INCIPIENT MOTION IN COBBLE/BOULDER BED RIVERS

MENNO GAZENDAM

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Promotor: Professor A Rooseboom

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DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

ABSTRACT

This study sets out to describe the incipient motion process in cobble/boulder bed rivers in terms of the unit applied power approach. This objective has been met through the collection of data on stone movement from a total of thirteen flood events observed in two undisturbed rivers in the Western Cape, namely the Molenaars and Berg Rivers.

The data were plotted on the original modified Liu diagram for incipient motion and it was found that the threshold of movement for the smaller stones did not conform with the portion of the Liu diagram which represents fully turbulent flow (i.e. where $\sqrt{gDs}/V_{ss} = 0.12$ for $Re_* > 13$). It was concluded that the only reason that could explain this deviation is the fact that the original modified Liu diagram had been derived for uniform particle size beds while the data of the Molenaars and Berg Rivers represent non-uniform particle size beds. This was proved through re-deriving the y-axis function of the original modified Liu diagram to include a factor that makes provision for the roughness of a non-uniform particle size bed. It was found that the average absolute roughness of the non-uniform particle size beds in the Molenaars and Berg Rivers is reasonably well approximated by a value of $k=d_{84}$.

Design curves (in terms of the original modified Liu diagram parameters) for intensity of motion were also produced. Although it is not possible to read off accurate percentages of movement values directly from these curves, it should be possible to deduce reasonably accurate values in practical situations.

OPSOMMING

Die studie poog om die begin van beweging proses in klip/rotsbed riviere te beskryf in terme van die eenheids aangewende drywing metode. Hierdie doel is bereik deur die insameling van klipbewegingdata in 'n totaal van dertien vloedgebeurtenisse in twee ongerepte riviere in die Wes-Kaap, naamlik die Molenaars en Bergriviere.

Die data was geplot op die oorspronklike aangepaste Liu diagram vir begin van beweging en dit was gevind dat die grens van beweging vir die kleiner klippe nie ooreenstem met die gedeelte van die Liu diagram wat volle turbulente vloei verteenwoordig nie (waar $\sqrt{gDs}/V_{ss} = 0.12$ vir $Re_* > 13$). Daar was tot die gevolgtrekking gekom dat die enigste rede wat die afwyking kan beskryf is die feit dat die oorspronklike aangepaste Liu diagram afgelei was vir uniforme partikelgrootte beddens terwyl die data van die Molenaars and Bergriviere nie-uniforme partikelgrootte beddens verteenwoordig. Dit was bewys deur die herafleiding van die y-as funksie van die oorspronklike aangepaste Liu diagram om 'n faktor in te sluit wat voorsiening maak vir die ruheid van 'n nie-uniforme partikelgrootte bed. Dit was gevind dat die gemiddelde absolute ruheid van die nie-uniforme partikelgrootte beddens in die Molenaars en Bergriviere word redelik goed benaderd met 'n waarde van $k=d_{84}$.

Ontwerpkurwes (in terme van die oorspronklike aangepaste Liu diagram parameters) vir intensiteit van beweging was ook ontwikkel. Alhoewel dit nie moontlik is om baie akkurate persentasies van beweging af te lees van die kurwes nie, is dit moontlik om akkuraat genoeg waardes te verkry in praktiese situasies.

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All my family and friends that supported and helped me in many different ways.

To God, for giving us inquisitive minds to try and find order in the nature he created.

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LIST OF SYMBOLS

a, b : constants

A : cross sectional flow area

A_s : grain area

C_D : drag coefficient

d : particle diameter

d_x : particle size for which x % is smaller

D : flow depth

Fr : Froude number

g : gravitational acceleration

k : absolute bed roughness

Q : discharge (m^3/s)

Re_* : Reynold's number

R' : proportion of the hydraulic radius appropriate to sediment transport

s : energy gradient ≈ channel gradient (uniform conditions)

S_f : energy gradient

u : mean velocity

u_* : shear velocity

V_{ss} : settling velocity

V_s : grain volume

y : flow depth

z : bed elevation above datum

φ : angle of repose

Φ : dimensionless bedload function

ρ : density of water

ρ_s : particle density

τ : shear stress

τ_0 : shear stress at bed

ν : kinematic viscosity

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1 INTRODUCTION

1.1 Background

In pristine cobble/boulder bed rivers the channel bed configuration is maintained by a range of flows which are characteristic of the natural flow regime and which typically incorporate flows of different timing, duration, magnitude and frequency. The health of these channel beds is crucial to a multitude of aquatic organisms that are dependent on the bed for their survival. The channel bed of cobble/boulder a bed river is often referred to as a faunal reservoir, as it provides the source for recolonization of a stream when aquatic populations are depleted by adverse conditions. A variety of factors control the abundance, distribution and productivity of aquatic organisms in rivers. These include competition for space, predation, chemical water quality, nutrient supplies, flow patterns, as well as flow variability and together they describe the biological, chemical and physical habitat (Gordon *et al.*., 1992).

Depending on the biological species and life-cycle, the channel bed provides refuge from floods, shelter during droughts and extreme temperatures and interstitial spaces in which to lay and incubate eggs. Sufficient flow through the interstitial spaces allows the replenishment of nutrients and oxygen while metabolic wastes are continuously removed. The cobbles and boulders also assist with the periodic physical breakdown of organic detritus and provide a mechanism for entrainment of organic matter in the spaces between larger bed elements. This disturbance or breakdown process is an essential organizing factor in many ecosystems (Picket and White 1985).

The construction of dams, leads to alterations in the natural flow regime, flooding magnitude, frequency and the sediment transport capacity in the river channels downstream. This has a definite, often negative, impact on the dynamics of substrate movement and maintenance, which in turn affects the faunal and floral aquatic environment. Traditionally chemical water quality has been viewed as the most important factor affecting the degradation of aquatic ecosystems (Hugues *et al.*., 1990). However,

the physical habitat and its modifications have recently been identified as key elements in stream ecosystem functioning (Lamouroux *et al.*., 1995).

The process of determination of the amount of water which is required for environmental needs, is known as "Environmental Flow Assessment" (EFA). Following the EFA, a modified flow regime is prescribed for the river. The amount of water required in the modified flow regime is that which is deemed to be necessary for maintaining the river in a pre-determined condition and is known as the "Environmental Flow Requirement" (EFR). EFR's are based on an understanding (Brown and King, 2000) of how flow changes relate to changes in river condition, in order to describe flow that will:

- minimize or mitigate the impacts of new water-resource development
- restore systems impacted by past developments
- allow calculation of the costs of compensating people affected by such impacts.

In order to maintain a healthy and productive substrate environment in cobble and boulder bed rivers it is necessary that the environmental flow requirement (EFR) accommodates a substrate maintenance flow component. The specification of this substrate maintenance flow component must provide information on the amount and frequency of managed flows which are required to maintain a river in a pre-determined, environmentally acceptable condition. The availability of water, especially in a water scarce country such as South Africa, the cost of water that is released and lost for storage and the financial implications associated with the installation of outlet structures at reservoirs, emphasize the need to specify substrate maintenance flows as accurately as possible.

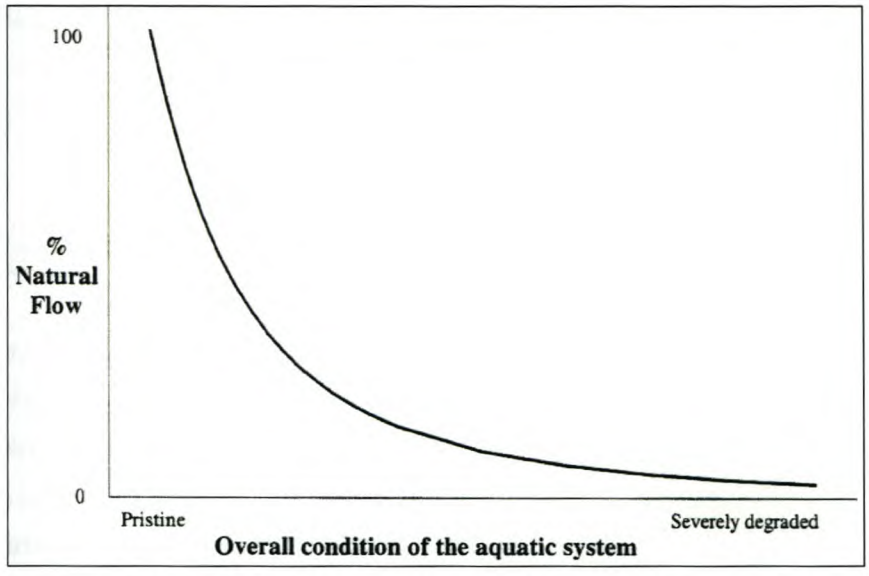

Figure 1.1: The relationship between percentage of natural flow and river condition (Brown and King, 2000)

Various factors complicate the determination of a substrate maintenance flow component. There is very little scientifically based data available regarding the impacts (both positive and negative) of different levels of substrate disturbance on the aquatic environment, from the scale of an individual disturbance event to that of the disturbance regime. Furthermore, it is necessary to contend with the complexity of flow and sediment transport processes in cobble/boulder bed rivers. This includes the effects of large scale roughness, macro scale bedforms (pool-riffle structures), the heterogeneous nature of the substrate particles and the effects of shielding or hydraulic protection on critical conditions for sediment movement.

With the increasing development of water infrastructure in mountain regions, knowledge of the hydraulic characteristics of rivers in the upper catchment areas has become very important, especially for determining environmental flow requirements. Due to their characteristic morphological and associated hydraulic attributes, the physical habitats within these rivers are extremely diverse, both on spatial and temporal scales. They are characterized by high gradients, great variability in sediment size and relatively low flow depths. The bed configuration typically contains a series of pools, steps, rapids, riffles

and plane bed beds, while energy losses are high as a result of turbulence and local hydraulic jumps (Jonker, 2003). Thus, in order to facilitate the specification of substrate maintenance flows in cobble/boulder bed rivers, which can be incorporated into either an environmental flow requirement or river rehabilitation programs, knowledge of the relationship between substrate disturbance, the aquatic environment and discharge is critical.

1.2 Objectives and Methodology

This thesis forms part of a bigger research project[1] sponsored by the Water Research Commission, of which the main aims are:

- To define and quantify ecologically significant substrate disturbance levels in cobble and boulder bed rivers.
- To develop theoretically-based hydraulic models that will address the relationship between discharge and substrate disturbance in cobble and boulder bed rivers.
- To develop guidelines for the specification of substrate maintenance flow components in cobble and boulder bed rivers.

In order to establish the relationship between substrate disturbance, the aquatic environment and discharge, detailed knowledge is required of different levels of bed disturbance in cobble/boulder bed rivers. Disturbances within these rivers can broadly be categorized in terms of the following levels of disturbance:

- No bed movement, where no sediment is being transported.
- Incipient motion, where the bed elements just start to move.
- Full bed movement, where all the particles along the bed surface are being transported.

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[1] WRC Project K5/1411, Determination of Substrate Maintenance Flows in Cobble and Boulder Bed Rivers, Ecological and Hydraulic Considerations.

The incipient motion condition is also referred to as the critical condition. Not only does incipient motion describe the movement threshold for sediment but it also serves to define the deposition threshold whereby sediment ceases to be transported. Thus a key in understanding the different levels of movement lies in the proper understanding of the incipient motion condition.

The following objectives were formulated for this thesis:

- *To describe incipient motion in cobble/boulder bed rivers.*
- *To produce graphs that will aid in the prediction of sediment movement in cobble/boulder bed rivers.*

The incipient motion process will be described by addressing the factors relating to the onset of incipient motion in the two streams studied.

1.3 Thesis Layout

Chapter 2 provides a literature overview of past and current methods for describing incipient motion. The data collection process is described in Chapter 3. In Chapter 4 the hydraulic relationships associated with incipient motion are addressed. Chapter 5 explains the process of producing graphs for practical use in predicting different levels of entrainment. Final conclusions and recommendations are contained in Chapters 6 and references are listed in Chapter 7. Appendices follow at the end.

2 LITERATURE REVIEW

2.1 Incipient motion theories

(i) Critical shear stress

Critical shear stress is defined as the maximum shear stress exerted on the bed that will not cause erosion of the sediment forming the bed. The retarding effect that limits the movement of one fluid element relative to another is traditionally represented by so called shear stress. This shear stress (τ) is shown by the following,

$$\tau = \rho g(D - y)s \qquad (2.1)$$

where D is the distance from the water level, y the distance from the bed, ρ the density of water and s the channel gradient.. Thus the maximum shear stress will prevail at the bed which is denoted by τ_o.

In field studies the critical shear stress has been estimated from the largest grain observed in motion (Andrews, 1983; Carling, 1983; Hammond *et al.*, 1984). Mixed-size sediment transport rates, from which incipient motion may be estimated, have been measured in several laboratory studies (Day, 1984; Dhamotharan *et al.*, 1980; Misri *et al.*, 1984) and in the field (Milhouse, 1973; Parker *et al.*). Experiments focusing on part of the problem, the pivoting angle of individual size fractions, have been undertaken by Li and Komar (1986).

The simplest shear stress model, the empirical power law, relating τ_o (shear stress at the bed) and d (diameter of stone) as

$$d_{50} = a\tau_o^b \qquad (2.2)$$

where *b* is the regression line slope and a is the y-intercept for a log-plot of τ_0 (shear stress at the bed) versus d_{50}. Knowing the shear stress at the bed (τ_0) allows one to solve

for the diameter of stones that will move (with the aid of equation 2.2 and the constants known) and from knowing the diameter (d) of a stone that moved the critical bed shear stress can be determined. However, the relationship is restrictive, applying only to a limited range of grain sizes and flow conditions where grain density and other entrainment parameters are known or are assumed to be constant (Carling, 1983).

Shields (1936) showed that the particle entrainment was related to a form of Reynolds' Number, based on the shear velocity u_* $(=\sqrt{\tau_0/\rho})$ i.e. $Re_* = \rho u_* D/\mu$. Shields plotted the results of his experiments in the form of an entrainment function (which is depicted by the y-axis and equals $\tau_0/(\rho_s - \rho)gD$) against Re_*.

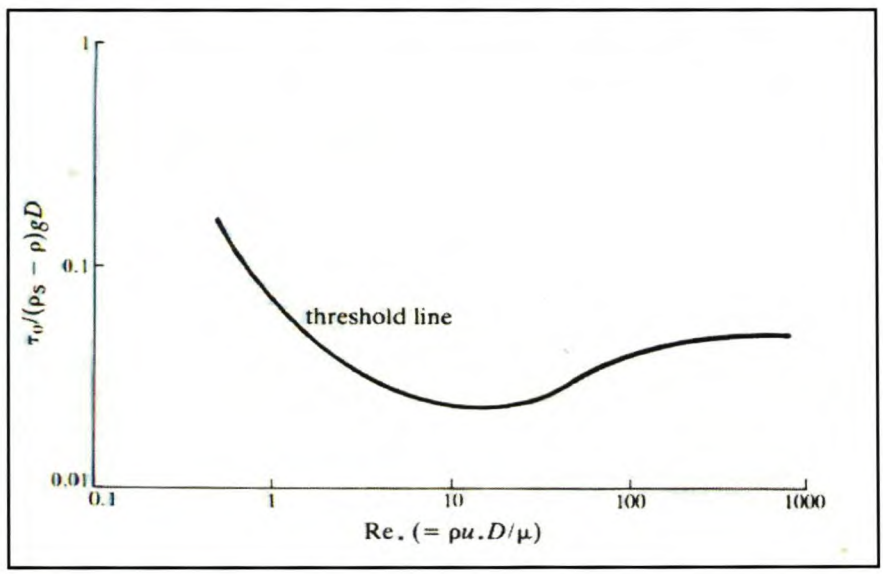

Figure 2.1: Shields' diagram

Power analysis by Rooseboom (1992) (Chapter 2.1.7) proves that the x-axis represents Laminar power/Turbulent power. The Shields equation was originally tested in a flume using spheres of uniform size and found to approach a constant value (y-axis) of 0.06 for course grained sediment with d > 6mm (Shields, 1936, Bagnold, 1966, and Allen, 1970). In natural streams, however, there is a high variance in the estimated values of τ_0 as a result of the non-uniformity of the bed particles.

An investigation of critical hydraulic conditions in gravel-bed rivers with naturally sorted bed material described by Andrews (1983) showed that the critical shear stress τ_0 could be given by an equation of the type shown in equation 2.3. As with the power law relationship this equation also allows calculation of a critical diameter once the shear stress is known or vice versa.

$$\tau_0 = a(\frac{d_i}{d_{50}})^b \qquad (2.3)$$

In this type of equation, the coefficient *a* represents Shields' entrainment function in homogeneous sediment conditions when $(d_i/d_{50})=1$. The (d_i/d_{50}) term attempts to provide a measure of the hydraulic protection that a stone of a certain diameter experiences due to its relative size in the bed. Several studies confirm the validity of this approach even though the values of the coefficients differ vastly. Table 2.1 shows these respective studies and their coefficients.

a	b	d_{50}	d_i/d_{50} range	Study
0.088	-0.98		0.045-4.2	Parker *et al.* (1982)
0.083	-0.87	0.13-2.5 5.4-7.4	0.3-4.2	Andrews (1983)
0.045	-0.68	2	0.4-5.9	Milhous (1973) in Komar (1987)
0.045	-0.68	2	0.5-10	Carling (1983)
0.045	-0.71	0.75	0.67-5.33	Hammond *et al.* (1984)
0.089	-0.74	2.3-9.8	0.1-2	Ashworth and Ferguson (1989)
0.047	-0.88	7.3	0.04-1.2	Ferguson *et al.* (1989)
0.049	-0.69	1.8-3.2	0.15-3.12	Ashworth *et al.* (1992)

Table 2.1: Different empirical equation coefficients

The difference in coefficients might be attributed to the fact that size distributions along individual reaches respond uniquely to a given distribution of particles, packing and turbulence characteristic of flow (Komar & Carling, 1991).

Several empirical flow equations are plotted in Figure 2.2. Differences in the slopes and intercepts of regression lines are obvious.

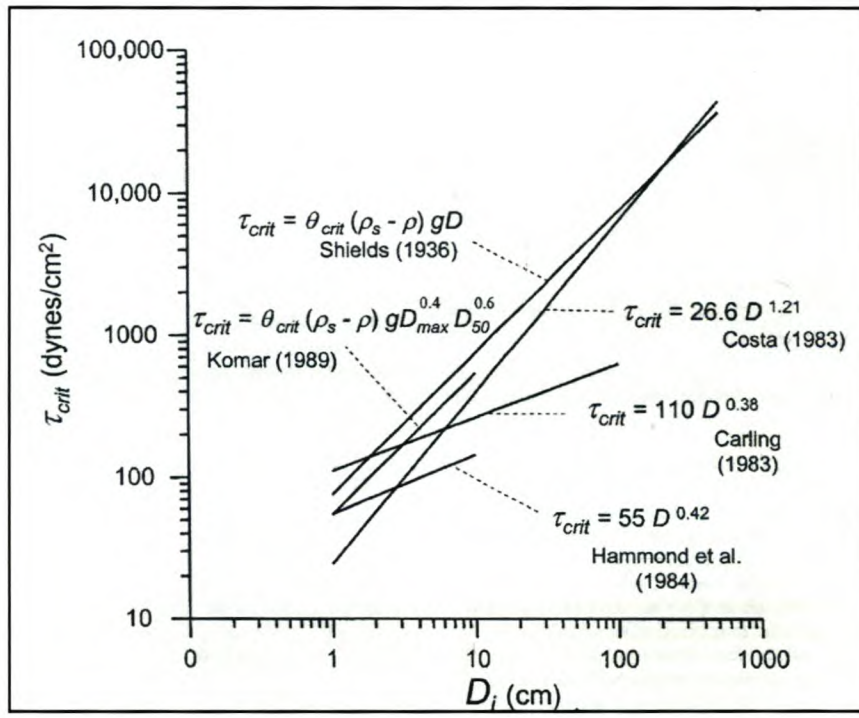

Figure 2.2: Empirical equations (Lorang and Hauer, 2003)

According to Wiberg and Smith (1987) a particle in a poorly sorted bed can have critical shear stresses that differ significantly from the critical shear stress associated with that particle when placed on a well sorted bed of the same size. In Chapter 4 this is shown to be true for applied stream power as well. Wiberg and Smith (1987) indicate that this difference is primarily due to the relative protrusion of a particle into the flow along with differences in the particle angle of repose, or bed pocket geometry that results from having a mixture of grain sizes on the bed. This led them to Figure 2.3 to determine critical shear stress for a specific particle. The graph contains incipient motion curves for

different ratios of grain diameter to bed roughness length, D/k_s, where bed roughness length refers to the diameter of the eddy sizes that can fit in between the bed particles. Critical shear stress is indicated with τ_* and the Reynolds' Number with Re_*.

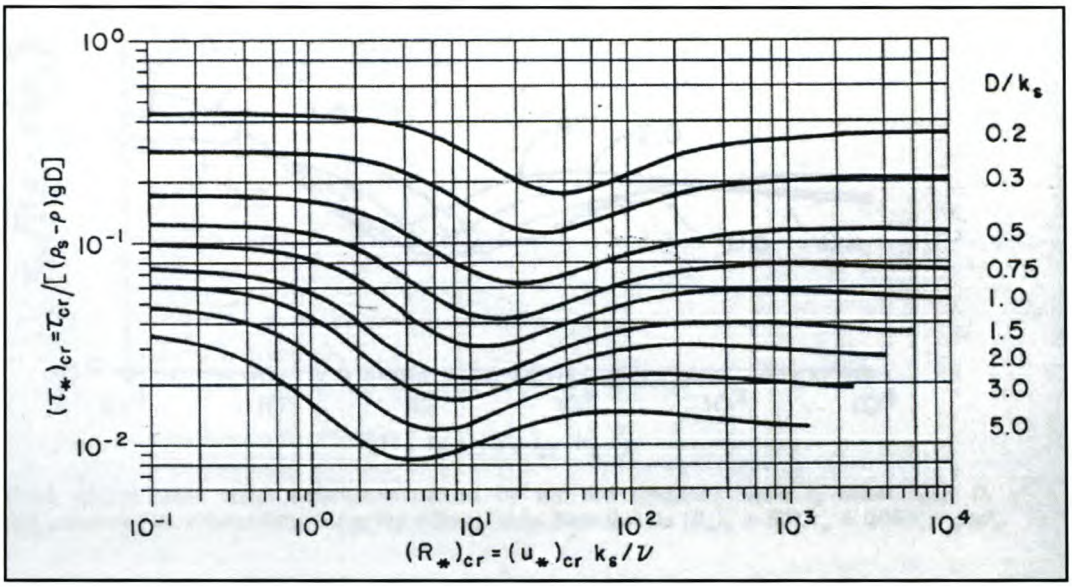

Figure 2.3: Shear stress for motion of sediments

Wilcock & Southard (1988) found that the sorting of the mixture had little effect on the critical shear stress of individual fractions, once the median size (d_{50}) of the mixture and a fraction's relative size (d_i/d_{50}) are accounted for. Their data showed a consistent relationship between the critical shear stress of individual fractions and each fraction's relative grain size, despite a broad variation in the available data of mixture sorting, grain size distribution shape, mean grain size, and grain shape.

(ii) Critical velocity

Critical velocity is defined as the maximum velocity of the stream that will not cause erosion of the sediment forming the bed. Extensive empirical data exists relating maximum velocities to various soil and vegetation conditions. Hjulstrom (1939) developed the graph in Figure 2.4, which relates average critical velocity to particle size.

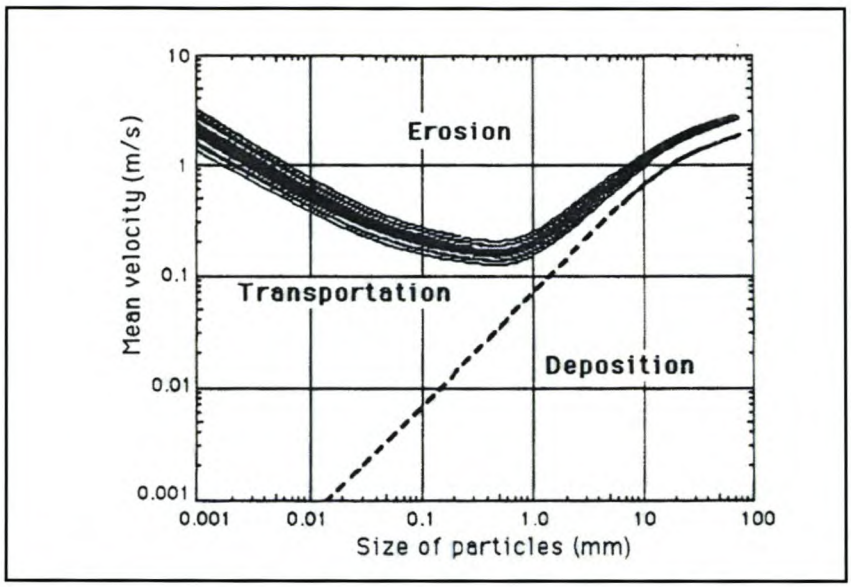

Figure 2.4: Hjulstrom curves for critical hydraulic conditions in uniform particle size sand beds

However, this simple method (critical velocity) for design does not consider the channel shape or flow depth. At the same mean velocity, channels of different shapes or depths may have quite different forces acting on the boundaries.

(iii) Critical flow discharge

Bathurst (1987) argues that on steep slopes the critical conditions for movement are best predicted by an approach based on water discharge rather than the Shields shear stress. He therefore adopted the Schoklitch (1962) approach to prediction of critical flow conditions, based on water discharge rather than shear stress. Using flume data for bed materials with relatively uniform size distributions he developed the empirical relationship:

$$q_{cr} = 0.15g^{0.5}d^{1.5}s^{-1.12} \qquad (2.4)$$

where q_{cr} = critical water discharge per unit width; and s = bed slope. The equation was derived for the range of slopes $0.0025<s<0.2$ and particle sizes $3<d<44$ mm and for ratios

of depth to particle size as low as 1. The above equation was used in conjunction with the following equation to determine the critical flow condition for each particle size:

$$q_{ci} = q_{cr}(d_i/d_r)^b \qquad (2.5)$$

where $b = 1.5(d_{84}/d_{16})^{-1}$, d_r is set equal to d_{50}, q_{ci} = the critical unit discharge for movement of particle d_i, q_{cr} = the critical unit discharge for the reference particle size d_r which is unaffected by the hiding/exposure effect and b = an exponent. Calibration of the above equation was carried out empirically using field data.

