.0535	0.0044	0°0422		7 860 ° 0	0 • 0 J 2 5	0.0295	0.0260	0.0221	U.0201	0.0185	U.0176	p.0172	0.0170	0.0707
ION CHANNE	5 • 0000	PTH N.		0.0795	60/0-0	0.0656	0°0585	0.0542	0.0480	0.0459	0-0154	• • •	0.0353	0.0297	0°0269	0 • 02 3 H	0°0202	0.0184	0.0170	0.0162	0.0157	0.0156	0.0643
CRUSS SECT	0000°\$	MORMAL DEI		0.0697	0 • 0 6 2 5	0.0500	0.0514	0.0462	0 ° 0 4 3 3	0.0409	0.0343	•••	0.0316	0.0266	0.0242	0.0213	0.0162	0.0166	0.0152	0.0145	0.0142	0.0140	0.0572
CIRCULAR	3.000			0.0594	0°0535	0-0497	0 .) 446	0.1416	0.J374	0.0354	0.3298		422.00	0.0232	0.3210	0.0186	0.0158	0.0144	0.0133	0.0127	0.J124	0.3123	0.0493
PTHS FUR A	2.0000			6240.0	0.0433	0.0403	0.0363	0.0339	3050.0	0.0269	0 - 024 4		0.0225	0.0190	0.0173	0.0153	0.0130	0.0119	0.0110	0.0105	0.0:62	0.0101	0-0400
AL FLOM DE	1.0000			0.0336	0.0306	0.02.95	0.0258	0.0241	0.0218	0.0206	0.0175		0.0161	1610.0	0-0124	0.0110	0°0014	0.0086	0.0079	0.0076	0.0074	0.0073	0.0280
TABULATEO NORM	FLOW RATE =		FIPE SLUPE	0.0017	0.0025	0.0033	0.0050	0.0066	0.0100	0.0125	0.0250		0.0349	0.0698	0-1045	. 0.1736	0+3402	0.5000	0.7070	0.8660	0.9059	1.0000	CRITICAL DEPTH M.

A8.8

0

9.2041 11.2255	9-2041 11-2255
8.5061 10.2006	8-5061 10-2006
8. JL84 4.9185	
8. Jdd1 9.9597	8.1184 4.9185
8-5120 10-2404	8.1184 9.9597 8.1481 9.9597
	8.1184 9.9185 8.1481 9.9597 8.1481 0.2404
9.2516 10.9717	8.1184 9.9185 8.1481 9.9597 8.5120 10.2404 9.2516 10.9717
9.2516 10.9717 9.7007 11.5005	8.184 9.518 9.2516 9.2516 10.2404 9.7107 11.5005
9.2516 10.9717 9.7007 11.5005 11.02295 13.7930	8.414.4 8.448.4 8.448.4 8.448.4 8.448.4 8.448.4 8.448.4 8.448.4 9.458.4 10.458.4 11.45
9.2510 10.9717 9.7007 11.5005 11.0229 13.7930	8.1184 9.1481 9.95979 9.0501 9.0501 9.7107 11.0299 13.7930 11.0299 13.7930
0E42.01 0152.6 2005.11 2007.6 212.62.01 01.62.6	8.1184 9.9597 9.05120 9.05120 9.007 9.1007 11.0299 13.7930 11.0299
9.2510 10.9717 9.700 2002.11 700/.9 0577.51 92005 13.7930 12.4359 15.2213	8.4184 9.4184 9.2516 9.2516 10.2404 9.7007 11.6299 11.6299 11.6299 11.6299 13.7930 12.6359 15.2213
057170-11-500 06711 700/-0 057211 620-11 0572-51 6254-51 05-94950 15-221 05-94950 18-9736	8.118 8.148 8.5120 9.9597 9.9597 9.7930 11.0299 11.0299 11.0299 13.7930 12.4359 15.9990 18.9736
057170-11-500 06711 700/-0 11-6299 0573-11-5005 11-6293 13-7930 13-7930 18-6735 18-6735 18-6735 18-6735 18-6735 18-6755 18-6755 18-6755 19-7555 19-755 19-755 19-7555 19-7555 19-7	8.1189 9.1189 9.95979 9.95110 9.95979 9.7179 9.7179 9.7179 11.0299
0120 0120	8.4189 9.9597 8.4189 9.9597 8.5420 10.2408 9.7007 10.2408 9.7007 11.65005 9.7007 11.55005 11.0299 13.7930 11.0299 13.7930 11.0299 13.7930 11.0299 13.7930 11.0299 13.7930 11.0299 13.7195 12.0495 14.973 21.7185 25.8130
9.2717 9.700 11.6299 11.6299 11.6293 11.6293 11.6293 12.6359 12.6359 12.6359 12.6359 12.6165 22.26159 22.25.8130 22.25.167	8.1484 9.1484 9.9597 9.9516 9.9597 9.7179 9.7179 9.7179 9.7179 11.0299 12.0295 12.0296 12.0296 12.0296 12.0296 12.0296 12.0296 12.0296 12.0206 12.
9.2717 9.7007 11.6299 11.6299 11.62959 11.62959 12.6459 12.6453 12.245	8.1189 9.1189 9.9597 9.2516 10.2599 9.7179 9.7179 9.7179 9.7179 9.7179 9.7179 11.0299 11.0299 11.0299 11.0299 11.0299 12.0159 12.0159 12.0159 12.0169 13.71910 12.05109 13.71610 12.05109 13.71610
9.2717 9.7007 11.6299 11.6299 11.6293 11.6293 11.6293 12.6495 12.6453 12.2453 12.2453 12.2453 12.2453 12.2453 12.2453 12.2453 12.2453 12.2453 12.2454 12.6109 12.2453 12.2454 12.2453 12.2454 12.2453 12.2454 12.255454 12.25554 12.25554 12.25554 12.25554 12.25554 12.25554 12.25554 12.25554 12.25554 12.255554 12.2555554 12.255555555555555555555555555555555555	8.1484 9.1484 9.1484 9.2516 10.2599 9.7717 9.79717 9.79717 9.707 9.707 11.5005 11.5005 11.5009 13.7930 13.7940 13.7940 13.7940 13.7940 13.7940 13.79400 14.7940 14.7940 15.7940 15.79400 15.79400 15.79400 15.79400 15.794000 15.794000 15.794000 15.794000000000000000000000000000000000000
7179-01 9.200 9.700 9.700 9.700 9.700 9.700 11.500 9.700 12.60350 12.60350 12.60350 12.60350 12.60500 12.60500 12.60500 12.60500 12.60500 12.605000 12.60500 12.605000000 12.6050000	8.1184 9.1184 9.118 9.1107 9.1201 9.9597 9.717 9.717 9.717 9.717 9.717 9.717 9.717 9.717 9.717 9.717 9.717 9.717 9.7130 11.5005 11.5005 11.5005 11.5005 12.459 15.2213 15.2169 15.2458 15.25169 15.2458 15.25169 15.2458 15.25169 15.2458 15.25169 15.2458 15.26100 15.26100 15.26100 15.261000 15.2610000 15.261000000000000000000000000000000000000
7179-21 9.2005 11.00299 11.00299 11.00299 11.00299 11.00299 11.00292 11.00292 11.00292 11.00292 12.012 12.	8.1184 9.9597 8.1481 9.9597 8.1481 9.9597 9.2516 10.2404 9.2516 10.9717 9.2516 10.9717 9.2516 10.9717 9.2516 10.9717 9.2516 11.5005 9.2513 11.5005 11.0299 11.5221 12.0359 15.2213 12.0453 21.7193 21.2453 21.7193 21.2453 22.5163 12.2453 21.7193 21.2453 22.5163 12.2453 32.55163 13.25183 21.5193 21.2453 32.5163 13.2513 25.6153 13.2513 25.6153 13.2513 25.6153 13.2513 25.6153 13.2513 25.6153 13.2513 25.6153 13.2513 25.6153 13.2513 25.6153 13.2513 25.6153 13.2513 25.6153 13.2513 25.6153 14.6173

A8.9

APPENDIX 9

JUMP LOCATION IN A 0.15 m DIAMETER PIPE AT SLOPE 1/300, CARRYING 6 &/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.

•	× ,												ich pi											
PRJGAAM RESULTS.	JUMM OLPTH EMFLEY EMERGY EMERCY JUMP JJ40 Jepti Chamge Upjund Down Cmamgi Fom, P35, A. M. M. M. M. M. 4.	MALJ AT LOD AT TIST PLPE ENTRY.	MALU AT LOU AT TEST PIPE ENTRY.	MMEO AT LOU AT TEST PIPE EMTRY.	J.111 U.U76 O.166 U.125 -0.04110.038 J.203	<pre>^************************************</pre>	J.11/ U.U76 0.166 0.125 -0.04110.038 J.813	446.0 0.0110 0.125 -0.04110.038 0.12	J.117 0.076 0.166 0.125 -0.04110.035 1.873	J.111/ 0.076 0.166 0.125 -0.04110.036 1.070	J.1117 U.U76 D.166 U.125 -V.04110.039 1.124	•	Constant n, tast and approa	Płjsaam kesults.	JUAN DEPTH ENFRCY EMERGY EMEPCY JUMP 1,14" Jeptic Change Upjump Down Change Fon. Pjs. M. M. M. M. M. Y. Y.	MALD AT L=O AT TEST PLPE ENTRY.	0.101 0.052 0.125 0.111 -0.013 8.309 J.	J.101 0.052 0.125 0.112 -0.013 0.509 J.138	J.131 0.052 0.125 0.112 -0.013 0.309 1.385	0.052 0.125 0.112 -0.013 0.309 1.910	461.2 0.30 0.012 0.112 -0.013 0.309 0.151.C	0.401 0.022 C.125 0.112 -0.013 8.309 2.350	J.101 0.052 0.125 U.112 -0.013 8.109 2.112	
LEST PIPE DATA AND	ENTRY JATRY UPJUNP ENERGY Fom UEPTA No. No. No.	JUHP UKU	JUMP ORU.	UND ANDE	7 0.2011.218 0.040	1 0.2013.665 0.440	8 0.3615.666 0.440	\$ 0.4517.55U U.J+0	0.5313.056 0.040	0.5314.050 0.44U	• 0.5719.90U 0.U40			TEST PIPE DATA AND	ENTAT ENTRY UPJUNP) ENE4GY F +M DEPTM M₀ M₀ M₀	JUMP URU	3 0.15 %.380 0.048	3 0.1813.641 0.044	1 3.2412.444 0.044	\$ 0.3615.666 U.V48	8+V-0 U22.517.55 č	0.5714.400 U.V.V	5.5324.615 U.U.44	4 0.5421.407 U.V4H
CONNIN DATA APPROACH PIPE DATA	Jo Ola MANNo SLOPE HN TERNo SLJDE HC HN EAIRY L/S mo Cueff (Sim) no Emercy (Sia) no no Depth no	6.0 0.15 0.010 0.0349 0.055 0.107 0.0033 0.071 0.117	6.0.0.15 6.018 0.0098 0.040 0.132 0.0013 0.071 0.117	6.0 0.15 0.018 0.1045 0.042 0.156 0.0033 0.071 0.117	6.0 0.15 0.018 0.1730 0.017 0.201 0.0033 U.071 0.117 U.037	6.0 0.15 0.018 0.3402 0.031 0.295 0.0013 0.071 0.117 0.011	».0 0.15 0.018 0.5000 0.028 6.375 0.3033 0.071 0.117 0.028	6.0 0.15 0.018 0.7070 0.026 V.469 0.033 0.071 0.117 0.025	0.0 0.15 0.018 0.8060 0.025 0.536 0.0033 0.071 0.117 3.023	\$0,0 0.1\$ 0.018 0.4454 0.024 0.575 3.033 0.071 0.117 0.025	\$*0 0*12 0*018 1*0000 0*054 0*569 0*0033 0*071 0*117 0*01		2	CUMMON DATA APPRUACH PIPE DATA	J. 01A. MANN. SLOPE HN TEKM. SLOPE HC HN EYTRY L/S M. COFFF (SIM) M. ENERCY (SIV) M. M. OEPTY M.	0.0 0.15 0.015 0.0349 0.050 0.118 0.0033 0.071 0.101	6.0 0.15 0.015 0.0698 0.042 0.153.0.0033 0.071 0.101 U.043	6.0 0.15 0.015 0.1045 V.038 0.186 0.0333 0.071 0.101 V.033	0.0 0.15 0.015 0.1736 0.033 0.246 0.0131 U.UTI 0.1UL U.DI	6.0 0.15 0.015 0.3402 0.026 0.370 0.0033 0.071 0.101 U.023	6.0 0.15 0.015 0.5070 0.026 0.475 0.0133 0.071 0.101 0.025	0.0 0.15 J.015 0.7973 0.024 0.547 0.0133 0.071 0.101 U.34	8.0 0.15 0.011 0.0 10.0 0.013 0.083 0.011 0.011 0.101 0.0	5.0 0.15 0.015 0.4659 0.022 0.735 0.0011 0.071 0.14

4.0 0.15 0.015 1.0309 0.022 0.752 0.0133 0.071 0.101 J.022 J.6421.807 0.044 J.1J1 0.052 0.125 0.112 -0.013 8.309

COMMIN DATA APPRUACI PIPE DATA

.

rest pre uata anu pajoran results.

EATAY ENTAY UPJUAP JJAN DIPIM ENTALY ENTRY FULP JJA OLPTA ENERCY FON ULPIA JCPTA CHANGE UPJUNP JUNN CAARGE FON, PJS. H. H. N. N. M. A. N. N. N. N. N. N. N. N. Y. ž ż Y z HN TERP. SLOPE H. ENEKGY (SI4) OIA. MANN. SLOPE N. CUEFF ISIN] ::

ecf.5 112.4 0.03 0.030 0.100 0.100 0.001 0.011 0.012 0.030 0.012 0.051 0.001 0.001 0.000 0.000 0.000 0.000 0.0 4.0 0.15 0.012 0.0349 0.045 0.138 0.0013 V.071 0.047 V.045 0.14 0.840 0.017 J.J4 V.03V 0.105 0.103 -0.0V4 7.771 1.455 0.105 0.103 -0.000 7.17L 3.335 0.023 716.0 4012 0.1045 0.034 0.237 0.013 0.071 0.084 0.080 0.012 0.020 0.034 0.0 ••• 0•15 0•012 0•1/16 0•030 0•322 0•0433 0•071 0•067 0•030 0•3214•610 0•057 1•067 0•030 0•105 0•103 -0•662 7•271 ••816 0.103 -0.002 7.271 5.235 0.103 -0.632 7.271 5.517 U.030 0.105 0.103 -0.002 7.471 5.517 \$*0 0.15 0.012 1.0000 0.020 1.021 0.0333 0.071 0.047 0.320 0.3225.356 0.057 1.347 0.030 0.105 0.149 -0.002 7.671 5.517 0.103 -0.004 7.471 4.724 0.103 -0.002 7.271 5.859 0.105 0.105 0.105 0.105 0.023 0.029 0.029 0.030 0.0 0.15 0.012 0.3402 0.025 0.493 0.0133 0.071 0.087 0.325 0.4918.274 0.057 J414 0.0 0.15 0.012 0.5000 0.023 0.636 0.0033 0.071 0.087 0.023 0.6323.615 0.037 0.087 0.0 0.15 0.012 0.4653 0.020 0.994 0.0131 0.071 0.087 0.020 0.4223.3453 0.457 J.337 6.0 0.15 0.012 0.7070 0.021 0.80% 0.0133 0.071 0.087 J.022 0.7522.887 0.057 J.037 5.0 0.15 0.012 0.6650 0.020 0.924 0.0033 0.071 0.087 0.023 0.9225.356 0.077 J.347 A9.3

Constant n, tast and approach pipe

CUNNON DATA APPROACH PIPE DATA

TEST PIPE DATA AND PLOSAAM NESULTS.

ž ž ¥: HM TERM. SLOPE N. EMLRCY (SIN) DIA. MANN. SLUPE M. CUEFF (SIM) ;;

542-27408-9 C000- 060-0 -0.000 L.b0413.405 0.046 -0.003 6.60414.195 0-048 -0.003 6-80414-195 ••• 0•15 0•004 0•0144 0•0145 0•013 0•071 0•071 0•014 0•1810•414 0•064 1•071 0•004 0•098 0•098 -8•004 8•375 0.048 -0.003 6.804L. 756 -U.U03 6. #0413. 898 0-U98 -0.03C 6.604 9.825 0.098 -6.003 6.60410.591 -0.003 6.00414.000 0.040 0.099 0.046 C.U98 69'L'.O 0°098 0.048 960.0 0°048 0.090 0.098 0.096 U.003. 0.003 6.0 0.15 0.009 1.0070 0.017 1.510 3.0113 0.071 0.071 0.017 1.011 1.4611.972 0.070 0.01 0.00% 0.003 (00.0 0.000 0.003 00000 LIC. VCU.U UIA.PISCO CCO.U C/U.O 1/0.0 CCU.U 2002 0.019 0.0000 0.0000 0.0 6.0 0.15 0.009 0.0098 0.013 0.262 0.0133 0.071 0.013 0.034 0.034 0.0470 0.06 610.6 veb. 0 vee. 1124.0 616. v v v 0 1 V v 150 0. LIL., UTU.0 111.05/11.1 410.0 170.0 170.0 110.0 110.0 0101.0 0707.0 400.0 21.0 0.4 5.0 0.15 3.064 0.4659 0.017 1.474 0.0133 0.071 0.073 J.01/ 1.401.0474 0.070 J.0/3 0.0 0.15 0.009 0.0644 0.018 1.370 0.0133 0.071 0.071 1.011 1.214.47 0.014 1.071 0.0 0.15 U.00 0.000 0.000 0.010 0.939 0.010 0.01 0.020 0.0 5.0 0.15 0.009 0.1736 0.026 U. 464 0.UJJ 0.071 0.073 U.073 0.0 0.15 0.009 0.3402 0.022 6.725 0.0033 0.071 0.073 0.022

i.