(iv) Critical Froude numbers

Aguirre-Pe *et al.* (2003) states that for ratios of flow depth to bed particle diameter less than ten (flow on very rough boundaries) neither the Reynolds number of the solid loose particles at a stream bed nor the Shields parameter are adequate variables to predict critical flow conditions for the initiation of motion. A particle densimetric Froude number $F^* = u/[(r-1)gd]^{1/2}$ is proposed as an alternative criterion to predict hydraulic conditions for the initiation of motion. Where u = mean velocity, r = ratio of sediment and fluid densities, g = acceleration due to gravity, and d = characteristic diameter of bed particle.

(v) Transport distances

D'Agostino *et al.* (1999 (a),(b)) used the ratio of transport distances and stone diameter to establish a criterion to define the incipient motion condition. The incipient motion condition of a grain size class is assumed to be given by an average distance of movement less than the diameter d_i representative of the diameter class itself. The average lengths of movement for different size stones were recorded. Where this average length was found to be less than the diameter of the stone itself, the stone diameter and the flood size were grouped together. Using the flood size and stone diameter, the boundary shear stress was obtained indirectly from flood size values by employing momentum conservation on a fluid control volume in uniform flow.

(vi) Probability models

Einstein (1942), in light of the fact that the incidence of an eddy capable of transporting a particular grain is some statistical function of time, proposed a probabilistic model of bedload for the case of even beds of grains. The basic ideas underlying Einstein's equation are the following:

For an individual grain, migration will take place in a series of jumps (Figure 2.5) of length $L = K_L D$. During a time T a series of *n* such jumps will occur, so that the particle will travel a total distance nL.

The probability, ρ, that a grain will be eroded during the typical period, T, must be some function of the immersed self-weight of the particle and the fluid force acting on the particle. The immersed self-weight is $(\rho_s - \rho)g(K_V d^3)$, and the lift force is $C_L \rho(K_A d^2)u^2/2$, where the grain area $A_s = K_A d^2$ and the grain volume $V_s = K_V d^3$. Therefore,

$$\rho = f\left(\frac{(\rho_s \rho)g(K_v d^3)}{C_L \rho (K_A d^2)u^2/2}\right) \qquad (2.6)$$

u is a 'typical' velocity at the sub-layer proposed by,

$$u \approx 11.6u_* \approx 11.6\sqrt{gR's} \qquad (2.6a)$$

where R' is that proportion of the hydraulic radius appropriate to sediment transport. Equation 2.6 is usually expressed as

$$p = f\{B_* \cdot \Psi\} \qquad (2.6b)$$

where

$$B_* = \frac{K_v}{C_L K_A 135/2} \tag{2.6c}$$

$$\Psi = \frac{(\rho_s - \rho)d}{\rho R's} \tag{2.6d}$$

The number of grains of a given size in area A ($K_L D \times 1$) is $K_L D / K_A D^2$, therefore the number of grains dislodged during time T will be $\rho K_L D / K_A D^2$. The volume of grains crossing a given boundary must therefore be

$$\frac{\rho K_L d}{K_A d^2} K_V d^3 = \frac{\rho K_L K_V d^2}{K_A} \tag{2.7}$$

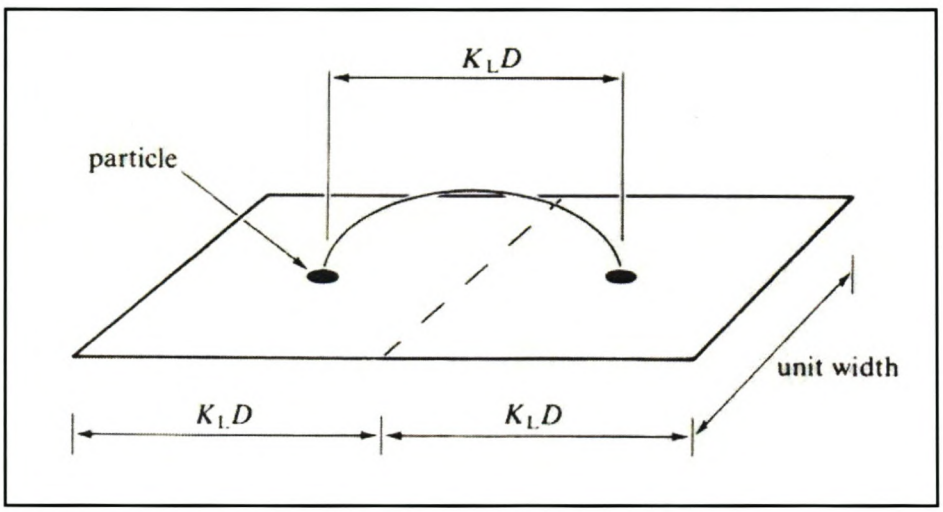

Figure 2.5: Einstein bedload model

The volume must also be given by $q_s T$. If the time T is some function of particle size and fall velocity, say $T = K_T d / V_{ss}$, then

$$q_s T = q_s \frac{K_T d}{V_{ss}} \tag{2.8}$$

Equating 2.7 and 2.8

$$\frac{q_s K_T d}{V_{ss}} = \frac{\rho K_L K_V d^2}{K_A} \qquad (2.9)$$

therefore

$$\rho = \frac{q_s K_T K_A}{V_{ss} K_L K_V d} \qquad (2.10)$$

Equating 2.6 and 2.10, leads, with some rearrangement, to

$$\Phi = q_s \sqrt{\frac{\rho}{(\rho_s - \rho) d^3}} = f(B_*, \Psi) \qquad (2.11)$$

where Φ is a dimensionless bedload function and B_* and Ψ have been defined above.

Following Einstein, a number of researchers investigated the relationship between Φ and Ψ. A typical result is due to Brown (in Rouse, 1950),

$$\Phi = 40(1/\Psi)^3$$

which is valid for $\Phi > 0.04$. As Φ (and therefore q_s) → $0.1/\Psi$ → 0.056, which corresponds to the Shields threshold condition where Shield's entrainment function reveals a value of 0.056 (see Figure 2.1).

(vii) Stream power

The movement of bed particles (or water) requires expenditure of energy, which is provided in streams by the release of potential energy as water travels down a slope. The

rate of energy dissipation is a measure of the stream power of a reach and specifically describes the amount (per unit volume) of power made available by the decrease in potential energy of flowing water (Jonker 2002) to maintain motion. This motion can be purely that of the fluid, or it can be of a fluid / solid mixture (Armitage & McGahey 2003). A number of researchers have preferred to use unit stream power as an indicator of sediment motion, although this application is not generally described in standard hydraulic introductory texts (e.g. Gordon *et al.* 2004).

Armitage & McGahey (2003) argue that the quantity represented by unit stream power is more directly related to the entrainment threshold, because it can be computed at any point in the water column, and because turbulence is directly related to dissipation of energy. Rooseboom (1998) argues that the application of the law of conservation of stream power (over that for example of momentum which is the basis for equations of critical shear stress) has advantages in that it involves scalar quantities (unlike the momentum-impulse law), its terms are directly time-dependent and account for the roughness (k) of the bed directly. Further, Rooseboom (1998) showed that the stream power equations uniquely give theoretical and numerical support to the empirically derived functions of the Liu Diagram for incipient motion (Liu, 1957), and provides a complete mathematical description of the Liu diagram..

Rooseboom (1974) defined the law of conservation of power under conditions of steady, uniform flow as

$$\int_{y_0}^{D} \rho g s v dy = \int_{y_0}^{D} \tau \frac{dv}{dy} dy \qquad (2.12)$$

with ρ : fluid density (kg/m^3)

g : gravitational acceleration (m/s^2)

s : energy gradient $\approx$ channel gradient

v : velocity at distance y above the bed (m/s) ($\approx \frac{1}{\kappa}\sqrt{gDs}\ln\frac{y}{y_0}$)

D : flow depth (m)

y_0 : ≈ k/30 ; ordinate where velocity is mathematically equal to zero (m)

τ : shear stress at distance y above the bed (N/m^2)

κ : von Karman coefficient ($\approx \frac{1}{\sqrt{2\pi}}$)

The parameter ρgsv in equation 2.12 represents the amount of unit power made available by the flowing stream, whereas the parameter $\tau\frac{dv}{dy}$ represents the power applied per unit volume to maintain motion.

Where alternative modes of flow exist, that mode of flow which requires the least amount of unit power will be followed and it therefore follows that fluid flowing over moveable material would only transport the material, if it will result in a decrease in the amount of unit power being applied (Rooseboom 1974; 1998). As the power applied along the bed of a river varies depending on whether laminar or turbulent flow conditions prevail at the bed, the critical condition for sediment movement also depends on whether flow condition at the bed is laminar or turbulent.

Under conditions of laminar or smooth turbulent flow, Rooseboom (1974) showed that the unit stream power applied along the bed equals

$$\frac{(\rho gsD)^2}{\rho\nu} \qquad (2.13)$$

with ν : kinematic viscosity (m/s^2)

The applied power required per unit volume to entrain a particle with density ρ_s and settling velocity V_{ss} in a fluid with density ρ, equals

$$(\rho_s - \rho)gV_{ss} \qquad (2.14)$$

Stokes's law (Graf 1971), defines the settling velocity of a particle with diameter d under viscous conditions as

$$(V_{ss})_{LAM} \ \alpha \ d^2 g \frac{\rho - \rho_s}{\rho \nu} \qquad (2.15)$$

The critical condition for the movement of sediment particles is reached when the power applied along the bed exceeds the power required to move the sediment particles out of their original positions. In laminar or smooth turbulent flow therefore, a relationship defining the threshold for sediment transport under viscous conditions can be defined from equation 2.13, 2.14 and 2.15. This relationship, calibrated with data by Grass (1970) and Yang (1973), was found to be:

$$\frac{\sqrt{gDs}}{V_{ss}} = \frac{1.6}{\frac{\sqrt{gDs}}{\nu} \cdot d} \qquad (2.16)$$

for values of $\frac{\sqrt{gDs} \cdot d}{\nu} < 13$, i.e. with smooth turbulent or completely laminar flow over a smooth bed (Rooseboom 1974, 1998).

Under conditions of rough, turbulent flow, Rooseboom (1974; 1998) showed that the unit applied power near the bed at (y_0), where $D\text{-}y_0 \approx D$, is

$$\tau \frac{dv}{dy} \approx \frac{30\rho gsD\sqrt{2\pi gsD}}{d} \qquad (2.17)$$

Under turbulent conditions energy dissipation occurs through the formation of turbulent eddies and not at the molecular level as is the case under laminar or smooth turbulent flow conditions. Viscosity is therefore not significant, but rather the size of the turbulent eddies that form. The size of these eddies represent the absolute roughness (k) of the bed. In the case of a bed with a uniform size distribution the size of the turbulent eddies that fit between the particles can be considered to be equal to the diameter of the bed particles. Furthermore, under conditions of turbulent flow, the settling velocity as expressed by Graf (1971) equals

$$(V_{ss})_{TURB} = \sqrt{\frac{4(\rho_s - \rho)gd}{3C_d}} \qquad (2.18)$$

with C_d : drag coefficient (assumed constant for larger diameters).

From equations 2.14, 2.17 and 2.18 the critical condition for the movement of sediment along an even bed in rough turbulent flow can thus be defined by

$$\frac{\sqrt{gDs}}{V_{ss}} = \text{Constant} \qquad (2.19)$$

This relationship was calibrated with measured data from Yang (1973) and the value of the constant was found to be 0.12 for values of $\frac{\sqrt{gDs}\cdot d}{\nu} > 13$ (Rooseboom 1974; 1998)

Rooseboom (1992) used the above parameters in a modified Liu diagram to describe the hydraulic relationships for sediment at incipient motion conditions as depicted in Figure 2.6.

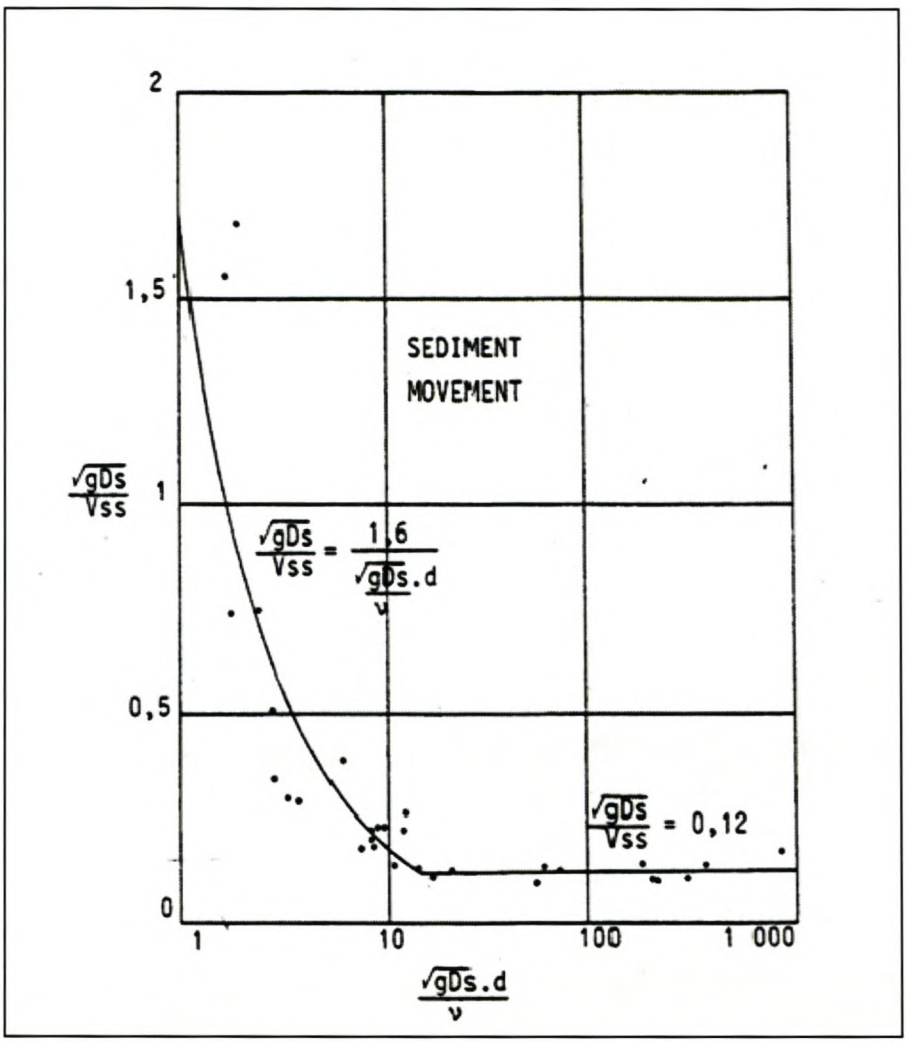

Figure 2.6: Modified Liu diagram (Rooseboom, 1992)

In the above figures the term $\frac{\sqrt{gDs}}{V_{ss}}$ can be interpreted as the ratio $\left[\frac{\text{Unit applied power along bed}}{\text{Unit power required to suspend particles}}\right]$, which reflects the ratio of the stream's capacity to entrain bed particles relative to the minimum power required to keep the particles in suspension (Rooseboom and Le Grange, 2000). On the other axis the term $\frac{\sqrt{gDs}\cdot d}{\nu}$ can be interpreted as the ratio $\left[\frac{\text{Laminar power}}{\text{Turbulent power}}\right]$ because it indicates whether the position of a data point on the modified Liu diagram is in a laminar flowing zone or a

turbulent flowing zone. The law of conservation of stream power states that the mode of flow which requires the least amount of unit power will be followed. Thus according to the ration $\left[\frac{\text{Laminar power}}{\text{Turbulent power}}\right]$ if turbulent flow is prevailing at the bed a data point will plot to the right on the x-axis and if laminar flow is prevailing then it will plot to the left.

A plot above the threshold line in Figure 2.3 therefore implies that the unit power applied along the bed is greater than the unit power required to suspend particles, while the function on the x-axis may be regarded as a type of Reynolds number, which indicates whether laminar or turbulent conditions prevail at the bed.

2.2 Conclusions

The information in this chapter support the assertion that applied power approach has significant advantages over other sediment transport theories. The results from other methods are inconsistent due to their empirical nature. Thus the data collection will be done with the aim of using the applied stream power approach in predicting the movement of sediment in cobble/boulder bed rivers.

3 DATA COLLECTION

3.1 Site selection

Two study sites were selected for this project. Both of these sites are situated in the Western Cape about 25 km from each other. This area of the country (indicated in Figure 3.1) is characterized by high winter rainfall (mean annual precipitation of over 1000mm) in the mountain catchments.

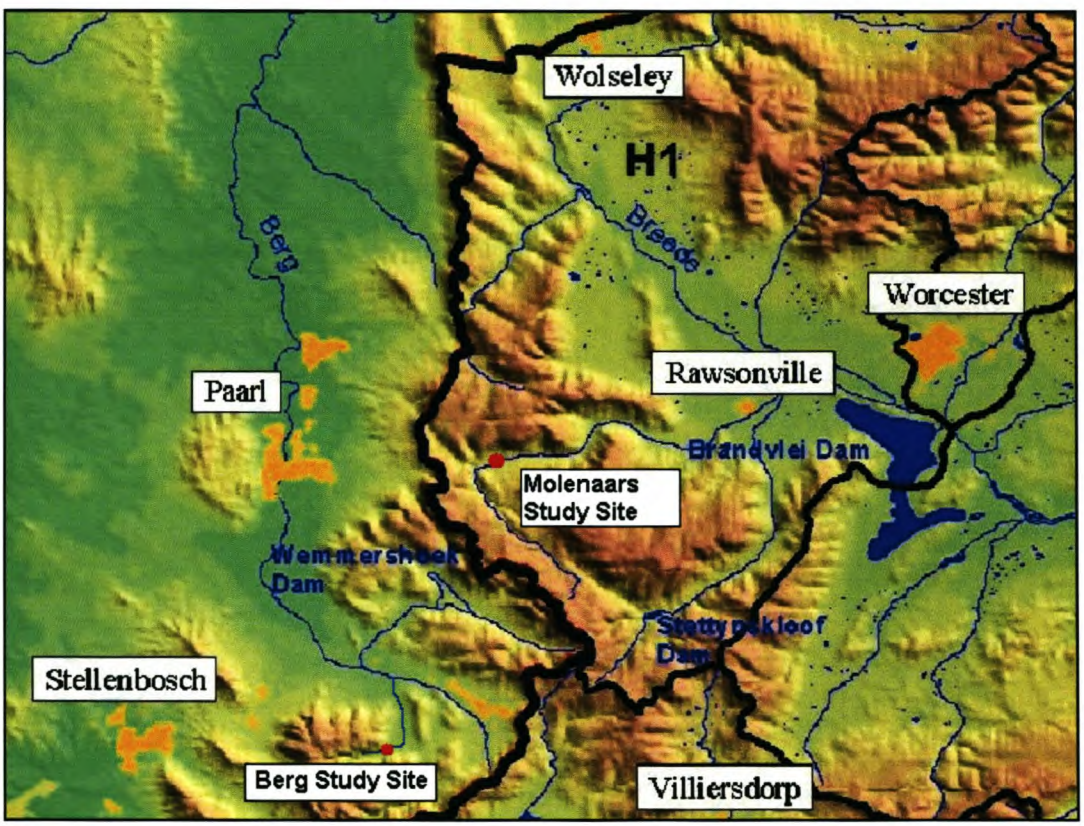

Figure 3.1: Location of study sites

Both sites are located in the headwaters of the Cape Fold mountains and are thus characterized by relatively steep gradients with bed particles predominantly derived from the Table Mountain group sandstones in the cobble to boulder bed range as defined by the Wentworth scale given in Table 3.1.

Class (Wentworth)	Diameter (mm)
Boulder	>256
Cobble	64 to 256
Gravel	2 to 64
Sand	0.0625 to 2
Silt	0.0039 to 0.0625
Clay	< 0.0039

Table 3.1: Classification of bed particle sizes

The first of these two study sites is located on the Molenaars River, about 2km east of the Huguenot Tunnel. This river has its origin in the Klein-Drakenstein Mountains and is one of the main tributaries of the Breede River, which is the largest river in the Western Cape and flows in an easterly direction into the Indian Ocean. The study reach was about 60m long with relatively well defined banks on both sides and consisted primarily of a riffle and rapid section ending in a large pool. The layout of the Molenaars River study site as well as the Thalweg profile and selection of cross sections, and the size distribution are shown in Appendix A1.

Figure 3.2: Molenaars River study site (looking downstream)

The second study site is located on the Berg River, which is the second largest river in the Western Cape and flows for the most part (including the area of the study reach) in a northerly direction and later in a westerly direction into the Atlantic Ocean. The site is situated near the origin of the Berg River which is found in the Franschhoek Mountains. The study site is located on a slight bend in the river and has a steep bank on the outside (left bank) and a lateral bar of deposited cobbles on the inside bank. A small rapid section dominates the top half of the site leading to a deeper pool in the lower half of the reach. The layout of the Berg River study site as well as the Thalweg profile and a selection of cross-sections and the stone size distribution are shown in Appendix A2

Figure 3.3: Berg River study site (looking upstream)

3.2 Site setup

(i) Surveys

A detailed land survey of the riverbed was conducted on both study sites. This consisted of surveying at 1m intervals along thirty transects which were spaced at 2m intervals. Also, an aerial photogramatic survey was conducted on the Molenaars study site in 2003 which was used to create a detailed digital terrain map of the site. The map is considered to be accurate to 10cm.

(ii) Stones

The thirty transects were marked by steel pegs on each bank of the river. The stones to be studied were selected by stringing a tape between the pegs and selecting stones at two meter intervals across the transect. A total of 345 and 435 stones were selected for the Molenaars (2003 and 2004) and Berg River (2004) study sites respectively.

Figure 3.4: Study site set up

In order to locate the selected stones after a flood they were marked and numbered with paint, putty or a waterproof pen. The stones were marked on both sides to note if they were disturbed without necessarily being moved from its original position. Initially small magnets were attached to some of the stones as it was felt that this would have less of an impact on the potential for organisms to reconolise a marked stone than paint or an ink mark. This however was abandoned when it was found that too much natural magnetism in the stones existed to make it a reliable method for relocating stones after a flood event.

Figure 3.5: Example of a marked stone

(iii) Water levels

To measure the water levels during a flood eight clear plastic pipes, 2m long, were placed at intervals along both banks of the study reach. The pipes were attached to metal y-sections that were secured at the base with cemented stone foundations. Water entered the pipes through small holes drilled at the bottom and air escaped through similar holes at the top. A handful of cork flakes or finely cut dry grass was placed in each pipe which would rise with the water level in the pipe clinging to the sides when the water level

dropped down again. After each flood the height the cork or grass reached in the pipe would be measured to indicate the maximum water levels reached during the relevant flood.

Figure 3.6: Plastic stage pipe used to measure flood levels

Figure 3.7: Plastic stage pipe used to measure flood levels (during flood conditions)

3.3 Base flow conditions

During the study site setup, base flow conditions were measured in terms of both hydraulic and ecological characteristics. Both sites were established at the start of the winter flood season in April/May under assumed winter base-flow conditions rather than summer low-flow conditions. The depth and average velocity were recorded above each of the marked stones. After sampling, the stones were returned to their original positions and the offset from the survey pegs recorded and used to determine the co-ordinates of each stone in a local co-ordinate system. Wherever possible the stones were removed from the bed and measured in terms of their three main axis. Invertebrate and perriphyton samples were taken and the stones were returned to their original positions. If the stones could not be removed then their visible dimensions were measured and they were recorded as embedded. The bed level of each stone could then be determined according to the detailed survey. The hydraulic base flow conditions in terms of stone size, depth, velocity, Froude number, Reynolds number, stream power and bed shear stress are shown in Appendix B1 for the Molenaars and Appendix B2 for the Berg River site, as well as the base flow water level profiles.

3.4 Flood events data

The initial set of flood data was collected at the Molenaars study site during six flood events in the winter of 2003. During the winter of 2004 more data were collected at five floods both on the Molenaars and Berg River sites.

Figure 3.8: The Molenaars study site in flood

In terms of environmental flow requirements the DRIFT methodology is used to classify different flood sizes (King *et al.*, 2003). DRIFT divides the long-term average daily flow data into eight flood classes. The inter-annual flood events with a return period between two and fifty years are represented by DRIFT classes V to VIII. Classes I to IV represent the intra-annual flood events and the level is obtained by halving the two year return period flood to obtain the Class IV flood which on its turn is halved to obtain Class III, and so on. Howard (2004) determined the eight classes for gauge G1H004 on the Berg River and Brown and King (2002) for gauge H1H018 on the Molenaars River and these are shown in Table 3.2. The two gauges G1H004 and H1H018 are located immediately downstream of the Berg and Molenaars study sites respectively. Gauge G1H004 data caused concern (Howard 2004) regarding reliability of its flow record prior to 1980. Thus flood classification was based on both the longer record and the shorter record after 1980. For the purpose of classifying the floods studied during this project, the classification based on the shorter record was used due to its higher level of accuracy. It does however bring with it a greater level of uncertainty, especially with regards to the higher floods.

Class	Recurrence Interval	H1H018 (Molenaars)	G1H004 (Berg) (Short Record)	G1H004 (Berg) (Long Record)
I	Intra annual floods	5.0	3.6	4.3
II		16.0	7.2	9.5
III		31.0	14.5	19.1
IV		61.0	29.0	38.2
V	1 : 2 years	93.7	58.7	76.3
VI	1 : 5 years	146.0	75.3	118.0
VII	1 : 10 years	181.0	78.8	154.6
VIII	1 : 20 years	187.0	85.6	178.0

Table 3.2: DRIFT classification of floods for H1H018 and G1H004 in terms of average daily flows (m^3/s) (Brown and King, 2002; Howard, 2004)

Flood data recorded by the two gauges during the winters of 2003 and 2004 are shown in Figures 3.9, 3.10 and 3.11. These figures show the average daily flow and instantaneous flow rates recorded at the two gauges. The DRIFT flood classification levels are also shown and can be related to the average daily flow for each of the observed events to determine its class.