20 0.15 U.OL 1.00.0 0.012 0.752 0.011 0.101 0.101 0.001 0.001 0.001 0.001 0.002 0.125 0.125 0.115 0.001 0.000

- A9.4

		1 0.743	1 2.009	60/ *2 1	1 3.122	1.1.2.1	1 1-605	1 1-954	1 3.059	1 5.182	1 5.182				114 135	165-1	(8.293	1 9.50B	611.110	111.756	112.363	114.590	112.195	562.210
		1.2.1	7.271	7.271	7.271	7-27	7.67	7.67	7.47	7.27	7.02	v.		Ē	F + N+	6.00	6.60	6.63	6.50	6 . e 3	6 . e 0	6.63	6.30	c.c34	0.00
	NERGE MANCE M.	-0.062	-0-04	.0.0.	-0.04	-0-062	-0-002	\$00° C-	-6.00k	-0-002	-0-005	0 1	•		MENGE HANGE Me	C00°0-	CC0*9-	600°9-	CO.0-	(0.0.0-	•0 • 0 0 0		FC0 * C-	000.0-	r 00 ° 0.
	4E467 =	. EU10	. 601.0	. 601.0	. 103 -	. 601-0	. [01.0	. [01-0	. [01.0	0.143	0.103	6			NERGY 6 DWM	. 840.0		- 660*0	- 6¢0*0	. 340.0		. 610.0	. 960-0	- 640-b	. 9,0.0
	LAGY ÊP	\$01-0	-105	\$01*	\$01-0	\$01.0	\$01-0	.1 05	.105	.105	\$01.0	: 			10 400 00	960*	96.0.48	960-0	£60°	\$60-	• n 9 3	560°	- C 6 3 -	• 0 6 q	66C*I
(ESJ. 75	PIN EN Ange up N.	010 0	0 010.	. 03.0	.024	.02 + 0	. 620.	. 02.9	•029 0	• 223	• 2C*	and a second		KE SULTS	P TH E P A46E UP M.	•00*	+ 0n •	•30+ 0	• 00 •	104.	. 103		.003	, 103 C	0 606.
34AH +	th Chi	0 /8	0 / P	17 0.	37 0	37 0	37 0	97 0	0 / 9	197 0	0 / F	-		CAAM I	4 061	13 6.	13 6.	13 0	13 6	0 (1	13 6	13 0	73 0.	13 0	13 0.
(** 0	1 111	0.1.70	C. L. 18	1 1.3	C.L 1.	C. L 1.	C . C .	(10	[" 1	[.[70	E 10		•	(14 N		0.1.4	C. v. 4 c	1 t.	1.5.13	(*r / r	[}.	[["["	(· [] ·	5.1.1.
ATA AI	UETU UEFT	0.0	0.0	1 0.0	0-0-5	0 ° 0	0.0 0	0.0	0.0	0.0 1	0.0 1			ATA A	UPJU UEPT	0-0-4	0.0	1 0.0	0 ° n	6 0°0	0.0	0 0.0	0°0 r	0.0.1	1 0.0
0 3.14	E 4 T R V V + • H N •	1.04	\$ 3.3d	44.C18	412.49	612.60	\$11.55	111.94	10.656	924.84	921.00			9196 0	E4 TRY V F + M N+	2 1.99	9E • Y • 3	11	10-210	00.510	\$11.55	111.44	10.656	421.84	421.84
TEST	ENEAG ENEAG M.	1 0.4	1.0.4	1.6	• 0.2	0.3	\$ 3.4	¢•0	C.C.	0.6	2°0			TEST	ENTAT ENEKG	1.0.1	1.0 6	1.0 1	3.2	1 0.1	0.0	2°0 1	¢.[1	¢•С 3	c 0 5
	E VI 24 DEPTH N.	0°1	40*r	1+03	0.33	9.02		1.0 °C	1 U . J .	SE.L 1	56.6 1				64124 DcPf4 M.	0.05	40*n	1 J.03:	1.4.03	- 1 ° 0	0.02	14C . E 1	1 u. 12	30.0	1 J. D2
	Z · T E	0.04/	0.04/	0.087	0.047	0.081	0.04/	0.047	0.087	0.087	0.047				I I	0.073	0.073	0.073	C10*0	0.073	0.01	0.073	0.07	9.073	0.013
•	N.	0.071	0.071	0.071	0.071	0.071	0.071	1/0.0	U.071	10.0	1/0-0		ı.		1.5	0.071	0.071	0.071	U.0/1	0.071	0.071	U = 07 L	0.071	U. U71	0.071
	61376 (514)	6600.0	0,0033	EErr°0	EECO*0	[[[]]0.0	££(0°0		0.0033	6Er0*0			1		1,(13)	.0033	66r0°0	510.0				[[[[[[[]	5666.0	EFFC.U
GATA	147. NL KGY	0.110	0.153	0.186	0.246	0.376	0.475	192.0	0.683	0.735	262.0			DATA	FKM. NERGY M.	0.118	0.153	0.186	0.246	0.170	6.475	164.0	(= 6 E 3	0.735	152-0
3414	H H H	0 • 0 • 0	0.042	0.036	0.033	0.025	970-0	0 * 05 4	0.023	0.022	0.022			9196	HW WH	0<0.0	0.042	910.0	0.033	970.0	970.0	•20.0	6 20.0	3.1122	270.0
PRUAC4	LUP E SIN J	C+C0*	.064d	\$101-	.1736	51 92	0005-	.707.	6948.	• • • • •	e000.			PRJACH	LOPE 5141	6460.	66 40 .	\$\$01.	41736	56.46.	• • E 0 5 •	C102.	1.4 . 0 .	1404.	(664.
TA AP	INN. S	0 210	0 710	012 0	012 0	0 210	0 210	0 210	012 0	0 210.	1 210			A API	INN. S	0 400	0 600	0 600	0 600	0 690	0 600	0 600	0 600	0 400.	1 600-
INO NE	1A. 7.	.15 0.	.15 0.	.15 0.	.15 0.	.15 0.	.15 3.	. 15 0.	.15 0.	.15 0.	.15 0.			TAG NC	1A. M.	.15 0.	.15 0.	.15 0.	.15 0.	.15 0.	.15 0.	.15 0.	.15 0.	.15 6.	0 \$1.0
C ON4		6.0 0	0 0 0	. 0 . «	0 0 0	6. 0 . 0	0 0 **	0 0 °¢	\$ 0 0	0.0.0	0 0 * 5			COM4	.0.	6.0 D	0 0 · •	5.0 0	6.0 0	C 0.«	0 0 0	C 0.4	0.0.0	0 U.¢	0 0 • 4,
	-			•						A9	.5 -	.			٦.										

I

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 HYDRAJLIC JUMP POSITION IN A CIRCULAR CROSS SECTION PIPE AT HILD SLOPE.

PIPE LENGTH = 2.0000 M. PIPE WIDTH OR DIAMETER = 0.1500 H. MANNING COEFF. = 0.0120 PIPE SLOPE = 0.5000 FLDHRATE = 0.0060 M**3/S. CUNTROL DEPTH = 0.0707 M. CRITICAL DEPTH = 0.0707 M. NORMAL DEPTH = 0.0231 M. CONTROL IS UPSTREAM, DEPTH = 0.0707 M. DISTANCE DEPTH ENERGY E+M 0. 0.0707 0.0980 6.7950 0.0001 0.0691 0.0981 6.8004 0.0983 0.0000 0.0675 6.8173 0.0937 0.0014 0.0060 6.8463 0.0025 0.0644 0.0993 6.8881 0.0042 0.1001 6.9436 0.0628 0.0063 0.0012 0.1011 7.0135 0.1024 0.1041 0.0090 0.0596 7.0990 0.0123 0.0581 7.2010 0.0163 0.0565 0.1060 7.3209 0.0549 0.0212 0.1084 7.4601 0.0271 0.0533 0.1113 7.6201 0.0342 0.0517 0.1146 7.8029 0.0501 0.1186 8.0104 0.0425 0.0525 0.0486 0.1234 8.2452 0.0543 0.0470 0.1289 8.5100 0.0733 0.0454 0.1355 8.8079 0.1433 0.0750 0.0438 9.1428 0.1524 0.1150 0.0422 9.5191 0.1390 0.0406 0.1633 9.9418 0.1530 0.0391 0.1762 10.4171 0.2033 6.0375 0.1916 10.9524 0-2100 11-5562 0-2457 0.0359 0.3012 0.0343 0.2321 12.2393 0.2590 13.0146 0.0327 0.3702 0.4500 0.0311 0.2917 13.8931 0.5807 0.0296 0.3321 14.9094 10.0736 0.7516 0.0240 0.3823 0.4453 17.4224 1.0150 0.0264 1.5032 0.0248 0.5256 18.4969 0.5401 19.2662 0.0246 2.0000

A10.2

PIPE LENGTH =40.0000 M.PIPE HIDTH DR DIAMETER =0.1500 M.MANNING COFFF. =0.0120PIPE SLOPE =0.0033FLOHRATE =0.00707 M.CUNTRUL DEPTH =0.0247 M.NORMAL DEPTH =0.0865 M.CRITICAL DEPTH =0.0707 M.

CONTROL IS UPSTREAM, DEPTH = 0.0247 M.

DISTANCE	DEPTH	ENERGY	E+m
0.	0.0247	0.5288	19.0558
0.4772	0.0278	0.3879	16.1981
0.9597	0.0309	0.2978	14.0539
1-4445	0.0339	0.2370	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	J.1320	8.6501
3.7935	0.0493	0.1211	8.1359
4.2212	0.0523	0.1133	7.7294
4.5222	0.0554	0.1076	7.4131
4.9333	0.0585	0.1036	7.1731
5.3102	0.0615	0.1009	6.9983
5.5722	6.6646	0.0992	6.8820
5.7538	0.0677	0.0983	6.8158
5.8237	0.0707	0.0980	6.7950

A10.3

PIPE LENGTH MANNING COE FLOWRATE =	1 = 40.00 FF. = (0.00t0)00 M.).0120 M**3/5.	PIPE WIDTH OR DIAMETER = 0.1500 M PIPE SLOPE = 0.0033 CONTROL DEPTH = 0.0707 M.	1.
NORHAL DEPT	n = 0.0)865 M.	CRITICAL DEPTH = 0.0707 H.	
CONTROL IS	DOWNSTREAM	15 DEPTH =	= 0.0707 H.	
DISTANCE 0. 0.0104 0.0429 0.1014 0.1936 0.3169 0.4330 0.7146 1.0123	DEPTH G.G707 O.0718 O.0728 O.0739 C.G750 O.0750 O.0771 C.0771 G.C772 G.C792 O.0603	ENERGY 0.0980 0.0981 0.0982 0.0983 0.0985 0.0957 0.0990 0.0993 0.0997 0.0997 0.1001	F+M 6.7950 6.7974 6.8047 6.8164 6.8326 6.8521 6.8521 6.8768 6.9056 6.9383 6.9749	
2.6237 3.6227 5.1555 8.0673 40.0000	0.0813 0.0224 0.0534 0.0245 0.0856 0.0856	0.1005 0.1009 0.1014 0.1019 0.1025 0.1030	7.0151 7.0591 7.1066 7.1576 7.2119 7.2696	
JUMP POSITI CONJUGATE E KINETIC ENE HYDROSTATIC DEPTH CHANS ENERGY LOSS	ION DEPTHS ERGY VALUE S+MCMENTUM GE AT JUMP S AT JUMP	$= 4 \cdot 85$ $= 0 \cdot 05$ $= 0 \cdot 10$ $= 7 \cdot 26$ $= 0 \cdot 29$ $= -0 \cdot 21$	547 M FROM PIPE ENTRY. 573 M UPSTREAM AND 0.0065M DOWNSTREAM 051M UPSTREAM AND 0.1029 M DUANSTREA 612 N. 9116E-01 M. 1271E-02 M.	• 4 M •

A10.4

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 .

HYJUMY

From C.

Schematic flow diagram.

Read output control IOUT. 1 = summary tables only O = water surface profiles. Read channel shape control SHAPE 1 = ractangular, 2 = circular. Read NN, NS, ICON NN-determines size of Sh in Simpsons Rule NS- Nº of steps necessary to complete water surface profile in Simpsons Rule. ICON - calculation control, = O Approach pipe surface profile calc. 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, RMI, DEN B = pipe diameter or channel width RMØ = approach pipe Manning Coeff. RMI = test pipe Manning Coeff. DEN = loss factor at test pipe entry, 0-1.0 Write titles. Set pipe count IZ = 0

From F, G, H.

E. From D.

F.

Read PL, SØ, G, HCONT, ENZ PL- pipe length, SP - pipe slope Q - flow rate, HCONT - cale 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 I con=0 or Z. check PL, = O GOTO C, JOGOTO D Set pipe count IZ=IZ+1 1 = approach pipe 2 = test pipe upstream jump 3= " " downstream Sf. IZ > 3, IZ set to 1. Check ICON, IZ = 1 ICON = 1 Calculate pipe entry depth ICON = 0, 2. from entry energy ENZ and flow rate Q. Set pipe count to 2 Calculate normal and critical flow depth hn, hc. Determine control depth position, from HCONT input.

Calculation abort chacks, h_n > B for IZ=Z, full bore flow, GOTOH h_n > B for IZ=3, " " GOTOH h_n < h_c for IZ=Z and 3, no jump, GOTOH.

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

G.

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

æ

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

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

>0 GOTO B

From
Example DATA program HYDJUMP

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

Line 1 IOUT, Format I3 000 (full output). Line 2 SHAPE, Format I3 VVI (rectangular section) Line 3 NN, NS, ICON, Format 314 77307200 7770 Line 4 B, RMP, RMI, DEN, Format 4 F10.4 VVV0.1500 20000.0150 00000.0150 00001.0000 Line 5 PL, SØ, G, HCONT, ENZ, Format 5F10.4 (approach pipe data) Line 6 PL, SQ, Q, HCONT, ENZ, Format 5F10.4 v v 40.0000 v v v 0.0025 v v v 6.0000 v v v 1.0000 v v v 0.0 (test pipe, upstream jump) Line 7 PL, SP, Q, HCONT, ENZ FORMAT 5F10.4 VVV40.0000 VVVV0.0025 VVVV 6.0000 VVVV0.0000 VVV0.000 (test pipe, downstream jump) Repeat Line 5, So = approved slope set 00000. Line 8 Repeat Line 6 Repeat Line 7 Line 9 Line 10 Line 11 PL, SØ, Q, HCONT, ENZ, Format 5F10.4 VVV 0.0000 077V 0.0000 (indicates and data section) Line 12 SHAPE Format I3 002 (circular saction) Repeat Line 3 - 11 Line 13-21 Format I3 Line 22 SHAPE

All.7 NO indicates end of date file.

Case 2	Repeat case 1 but summary data only required.
Line 1	IOUT, Format I3
Line 2-22	as Case 1
Case 3.	Repeat case l but terminal conditions assumed in approach pipe, normal flow downstream jump in test pipe.
Line 1-2	Repeat cuse 1
Line 3	NN, NS, ICON, Format 314
Line 4-22	Repeat case !.
Case h	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 4 F10.4 00000:1500 00000.0150 0000 0.0090 0000 1.000
Line 5-13	Repeat casel
Line 14	Repeat Line & above.
Line 14-22	Repeat case 1

```
DOALL.I
С
C
C
      PROGRAM HYDJUMP REFERS TO A PROGRAM DESIGNED TU
C
      CALCULATE THE HYDRAULIC JUMP POSITION AFTER A CHANGE IN
С
      SLOPE IN EITHER A RECTANGULAR OR CIRCULAR CROSS
С
      SECTION PIPE.
      UIMENSION X(2,100), F(2,100), FP(2,2), I4(6)
      DIMENSION DP(2,2),EN(2,100),DEP(2,100),IP(2),HJ(2),EJ(2)
      DIMENSION OT(300), S1(300), HN1(300), S2(300), HC2(300)
      DIMENSION HN2(300), TEN1(300), EEN(300), HEN(300), HUP(300)
      DIMENSION HON(300), EUP (300), EDN(300), CFPM(300)
      DIMENSION FEN(300), 0 JH (300), CL J (300), KJUMP (300)
      INTEGER SHAPE
      CUHMON/CM1/P,C,G,CJN,SJ,GAM,FHO,HCRIT,HNOKM,AREA,PER,FPM,ENERG
      COMMON/CM2/SHAPE
      COMMON/CH3/IZ
      READ(4,702)IDUT
      READ(4,702)SHAPE
C
      IDUT IS A CUTPUT FORMAT CONTROL CLDE,=1 ONLY UUTPUT
00
      IS A SUMMARY TALLES = 3 GUTPUT INCLUDES HATER SURFACE
      PROFILES.
702
      FURMAT(13)
902
      READ(4,120)NN,NS,ICT+
      READ(4,121) 8.880.841.0EN
121
      FURMAT(4FIC.4)
      3=9.81
0000000000
      IC=0
      ICOUNT = 0
      1Z = 0
300
      CONTINUE
      IF(IZ.E0.3) GOTC 9010
      CONTINUE
3011
      IF(IZ.GT.1) IF(IZ)=IS
      IZ = IZ + 1
      IF(IZ.E0.1) WR ITE(3,504)
504
      FORMAT(1H1,/////)
      IF(IZ.EO.1.AND.SHAPE.EQ.1)WFITE(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.EC.2.AND.IZ.EJ.1)WFITE(3,500)
      FURMATIZON, "PREDICTION OF THE HYDRAULIC", / 204,
500
     L'JUMP POSITION IN A CIRCULAR', /, 20%,
     2*CROSS SECTION FIPE AT MILE SLOPE.*./////) "
       IF(IZ.GT.3) IZ=1
      IF(IZ \cdot EQ \cdot 1)IC = IC + 1
      READ(4,100)PL, SO, C, HEJNT, ENZ
С
С
С
```

```
A11.9
```

000

С IF ICON=2 THE ANALYSIS IS PASED ON THE ASSUMPTION OF С TERMINAL FLOW CONDITIONS AT THE DISCHARGE FROM THE С APPROACH PIPE. C ICON = 2 ALSO INTRODUCES THE CONSTRAINT THAT THE С TEST PIPE IS LONG ENDUGH FOR NOPHAL FLOW DEPTH TO BE ESTABLISHED DOANSTREAM OF THE JJMP. NORMAL С C DEPTH THEN FECOMES THE DOWNSTREAM CONJUGATE DEPTH C HHICH ALLOWS CALCULATION OF THE "F+M" TEPM WITHOUT C CALCULATING THE WATER SURFACE PROFILE DOWNSTREAM OF THE C JUMP. C IF ICUN=1 THE FLOW ANALYSIS IS PASED ON AN INPUT ENERGY AT C ENTRY TO THE MILD SLOPE PIPE, TERM ENZ. SIMILARLY THE LOSS C COEFFICIENT AT PIPE ENTRY MAY BE LXPRESSED AS A FACTOR, DEN, C VALUE O TO 1.0, TO BE MULTIPLIED BY THE ENZ TERM. С AS THE ENTRY FLOW DEPTH IS TO BE CALCULATED FROM ENZADEN С AND NUT BASED ON FLOA CRITICAL DEPTH, THE CONTROL TERM С HCONT IS SET TO 1.0. THE UTHER PARAMETERS REFER TO PIPE FLOW С RATE AND DIFENSIONS. 100 FURMAT(SF10.4) IF (PL.E9.0.0)60TG 931 С PL-PIPE LENGTH, E-HIDTH, RM-MANNING COEFF, SO-SLOPE, С U-FLOWRATE IN L/S TO BE USED IN MARAJS, HOONTHCONTROL DEPTH С SET TO ZERC IF CRITICAL DEPTH ASSUMED. U=0/1000.0 2-10=1000.0 IF(IZ.EQ.1) FR=RMU IF(IZ.GT.1) PM=FM1 CON=RM ##2/SC $GAM = G \neq RHO$ SC С $JT(IC) = 0 \neq 1 \cup CC = 0$ $IF(IZ_{\circ}EQ_{\circ}I)SI(IC)=S)$ IF(IZ.EQ.2)SZ(IC)=SJ С PROGRAM CONTFOL DATA. 120 FORMAT(314) С NN-SIZE OF THE CH STEP IN SIMPSONS RULE, NS-NO. С STEPS IN DEPTH CALC., ICON DETERMINES HHETHER ENERGY С INPUT OR UPSTREAM SLOPE IS USED. DEN IS THE ENERGY С LUSS FACTOF FOF THE PIPE ENTRY, IN EITHER ENTRY CASE. C ENZ-INPUT ENERGY TO REPLACE SLOPE IF ICON = 1. IF (ICON.EC.1) GGIO 650 GOTO 651 650 ENZ=DEN*ENZ CALL BOUNDIENZ, Q.B. H3) IZ=2HCONT=HB GOTO 18 651 CONTINUE IF (HCONT.EC.1.0) GOTO 17 GOTO 18 -17 ENGD=DEN¢ENGD CALL BOUND(ENGD, Q, B, HB) HCONT=HB 18 CUNTINUE C.