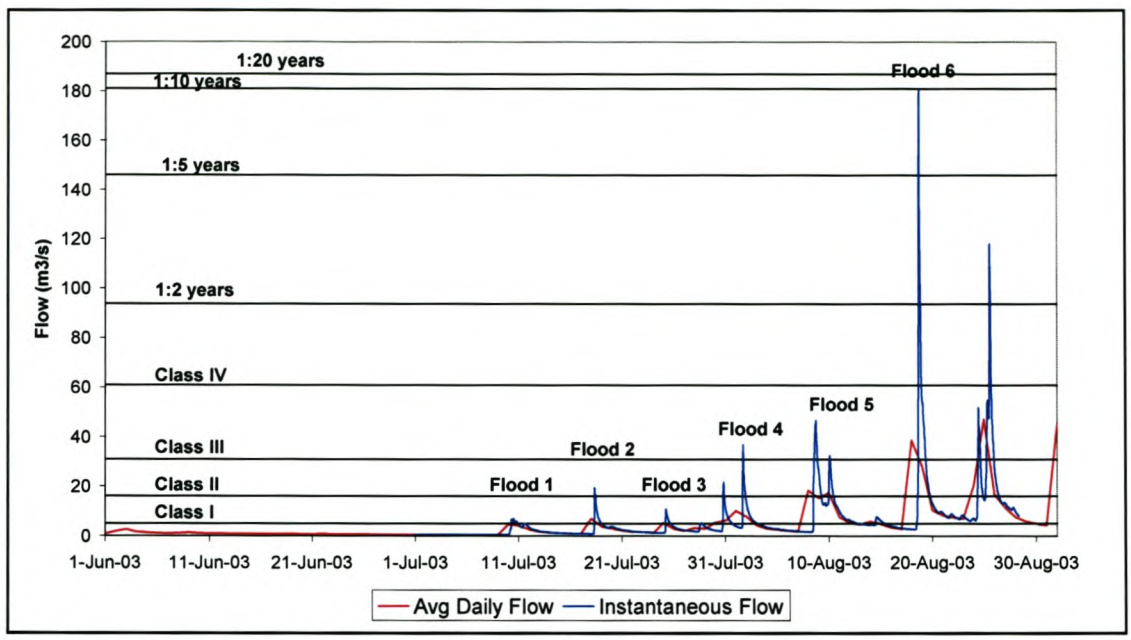

Figure 3.9: Flood events observed on the Molenaars River (H1H018) in 2003

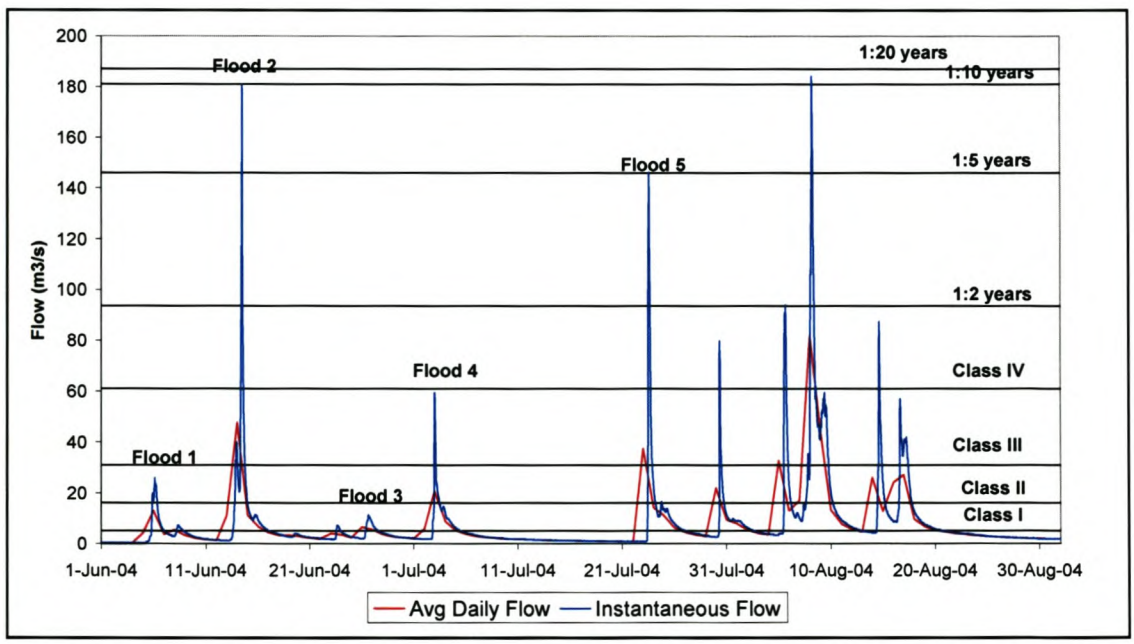

Figure 3.10: Flood events observed on the Molenaars River (H1H018) in 2004

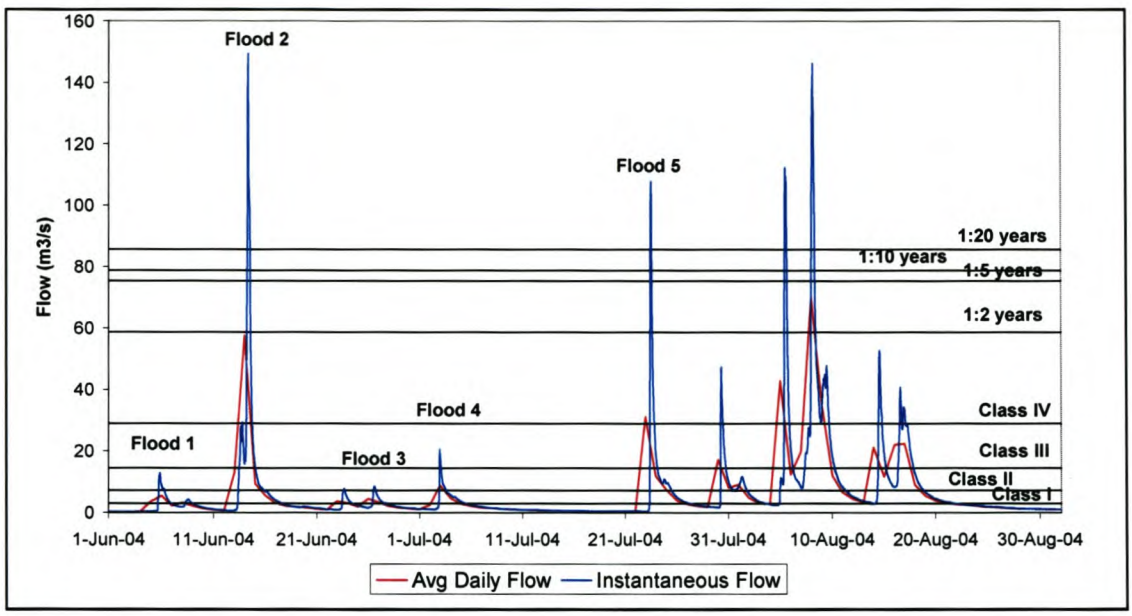

Figure 3.11: Flood events observed on the Berg River (G1H004) in 2004

In order to calculate the maximum flow rate experienced at the study reach during each flood, the instantaneous flood peak observed at the downstream gauge was reduced by the ratio of the catchment area upstream of the study site to the catchment area upstream of the gauge. Tables 3.3 and 3.4 depict the estimated maximum flow rate, average daily flow rate, flood volume (including base flow) and class of flood as determined from the average daily flow rate at the downstream gauge for all the observed flood events. The flood DRIFT classes (Tables 3.4 and 3.4) were determined with the values given in Table 3.2. If a flood size falls in the interval between a 1:2 year and half of a 1:2 year flood it is deemed a DRIFT class IV flood. If a flood size falls in the interval between half of a 1:2 year flood and a quarter of a 1:2 year flood it is deemed a DRIFT class III flood and so on for DRIFT class II and I floods.

Year	Event Number	Date	Duration (hours)	Max Flow (m^3/s)	Avg. Daily Flow (m^3/s)	Volume (Mm^3)	DRIFT Class
2003	1	10th July	33	5.56	3.72	0.41	I
	2	18th July	21	15.23	5.41	0.49	I
	3	25th July	14	8.60	4.20	0.28	I
	4	1st August	26	28.76	7.98	0.95	I
	5	8th August	26	36.46	14.45	1.74	II
	6	18th August	32	140.80	30.29	4.15	III
2004	1	6th June	29	20.20	10.02	1.04	I
	2	14th June	33	140.97	37.21	3.82	III
	3	26th June	31	8.87	5.13	0.66	I
	4	3rd July	21	46.38	16.08	1.35	II
	5	23rd July	18	113.93	29.17	2.67	III

Table 3.3: Flood events observed at the Molenaars study site

Year	Event Number	Date	Duration (hours)	Max Flow (m^3/s)	Avg. Daily Flow (m^3/s)	Volume (Mm^3)	DRIFT Class
2004	1	5th June	28	7.27	2.08	0.40	I
	2	14th June	44	84.51	32.58	3.48	IV
	3	26th June	27	4.82	2.62	0.29	I
	4	3rd July	24	11.74	5.68	0.44	II
	5	23rd July	20	60.98	17.70	1.66	IV

Table 3.4: Flood events observed at the Berg study site

As mentioned previously, the highest water level for each flood event was recorded from the height of the mark left inside the pipe by the cork or grass. From the land survey, which included the leveling of the base of the pipes and from the measured height inside the pipes it was possible to calculate an average water level profile for each study reach. This was used to determine the water surface slope during the flood as well as the depth above each sampled stone. The water surface profiles for the observed flood events are given in Figures 3.12, 3.13 and 3.14.

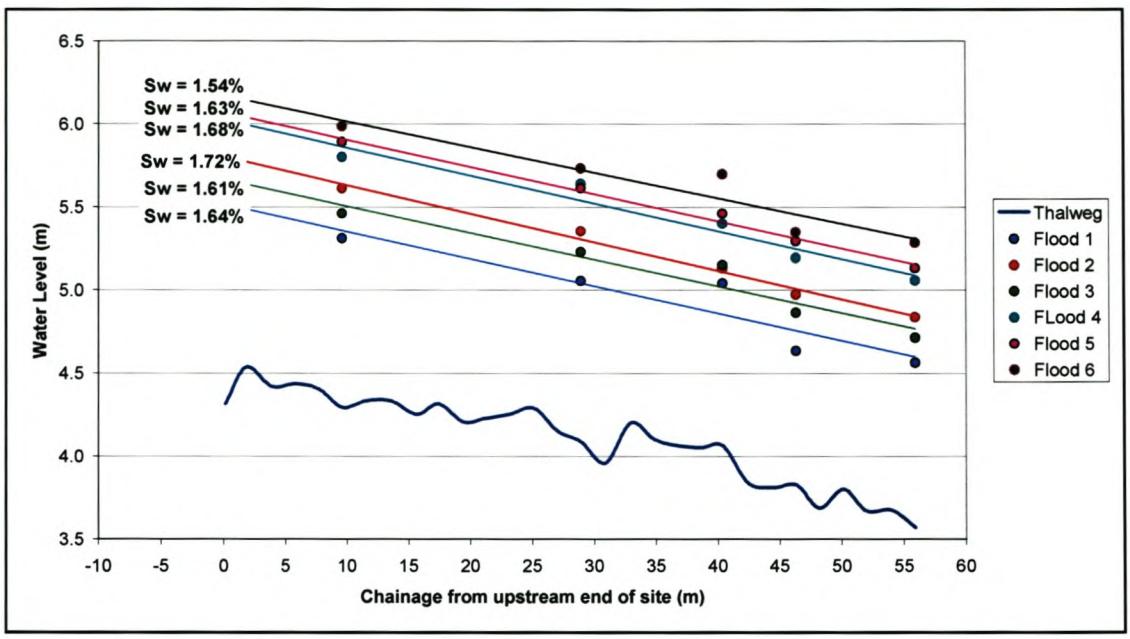

Figure 3.12: Water level profiles for the Molenaars study site in 2003

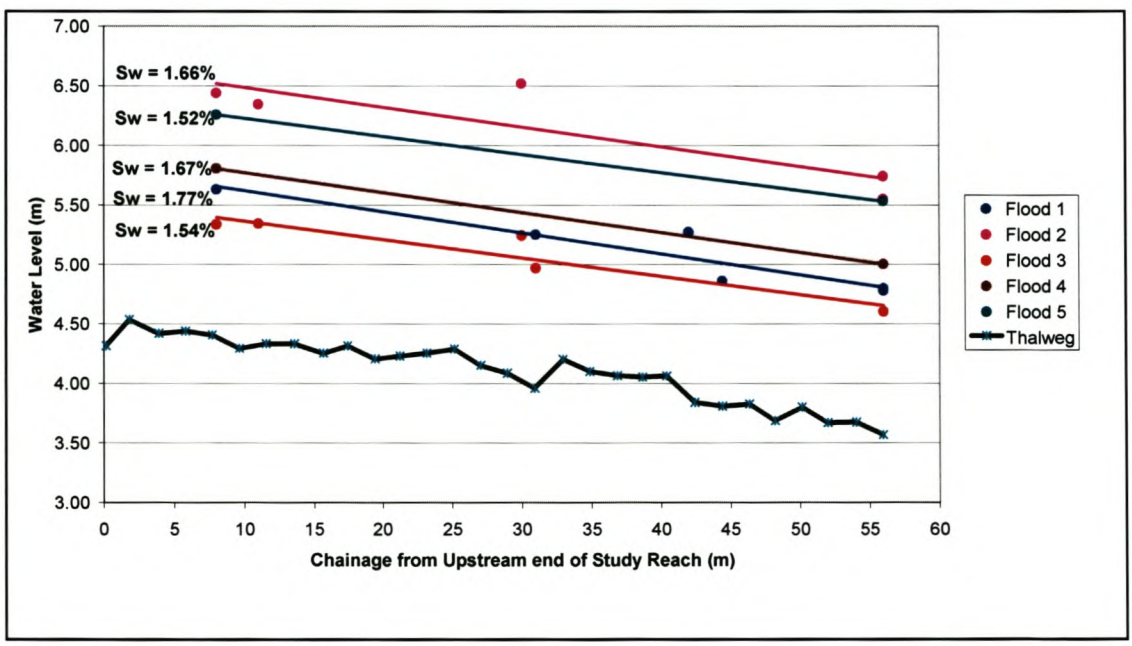

Figure 3.13: Water level profiles for the Molenaars study site in 2004

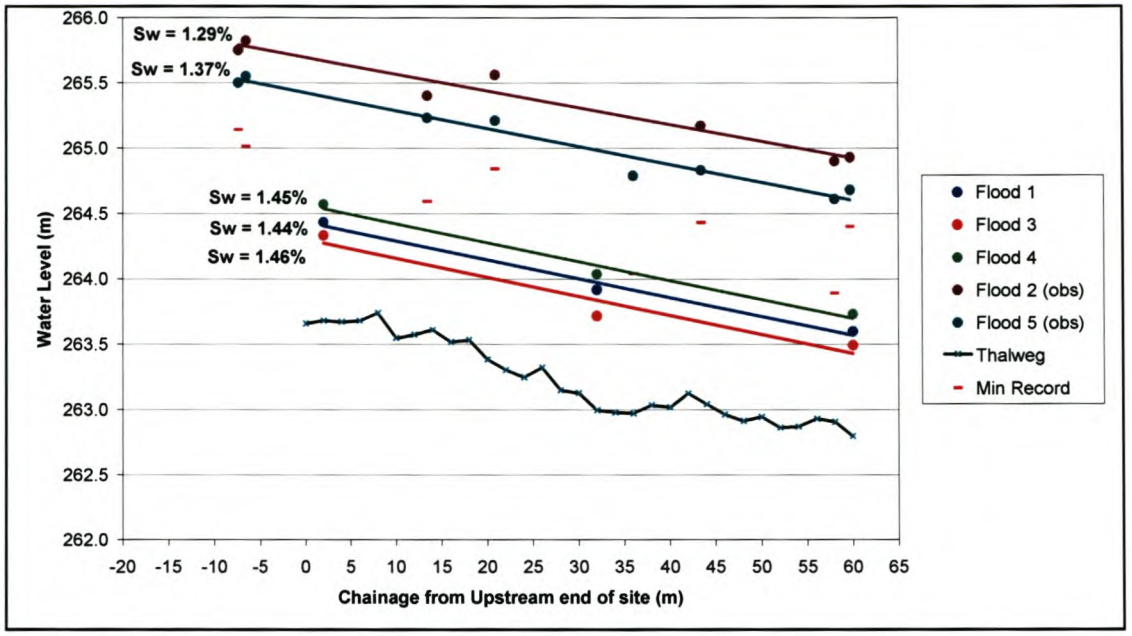

Figure 3.14: Water level profiles for the Berg study site in 2004

It has to be noted that the original water levels used for Flood 6 in 2003 on the Molenaars was considered to be inaccurate. This was based on a comparison with the profile for Flood 2 in 2004 on the same river, which was of similar magnitude (140.8 and 140.97 m^3/s respectively). The reason for this is that the cork inside the pipes was washed off during Flood 6 of 2003 and the levels had been estimated visually. Flood 2 in 2004 did however leave clear cork marks and these heights were used to determine the average water slope and depths for Flood 6 in 2003. A problem also arose with the lower floods namely Floods 1, 3 and 4 on the Berg site. The minimum height that the pipes stationed on the banks could measure was too high for these particular floods. The levels of these floods were estimated using the following equation (3.1) (Jonker, 2002) for calculating the water depth in cobble/boulder bed rivers.

$$Q = A\sqrt{\frac{2gd_{50}s}{0.5285(R/d_{50})^{-2.166}}} \qquad (3.1)$$

3.5 Collection of incipient motion data

After each flood event both study sites were revisited and the marked stones were located wherever possible. The movement of a stone was recorded as being removed out of its original position or simply turned over. In the case of a stone being removed out of its position the distance of the displacement was measured. In the case of the bigger floods some of the moved stones could not be relocated. It was assumed that these stones were washed out of the reach. They were replaced by equivalent size stones. The dimensions of the new stones were recorded and used in the analysis in subsequent floods. The field notes for the initial site setup and from each visit to locate moved stones are included in Appendix C and the locations of the stones that moved during each flood are given in Appendix D. A summary of the stone movements by stone class size is given in the Figures and Tables below.

Intensity of Movement: Molenaars 2003							
Stone Size Classification		Total	G	SC	LC	SB	LB
Max size in class (mm)			64	161	256	514	1000
Total Number of Stones		344	4	91	73	111	65
Flood 1	Moved Stones	0	0	0	0	0	0
	Movement %	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Flood 2	Moved Stones	7	0	7	0	0	0
	Movement %	2.0%	0.0%	7.7%	0.0%	0.0%	0.0%
Flood 3	Moved Stones	2	0	1	1	0	0
	Movement %	0.6%	0.0%	1.1%	1.4%	0.0%	0.0%
Flood 4	Moved Stones	10	0	6	4	0	0
	Movement %	2.9%	0.0%	6.6%	5.5%	0.0%	0.0%
Flood 5	Moved Stones	26	1	18	4	3	0
	Movement %	7.6%	25.0%	19.8%	5.5%	2.7%	0.0%
Flood 6	Moved Stones	115	4	65	29	16	1
	Movement %	33.4%	100.0%	71.4%	39.7%	14.4%	1.5%

Table 3.5: Stone movement in the Molenaars River during 2003 flood events

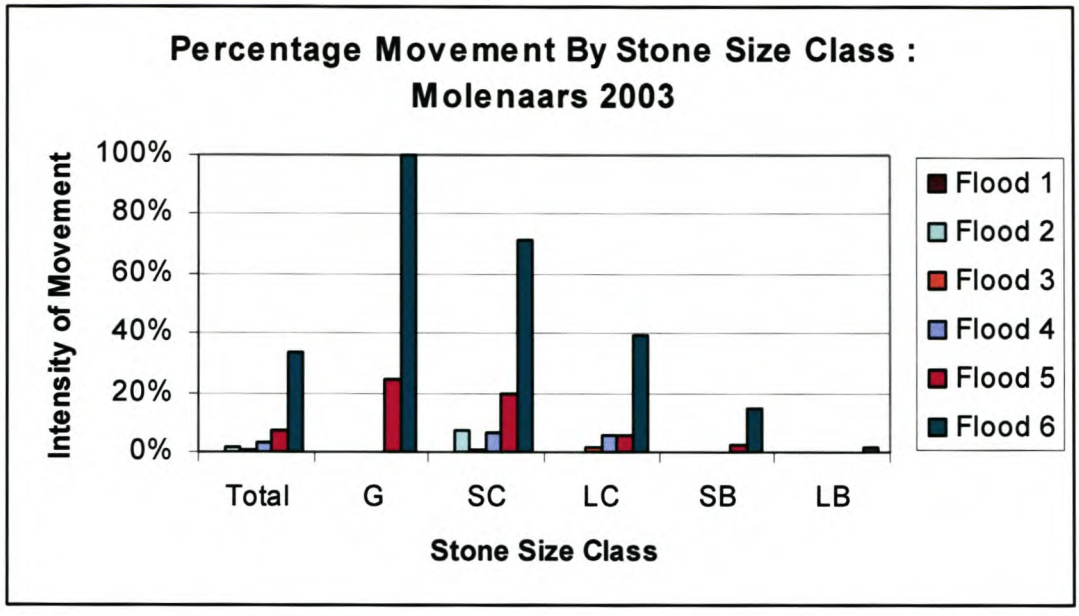

Figure 3.15: Level of disturbance in the Molenaars River during 2003 flood events

Intensity of Movement: Molenaars 2004							
Stone Size Classification		Total	G	SC	LC	SB	LB
Max size in class (mm)			64	161	256	514	1000
Total Number of Stones		343	5	60	73	136	69
Flood 1	Moved Stones	3	1	2	0	0	0
	Movement %	0.9%	20.0%	3.3%	0.0%	0.0%	0.0%
Flood 2	Moved Stones	78	4	41	20	13	0
	Movement %	22.7%	80.0%	68.3%	27.4%	9.6%	0.0%
Flood 3	Moved Stones	7	0	6	1	0	0
	Movement %	2.0%	0.0%	10.0%	1.4%	0.0%	0.0%
Flood 4	Moved Stones	15	1	7	2	5	0
	Movement %	4.4%	20.0%	11.7%	2.7%	3.7%	0.0%
Flood 5	Moved Stones	83	2	39	23	17	2
	Movement %	24.2%	40.0%	65.0%	31.5%	12.5%	2.9%

Table 3.6: Stone movement in the Molenaars River during 2004 flood events

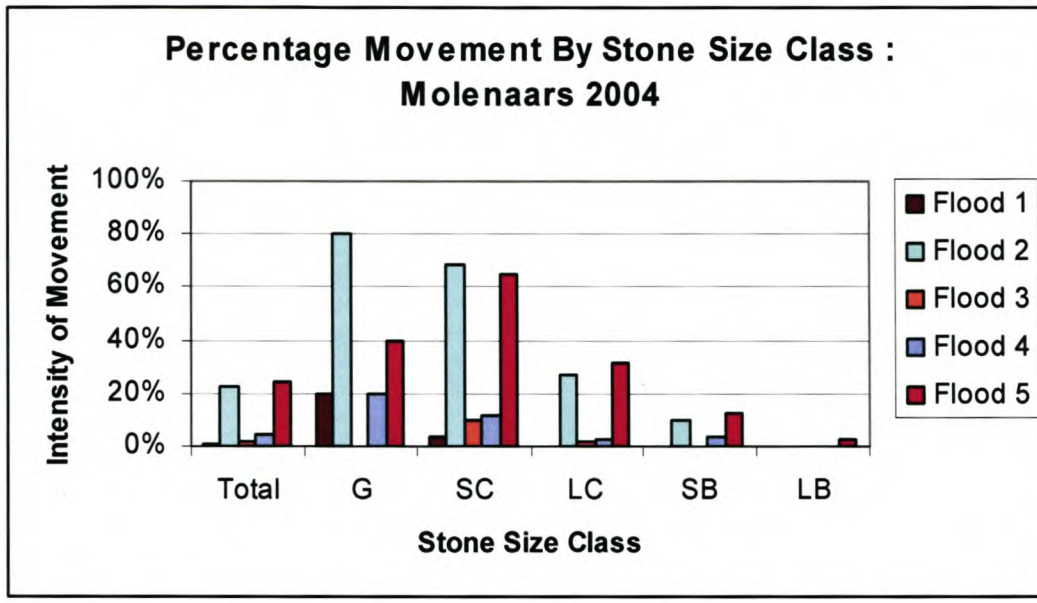

Figure 3.16: Levels of disturbance in the Molenaars River during 2004 flood events

Intensity of Movement: Berg 2004							
Stone Size Classification		Total	G	SC	LC	SB	LB
Max size in class (mm)			64	161	256	514	1000
Total Number of Stones		432	27	120	92	139	54
Flood 1	Moved Stones	1	1	0	0	0	0
	Movement %	0.2%	3.7%	0.0%	0.0%	0.0%	0.0%
Flood 2	Moved Stones	187	26	92	44	24	1
	Movement %	43.3%	96.3%	76.7%	47.8%	17.3%	1.9%
Flood 3	Moved Stones	10	2	3	3	2	0
	Movement %	2.3%	7.4%	2.5%	3.3%	1.4%	0.0%
Flood 4	Moved Stones	7	1	4	2	0	0
	Movement %	1.6%	3.7%	3.3%	2.2%	0.0%	0.0%
Flood 5	Moved Stones	111	10	58	28	14	1
	Movement %	25.7%	37.0%	48.3%	30.4%	10.1%	1.9%

Table 3.7: Stone movement in the Berg River during 2004 flood event

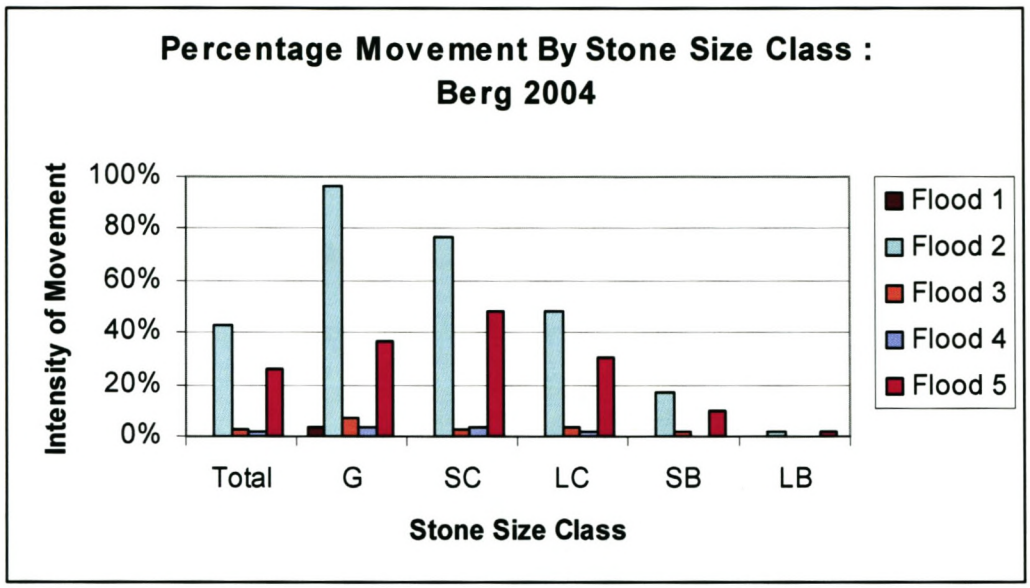

Figure 3.17: Level of disturbance in the Berg River during 2004 flood events

4 CRITICAL CONDITIONS

4.1 Original modified Liu-diagram

In order to test the applied stream power approach in describing the critical hydraulic relationships for each stone under flood conditions, all the measured data from the Molenaars and Berg Rivers have been plotted (Figures 4.2 – 4.4) in the original modified Liu diagrams (Rooseboom, 1992) as described in Chapter 2. The original modified Liu diagram shown in Chapter 2 is repeated (Figure 4.1). It should be noted that in original modified Liu diagram terms all observations can be expected to be in the rough turbulent zone, given the nature of the flow conditions during floods through cobble/boulder bed streams; i.e. the incipient motion line should have a constant value.