C 00000 ÷, C C C C DETERMINATION OF CRITICAL AND NOFMAL DEPTHS. THIS SECTION CALCULATES THE NURMAL AND CRITICAL DEPTH IN EACH PIPE LENGTH FOR LATER COMPARISON TO THE CUNTROL JEPTH C INPUT. С CALCULATION OF CRITICAL DEPTH. UP = PDN=0.0HC=UP/2.0 7 CONTINUE GALL CALC(HC,DL) IF(HCRIT)3,4,5 3 JH=HC GUTS 6 5 UP=HC ć :10N=(UP+0N)/2.0 IF(A95((HCN-HC)/HC).LE.0.001) GOTE 8 10=203 GUTO 7 3 HC=HCN IF(HCONT.EC.O.O)HC)NT=HC 4 С CALCULATION OF NORMAL DEPTH. UP = 30.0=KU HN=UP/2.0 9 CONTINUE CALL CALC(HN,EL) 000000000 C IF(HNORM) 10,11,12 10 ON=HN **GOTO 13** 12 JP = HN13 HNN = (UP + DN) / 2.0IF (ABS((HNN-FN)/HN).LE.0.001) GDTU 14 HAH=HNK GOTO 9 14 -1N=HN.1 11 CONTINUE IF(IOUT.EC.1) GOTU 31) WRITE(3,200)PL, E, KM, SJ, Q, HOUNT

200	FORMAT(////20X, *PIPE LENGTH =*,F10.4,* M.*,5X, L*PIPE WIDTH OF DIAMETER =*,F10.4,* M.*,/,20X,* MANNING COEFF. =* 2F10.4,5X,*FIPE SLUPE =*,F10.4,/,20X,*FLOHKATE =*, 3F10.4,* M**3/S.*,3X,*CONTROL DEPTH =*,F10.4,* M.*,//) WRITE(3,201)FN.HC
201 C	FORMAT(20X, "NORMAL DEPTH =",FI0.4," M.",4X, "CRITICAL DEPTH =", IF10.4," M.",//) FORMATION OF A HYDRAULIC JUMP REQUIRES THAT DEPTH
C	IF NORMAL CEPTH IS LESS THAN CRITICAL NO JUMPFORMS. IF (IZ.GT. 1.AND.HN.LS.HC)WRITE(3.209)
209 310 C	FORMAT(/,20X, JUMP FORMATION IMPOSSIBLE AS HNKHC.",/) CONTINUE
C C	
000	
C C C	
C C	
	IF(IZ.GT.1)HN2(IC)=HH IF(IZ.GT.1)HN2(IC)=HH IF(IZ.GT.1)HC2(IC)=HC
C	IF(IZ.GT.1.AND.HN.LE.HC)GOTC 200 FULL BORE FLOW IS NOT DEALT WITH BY THIS PROGRAM. IF THE VALUE OF MN > PIPE DIAMETER SOLUTION IS
Ċ .	TERMINATED. IF(IZ.EQ.J.ANU.ICUN.E4.2) GBTE 94c
с с	IF THE TEST FIPE IS LONG THEN A CUNSIDERABLE SIMPLIFICATION IS POSSIBLE AS THE FLOW DEPTH MAY PE ASSUMED TO BE "NORMAL"
C 946	DEPTH AND THE (F+M) VALUE AT THE JUMP IS FIXED. CALL CALC(HN,DL) EXEEPH
	EX2=ENERG HX2=HN
	HLIM=8+0.99 IF(HN.GE.HLIM) HN2(IC)=8 IF(HN.GE.HLIM) GGT0 300
С	DO 949 J6=1, IS-1 IF THE F+M TERM AT ENTRY IS LESS THAN THE F+M VALUE
c	JUMP HAS MEVED TO L=0 AS A DROWNED JUMP. FEN(IC)=F(1,1)
949	IF(FK.GT.F(1,1)) GOTO 330 IF(F(1,J6).CF.FX.AND.F(1,J6+1).LF.FX) GOTU 940 CONTINUE
C	
000	

```
-----
     HX1=DEP(1, Je)+Re(UEP(1, J6+1)-DEP(1, J6))
     EX1 = EN(1, J6) + F \neq (EN(1, J6 + 1) - EN(1, J6))
     CHH=HN-HX1
      CHE=EX2-EX1
      IF(IOUT.EO.1) GOTO 311
      WRITE(3,952)
     FORMAT(/20%, TEST PIPE ASSUMED LONG, NURMAL FLOW DEPTH ",
952
     L'ESTABLISHED DOWNSTREAM OF THE JUMP. ",/)
     HRITE(3,107)XX,HX1,HX2,EX1,FX2,FX,CHH,CHE
      GJTO 800
311
     CONTINUE
     HUP(IC)=HX1
     HON (IC)=HA
      EUP(IC)=CX1
      EDN(IC)=EX2
      JJH(IC) = CHH
      BEJ(IC) = CHE
      CFPM(IC)=FX
      XJUMP(IC)=XX
      JULD 300
333
      IF(I0UT.EG.C) WRITE(3,332)
      FORMAT(/20X, JUMP ORDENED AT L=0 ,/)
332
      FEN(IC) = F(1,1)
      CFPM(IC)=FX
      GOTO 800
000000000
C
С
947
      CONTINUE
С
      THE APPROACH PIPE LENGTH MAY BE IGNORED IF TERMINAL
С
      CONDITIONS ARE ASSUMED. THIS SECTION USES THIS OPTION
С
      BY CHECKING ON THE PIPE NUMBER .IZ. AND THE VALUE OF
C
      ICON WHICH IS SET TO 2
      IF(IZ.ED.1.AND.ICUN.ED.2) GCTU 943
      GUTO 945
943
      H=HN
      CALL CALC(H, CL)
      ENGD=ENERG
      IF(IOUT.E0.1)GOT0 312
      WRITE(3,944)H, ENGD
944
      FORMAT(/20X, TERMINAL VELOCITY CONDITIONS IN APPPOACH PIPE.".
     1/20X, DEPTH = ",F10.4," M.",5X, "ENERGY = ",F10.4," M.",/)
      006 0T00
312
      CONTINUE
      TEN1(IC)=ENGD
      GUTD SUC
945
      CONTINUE
      HEIM=0.9948
      IF(IOUT.ED.1) COTU 313
      IF(IZ.GT.1.ANG.HN.JE.HLIM)WFITE(3,790)
313
      IF(HN.GE.HLIM) HN2(IC) = A
      IF(IZ.GT.1.AND.HN.GE.HLIM)GGTU PCG
C
```

```
L
CCCCCC
      THIS SECTION PREPARES FOR THE PROFILE CALCULATIONS
      BY SORTING FLOWS BASED ON PIPE SLOPE AND THE NORMAL AND
C
      CRITICAL DEPTH VALUES.
      IF(HN.LT.HC) GOTO 50
С
      MILD SLOPE.
      IF(HCDNT.LT.HC) GOTD 45
С
      SUBCRITICAL FLOW, HOONT GT. HC.
      SIGN=-1.0
      DH=(HCONT-HM)+0.993/FLOAT(NN)
      IF(IDUT.EQ.C) WRITE(3,202)HCONT
      FURHAT (20X, CONTROL IS DOWNSTREAM, DEPTH = ',F10.4, M.')
202
      GOTO 60
      SUPERCRITICAL FLOW, MOONT LT. HC.
C
45
      SIGN=1.0
      JH=(HC-HCUNT)/FLOAT(44)
      IF(IOUT.EG.C) HEITE(3,203)HCENT
      FORMAT(20X, CONTROL IS UPSTREAM, CEPTH = ", F10.4, " M.")
203
      GOTO 60
С
      STEEP SLOPE, HN LT HC.
5 C
      IF(HCONT.LE.HC) GUT3 55
0
      SUBCRITICAL FLEW, HEBAT GT HC.
      515N=-1.0
      DH=(HCUNT-FC)/FLCAT(NN)
      IF(IOUT.EQ.0) WRITE(3,202)HCENT
      GOTO 60
С
C
С
000
C
C
C
C
С
С
      SUPERCHITICAL FLOW, HOONT LT HC.
55
      SIGN=1.C
      N2 = NN \neq 2
      DH=(HN-HCUNT) \neq 0.998/FLOAT(N2)
      IF(IOUT.EQ.C) WRITE(3,203)HCGNT
60
      SL=0.0
      IS=1
      H=HCONT
      CALL CALC(H, EL)
      E=ENERG
      FM=FPM
      IF(IZ,GT,1)F(IZ-1,IS)=FM
      IF(IZ.E0.2))(1,IS)=).0
      [F(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(IDUT.E9.1) GGT0 314 WRITE(3,204)
204	FORMAT(///,19X," DISTANCE "," DEPTH "," ENERGY "," F+H")
205	- HKITE(39200)32,989E9FM Fu2MAT(18X94F10.4)
314	IF(IZ.E0.2)HEN(IC)=H =
c	IF(IZ.EQ.2)EEN(IL)=E
c	
C	
C	
C.	
C	
c	
C	
C	
č	WATER SUPFACE FROFILE CALCULATIONS USING SIMPSONS RULE
С	TU EVALUATI THE INTEGRAL.
	ST0=27
	IS=IS+1
	HZ=HCUNT+SIGN+DH+FLJAT(I+1)
	CALL CALC(Hall)
	CALL CALC(HZ,LL2)
	CALL CALC(H3,LL3)
	St=St+DY
	IF (SL. GF. PL)GOTO 82
	H=H2
	E=ENERG
	FM=FPM
904	CONTINUE
	GOTO 912
911	SL=PL
	E=ENERG
	FM=FPH
912	CONTINUE TETT FOR AND HOF AN COTO BIL
•	HHX=ABS((H-HN)/HN)
	IF(IZ.EQ.3.ANG.HHX.LE.0.001)SL=PL
811 C	CUNTINUE
C C	
C	
C	
c	
C	
C	
c	

4

,

.

IF(12.EQ.2)×(1,15)=SL $IF(IZ_{e}EQ_{e}3)X(2_{e}IS)=PL-SL$ IF(IZ.GT.L)DEP(IZ-1,IS)=H $IF(IZ_GT_1)EN(IZ_1)IS = E$ IF(IZ.EQ.2./ND.H.GT.HC) GUTG LOC IF(IZ.EQ. 3. AND. H. GE. 3) GOTO 606 IF(IOUT.EJ.1) GOTU 315 WRITE(3,205)SL, H.E. F4 315 CONTINUE IF(IZ.EO.1. AND.SL.GE.PL) GOTO 801 IF(IZ.EQ.1.AND.SL.LE.SLO) GOTE HOL IF(IZ.EQ.3.AND.SL.GE.PL) GUTG 900 30 CONTINUE 801 ENGD=E IF(IZ.EQ.3) COTC 900 GUTO 800 H=H2-SIGN#2.0#UH#(SL-PL)/JX 32 CALL CALC(H, LL) E=ENERG FM=FPM ENGD=5 SL=PL GUTD 904 905 CONTINUE С ćς С С THIS SECTION DEALS WITH THE POSSIBILITY OF FULL BORE FLOW BECOMING ESTABLISHED IN THE PIPE COMNSTREAM OF THE JUMP С C LOCATION. THE PUSITION OF THE HYDRAULIC JUMP IS С DETERMINED BY EQUIVALENCE OF THE F+M FERM BETHEEN THE С FULL BORE FLOW AND THE UPSTREAM SUPERCRITICAL FLOW. IF(SHAPE.EG.1) AREA=8##2 IF(SHAPE.EC.2) AREA=(3.142*E**2)/4.0 IF(IOUT.EQ.1) GOTO 315 WRITE(3,790) 790 FURMAT(/,20%, FULL 3JRE FLOH ESTABLISHED. //) 316 CONTINUE EN(2,IS)=8+(C++2)/(2.)+G+APEA++2) F(2, IS)=RHD¢C¢C/AREA+GAM¢AREA¢B/2.0 IF(IOUT.EQ.1) GGTO 317 WRITE(3,205)SL,6,EN(2,IS),F(2,IS) 317 CONTINUE XL=PL-SL IS = IS + 1DEP(2, IS) = E $X(2, IS) = C \cdot C$ SL=PL EN(2, IS) = EN(2, IS-1) $F(2, IS) = RHO \neq Q \neq Q / AREA + GAM \neq AREA \neq (B/2.0)$ IF(IOUT.EQ.1) COTU 3171 HRITE(3,205)SL, B, EN(2, IS), F(2, IS) CONTINUE 3171 GOTO 900 900 CUNTINUE С

 $IF(IZ_{O}T_{O}I)F(IZ_{-1},IS) = FM$

```
C
C
C
      IDENTIFICATION OF JUMP POSITION BY EQUIVALENCE
      JF THE F+M TERM.
С
      IF(F(1,1).LT.F(2,15).AND.IOUT.EQ.0)WRITE(3.385)
385
      FORMAT (/20x, "JUMP DROANED AT L=0 AT TEST PIPE ENTRY",/)
      IF(F(1,1).LT.F(2,IS)) GOTU 800
      XP = 0.0
      JELX=PL/500.0
      XP = XP + DELX
103
      00 102 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).EG.0.0) GUTO 103
102
      CONTINUE
      CALL INTER(X(J, I+1), F(J, I+1), X(J, I), F(J, I), XP, FX)
103
      J = 1
      00 104 K=1,100
      IF(K.GT. [#(2)) G0T3103
      IF(X(J,K).LF.XP.ANJ.K(J,K+1).UT.XP)COTB 109
      GOTC 104
      CONTINUE
109
      IF(F(J,K).CE.FX.AND.F(J,K+1).LE.FX)50T0 110
104
      CONTINUE
Ç
C
00
С
C
С
CC
110
      CONTINUE
      FP(1,1) = F(1,K)
      FP(1,2) = F(1,K+1)
       OP(1,1) = X(1,K)
      DP(1,2) = X(1, K+1)
       FP(2,1) = F(2,1+1)
      FP(2,2) = F(2,1)
       OP(2,1) = X(2,1+1)
       OP(2,2) = X(2,1)
      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),
      10P(2,2),FP(2,2),XJ,FJ
C
       CALCULATION OF DEPTH AND ENERGY CHANGES AT THE JUMP.
       00 49 K=1.2
       CALL INTER(X(K, IP(K)), DEP(K, IP(K)), X((, IP(K)+1),
      1 \ge P(K, IP(K) + 1), X = H = (K)
       CALL INTER(X(Y, IP(X)), EN(K, IP(K)), Y(X, IP(X)+1),
      1EN(K, IP(K)+1), XJ, EJ(K))
49
       CONTINUE
С
0
```

C