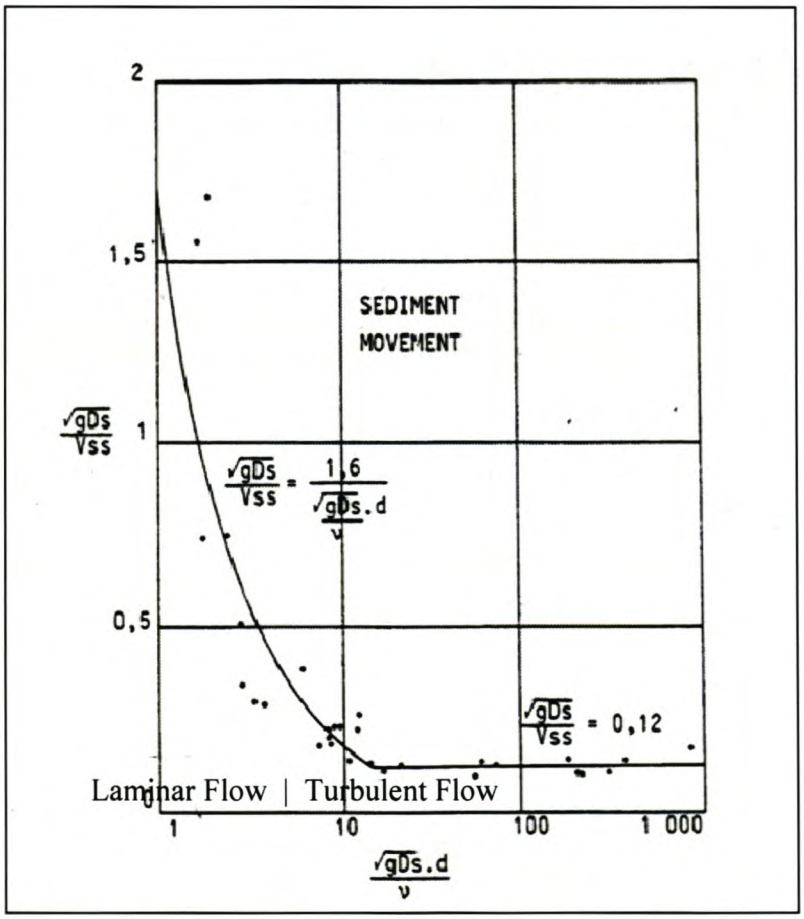

Figure 4.1: Original modified Liu diagram (Rooseboom, 1992)

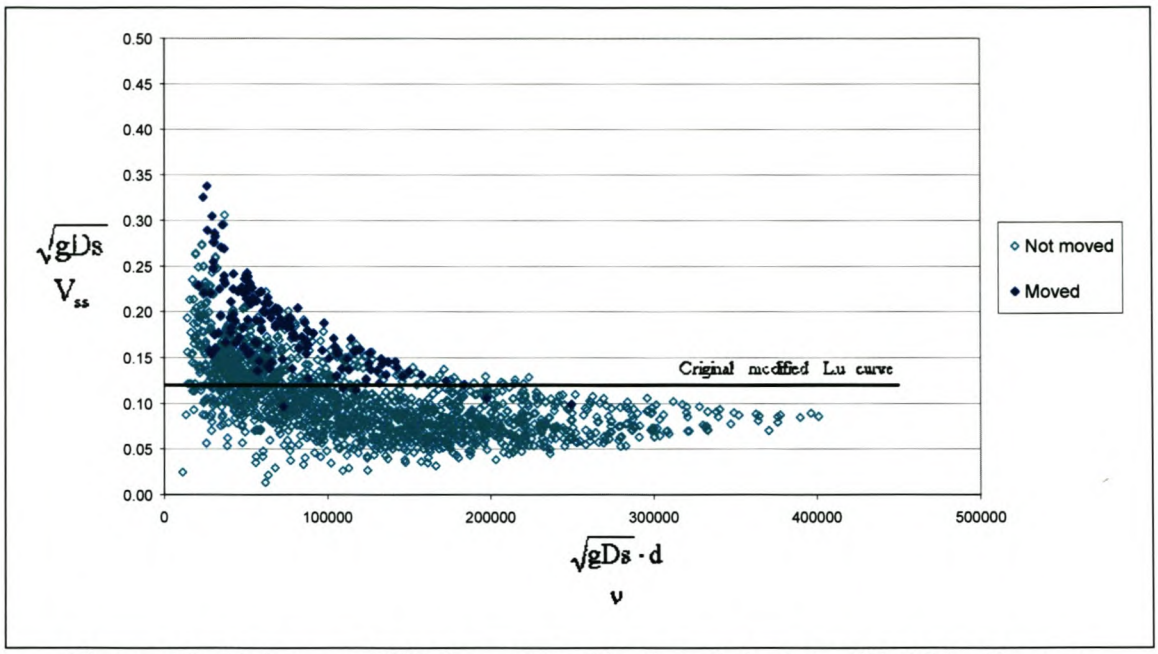

Figure 4.2: Molenaars 2003 data plotted in the original modified Liu diagram

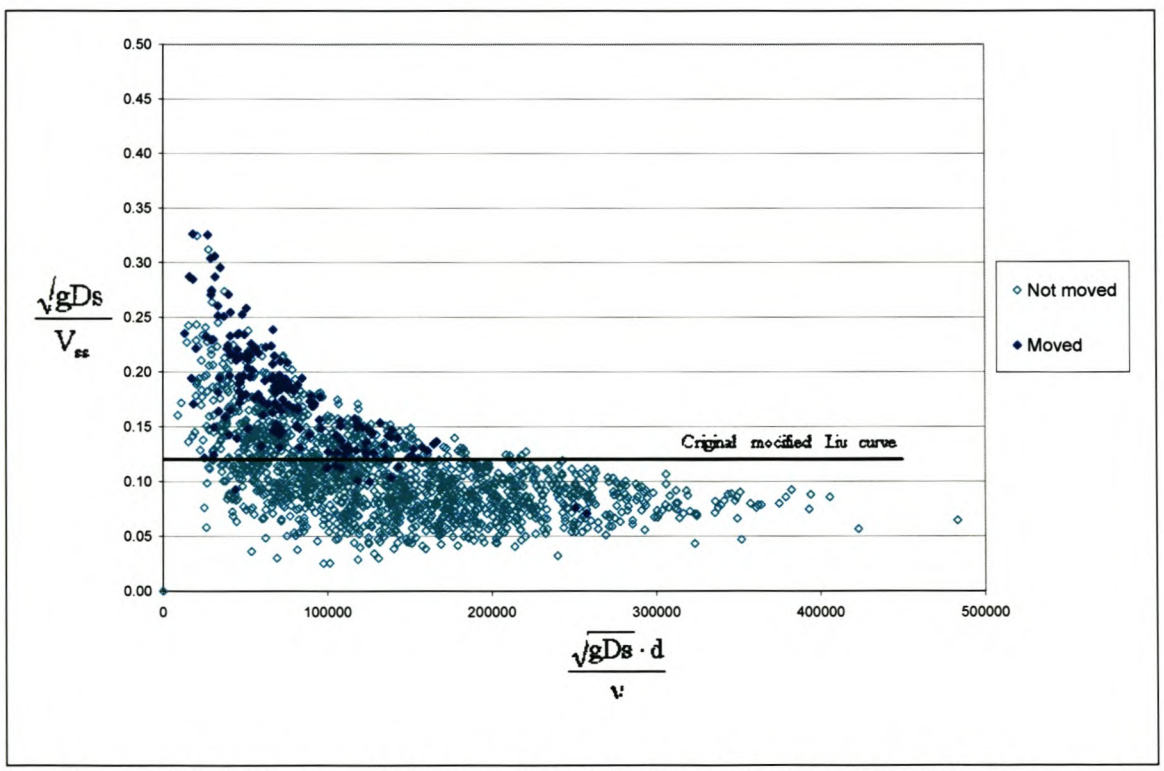

Figure 4.3: Molenaars 2004 data plotted in the original modified Liu diagram

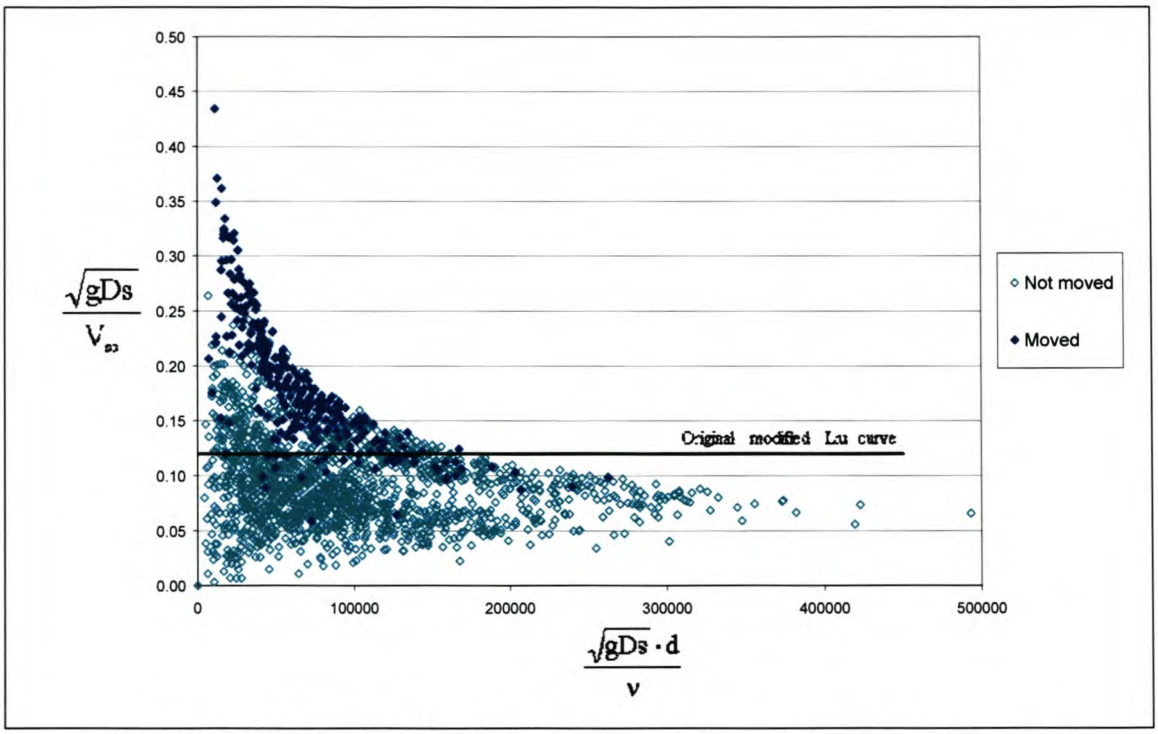

Figure 4.4: Berg 2004 data plotted in the original modified Liu diagram

The data points which represent stones that did move are not as reliable as those for stones that did not move due to the fact that movement did not necessarily take place at the peak measured discharge, as is implied. By using maximum recorded flood levels to represent incipient motion conditions, the upper points representing non-movement are more reliable as there is no doubt as to the maximum flow depths and applied power values that the non-moving stones had been subjected to. In other words, a stone that was moved might have moved early on in a flood at a lower level and discharge than those recorded and used in the data analysis. However, the deviating trend is evident for the stones that had moved as well as stones that had not moved.

It is noticeable from the above figures that the data for the Molenaars and Berg Rivers deviate from the expected constant value in the original modified Liu diagram, given the rough turbulent conditions in the Molenaars and Berg Rivers under flood conditions. It is only at an x-axis value smaller than 13 that any sort of deviation is expected as this is where laminar flow is prevalent (see Figures 4.1 and 4.17). Even though the data clearly fall within the turbulent boundary zones of the Liu diagram (i.e. x-axis values >> 13),

most data of the stones that moved (dark data points in Figures 4.2 – 4.4) deviate from the expected constant value (0,12) for $\frac{\sqrt{gDs}}{V_{ss}}$ as derived in Chapter 2 for fully turbulent conditions. It is also evident that the deviation is much more pronounced for smaller stones (i.e. the data closest to the y-axis). The data points to the right, representing the larger stones, tend towards a constant value.

The deviation pattern noticed is strikingly similar to the pattern followed by the threshold of movement line in the original modified Liu diagram where laminar boundary conditions prevail (Figure 4.1). The boundary between points that represent movement and those that do not represent movement is equivalent to the incipient motion curve. In comparing the data with the original modified Liu curve it is necessary to consider the significance of the new data.

Three possible explanations exist as to why the Molenaars and Berg Rivers' data on incipient motion deviate from the expected horizontal line for the threshold of movement in the original modified Liu diagram for rough turbulent flow:

- The stones are embedded and the derivation of a constant value for the threshold of movement in the original modified Liu diagram does not account for such conditions.
- The original modified Liu diagram (Rooseboom, 1992) was derived for beds with uniform particle sizes, while the data for the Molenaars and Berg rivers represent beds which consist of non-uniform bed particles.
- The deviation noticed for the data from the Berg and Molenaars Rivers is due to laminar conditions playing a role in the entrainment process of the stones.

Each of these will be explored in turn.

4.2 Influence of embedded stones

No factor is included in the original theoretical derivation (Chapter 2) of the parameters in the original modified Liu diagram to correct for the level of embeddedness. Intuitively one expects the embedded stones to be more difficult to transport than non-embedded stones. They will therefore be able to withstand higher applied power values exerted on them than if they were not embedded. A stone in such a situation will typically plot above the theoretical threshold of movement line on the original modified Liu diagram (as shown in Chapter 2 the y-axis represents $\left[\frac{\text{Unit applied power along bed}}{\text{Unit power required to suspend particles}}\right]$) and this could possibly explain the deviation from the expected constant line.

During data collection, all the observed stones were classified as embedded or non-embedded depending on whether they could be removed from the bed by hand or not. Embedded stones would include stones that were covered by sediment as well as stones that were firmly lodged between other stones. The influence of embeddedness can be determined by excluding the data for these embedded stones from the data plotted in the original modified Liu diagram. Figures 4.5 – 4.7 depict the data from the Berg and Molenaars Rivers in the original modified Liu diagram, without the embedded stones data.

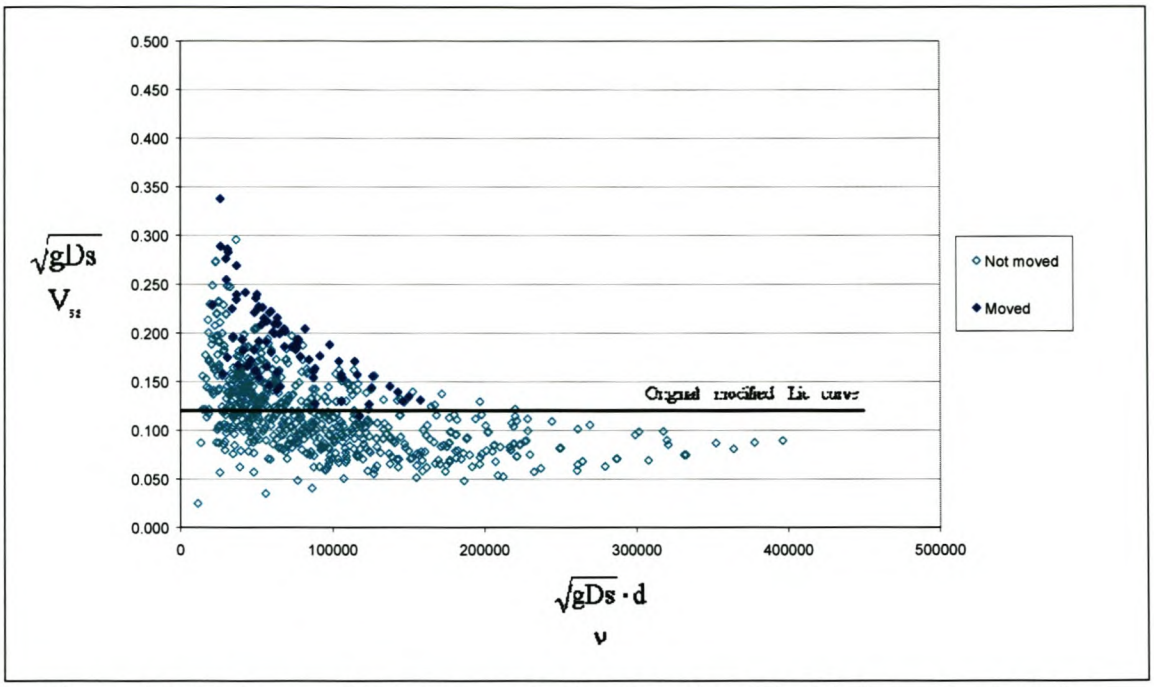

Figure 4.5: Molenaars 2003 data, excluding data for embedded stones, plotted on the original modified Liu diagram

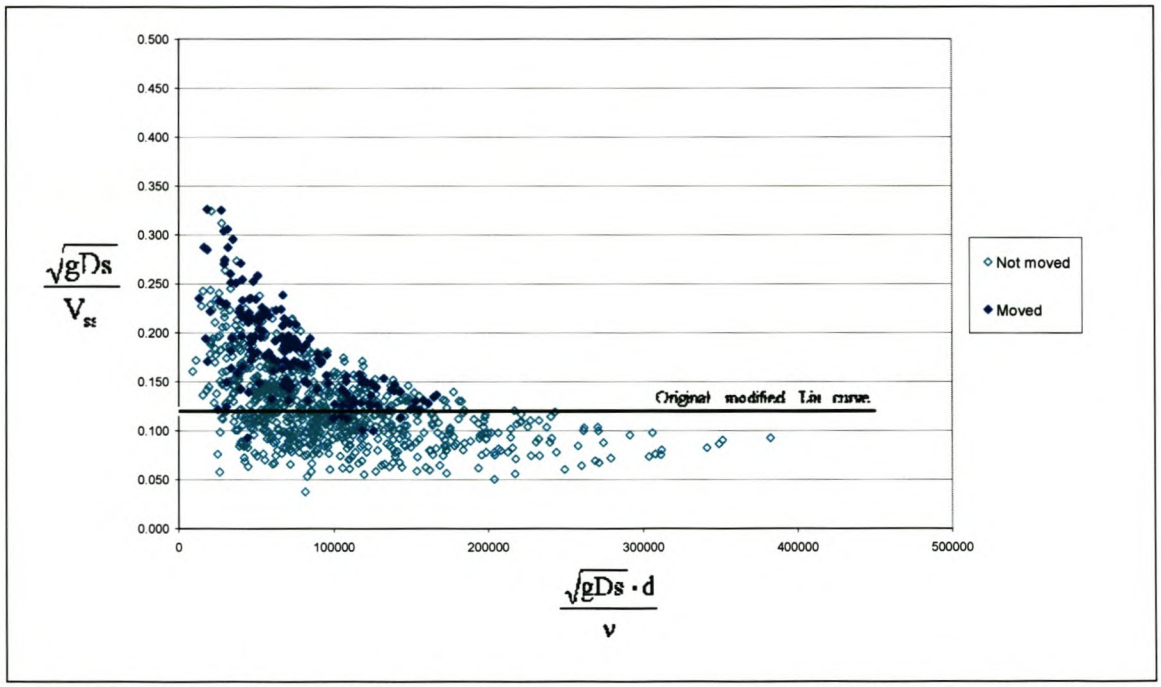

Figure 4.6: Molenaars 2004 data, excluding data for embedded stones, plotted on the original modified Liu diagram

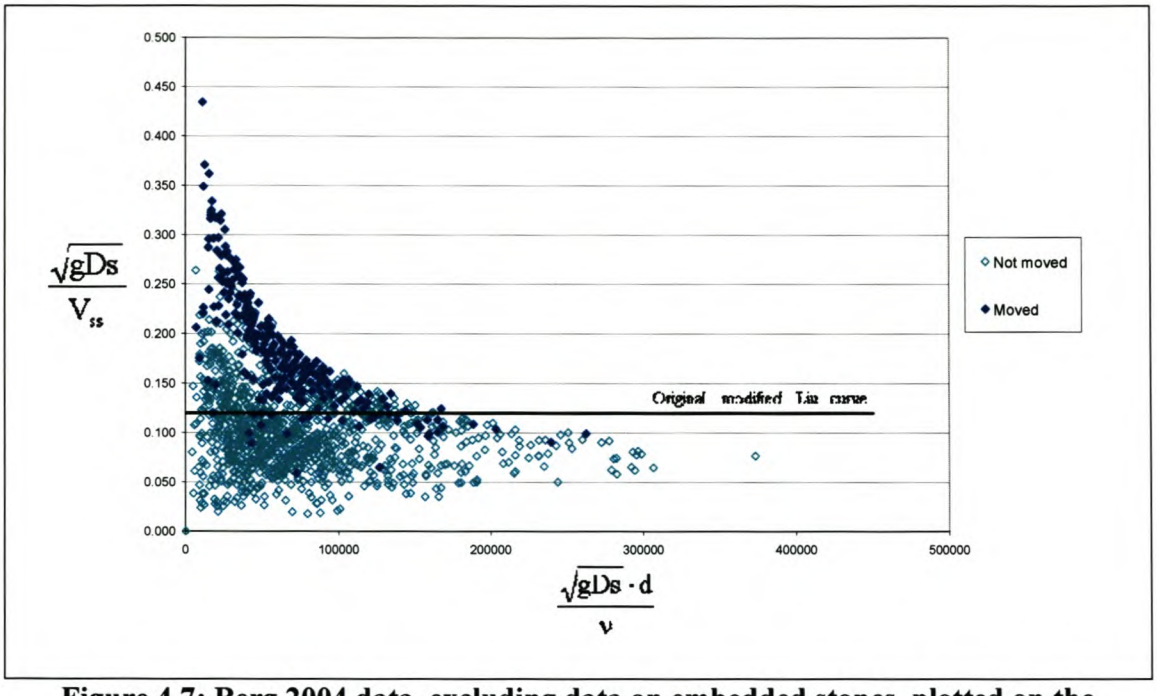

Figure 4.7: Berg 2004 data, excluding data on embedded stones, plotted on the original modified Liu diagram

Figures 4.5 - 4.7, show the same deviating patterns as seen in Figures 4.2 - 4.4. Even though embeddedness of stones could possibly play a role in the incipient motion criteria it does not account for the general deviation from the expected horizontal line when the data are plotted in the original modified Liu diagram.

4.3 Influence of non-uniformity under fully developed turbulent conditions

The Liu diagram shown in Chapter 2 was derived for beds with uniform particle sizes. In order to establish what should happen in the case of a non-uniform particle size bed, with varying roughness, the Liu parameters have to be derived anew to allow for the non-uniformity in the bed.

For rough turbulent flow, the unit stream power applied in maintaining motion along a bed consisting of particles with diameter d, as shown in Chapter 2, is proportional to

$$\frac{\rho g s D \sqrt{gDs}}{k} \tag{4.1}$$

with ρ : fluid density (kg/m^3)

g : gravitational acceleration (m/s^2)

s : energy gradient $\approx$ channel gradient

D : depth of water above stone (m)

k : absolute bed roughness (m)

In terms of the concept of minimum applied power, the stream will begin to entrain particles when the power required to suspend the particles effectively becomes less than the unit power to maintain the status quo. At that stage

$$(\rho_s - \rho) g V_{ss} \propto \frac{\rho g s D \sqrt{gDs}}{k} \tag{4.2}$$

where $(\rho_s - \rho) g V_{ss}$ represents the unit applied power required to lift a particle.

According to the general equation for settling velocity (Graf, 1971)

$$V_{ss} \propto \sqrt{\frac{(\rho_s - \rho) g d}{\rho C_D}} \tag{4.3}$$

Thus when a particle is entrained,

$$(\rho_s - \rho) g V_{ss} = \frac{\rho C_D \cdot d (\rho_s - \rho) g V_{ss}}{\rho C_D \cdot d} \propto \frac{\rho g s D \sqrt{gDs}}{k} \tag{4.4}$$

From equation 4.3 it follows that

$$V_{ss}^2 = \frac{(\rho_s - \rho)gd}{\rho C_D} \tag{4.5}$$

Which, when substituted into equation 4.4, leads to

$$\frac{\rho C_D V_{ss}^3}{d} = \text{Constant} \cdot \frac{\rho gsD\sqrt{gDs}}{k} \tag{4.6}$$

This simplifies further to,

$$\frac{C_D V_{ss}^3}{d} = \text{Constant} \cdot \frac{\left(\sqrt{gDs}\right)^3}{k} \tag{4.7}$$

and still further to,

$$C_D = \text{Constant} \cdot \frac{\left(\sqrt{gDs}\right)^3}{V_{ss}^3} \cdot \frac{d}{k} \tag{4.8}$$

Assuming that C_D, the drag coefficient , is a constant, which is true for larger diameters, then from the above equation the condition of incipient motion under rough turbulent conditions for a non-uniform bed can be expressed as:

$$\frac{\sqrt{gDs}}{V_{ss}} \cdot \left(\frac{d}{k}\right)^{1/3} = \text{Constant} \tag{4.9}$$

This newly derived equation can be used to explain why the data in the original modified Liu diagram, for smaller stones, deviate from the expected horizontal line for the threshold of movement. The difference between equation 2.19 which was derived for uniform particle size beds and equation 4.9 which was derived for non-uniform particle

size beds (derivation shown in Chapter 2) is the extra factor $\left(\frac{d}{k}\right)^{1/3}$. This factor indicates that on a non-uniform particle size bed the power required, for a given value of $\sqrt{gDs}$, to entrain a particle of size d will increase as the overall absolute hydraulic roughness (k) increases. In order to determine the relationship between k and d, one will have to look closely at the eddy formation process at bed level.

The development of eddies, on any bed, is a three-dimensional process. The bed configuration (in all directions) in the vicinity of a stone in the bed will determine the local eddy size. In the case of a bed with uniform size particles the eddy size would be of the same order as the particle diameter. The reason for this is that on a uniform particle size bed the bed shape will generate eddies similar in size as the particles. This is shown in Figure 4.8.

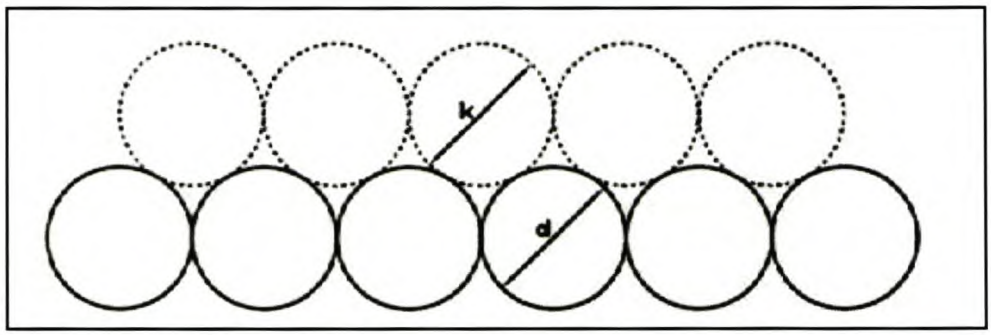

Figure 4.8: Two-dimensional representation of the eddy formation process in a uniform particle size bed

For this reason k can be substituted for d on a uniform bed. It is not possible to accurately predict the exact size of the eddies that will form in a non-uniform particle size bed due to the complexity and variability of such a bed configuration. However, in a non-uniform particle size bed the average bed roughness will be largely determined by the larger stones in the bed. Because flow resistance across the bed is not a localized phenomenon it may be assumed that the applied power and hence the eddy size across a non-uniform bed will tend towards uniformity, with the average eddy size of the same order as that of the

larger stones that dominate in determining the average absolute roughness of the bed. Figure 4.9 depicts a two-dimensional representation of the eddy formation process in a non-uniform particle size bed.

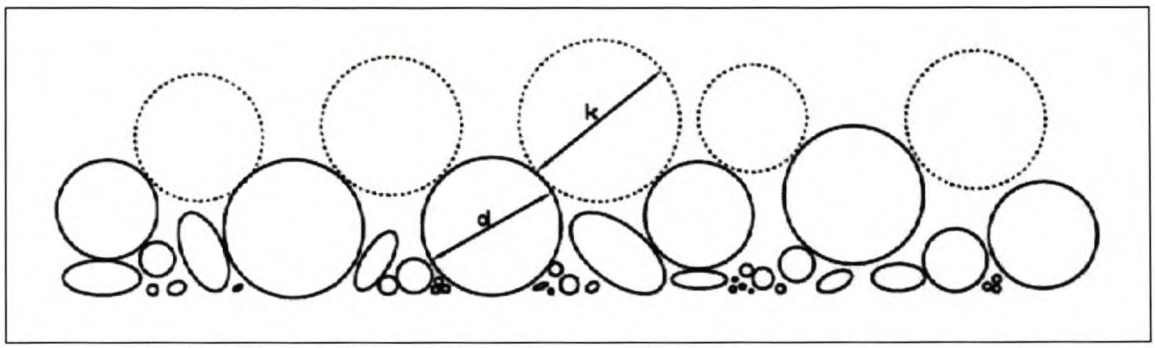

Figure 4.9: Two-dimensional representation of the eddy formation process in a non-uniform particle size bed

It is clear from Figure 4.9 that the bigger eddies will play a dominant role in the eddy formation process in a non-uniform particle size bed. Figure 4.9 not only depicts a two-dimensional representation of the eddy formation process in a non-uniform particle size bed but also the relative positions of different size stones. In a non-uniform particle size bed smaller particles will generally be found in lower positions i.e. in the sheltered hollows between the larger stones.

As indicated in Figure 4.9 in a non-uniform particle size bed, the average roughness and hence the average eddy size is largely determined by the larger stones in the bed. The smaller a stone the smaller the $\left(\frac{d}{k}\right)^{1/3}$ value will be for that stone since the general eddy size (k) will be of the same order of magnitude as the size of the larger stones in the bed. As the stone size increases the value of the term $\left(\frac{d}{k}\right)^{1/3}$ will increase accordingly as the size difference between a stone and the average eddy diminishes.

The above observation helps to explain, mathematically, why a deviation is noticed in the plot of the Molenaars and Berg River data in the original modified Liu diagram (Figures 4.2 - 4.4). In these diagrams a uniform bed was assumed (i.e. k was set equal to d for every stone). It is thus apparent, when looking at Figure 4.9, that if k is set equal to d it underestimates the size of the average eddy forming over the smaller stones. This underestimation of eddy size increases as the stone size becomes smaller. Alternatively the bigger the stone size the more accurate the assumption that k equals d due to the fact that the average eddy size, which is being formed by the biggest stones, is much closer to the size of the bigger stones. This explains why the bigger stones on the graphs (i.e. furthest from the y-axis) plot close to the theoretical constant value (0,12) on the y-axis. It also clarifies why there is a deviation in the data plots of the smaller stones but does not yet explain the pattern of the deviation (i.e. an upward curve towards the y-axis). Mathematically this upward deviation in the Liu diagram for smaller stones (i.e. those closest to the y-axis) can be explained in terms of the function that represents $\left[\frac{\text{Unit applied power along bed}}{\text{Unit power required to suspend particles}}\right]$ for non-uniform beds, namely $\frac{\sqrt{gDs}\cdot\left(\frac{d}{k}\right)^{1/3}}{V_{ss}}$.

For a certain size stone in a non-uniform particle size bed the applied power, represented by the numerator in the above term, will depend on the average eddy size (k) and the value of $\sqrt{gDs}$. A smaller k would indicate an increase in the applied power and vice versa. Also a smaller value of $\sqrt{gDs}$ would indicate a decrease in the applied power and vice versa. As stated above, eddy sizes for the smaller stones (where the deviating trend is noticed) were underestimated by equating k to d and thus the k values that were used were too big. A bigger k value will thus cause the unit applied power value over the stone to decrease. When the applied power has decreased over a stone it will only increase with a bigger value of $\sqrt{gDs}$. A stone of a certain diameter will thus start to move at a higher value of $\sqrt{gDs}$ than would have been the case for that stone in a uniform particle size bed due to the fact it underlies a bigger eddy. Several studies (Andrews 1983, Bathurst 1987, Egiazaroff 1965, Wiberg & Smith 1987, Wilcock 1993) found that in bed materials

with non-uniform size distributions, particles smaller than a particle reference size are relatively difficult to move while particles larger are relatively easy to move. The smaller the stone in a non-uniform particle size bed, the smaller the term $\left(\frac{d}{k}\right)^{1/3}$ will become and the higher the value of $\sqrt{gDs}$ must become to move the stone. Figures 4.10 – 4.12 explain this situation graphically.

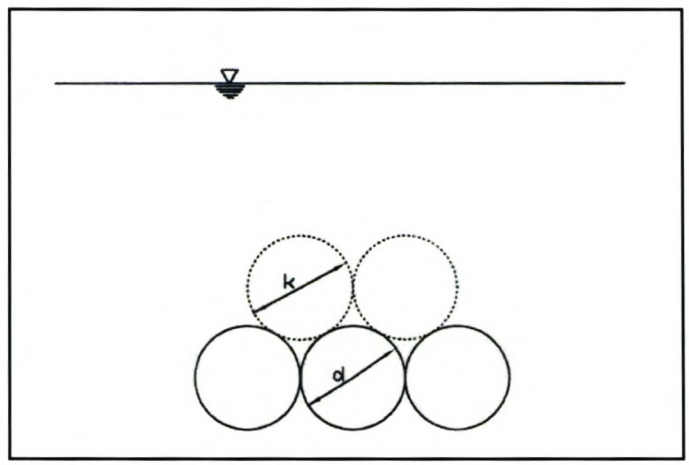

Figure 4.10: Stone d in a uniform particle size bed with a fixed $\sqrt{gDs}$

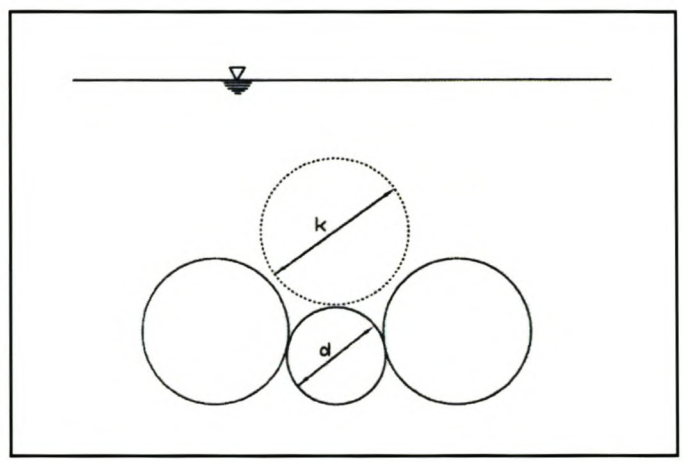

Figure 4.11: Stone d in a non-uniform particle size bed with a fixed $\sqrt{gDs}$

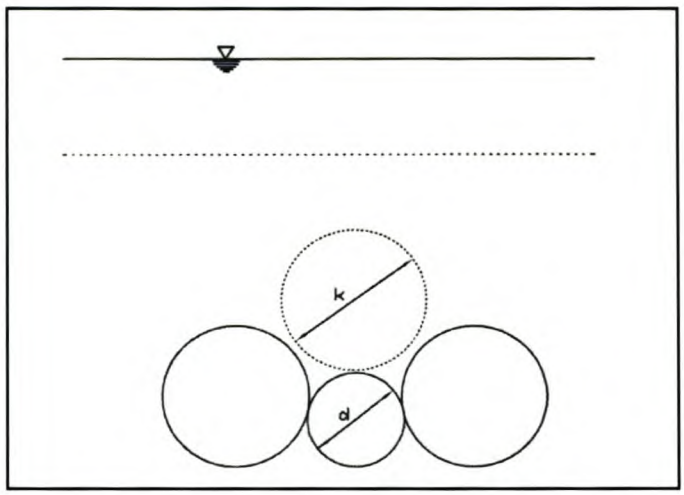

Figure 4.12: Stone d in a non-uniform particle size bed with an increased $\sqrt{gDs}$

Figure 4.10 depicts a stone of size d at the threshold of movement in a uniform particle size bed. In Figure 4.11 the same stone d is shown in a non-uniform particle size bed with the same $\sqrt{gDs}$ as in Figure 4.10. This change in bed topography causes the eddy over stone d to increase in size. As shown in the previous paragraph this causes the applied power to decrease and hence the stone will be at rest and not be at threshold conditions anymore. The only way for the stone to approach threshold conditions again is through an increase in $\sqrt{gDs}$ which will cause an increase in the applied power. This is shown in Figure 4.12 where the difference is shown between the level of water needed to move stone of diameter d in a uniform particle size bed (dashed line) and the water level required to move stone of diameter d in a non-uniform particle size bed. This difference in water level represents the increase of $\sqrt{gDs}$ in order to reach threshold conditions between a stone in a uniform particle size bed and in a non-uniform particle size bed.

Figures 4.2 - 4.4, which were derived for uniform particle beds (equation 4.9), do make provision for this change in $\sqrt{gDs}$ to be accommodated in the plotting of the data but not a change in eddy size. This deviation thus reflects the increase in $\sqrt{gDs}$ needed to overcome the decrease in applied power over a stone due to increased eddy size.

The Liu diagram, as adapted for non-uniform particle size beds to make provision for this change in k, is shown in Figures 4.13 – 4.15 for the Molenaars and Berg River data respectively. The average eddy value (k) has been set equal to d_{84}. This is justified by the explanation given above that the average eddy size would be determined by the size of the larger stones in the bed. Stones in the size range d_{50} to d_{100} should play a determinant role in the eddy formation process. These are stones that protrude above the bed and will typically not be as sheltered as the stones smaller than d_{50}. Stones smaller than d_{50}, as mentioned before, fall in between and hide behind bigger stones and thus play a much smaller role (if indeed any for the smallest stones) in determining the average eddy size. Setting the average roughness equal to d_{84} is also justified through the fact that it provides the closest approximation for the data against a y-axis value of 0,12 compared to setting k equal to other values

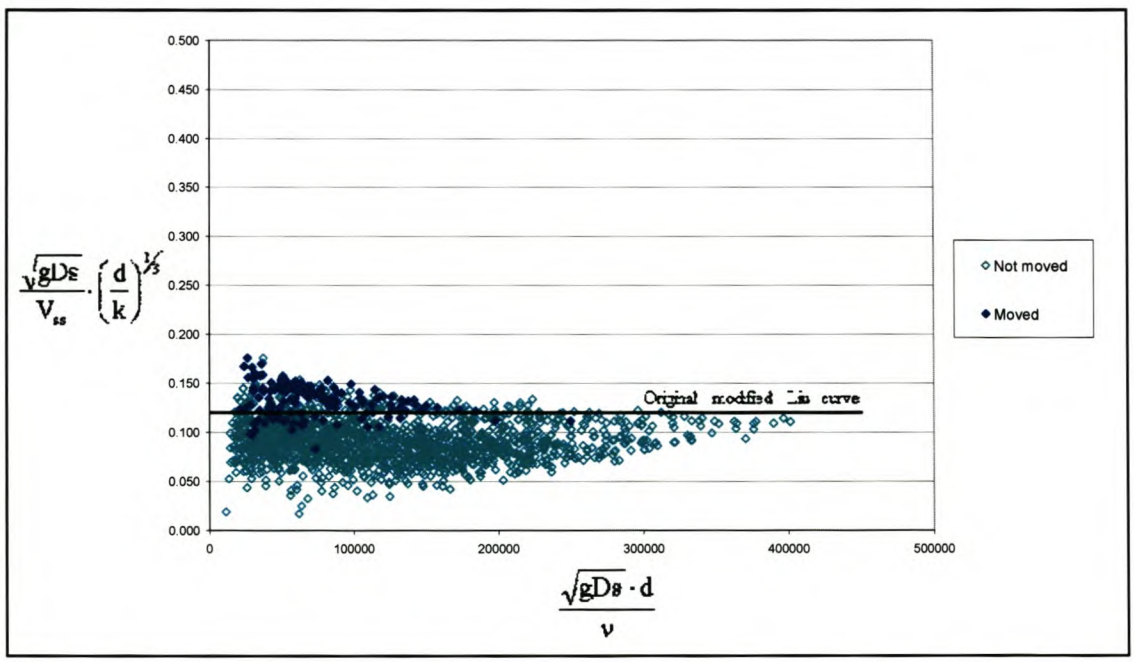

Figure 4.13: Liu diagram, adapted for non-uniformity, k=d84 Molenaars 2003

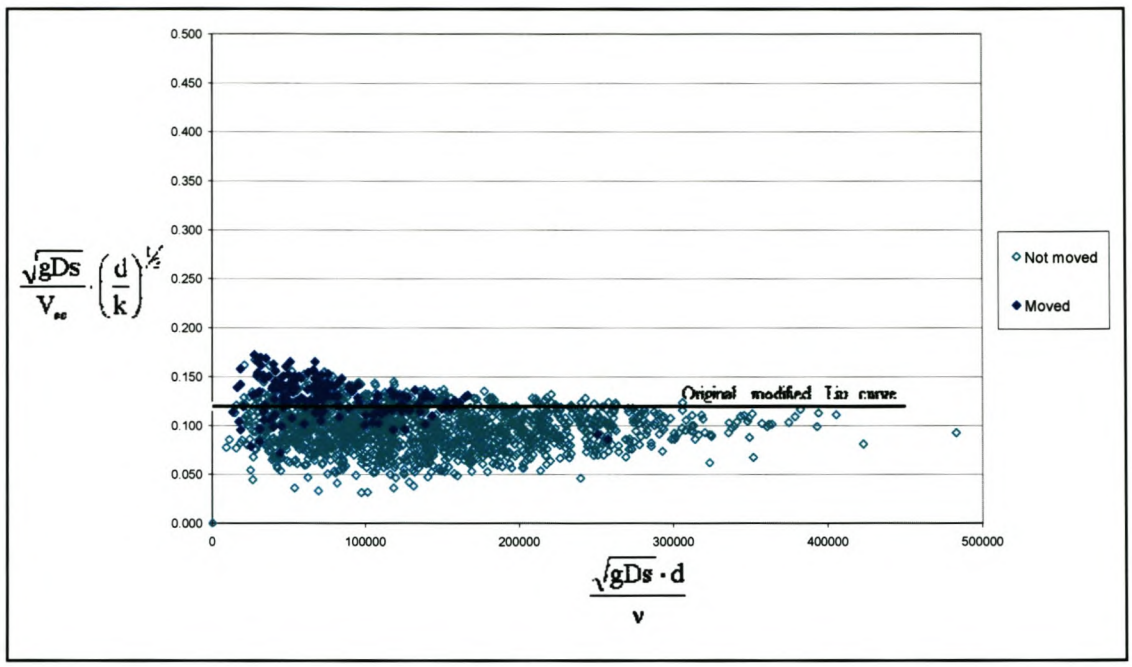

Figure 4.14: Liu diagram, adapted for non-uniformity, k=d84, Molenaars 2004

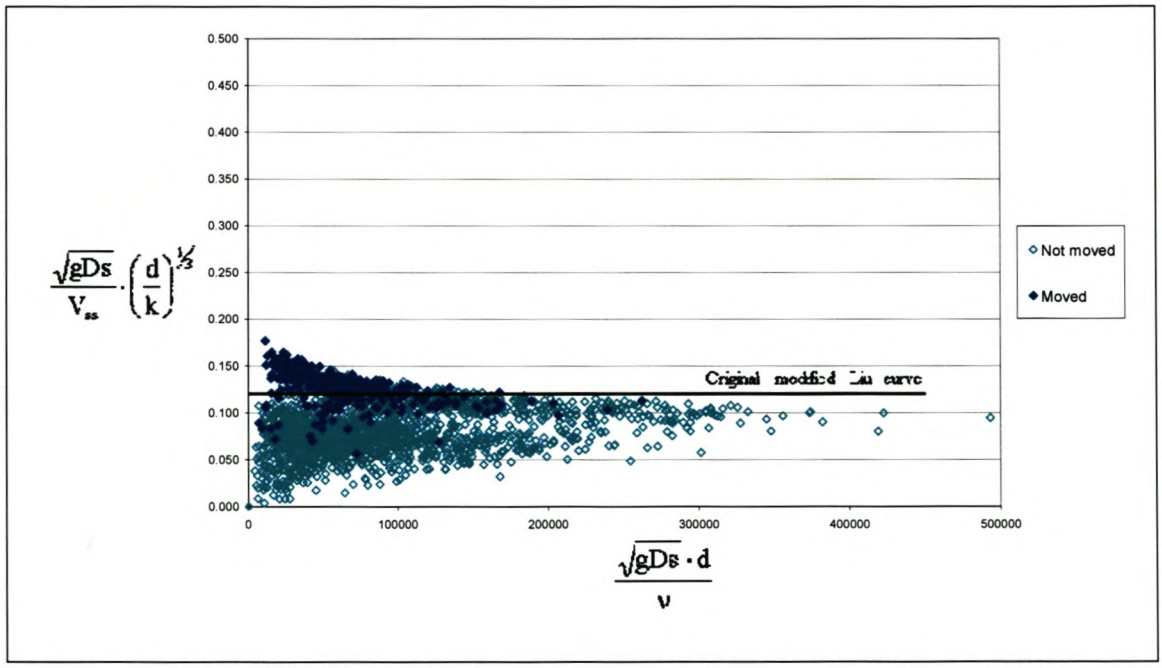

Figure 4.15: Liu diagram, adapted for non-uniformity, k=d84, Berg 2004

From the above figures it is clear that the data deviates much less from the theoretical horizontal line than in Figures 4.2 - 4.4, although there are still small but definite deviations noticeable. These small deviations can be attributed to the fact that even though provision has been made in terms of the average k value of the bed being used, transition effects in the hashed areas in Figure 4.16, were not modelled. These transition effects are highly complex and are thus impossible to model.

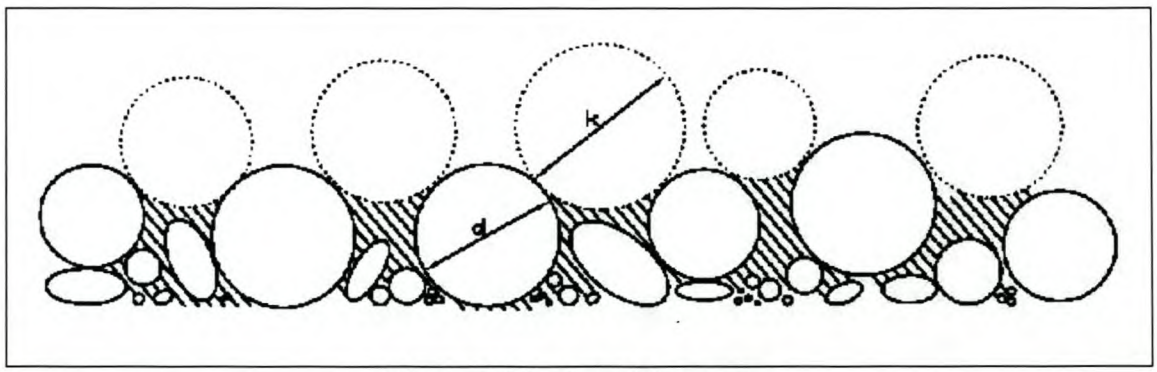

Figure 4.16: Transition zones

The smaller a stone, the deeper it will tend to lie in the bed (i.e. it won't protrude into the flow as much as bigger stones), and the further away from the prevailing turbulent eddies it will be located. Secondary effects will thus be greater for smaller stones and could explain why the biggest remaining variations in the Liu diagram, adapted for non-uniformity (Figures 4.13 – 4.15), are found for the smallest stones.

The deviation of the Molenaars and Berg Rivers data from the expected horizontal line for threshold of movement in the original modified Liu diagram (Figures 4.2 – 4.4) can thus be explained in terms of non-uniformity of bed materials.

4.4 Influence of laminar zones on incipient motion

As mentioned in Chapter 4.1 the deviations of the Molenaars and Berg Rivers data from the expected horizontal line for threshold of movement, when plotted in the original modified Liu diagram, show a striking resemblance to the deviation of the data on the left

in the original modified Liu diagram where laminar flow is dominant. Could laminar conditions thus also play a role in the incipient motion process in cobble stone river beds?

On plotting incipient motion data from sand bed rivers with large bedforms, Rooseboom and Le Grange (1994) found a dependency of the threshold of movement of particles on viscosity well into the turbulent boundary range. This can be seen in Figure 4.17.

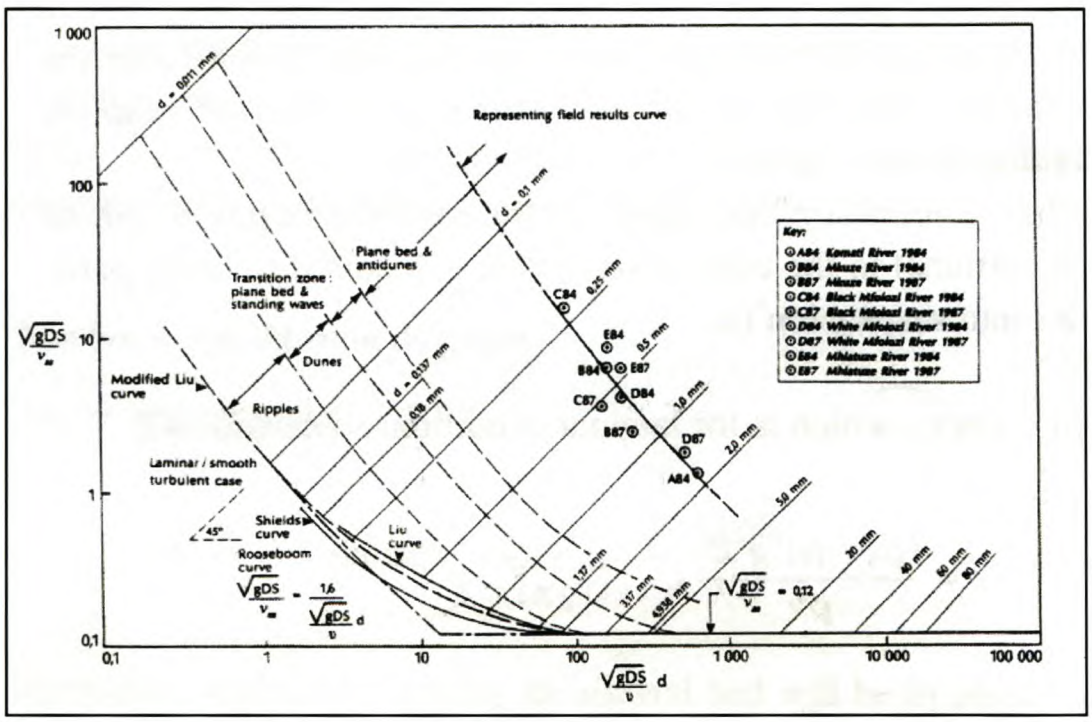

Figure 4.17: Critical conditions for sediment particles (Liu diagram) with river flood data and bedforms added (Rooseboom and Le Grange, 2000)

This observation led to the following statement:

"The only conceivable way in which viscosity can play a role is through the development of a laminar boundary layer beneath the turbulent flow zone. It is generally accepted that laminar boundary conditions develop along even beds and there is no reason why this should not happen in the sheltered hollows between bedforms" (Rooseboom and Le Grange, 2000).