```
CHH=HJ(2)-HJ(1)
      CHE = EJ(2) - EJ(1)
      IF(IOUT.EQ.1) GOTO 313
      WRITE(3,107)XJ,HJ(1),HJ(2),EJ(1),EJ(2),FX,CHH,CHE
107
     FURMATE////,20X, JJ42 POSITIEN
                                             = * • F10.4 •
     1º M FROM PIPE ENTRY.",
     1/,20X, CONJUGATE DEPTHS
                                  = ""FS".4" M UPSTREAM AND ",
     LF6.4, "H DOWNSTREAM. ",/,20X,
     1°KINETIC ENERGY VALUE = ",F8.4, "M UPSTREAM AND ",F8.4,
     1º M DOHNSTREAM. , /, 20K,
     1°HYDRUSTATIC+MOMENTUM = ",F9.4," N. ",/,
     1/,20X, "DEPTH CHANGE AT JUMP = "+E14.5," M.",
     2/,20%,"ENERGY LOSS AT JUMP = ",E14.5," M. ")
319
      CONTINUE
      HUP(IC) = HJ(1)
      HDN(IC)=HJ(2)
      EUP(IC) = EJ(I)
      EON(IC) = EJ(2)
      UJH(IC)=CHF
      JEJ(IC)=CHE
      CFPM(IC) = FX
      X JUMP(IC) = X J
      C = \sum I
      GUTO HOO
С
000
C
Ċ
С
C
Ċ
C
Ċ
C
9010
       CONTINUE
      IF(IOUT.EQ.O) GOTO 320
С
      THIS OUTPUT SECTION IS ONLY USED IF IUUT=1, TABULAR
C
      JUTPUT ONLY
      IF(ICCN.EQ.2.AND.ICOUNT.EQ.0) WPITE(3,325)
325
      FORMAT("1 PROGRAM RESULTS BASED ON TERMINAL CONDITIONS",
     1. IN THE APPPGACH PIPE AND NERMAL FLOH DEPTH JUWNSTREAM.
     2° OF THE JUMP IN THE TEST PIPE. ",//)
      IF(ICON.EQ.2.AND.ICOUNT.EQ.O)WRITE(3.321)
      I = I C
      IF (ICOUNT.EC.20.AND.ICON.EC.2) HPITE(3,325)
      IF(ICOUNT.EC.20)WRITE(3,321)
      IF(ICUUNT.EC.20)ICOUNT=0
      ICOUNT=ICGUNT+1
      IF(HN2(I).LT.HC2(I)) 30T0 370
      IF(HN2(I)_EC_B) GUTD 371
      IF (FEN(I).LE.CFFM(I)) GOTO 372
      dRITE(3,323)6T(I),3,44,51(I),HN1(I),TEN1(I),52(I),HC2(I),
     .1HN2(I),HEN(I),EEN(I),FEN(I),HUP(I),HDN(I),DJH(I),EUP(I),EUN(I).
     2JEJ(I) CFPH(I) JUMP(I)
      GUTO 322
370
      dRITE(3,380)QT(1),3,24,51(1),HN1(1),TEN1(1),52(1),HC2(1),HV2(1)
```

GUTO 322 HRITE(3,381)CT(I),3,R4,S1(I),HN1(I),TEN1(I),S2(I),HC2(I),HN2(I) 371 COTO 322 ARITE(3,382)GT(I),8,RH,S1(I),HN1(I),TEN1(I),S2(I),HC2(I),HN2(I) 372 GUTO 322 CONTINUE 322 0 323 FORMAT(/5K,F4.1,F5.2,F6.3,F7.4,2F6.3,F7.4,3F6.3,F6.2,3F6.3, 14F7.3.2F6.3) FORMAT(/5X, F4.1, F5.2, F6.3, F7.4, 2F6.3, F7.4, 2F6.3, 15X, 380 1° JUMP IMPOSSIBLE AS ANCHO IN TEST PIPE.") FORMAT(/5x,F4.1,F5.2,F6.3,F7.4,2F6.3,F7.4,2F6.3,15X. 381 1º FULL BORE FLOW ESTABLISHED IN TEST PIPE. ") FJKMAT(/5X+F4+1+F5+2+F5+3+F7+4+2F6+3+F7+4+2F6+3+15X+ 382 1º JUMP DRUHNED AT L=O AT TEST PIFE ENTRY.") 321 FURMAT(///5%, COMMUN DATA , APPROACH PIPE DATA ... 125X, TEST FIPE DATA AND PROGRAM PESULTS. ,//, 25K. D. DIA. MANN. SLOPE - HN TEPM. SLOPE HN . 3 ENTRY ENTRY UPJUNP DOWN DEPTH ENERGY ENERGY ENERGY . 4" JUHP JUHP "9/9549"L/S H. CEEF (SIN) N. ENERGY"9 5" (SIN) M. N. DEPTH ENERGY F+M DEP 6"UPJUMP DUFN CHANGE F+M. PUS. "./.5%. . No DEPTH ENERGY F+M DEPTH DEPTH CHANGE ". 723X, M. *,19X, M. M. N. N. ۰. Μ. Л. 31 M. * . /) M ... ۲. 4. N. 320 CUNTINUE JUTD 9011 701 CONTINUE READ(4,702)SHAPE IF(SHAPE.GT.O) GOTU 902 END С С ~ -SUBROUTINE INTER(A, 3, C, D, X, Y) С SUBROUTINE INTER SIMPLY INTERPOLATES LINEARLY BETWEEN С THU SETS OF DATA PUINTS AND IS USED TO CALCULATE С JUMP DEPTH AND ENERGY CHANGES AS HELL AS PUSITION. $Y = B + (X - A) \Rightarrow (D - E) / (L - A)$ RETURN END 50 С SUBROUTINE SOLVE(X1,Y1,X2,Y2,X3,Y3,X4,Y4,X5,Y5) С SUBPOUTINE SOLVE DETERMINES THE INTERSECTION POINT OF С TRO STRAIGHT LINES ORANN BETHEEN FPH-X COORDINATES IDENTIFIES AS LYING ON EITHER SIDE OF THE JUAP POSITION. A = (Y1 - Y2) / (X1 - X2) $9 = Y 1 - X 1 \neq A$ C = (Y3 - Y4) / (X3 - X4) $) = Y 3 - X 3 \neq C$ X5=(D-2)/(A-C) 15-A+X5+6 RETURN END C C

C

č C SUBROUTINE POUND(E.Q.B.HB) INTEGER SHAPE CUMMON/CH2/SHAPE SUBROUTINE EDUNG CALCULATES THEFENTRY CONDITION TO THE C С HILD SLOPE PIPE (IZ=2) BY REFERENCE TO THE ENERGY AT С DISCHARGE FFOM THE STEEP SLOPE PIPE (12=1), OR SIMPLY FROM THE ENERGY INPUT DATA IF THAT MOJE IS CHOUSEN С С BY THE INPUT OF ICON = 1 IN THE INITIAL READ STATEMENTS. C PIPE CROSS SECTION IS CONTROLLED BY THE VALUE OF Ĉ TERM SHAPE, 1=RECTANGULAR OF 2=CIFCULAR, IN THE INPUT. G=9.81 IF(SHAPE.GT.1) GOTO 2 Y1 = 0.0HB=0/(8¢(2.0¢0¢E)¢¢0.5) UH=H8/200.0 HX=H8/2.0 00 75 1=1,100 IF(1.6T.1) Y1=Y HX=HX+DH $Y = (0 \neq \neq 2) / (2 \cdot 0 \neq G) + ((3 \neq + x) \neq \neq 2) \neq (H x - E)$ IF(1.E0.1)(CTU 75 IFIY1.GE.U.C.ANL.Y.LE.D.JJ GETE 76 IF(YL.LF.C.C.ANL.Y.GE.D.C) CCTU 76 75 CONTINUE 76 H3 = HXGOTO 1 Ζ. CONTINUE n = 0.0EC1=0.0 DELH=0/200.C P[=3.142]X=8/2.0 3 H=H+DELH IF(H.LT.R) THETA=2.0+ATAN(SORT(H+(3-H))/(R-H)) IF(H.EQ.R) THETA=PI IF(H_{GT_R}) THETA=PI+2.0*ATAN($(H_{F})/(S_{R}T(n*(B_{H})))$) $AREA = \{(P \Rightarrow \Rightarrow 2) / E = C\} \Rightarrow (T + ETA - SIN(T + ETA))$ 202=H+(Q++2)/((A++A++2)+2.0+6) IF(EC2.LE.E.AND.EC1.SE.E) GOTO 4 EC1=EC2GOTO 3 H8=H 4 1 CONTINUÉ RETURN END С С C CCCCC A11.20 -

C

1

20

<u>с</u>

22.

21

2

```
SUBROUTINE CALC(H, UL)
     SUBROUTINE CALC IS USED THROUGHOUT THE PROGRAM TO
     DETERMINE THE FLOW-PIPE PARAMETERS SUCH AS FLUW
     DEPTH, AREA, WETTED PERIHETER AS WELL AS BEING USED
     IN THE BISECTION METHOD CALCULATION OF NORMAL AND
     CRITICAL DEPTHS IN EACH OF THE PIPE LENGTHS.
     IN THE CIRCULAR PIPE CROSS SECTION CASE IT ALSO
     CALCULATES SUBTENDED ANGLE AND THE WATER SURFACE
     AIDTH AS DEPTH CHANGES.
     AS IN BOUND AND MAIN PROGRAM THE PIPE SHAPE IS DETERMINED
     BY THE VALUE OF THE TERM SHAPE INPUT AS DATA.
     INTEGER SHAPE
     COMMON/CM1/P,Q,G,CUN,SO,GAM,RHG,HCRIT,HNORM,AREA,PER,FPM,ENERG
     COMMON/CH2/SHAPE
     COMMON/CM3/IZ
     IF(SHAPE.GT.1)GOTU 1
     IF(IZ.EQ.3.ANL.H.GE.B)H=B
     AREA=H42
     PER=8+2.0+H
     HCRIT=1.0-(Cret2)+B/(G+AREA++3)
     HNURM=1.0-(C++2)+CUN/((ARLA++3.333)/(PEK++1.333))
     DL=HCKIT/(HNOK M4SC)
     FPM=(GAX+++E2++/2.0)+(RH)+C+(/2+E2)
     FNERG=H+(u++2)/((AKEA++2)+2.u+G)
     JUTC 2
     x=2#0.0
     11=3-142
     IF(IZ-10-3-AND-H-GE-3) GUTC 20
     IF(H.LT.R) THETA=2.04ATAN(SGRT(H4(3-H))/(d/2.J-H))
     IF(H.EG.R) THETA=PI
     IF(H.GT.P) THETA=PI+2.09ATAN(()-E/2.0)/(SŪKT(H+(8--))))
     G3T0 22
     4= 5
     THETA=2.00PI
     AREA=PI¢(8/2.0)¢¢2
     PER=PI#8
     X0=8/2.0
     GOTO 21
     CONTINUE
     AREA=((B¢ +2)/8.0)+(THETA-SIN(THETA))
     PER=8¢THETA/2.0
     T=2.0¢((H¢(E−H))¢¢).5)
     HCRIT=1.0-(C*=2.0)+T/(G#AREL==3)
     HNORM=1.0-(G*+2.0)+CON/((AFFA++3.333)/(PER++1.333))
     OL=HCRIT/(HN(KM¢SO)
     X0=(2.0/3.0)*(6/2.0)*(3.0*SIN(THETA/2.0)-SIN(3.0*THETA/2.0))
    1/(4.0 + (THETE/2.0 - 0.5 + SIN(THETA)))
     HJAR=XU+H-E/2.U
     FPM=GAMAAKE & AHBAR+ RHJADAD/APEA
     ENERG=H+(0++2)/((AREA++2)+2.0+6)
     CUNTINUE
     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 VVVV0.1500VVV0.0150VVV1.0000VVV1.0000VV2VV3

- Line 3 Sl test pipe slope, Format F10.4. VVVV0.0025
- Line 4 Sl test pipe slope, Format Fl0.4 VVVV0.0050
- Line 5 S2 approach pipe slope, Format Fl0.4 VVV0.5000
- Line 6 S2 approach pipe slope, Format Fl0.4 VVV0.7070
- Line 7 S2 approach pipe slope, Format Fl0.4 VVVV0.8660
- Line 8 SHAPE Format I3 VV1
- Line 9 B, RM, QMIN, DQ, N1, N2 Repeat Line 2
- Line 10 SHAPE $\nabla \nabla 0$ - indicates end of file.