It has also been shown (Rooseboom 1974, 1992) that whenever alternative modes of flow exist, that mode which requires the least amount of applied unit power will be followed. Flow will therefore be either laminar or turbulent depending on which mode requires the least amount of power to generate the equilibrium stresses. It also follows that fluid flowing over transportable material will not transport such material unless this would result in less power being applied than without sediment transport.

Using the equations (Chapter 2) for applied unit power,

$$\frac{30\rho gsD\sqrt{2\pi gDs}}{k} \qquad (2.17)$$

and applied laminar power,

$$\frac{(\rho gSD)^2}{\rho\nu} \qquad (2.13)$$

the values for unit applied power under turbulent and laminar conditions were determined. For both the Berg and Molenaars Rivers floods the value of unit applied laminar power exceeded that of unit applied turbulent power by orders of approximately a thousand times. According to the above statement that whenever alternative modes of flow exist, that mode which requires the least amount of applied unit power will be followed (Rooseboom 1974, 1992), turbulent power will prevail at bed level for the Molenaars and Berg Rivers.

4.5 Conclusions

In the first part of this chapter the data from the Molenaars (2003 and 2004) and Berg (2004) Rivers were plotted in the original modified Liu diagram (Rooseboom, 1992). The data sharply deviated from the expected constant horizontal line (y-axis value = 0,12). Three possible reasons were identified that could mathematically explain this deviation:

- The stones are embedded and the derivation of a constant value for the threshold of movement in the modified Liu diagram does not account for such conditions.
- The original modified Liu diagram (Rooseboom, 1992) was derived for beds with uniform particle sizes, while the data for the Molenaars and Berg rivers represent beds which consist of non-uniform bed particles.
- The deviation noticed for the data from the Berg and Molenaars Rivers is due to laminar conditions playing a role in the entrainment process of the stones.

It was found that the only reason that could account for the deviation from the expected horizontal line in the original modified Liu diagram was the fact the original modified Liu diagram was derived for uniform particle size beds whereas the data of the Molenaars and Berg Rivers represented non-uniform particle size beds. When the derivation for the y-axis in the original modified Liu diagram, which depicts

$$\frac{\sqrt{gDs}}{V_{ss}} \text{ or } \left[\frac{\text{Unit applied power along bed}}{\text{Unit power required to suspend particles}}\right],$$

was modified to provide for non-uniform bed particle sizes, an extra factor was obtained and the function on the y-axis changed to:

$$\frac{\sqrt{gDs}}{V_{ss}} \cdot \left(\frac{d}{k}\right)^{1/3}$$

An analysis of the observed flow data showed that the absolute roughness (k) of a non-uniform bed is reasonably well approximated by a value of d84. This is due to the fact that the bigger stones in the bed (d50 to d100) play the dominant role in determining the eddy size. When the Liu diagram was re-plotted with the newly derived y-axis function and the k-value for each stone set equal to the average roughness of the bed (k=d84) the data plotted close to the expected horizontal line. The much smaller remaining deviation

from a horizontal line relationship is attributed to secondary effects which are not accounted for in the theory.

5 INTENSITY OF MOVEMENT GRAPHS

5.1 Introduction

In terms of the objectives set out in Chapter 1 of this thesis a graph or set of graphs were to be produced. These graphs would aid environmentalists and other interested parties who do not necessarily have a technical background in hydraulics to make management decisions e.g. on how much water must be released from dams to satisfy the ecological needs in terms of bed material transport.

5.2 Intensity of movement

(i) Original modified Liu-diagram

As shown in Chapter 4 the main reason for the deviation from the expected horizontal line (y-axis) when data from the Molenaars and Berg Rivers are plotted in the original modified Liu diagram is the fact that the original modified Liu diagram does not make provision for non-uniform bed particles. Due to the difficulty (also mentioned in Chapter 4) in predicting the roughness (k) accurately the graphs (Figures 4.2 – 4.4) are used in providing design curves for sediment movement. Rivers with similar bed roughness (even if the exact value of the roughness of every stone cannot be determined) will show similar deviation from the expected horizontal line when plotted in the original modified Liu diagram. Thus, even though the deviation is explained through the inclusion of the average roughness of the non-uniform particle size beds, the graphs (Figures 4.2 – 4.4) can be used to produce design curves for defining intensity movement.

As explained in Chapter 4.1, the boundary between data points that represent movement and those that represent non-movement in the original modified Liu diagram (Figures 4.2 – 4.4) is equivalent to the incipient motion curve. Also mentioned is the fact that the data on movement are not as accurate as those that depict non-movement. It is thus not possible to draw an exact incipient motion curve from the boundary between data points that represent movement and those that represent non-movement based on the observed

data from this study. However, the data plotted in the original modified Liu diagram reveal more than the location of the incipient motion curve. It also shows the maximum value of $\left[\frac{\text{Unit applied power along bed}}{\text{Unit power required to suspend particles}}\right]$ or $\frac{\sqrt{gDs}}{V_{ss}}$ for every stone size observed during a particular flood. Figure 5.1 depicts the Molenaars 2003 Flood No. 6 as an example of a single flood, with a curve drawn where the maximum $\frac{\sqrt{gDs}}{V_{ss}}$ value for every stone size class is located. Straight lines have been added to indicate stones with equivalent diameters. In this particular figure (5.1) lines have been assigned to only a few of the stone size classes to indicate the pattern stone sizes follow in the Liu diagram.

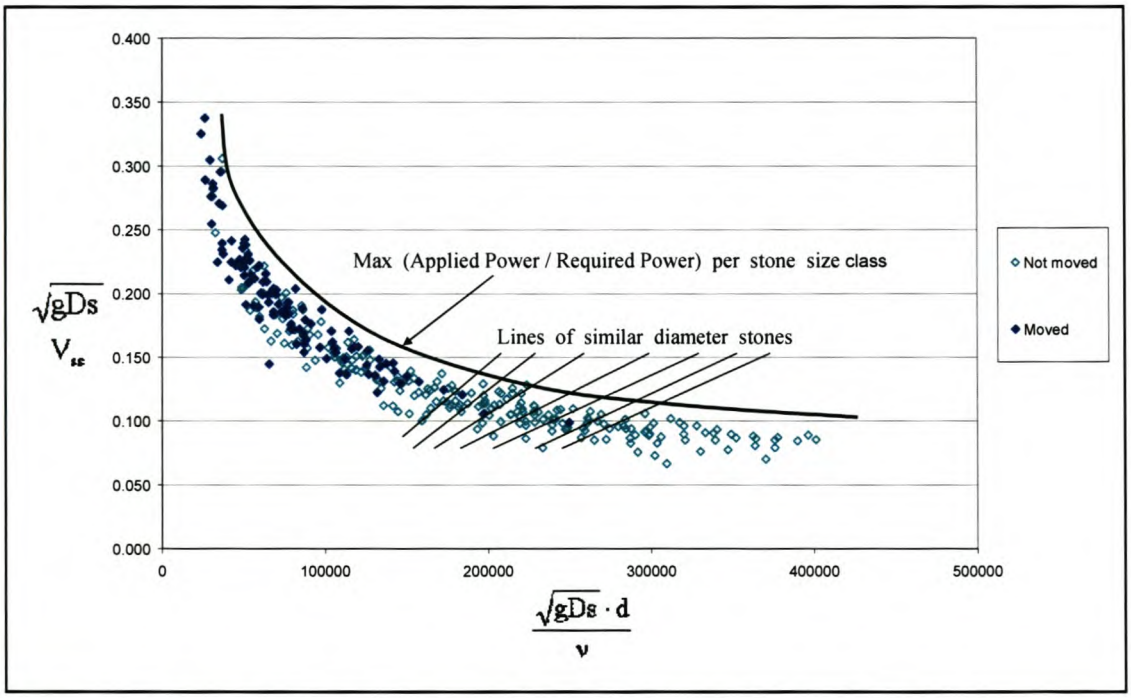

Figure 5.1: Max Applied Power/Required Power per stone size class for Molenaars 2003 Flood 6

From Figure 5.1 it can be appreciated that an upper envelope curve for the data of a specific flood represents the maximum $\frac{\sqrt{gDs}}{V_{ss}}$ value, for that flood, for every stone size class.

Although the data on movement in the Liu diagram (Figures 4.2 – 4.4) is not completely accurate, the number of stones that were moved during a flood is correct. When this data on the number of stones that moved during each flood is super-imposed on the curve (Figure 5.1) that represents the maximum $\frac{\sqrt{gDs}}{V_{ss}}$ value for every stone size, it reveals a curve that represents the number of stones that were moved by a certain size flood.

Figures 5.2 -5.4 contain data from the Molenaars and Berg Rivers plotted in the original modified Liu diagram. The data have been plotted for each flood. The amount of bed movement in each flood is indicated in the legend. The amount of movement has been defined as the percentage of stones that were moved.

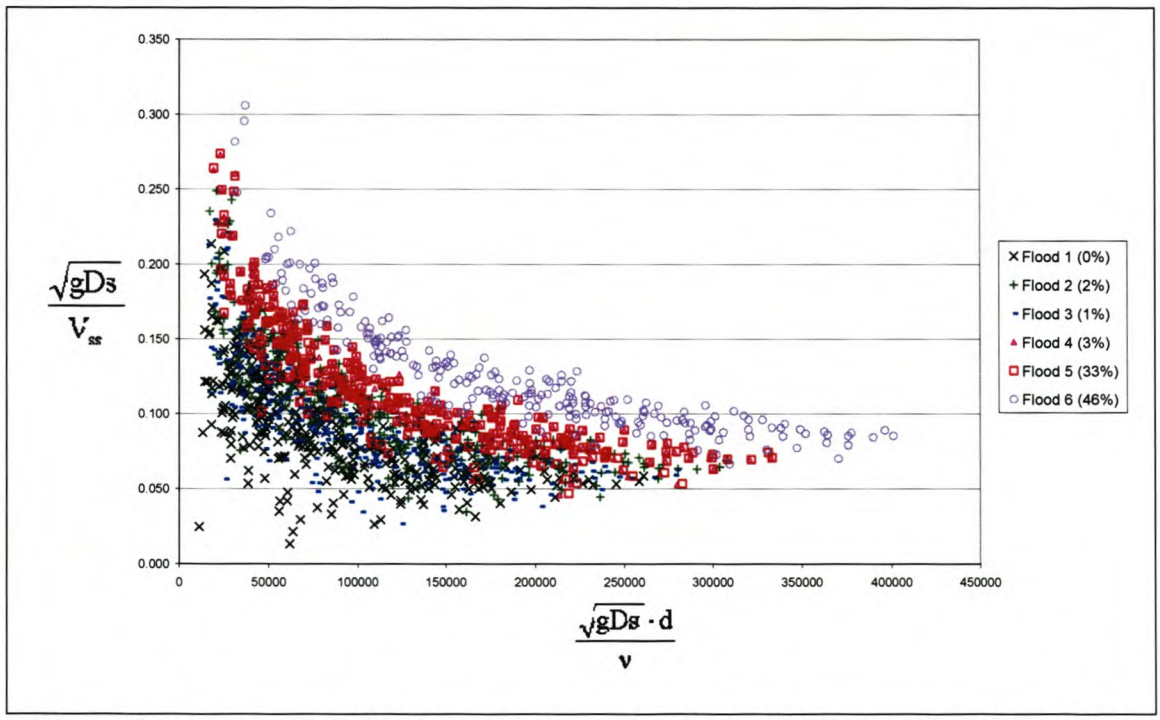

Figure 5.2: Molenaars 2003 data, floods separated, plotted in the original modified Liu diagram

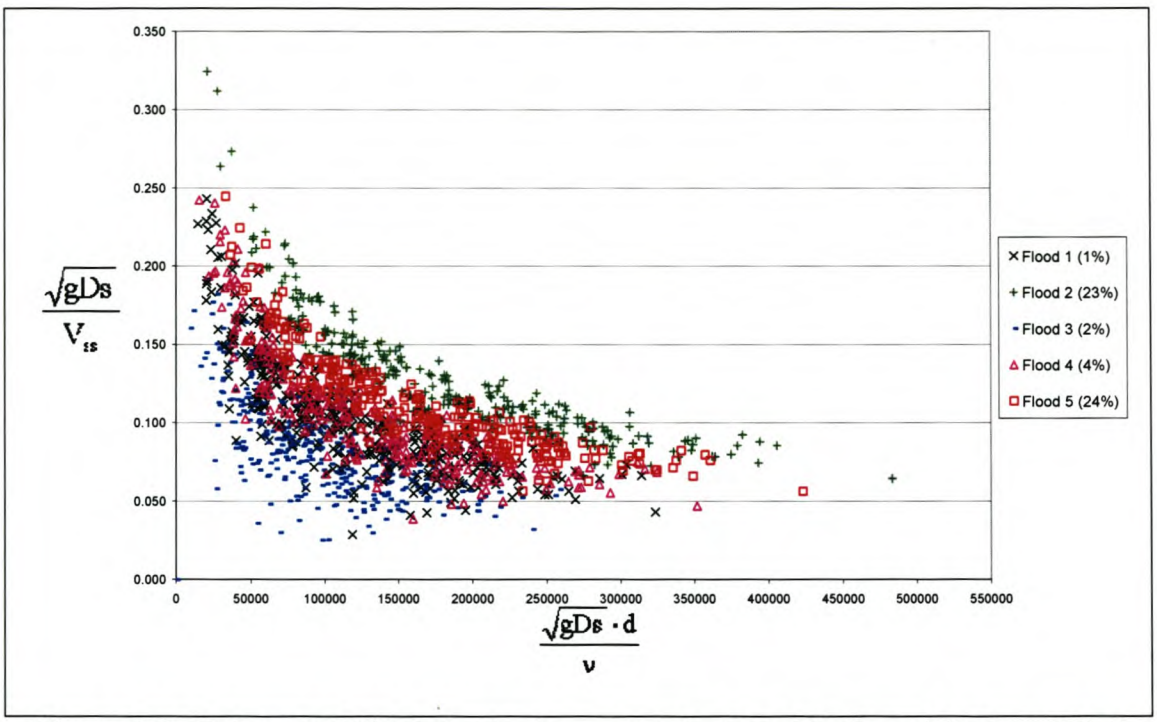

Figure 5.3: Molenaars 2004 data, floods separated, plotted in the original modified Liu diagram

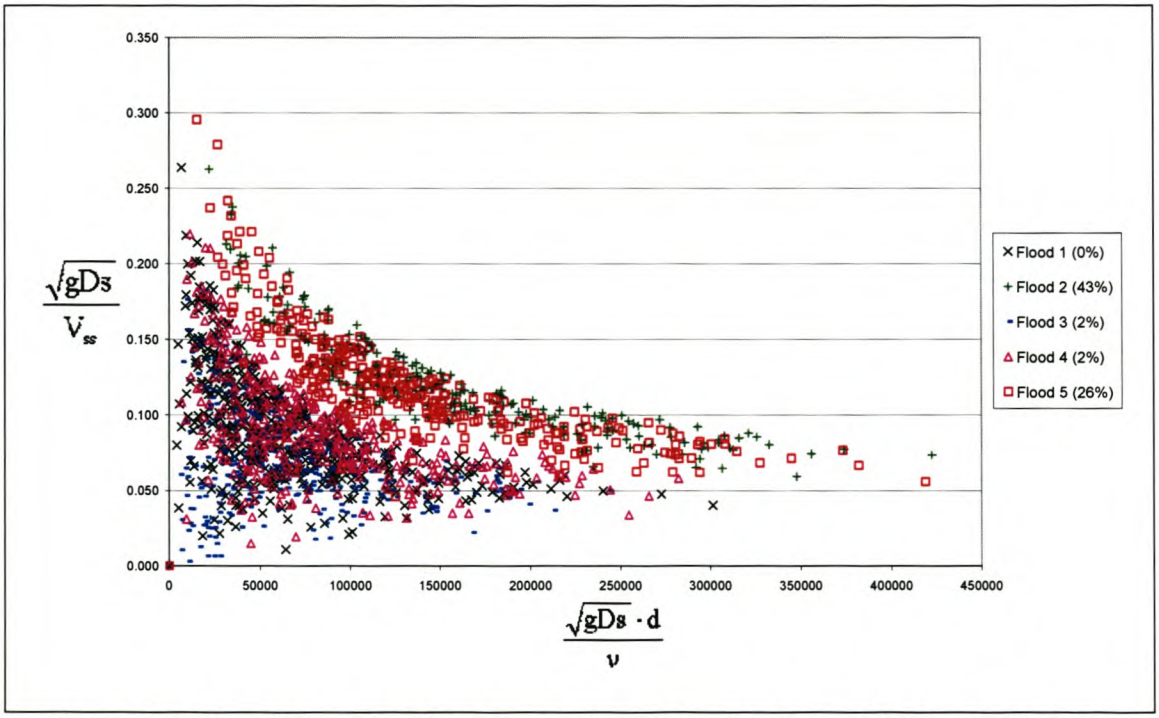

Figure 5.4: Berg 2004 data, floods separated, plotted in the original modified Liu diagram

Considering Figures 5.2 – 5.4 a general trend is revealed. Comparing the upper data points for every flood (through which the topmost envelope curve for every flood is drawn) and the intensity of movement, it is seen that as the $\frac{\sqrt{gDs}}{V_{ss}}$ value increases more stones are transported. Figures 5.5 – 5.7 provide a clearer picture of these envelope curves. All the data in Figures 5.5 – 5.7 have been provided with envelope curves for every flood (the data points have been removed to provide clearer graphs)

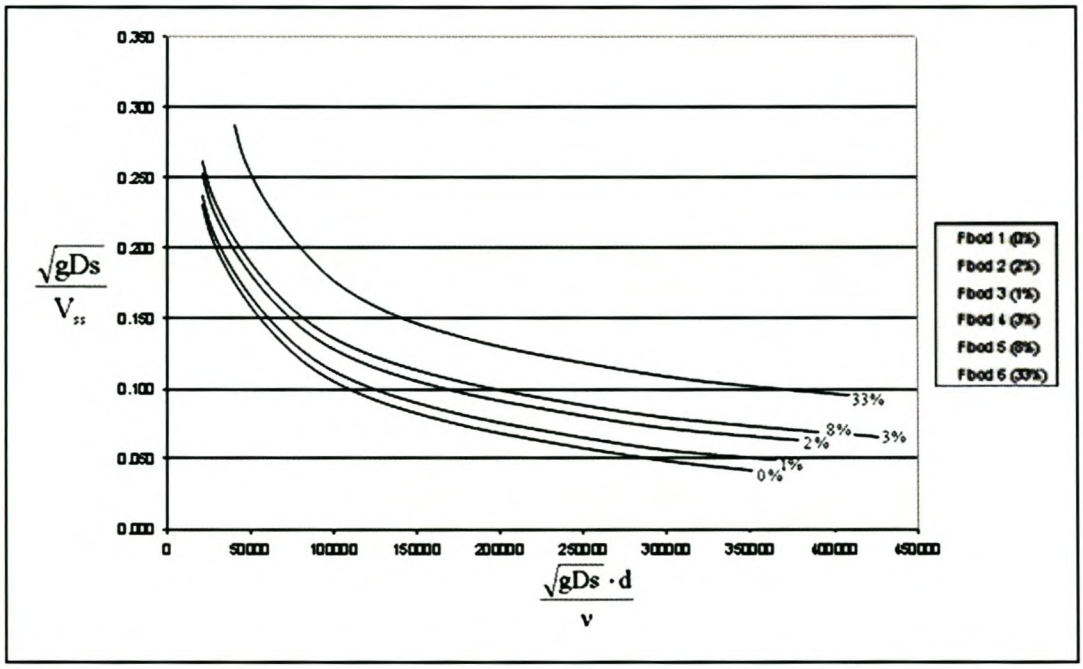

Figure 5.5: Envelope curves for intensity of movement, Molenaars 2003

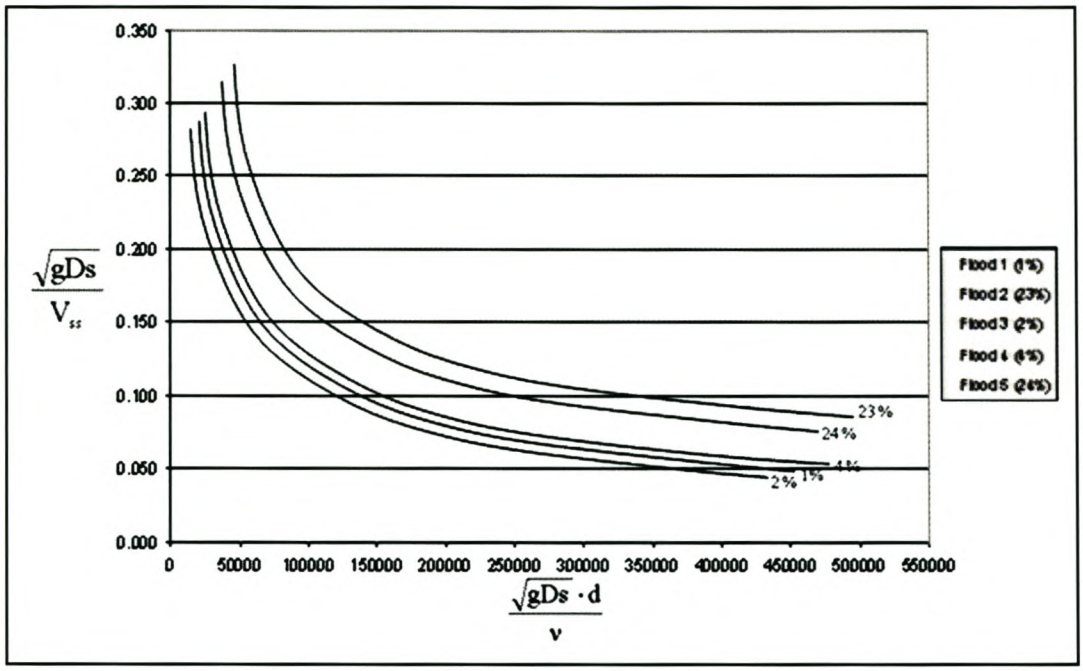

Figure 5.6: Envelope curves for intensity of movement, Molenaars 2004

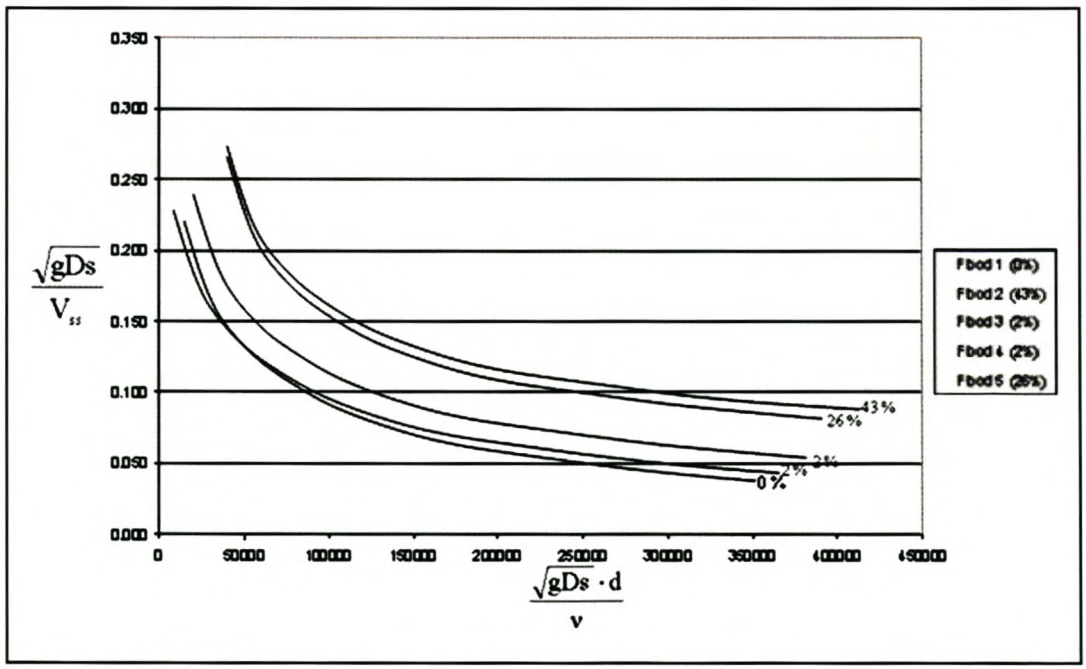

Figure 5.7: Envelope curves for intensity of movement, Berg 2004

Analysis of Figures 5.5 – 5.7 reveals the following:

- Although, the overall trend of the curves indicates that the intensity of movement increases as the curves plot higher it is not necessarily the case that a higher plot will yield a bigger intensity of movement. For example in Figure 5.6 the curve that is associated with 2% movement plots lower than the curve associated with 1% movement.
- The intensity of movement does not increase linearly with $\frac{\sqrt{gDs}}{V_{ss}}$. The lower curves are associated with relatively small values of intensity of movement. From there a point is reached where a relatively small increase in $\frac{\sqrt{gDs}}{V_{ss}}$ is associated with a rapid increase in the intensity of movement.

The above Figures 5.5 – 5.7 do not distinguish between floods of different durations and thus the first of these remarks can possibly be explained in terms of the durations of floods. Tables 3.3 and 3.4 contain the particulars of every flood (which include the durations) and are repeated here as Tables 5.1 and 5.2 for the purpose of comparison.

Year	Event Number	Date	Duration (hours)	Max Flow (m^3/s)	Avg. Daily Flow (m^3/s)	Volume (Mm^3)	DRIFT Class
2003	1	10th July	33	5.56	3.72	0.41	I
	2	18th July	21	15.23	5.41	0.49	I
	3	25th July	14	8.60	4.20	0.28	I
	4	1st August	26	28.76	7.98	0.95	I
	5	8th August	26	36.46	14.45	1.74	II
	6	18th August	32	140.80	30.29	4.15	III
2004	1	6th June	29	20.20	10.02	1.04	I
	2	14th June	33	140.97	37.21	3.82	III
	3	26th June	31	8.87	5.13	0.66	I
	4	3rd July	21	46.38	16.08	1.35	II
	5	23rd July	18	113.93	29.17	2.67	III

Table 5.1: Flood events observed at the Molenaars study site

Year	Event Number	Date	Duration (hours)	Max Flow (m^3/s)	Avg. Daily Flow (m^3/s)	Volume (Mm^3)	DRIFT Class
2004	1	5th June	28	7.27	2.08	0.40	I
	2	14th June	44	84.51	32.58	3.48	IV
	3	26th June	27	4.82	2.62	0.29	I
	4	3rd July	24	11.74	5.68	0.44	II
	5	23rd July	20	60.98	17.70	1.66	IV

Table 5.2: Flood events observed at the Berg study site

When comparing the positions of the curves relative to each other (Figures 5.5 -5.7) with the duration of every flood (Tables 5.1 and 5.2) no explanation is evident in terms of the durations of the floods that would describe all the discrepancies.

Although it is not possible to read off accurate values of movement values (to within 1%) directly from these curves, it should be possible to use judgement and deduce accurate enough volumes in practical situations since management decisions on the amount of water to be released will typically indicate small, medium or large movements and not a singular percentage value of movement.

(ii) Incipient motion in terms of DRIFT classification

When plotting the intensity of movement for every flood against the DRIFT classifications of these floods, a clearer picture is obtained of when (in terms of DRIFT classification) stones start to move (incipient motion) and how the intensity of movement varies with flood size.

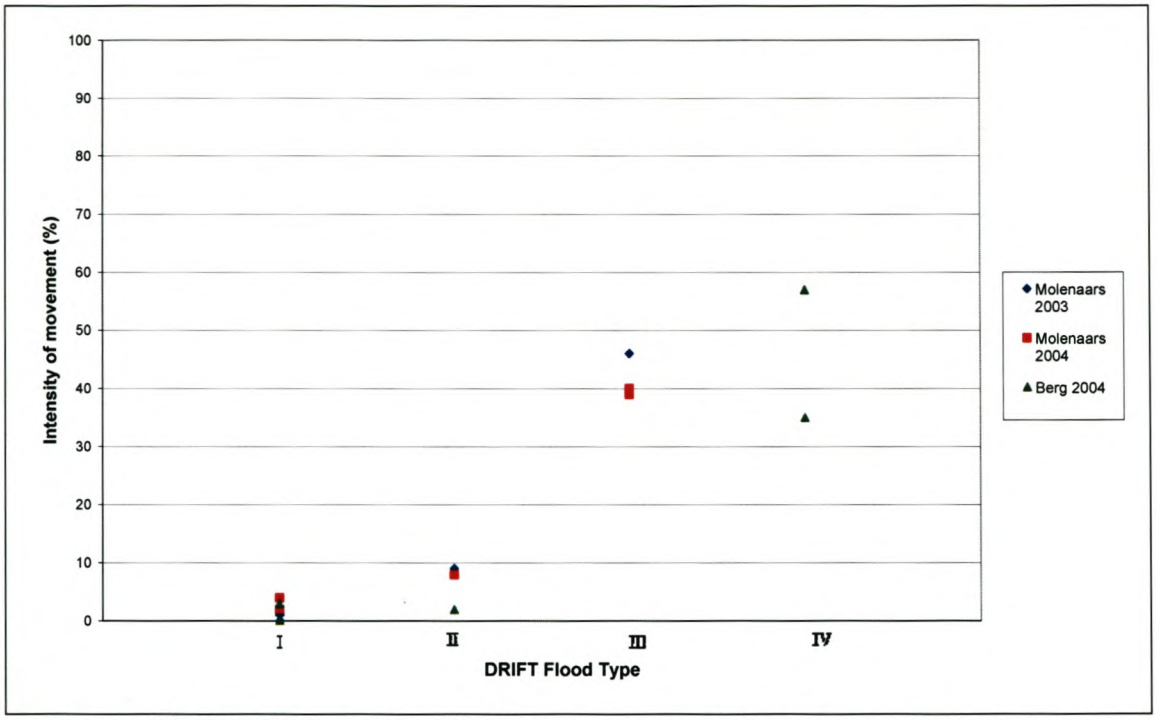

Figure 5.8: DRIFT flood classification vs. Intensity of movement (excluding non-embedded stones)

Figure 5.8 shows that very little movement is noticed with DRIFT Class I and II floods. The intensity of movement might in some cases be even less for a class II flood than for a class I flood. However, there is a definite increase in the intensity of motion between a class II and a class III flood. It is also noticed that class IV floods in some cases have smaller values of intensity of motion than class III floods. This indicates that in terms of incipient motion movement starts somewhere before the DRIFT class II floods are reached

When Figure 5.8 is adapted to include data on embedded stones the effect of embeddedness on incipient motion can be detected. This is shown in Figure 5.9.

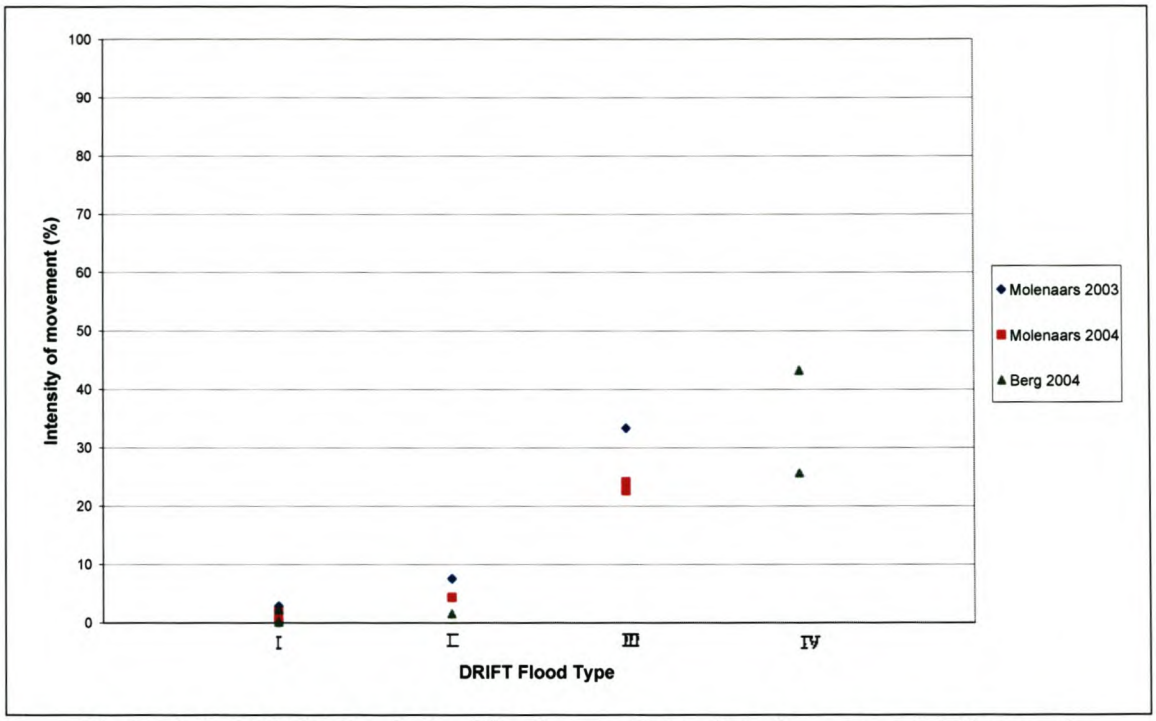

Figure 5.9: DRIFT flood classification vs. Intensity of movement (all stones)

Figure 5.9 depicts the same trend as is noticed in Figure 5.8 namely that a rapid increase in intensity of motion is noticed between a class II and a class III flood. Although in Figure 5.9 (for all the stones) the shift is smaller than in Figure 5.8 (non-embedded stones only).

5.3 Conclusions

From the information in this chapter it can be concluded that a curve through those data points in the original modified Liu diagram that represent the maximum $\frac{\sqrt{gDs}}{V_{ss}}$ value for every stone size, forms an upper envelope curve for the data of every flood. This curve represents the intensity of motion for this flood. Unfortunately when separate curves where drawn for the Molenaars and Berg Rivers, it was found that no singular pattern is revealed that would allow these curves to be used as accurate design curves for practical use. However, they did reveal a trend with the higher plotting lines representing higher intensities of motion and vice versa. Although it is not possible to read off accurate

values of movement values (to within 1%) directly from these curves, it should be possible to use judgement and deduce accurate enough volumes in practical situations since management decisions on the amount of water to be released will typically indicate small, medium or large movements and not a singular percentage value of movement. The intensity of motion also does not increase linearly with flood size but there is a sudden increase in the number of stones that move after a certain flood size is reached. When plotting the DRIFT classes of the floods against their respective intensity of movements it is seen this sudden increase in the number of stones that move is at a point between a DRIFT class II and class III flood. It also indicated that a DRIFT class II flood does not necessarily go with a higher value of intensity of movement than a DRIFT class I flood. The same is noticed at the higher floods where a DRIFT class IV flood does not necessarily mean a higher value of intensity of movement than a DRIFT class III flood. In terms of intensity of motion it indicates that incipient motion takes place some point before the DRIFT class II floods are reached. When the data on non-embedded stones are included (Figure 5.9) the same trend as explained above is noticed with the one difference being that the increase in intensity of movement between DRIFT class II and class III flood is not as rapid when the data on embedded stones is included (Figure 5.9).

6 COMBINED CONCLUSIONS AND RECOMMENDATIONS

6.1 Combined conclusions

The objectives which were defined at the start of this research, have been met through describing the incipient motion process in terms of the applied power approach and producing graphs which provide a clearer picture of incipient motion in cobble/boulder bed rivers.

The main conclusions that have been reached are:

- Data which represent incipient motion on non-uniform particle size beds deviate from the expected horizontal line (y-axis value = 0,12) when plotted in the original modified Liu diagram. It was found that the only reason that can account for this deviation is the fact that the original modified Liu diagram does not make provision for non-uniform particle size beds.
- When the derivation of the parameters the original Liu diagram was redeveloped to provide for non-uniform particle beds an extra factor was obtained and the function on the y-axis changed to: $\frac{\sqrt{gDs}}{V_{ss}} \cdot \left(\frac{d}{k}\right)^{1/3}$. When the absolute roughness (k) was set equal to d84 for every stone the data plotted close to the expected horizontal line. Using d84 as a value for the absolute roughness of the bed is justified through the fact that the bigger stones in the bed (d50-d100) play the dominant role in determining eddy size. The much smaller remaining deviation from a horizontal line relationship is attributed to secondary effects which are not accounted for in the theory.
- Intensity of motion curves were obtained by drawing upper envelope curves through the data of every flood in the original modified Liu diagram and super-imposing this curves on the number of stones that were moved during the flood. Although it is not possible to read off accurate percentages of movement values directly from these curves, it should be possible to use judgement and deduce accurate enough values in practical situations.

- In terms of DRIFT class flood classification incipient motion of sediment takes place at a size flood smaller or equal to a DRIFT class II flood. There is a rapid increase in the intensity of movement between DRIFT class II and class II floods.

6.2 Recommendations

- The curves shown in Figure 5.5 – 5.7, which depict intensity of movement, should be calibrated with more data sets. This would allow more accurate design curves to be produced for predicting stone movement. These data sets used for further calibration should typically be of rivers with different particle size distributions in order to see what effect size distribution has on incipient motion.
- Embeddedness should be recorded in as much detail as possible in future data collections. This will aid in making provision for embeddedness in the Liu diagram.
- The impact of the duration of floods should be included in further development of design curves for intensity of movement.
- The benefits of introducing extra physical variables into the theory (e.g. particle shape, hydraulic sheltering etc.) should be investigated.
- The intensity of movement curves should be linked to some physical river characteristic/s. This will avoid gathering of large data sets (as was done for this study) in order to calibrate design curves.

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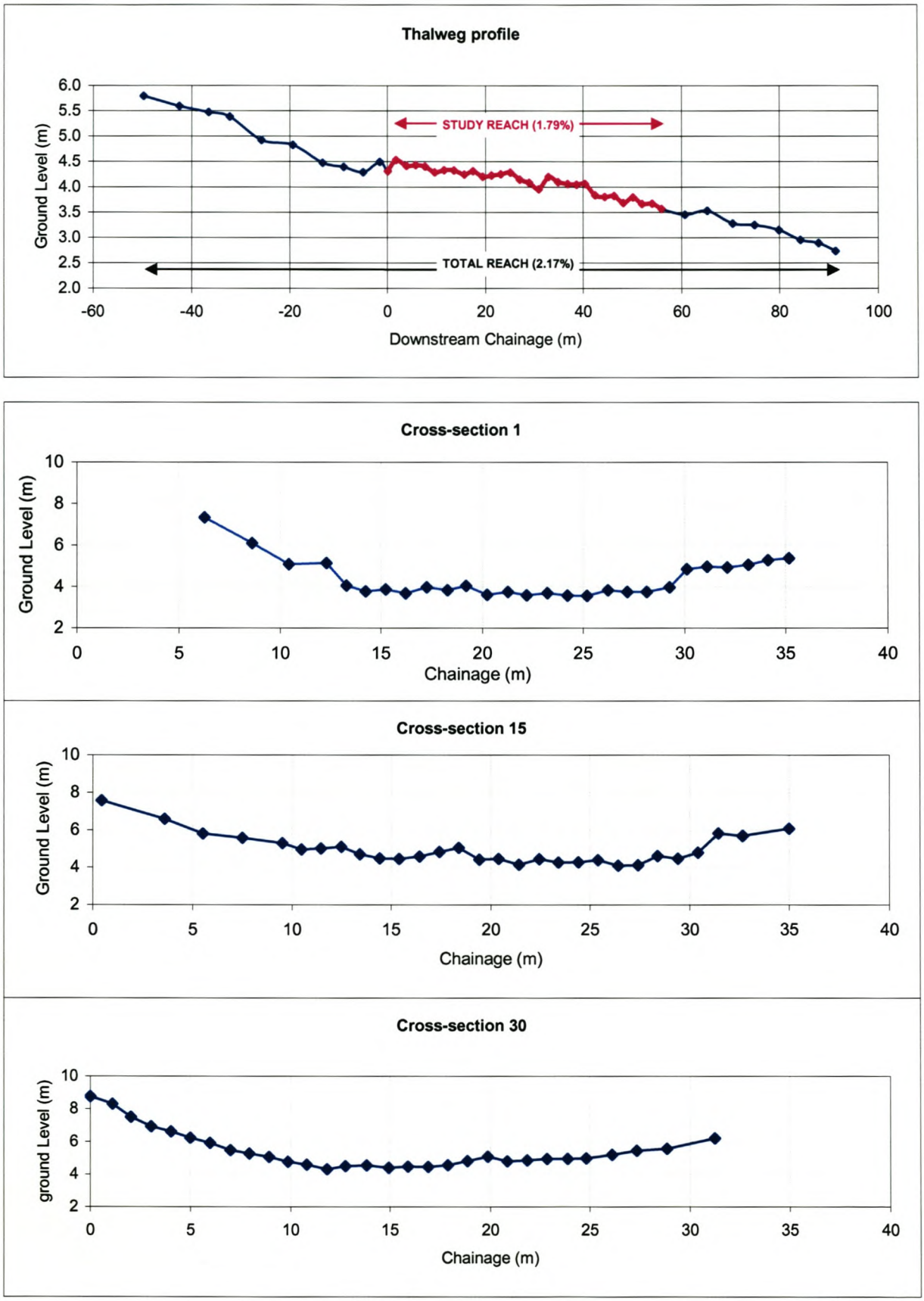
Appendix A: Details of Study Sites

Figure A1a: Molenaars Study Site: Thalweg and Sample Cross-sections



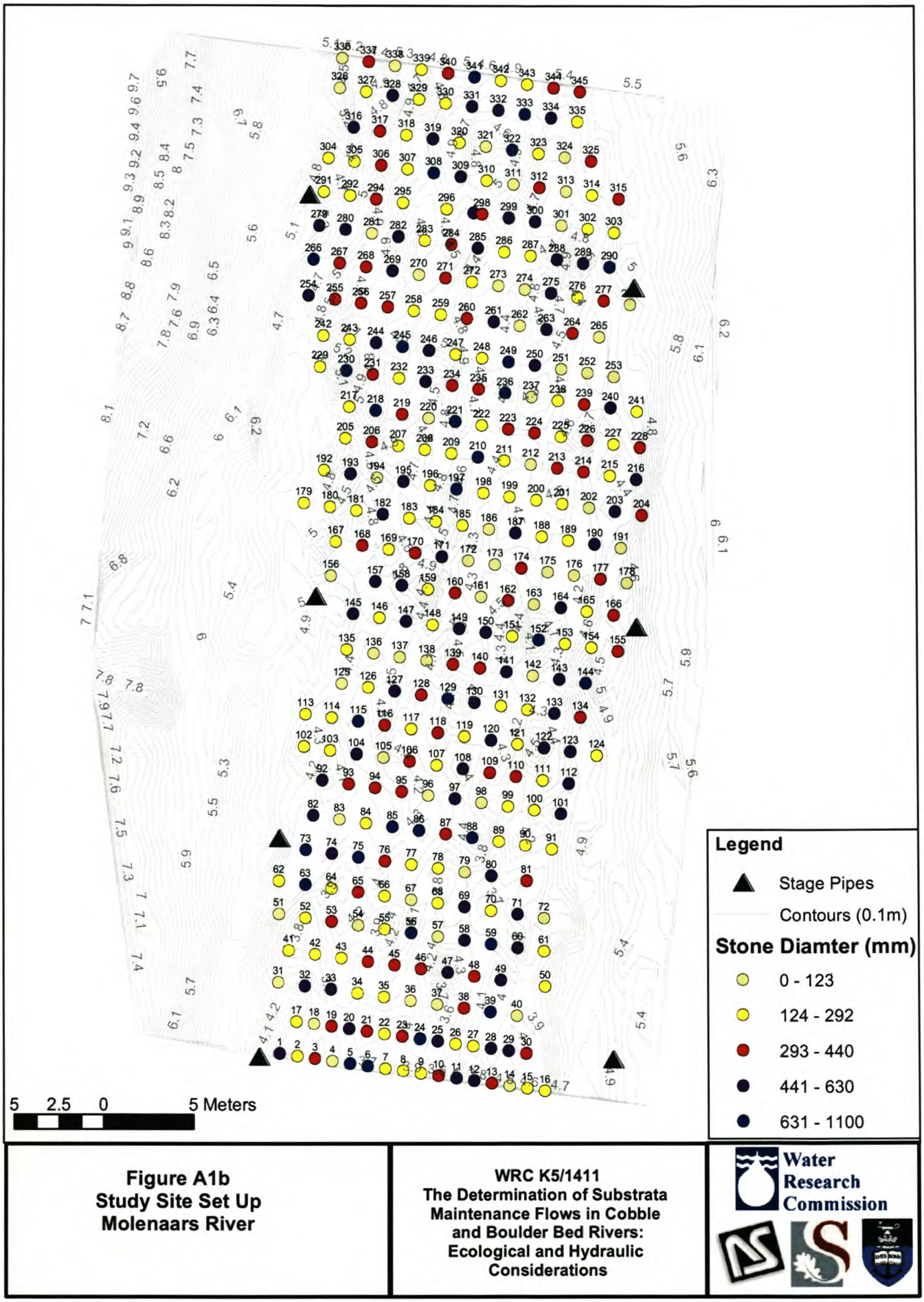


Figure A1b
Study Site Set Up
Molenaars River

WRC K5/1411
The Determination of Substrata Maintenance Flows in Cobble and Boulder Bed Rivers: Ecological and Hydraulic Considerations

Water Research Commission

Figure A1c: Molenaars Study Site: Partical Size Distribution

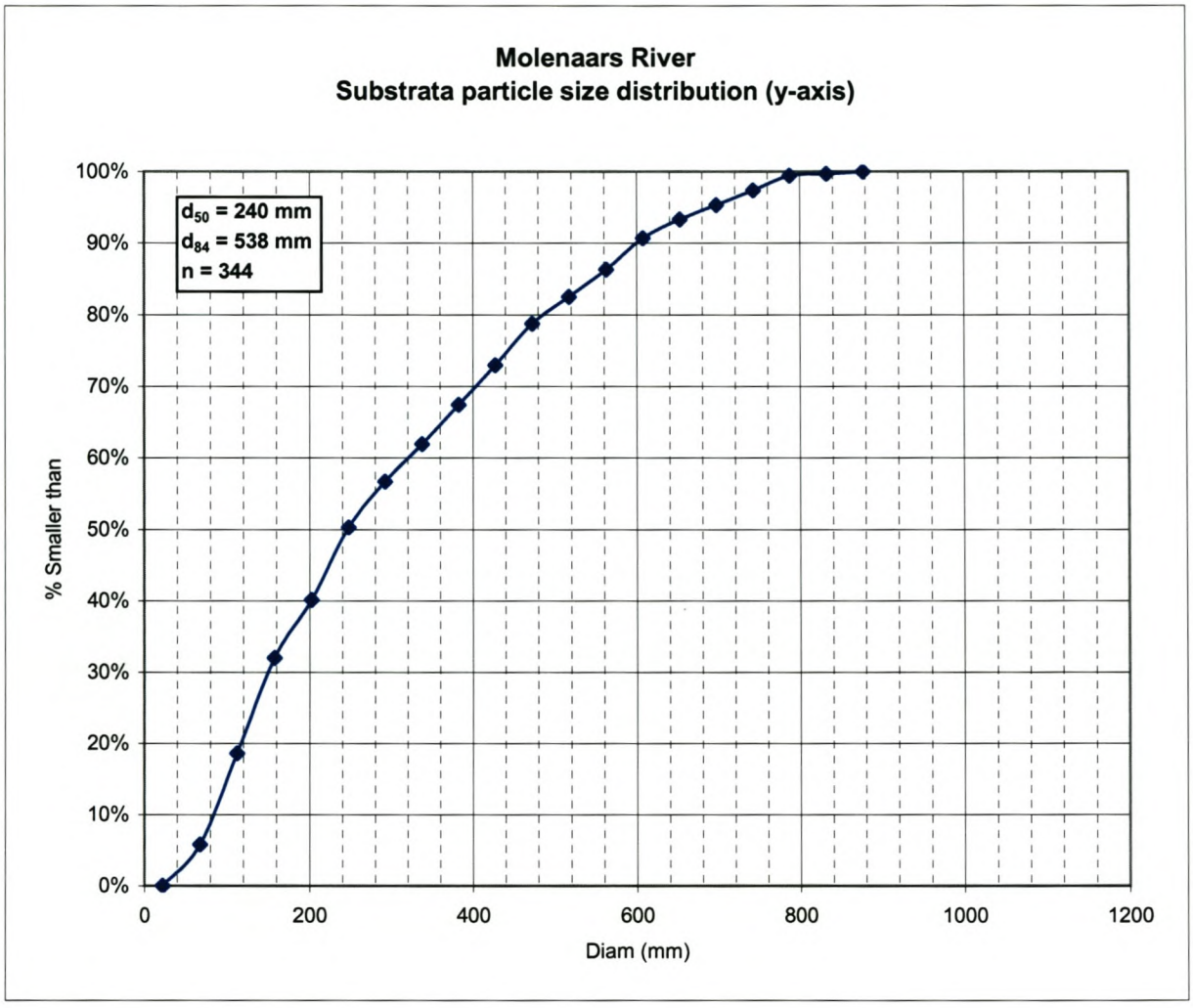
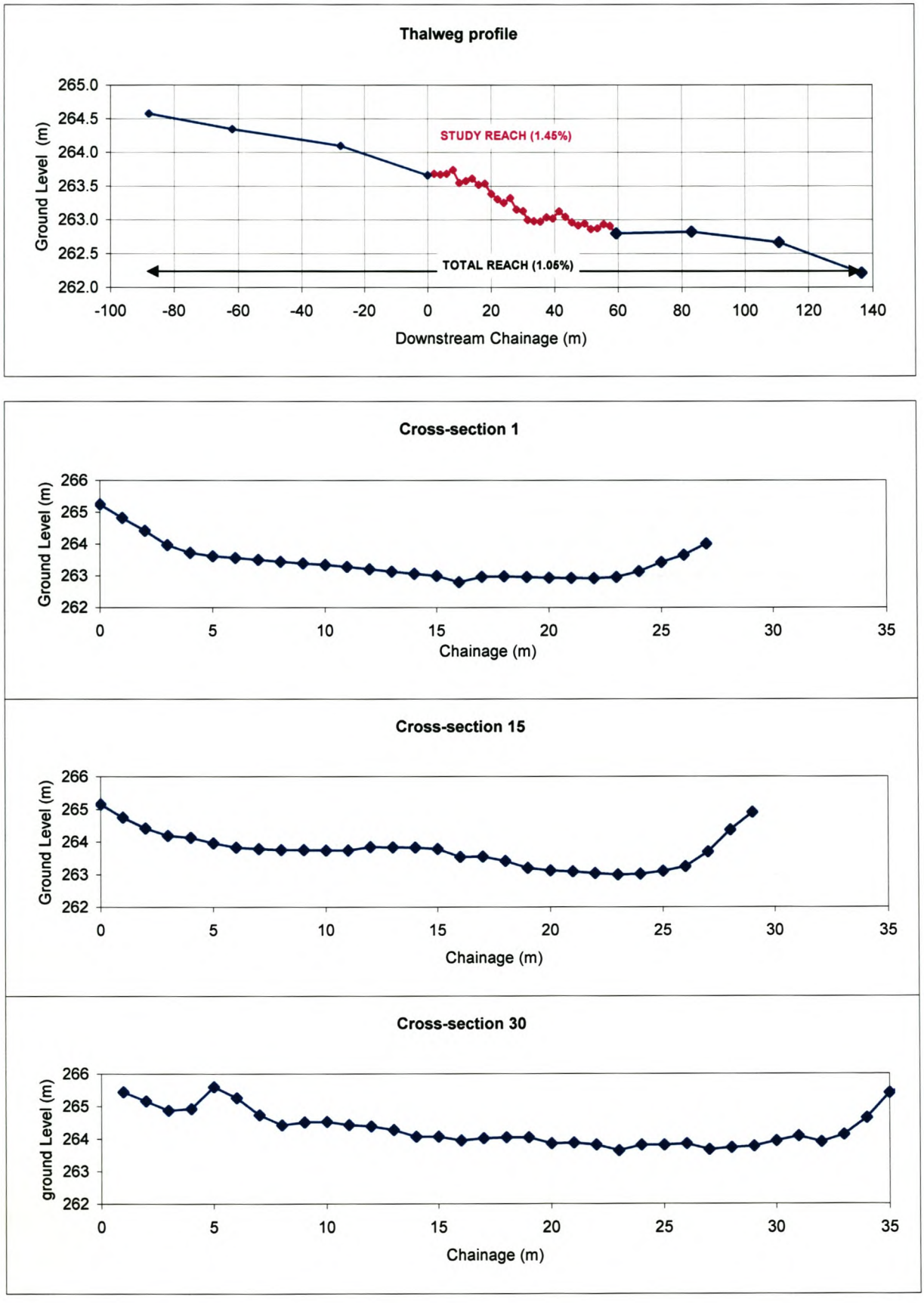