SBATS:	1 · · · · · · · · · · · · · · · · · · ·
С	HYDSUM CALCULATES VALUES OF HC AND HN TO DETERMINE
C	WHETHER JUMP FOMATION IS POSSIBLE, ALSO VALUES OF
С	F+M ARE CALCULATED TO INDICATE WHETHER THE JUNP IS
С	JROWNED ET PIPE ENTRY.
	DIMENSION QT(10), SLOPE(100), HNP(1CG,10), HCP(10), F(100,10)
	INTEGER SHAPE
	COMMON/CH1/P+Q+G+CON+SQ+GAM+RHD+HCRIT+HNORM+AREA+PER+EPM+ENERG
	COMMON/CM2/SHAPE
	READ 14 - 702 ISHARE
702	ENDMAT(13)
IVE	95AD/4.40019.9M.0MIN.00.N1.N2
600	
000	
4.01	
OAT	
	UU GUZ J=19NI
	KEAU(4,603)51
503	FURHAI (F10-4)
	SLUPE(1)=S1
502	CONTINUE
	DU 604 J=1. N2
	READ(4,603)52
_	SLOPE(I)=S2 .
504	CONTINUE
	N3=N1+N2
	N4=NL
622	CONTINUE
	00 605 I=1,N3
	DU 606 K=1,8
	Q=QT(K)/1000.0
	G=9.81
	RH0=1000.0
	GAM=G#RH0
	SO=SLOPE(I)
	CON=(RM##2)/SO
C	DETERMINATION OF CRITICAL AND NURMAL JEPTHS.
C	CALCULATION OF CRITICAL DEPTH.
	JP=B
	DN=0.0
-	HC = UP/2.0
7	CONTINUE
	CALL CALC(HC, DL)
	IF(HCRIT)3,4,5
3	DN=HC
-	GOTO 6
2	UP=HC
6	HCN=(UP+DN)/2.0
	IF(ABS((HCN-HC)/HC).LE.0.001) GOTO 8
0	GUIU 7
3	HC=HCN
-	IF (HCUNT.EQ.O.O)HCUNT=HC
6	LALCULATION OF NORMAL DEPTH.
2	
4	CONTINUE

•

t

```
IF(HNORM) 10,11,12
10
     DN=HN
      GOTO 13
12
     UP = HN
     HNN=(UP+DN)/2.0
13
      IF (ABS ((HNN-HN)/HN).LE.0.001) GOTD 14
     HN=HNN
     GOTO 9
14
      HN=HNN
11
     CONTINUE
      [F(HN.GE.8) HN=B
     CALL CALC(HN,DL)
     HNP(I.K)=HN
    " HCP(K)=HC
     F(I \cdot K) = FPM
606
      CONTINUE
605
      CONTINUE
      IF(SHAPE.EQ.1) HRITE(3,607)B,RM
      IF(SHAPE.E0.2) WRITE(3,608)P,RM
      FORMAT(1H1,1X,//,5X, TABULATED NORMAL FLOW DEPTHS",
507
     1" FOR A RECTANGULAR CHANNEL OF WIDTH ",FIG.4," H. ",
     2"AND MANNING COEFF. ",F10.4,/)
509
     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,/J
      HRITE(3,609)(GT(K),K=1,8)
      FORMAT(//,5X, *FLOW RATE = *,8F10.4, * L/S.*,5X,
609
     1°PIPE DIA. OR°,/,107X, "WIDTH M.")
      HRITE(3,619)
      FORMAT(/50X, "NORMAL DEPTH M.")
619
      HRITE(3,610)SLOPE(1),(HNP(1,K),K=1,8),8
610
      FORMAT(5X, *PIPE SLOPE*, 2X, /, 7X, *(SIN)*, /, 5X,
     1F10.4,2X,3F10.4,10X,F10.4)
      00 611 I=2;N1
      HRITE(3,612)SLOPE(I),(HNP(I,K),K=1,8),8
612
      FORMAT(5x,F10.4,2x,3F10.4,10x,F10.4)
611
      CONTINUE
      I=N4
      WRITE(3,613)
      FORMAT(//,56X, ********,//)
613
      N5=N4+1
      DO 614 I=N5.N3
      WRITE(3,612)SLOPE(I),(HNP(I,K),K=1,8),B
      CUNTINUE
514
      4RITE(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 VALJES OF F+M AT NORMAL ",
     1"DEPTHS IN A RECTANGULAR CHANNEL OF WIDTH ".F10.4.
     2" M. AND MANNING COEFF. ",F10.4,/)
      FORMAT(1H1,1X,/////5x, "TABULATED VALJES OF F+M AT NORMAL ",
517
     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.")
      4RITE(3,610)SLOPE(1),(F(1,K),K=1,8),0
      DO 618 I=2,N3
      IF(I.LE.N4)WRITE(3,612)SLOPE(I),(F(I,<),K=1,8),B
      IF(I_GT_NA)WRITE(3,512)SLUPE(I),(F(I_K)K=1,d),B
      IF([_EQ_N4) WRITE(3,613)
```

2

```
613
      CONTINUE
      READ(4,702)SHAPE
      IF(SHAPE.EQ.O) GOTO 621
      READ(4,600)8,RM, 0HIN, 00,N1,N2
      GOTO 622
621
      CONTINUE
      END
      SUBROUTINE CALC(H.DL)
      SUBROUTINE CALC IS USED THROUGHOUT THE PROGRAM TO
C
C
      DETERMINE THE FLOH-PIPE PARAMETERS SUCH AS FLOW
С
      DEPTH, AREA, WETTED PERIMETER AS WELL AS BEING USED
C
      IN THE BISECTION METHOD CALCULATION OF NORMAL AND
С
      CRITICAL DEPTHS IN EACH OF THE PIPE LENGTHS.
С
     IN THE CIRCULAR PIPE CROSS SECTION CASE IT ALSO
С
      CALCULATES SUBTENDED ANGLE AND THE WATER SURFACE
C
      WIDTH AS DEPTH CHANGES.
С
      AS IN BOUND AND MAIN PROGRAM THE PIPE SHAPE IS DETERMINED
Ć
      BY THE VALUE OF THE TERM SHAPE INPUT AS DATA.
      INTEGER SHAPE
      COMMON/CH1/0.9, G. CON. SO. GAM. RHO. HCR IT. HNORM. AREA. PER. FPM. ENERG
      COMMON/CH2/SHAPE
      COMMON/CM3/IZ
      IF(SHAPE.GT.1)GGT0 1
      IF(IZ_EQ_3_AND_H_GE_B)H=B
      AREA=H#B
      PER=B+2.0*H
      HCR[T=1.0-(0\neq 2)\neq 6/(G\neq AREA\neq 3)
      HNORH=1.0-(C++2)+CON/((AREA++3.333)/(PER++1.333))
      OL=HCRIT/(HNOR H+SO)
      FPM=(GAH+AREA+H/2.0)+(RH0+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.3) GOTO 20
      IF(H_{0}T_{R}) THETA=2.0*ATAN(SORT(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
      -1=8
      THETA=2.0+PI
      AREA=P1*(8/2.0)**2 .
      PER=PI#8
      x_0 = 8/2.0
      GOTO 21
22
      CONTINUE
      AREA=((B**2)/8.0)*(THETA-SIN(THETA))
      PER=B#THETA/2.0
      T=2.0¢((H¢(2-H))¢¢0.5)
      HCRIT=1.0-(0**2.0)*T/(G*AREA**3)
      -INORM=1.0-(0**2.0)*CJN/((AREA**3.333)/(PER**1.333))
      DL=HCRIT/(HNORM#SO)
      x0=(2.0/3.C)*(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)))
      HBAR=X0+H-B/2.0
21
      FPH=GAM#AREA#HBAR+RH0#Q#Q/AREA
      ENERG=H+(Q**2)/((AREA**2)*2.0*G)
2
      CONTINUE
      RETURN
      END
$8ENJ
```

NBS-114A (REV. 2-80)							
U.S. DEPT. OF COMM.	1. PUBLICATION OR	2. Performing Organ. Report No. 3. F	ublication Date				
BIBLIOGRAPHIC DATA	REPORT NO.						
SHEET (See instructions)	NBSIR 81-2367		November 1981				
4. TITLE AND SUBTITLE							
DEDICTION OF THE	HYDRAULTC TIMP LOCATT	ON FOLLOWING & CHANCE OF	NOPE IN A				
PREDICTION OF THE	DEATNACE DIDE	ON FOLLOWING A CHANGE OF 3	SLOFE IN A				
PARITALLI FILLED I	JRAINAGE FIFE						
5. AUTHOR(S)							
John A. Swaffield							
6. PERFORMING ORGANIZA	TION (If joint or other than NBS	, see instructions) 7. Co	ntract/Grant No.				
DEPARTMENT OF CONN	STANDARDS EPCE	8. Tv	ne of Report & Period Covered				
WASHINGTON, D.C. 2023	4						
9. SPONSOBING OBGANIZAT	NON NAME AND COMPLETE A	DDRESS (Street, City, State, ZIP)					
Department of House	sing and Urban Develop	ment					
451 7th Street, SI	W						
Washington, D.C.	20410						
10. SUPPLEMENTARY NOTE	S						
Document describes a	a computer program; SF-185, FIP	S Software Summary, is attached.					
11. ABSTRACT (A 200-word o	or less factual summary of most	significant information. If document in	cludes a significant				
bibliography or literature	survey, mention it here)						
The criteria gover	rning the formation of	a hydraulic jump in a par	tially filled				
fluid conduit down	nstream of a slope cha	inge are presented together	: with the				
necessary techniq	ues to enable water su	rface profiles and jump lo	ocation to be				
predicted.							
Computer programs	designed to model the	conditions leading to jun	np formation				
under flow and cha	annel scale conditions	compatible with current of	lrainage system				
design are present	ted.						
The results of a	wide range of test cor	ditions in terms of jump f	formation and				
position downstre	am of a change in char	nel slope are presented to	gether with a				
set of criteria to	set of criteria to be used in evaluating whether a jump will occur for a given						
set of design con	ditions	ig whether a jump will occu	ii ioi a given				
set of design conditions.							
12. KEY WORDS (Six to twelv	e entries; alphabetical order; ca	pitalize only proper names; and separa	te key words by semicolons)				
building drainage: gradually varied flow: hydraulic jump: portiolly filled nice							
flow.							
13. AVAILABILITY			14. NO. OF				
[V] Helimited			PRINTED PAGES				
For Official Distribut	193						
20402.	15. Price						
X Order From National	Technical Information Service (N	TIS), Springfield, VA. 22161	\$15.50				
		and the second					