Figure A2a: Berg River Study Site: Thalweg and Sample Cross-sections



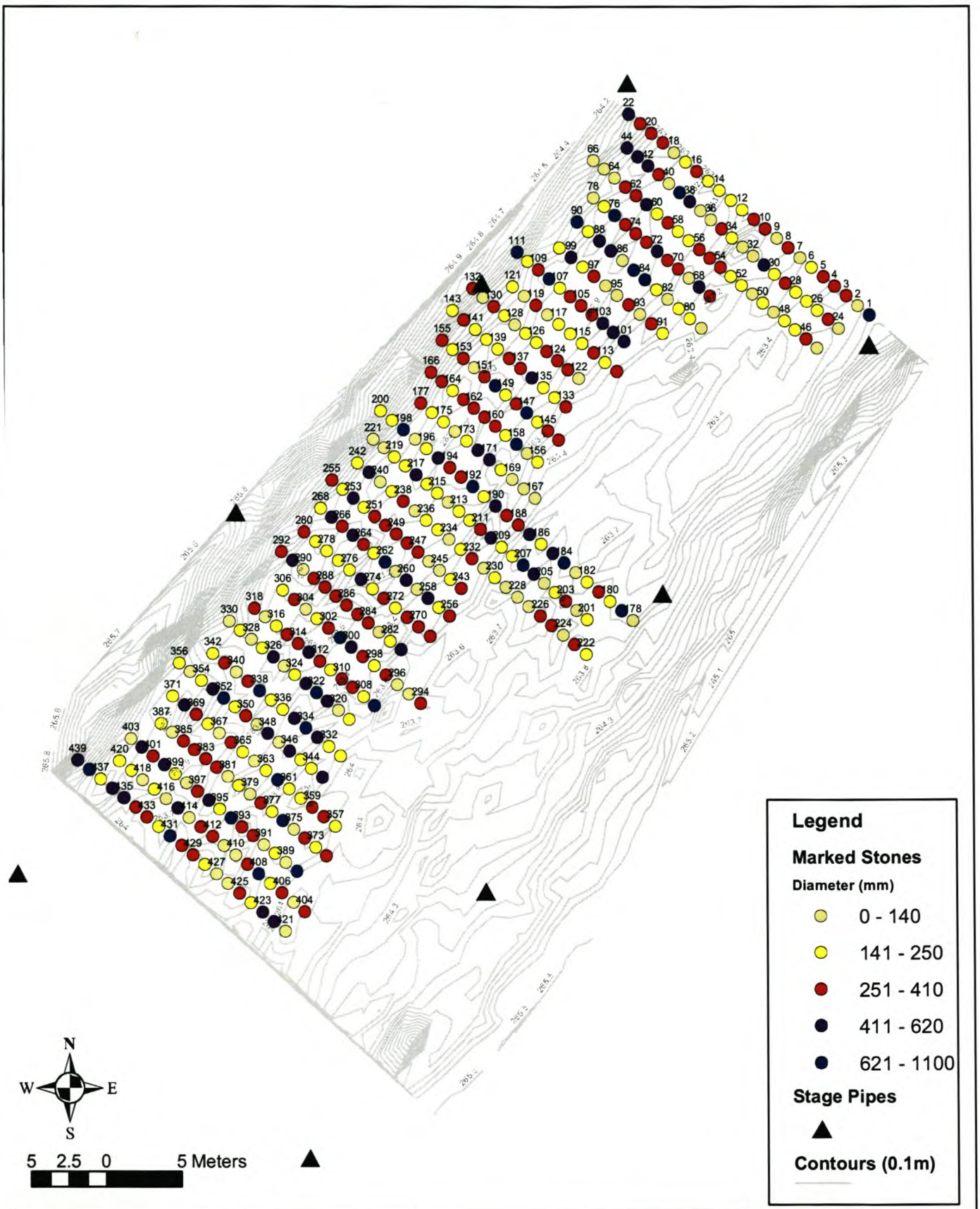
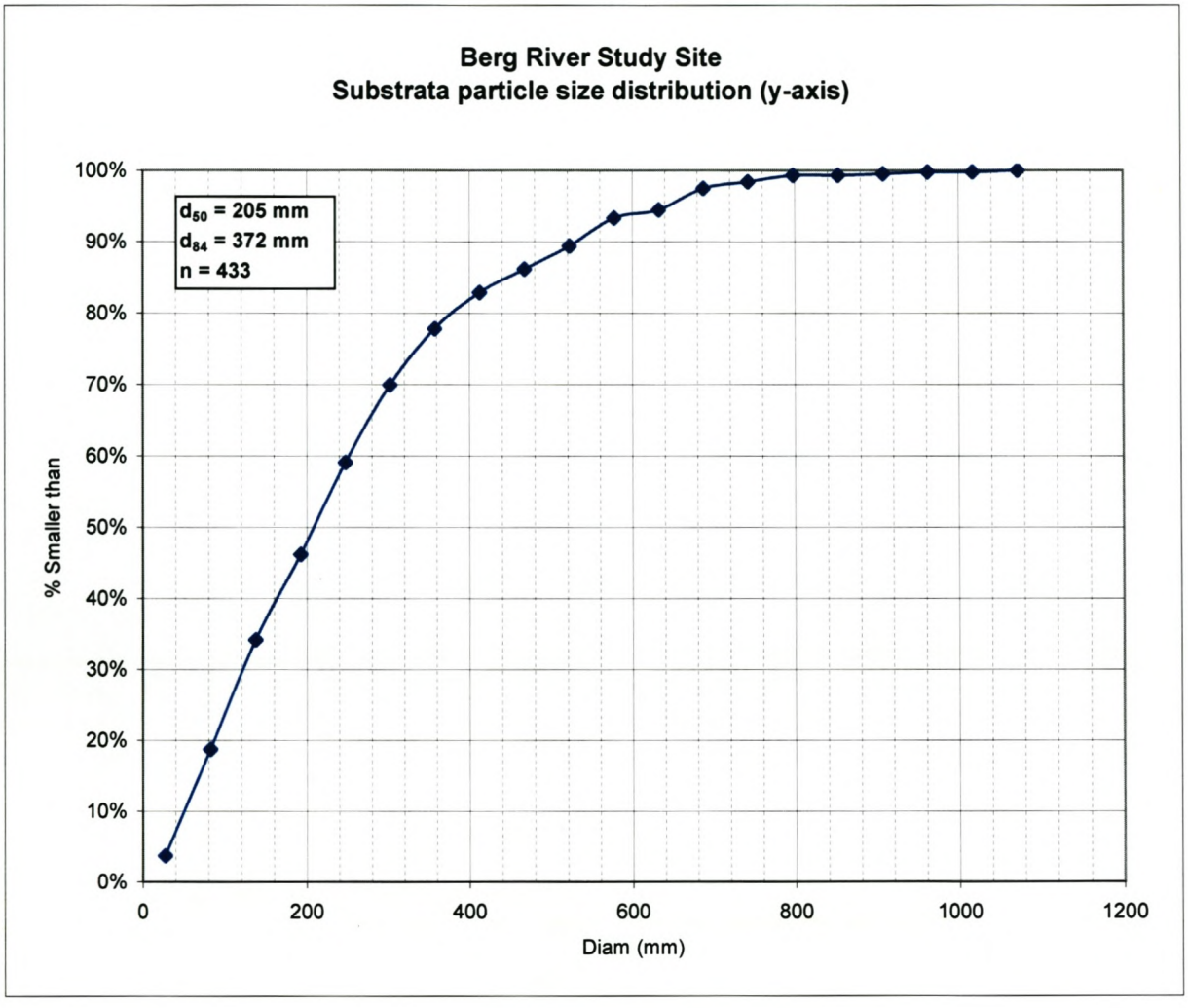


Figure A2b
Study Site Set Up
Berg River

WRC K5/1411
The Determination of Substrata Maintenance Flows in Cobble and Boulder Bed Rivers: Ecological and Hydraulic Considerations

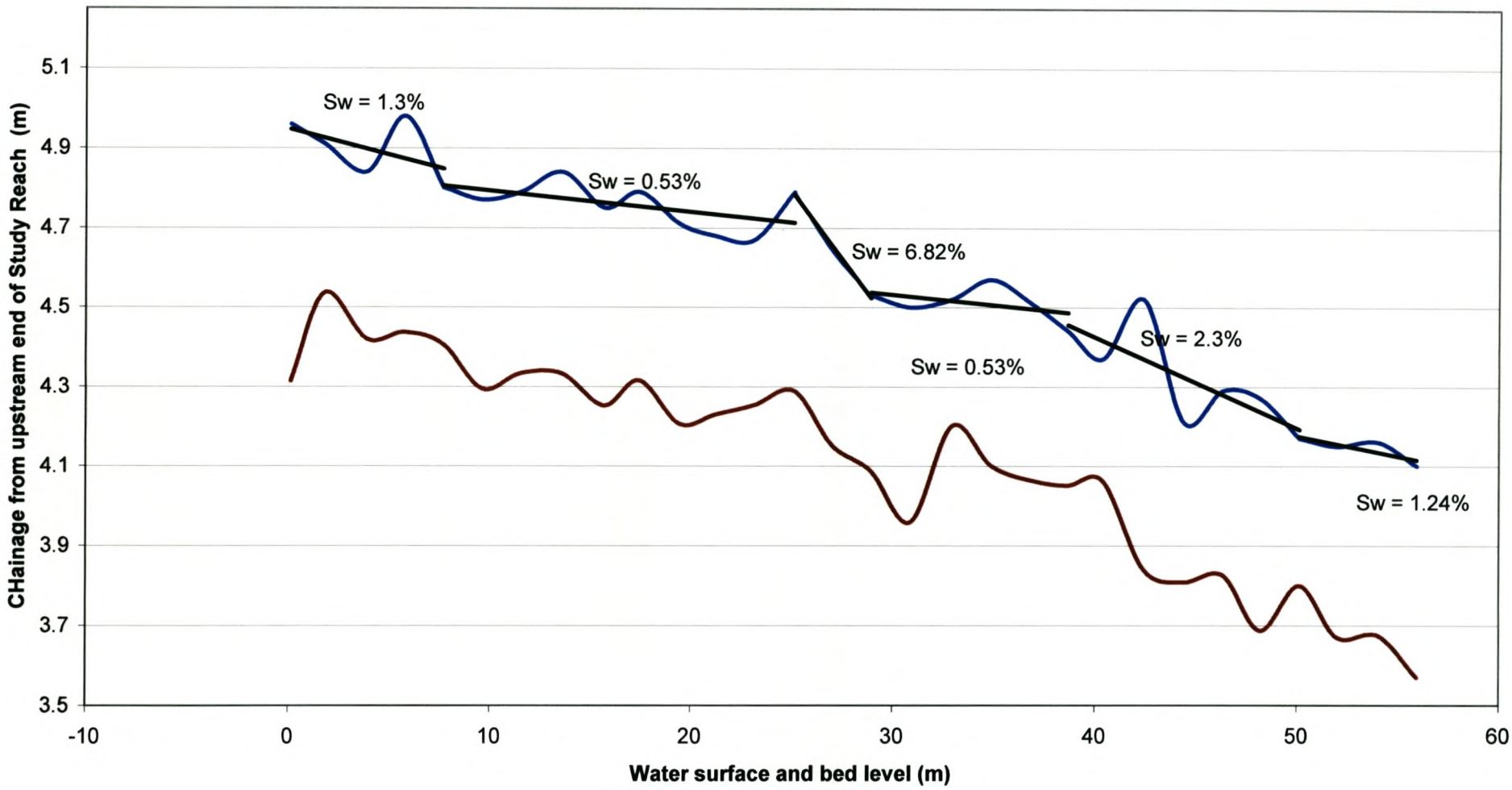
Water Research Commission

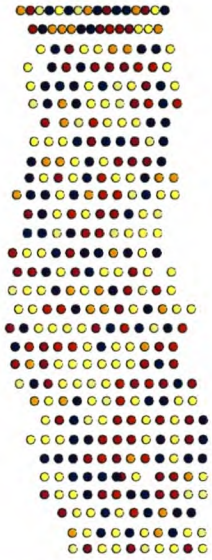
Figure A2c: Berg River Study Site: Partical Size Distribution



Appendix B: Base Flow Conditions

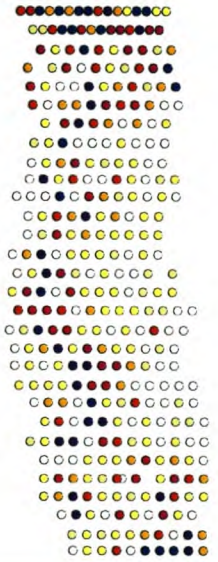
Figure B1a: Base Flow Water Surface Profiles Molenaars River Study Stie Initial Set up 2003
Low flow water surface profile





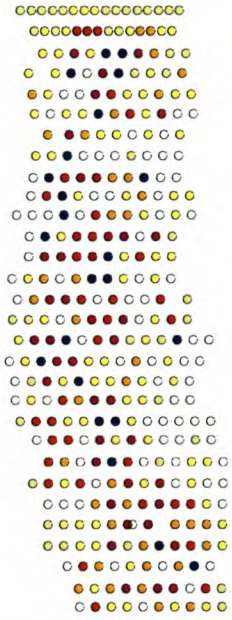
Diameter (mm)

- 0 - 85
- 86 - 142
- 143 - 197
- 198 - 246
- 247 - 294
- 295 - 365
- 366 - 450
- 451 - 560
- 561 - 690
- 691 - 870



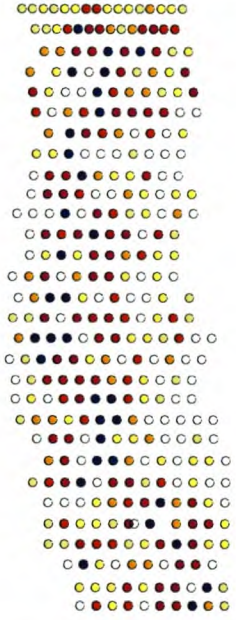
Depth (cm)

- 0 - 4
- 5 - 9
- 10 - 15
- 16 - 21
- 22 - 26
- 27 - 30
- 31 - 34
- 35 - 41
- 42 - 48
- 49 - 60



Velocity (m/s)

- 0.00 - 0.06
- 0.07 - 0.14
- 0.15 - 0.21
- 0.22 - 0.29
- 0.30 - 0.37
- 0.38 - 0.45
- 0.46 - 0.54
- 0.55 - 0.67
- 0.68 - 0.92
- 0.93 - 1.16



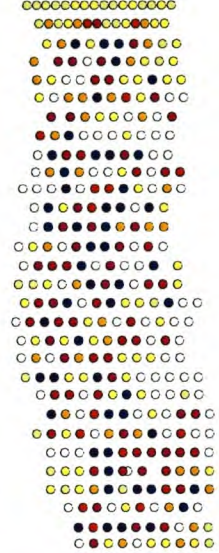
Depth x Vel (m2/s)

- 0.0000 - 0.0051
- 0.0052 - 0.0113
- 0.0114 - 0.0200
- 0.0201 - 0.0333
- 0.0334 - 0.0505
- 0.0506 - 0.0773
- 0.0774 - 0.1168
- 0.1169 - 0.1668
- 0.1669 - 0.2398
- 0.2399 - 0.5300

Figure B1b
Base Flow Conditions
Molenaars Study Site
2003

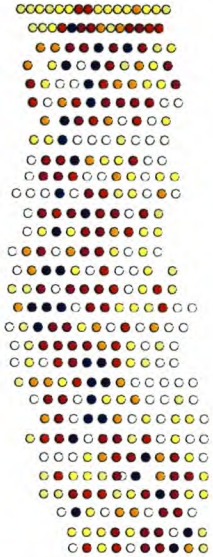
WRC K5/1411
The Determination of Substrata Maintenance Flows in Cobble and Boulder Bed Rivers: Ecological and Hydraulic Considerations

Water Research Commission



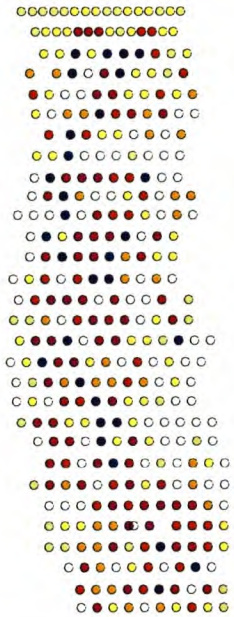
Froude No.

- 0.0000 - 0.0301
- 0.0302 - 0.0718
- 0.0719 - 0.1158
- 0.1159 - 0.1668
- 0.1669 - 0.2216
- 0.2217 - 0.2770
- 0.2771 - 0.3355
- 0.3356 - 0.4358
- 0.4359 - 0.7804
- 0.7805 - 1.4735



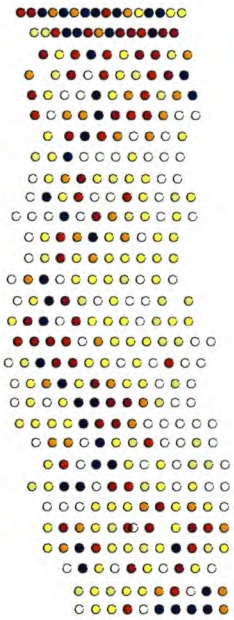
Reynolds No.

- 0 - 4323
- 4324 - 9947
- 9948 - 17500
- 17501 - 29193
- 29194 - 44289
- 44290 - 67807
- 67808 - 102421
- 102422 - 146316
- 146317 - 210316
- 210317 - 464912



Stream Power

- 0.0000 - 5.2307
- 5.2308 - 12.5293
- 12.5294 - 19.0981
- 19.0982 - 27.0050
- 27.0051 - 35.6417
- 35.6418 - 47.4412
- 47.4413 - 60.9376
- 60.9377 - 81.0149
- 81.0150 - 112.2774
- 112.2775 - 141.1070



Bed Shear Stress

- 0.0000 - 0.4960
- 0.4961 - 1.1160
- 1.1161 - 1.8600
- 1.8601 - 2.6040
- 2.6041 - 3.2240
- 3.2241 - 3.7200
- 3.7201 - 4.2160
- 4.2161 - 5.0840
- 5.0841 - 5.9520
- 5.9521 - 7.4400

Figure B1c
Base Flow Conditions
Molenaars Study Site
2003

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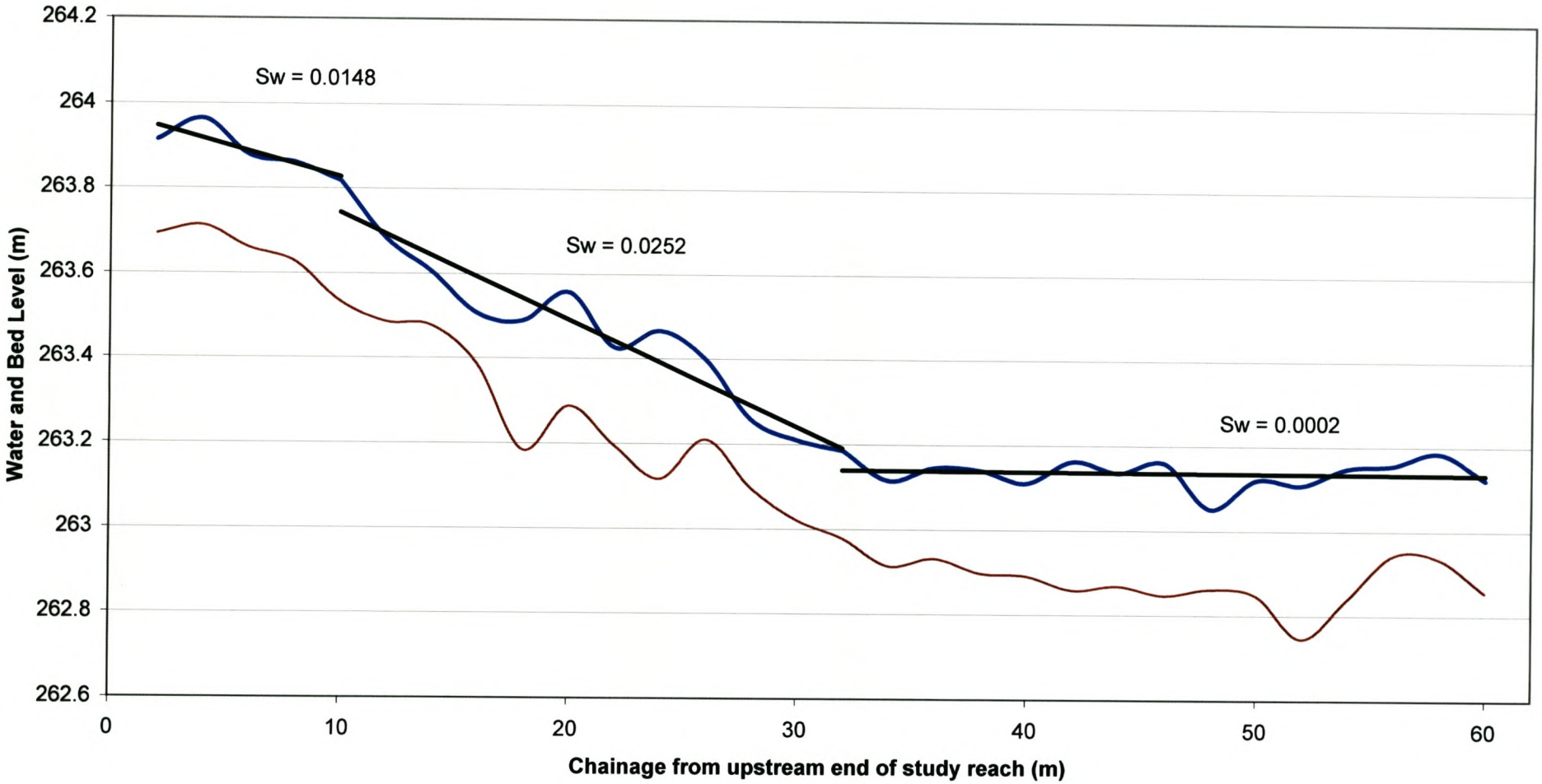
Figure B2a:Average Base Flow Water Level
Berg River Study Site
Initial Set Up

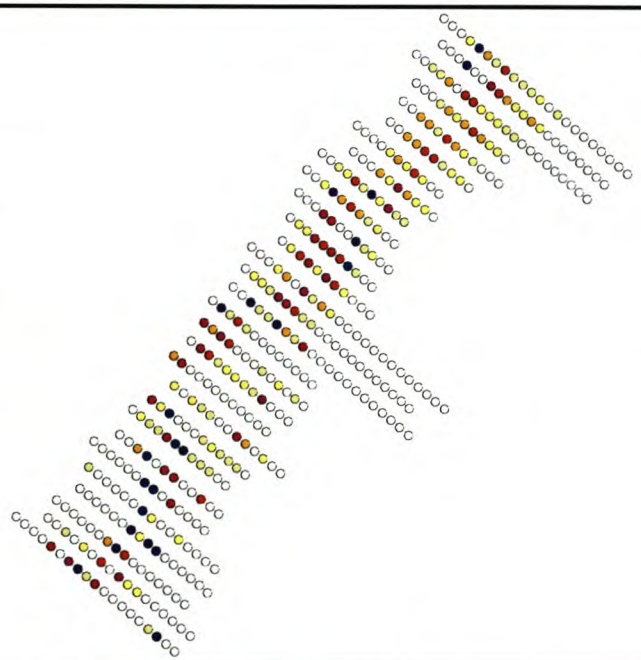


Diameter (mm)

- 0 - 75
- 76 - 130
- 131 - 190
- 191 - 250
- 251 - 315
- 316 - 385
- 386 - 485
- 486 - 600
- 601 - 780
- 781 - 1100

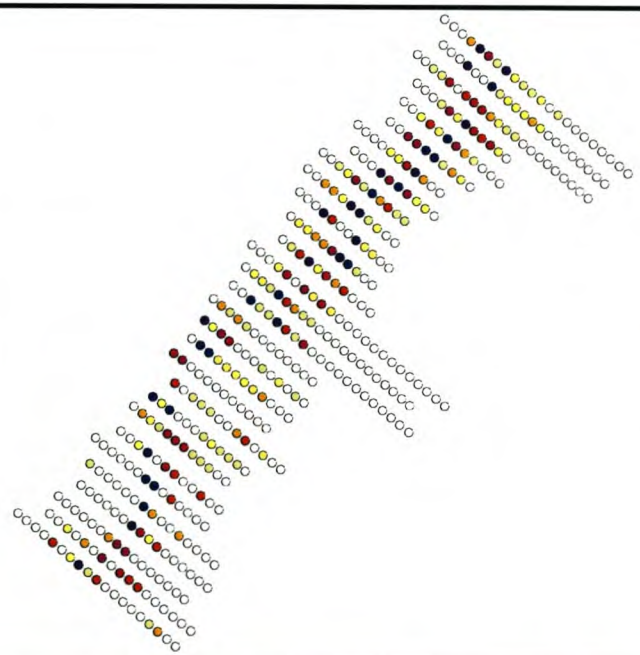
Depth (cm)

- 0 - 3
- 4 - 6
- 7 - 9
- 10 - 12
- 13 - 16
- 17 - 20
- 21 - 25
- 26 - 30
- 31 - 36
- 37 - 50



Velocity (m/s)

- 0.00 - 0.03
- 0.04 - 0.08
- 0.09 - 0.14
- 0.15 - 0.19
- 0.20 - 0.25
- 0.26 - 0.33
- 0.34 - 0.40
- 0.41 - 0.50
- 0.51 - 0.60
- 0.61 - 0.78



Depth x Vel (m2/s)

- 0.000 - 0.002
- 0.003 - 0.006
- 0.007 - 0.012
- 0.013 - 0.018
- 0.019 - 0.026
- 0.027 - 0.036
- 0.037 - 0.050
- 0.051 - 0.073
- 0.074 - 0.101
- 0.102 - 0.161

Figure B2b
Base Flow Conditions
Berg River Site
2004

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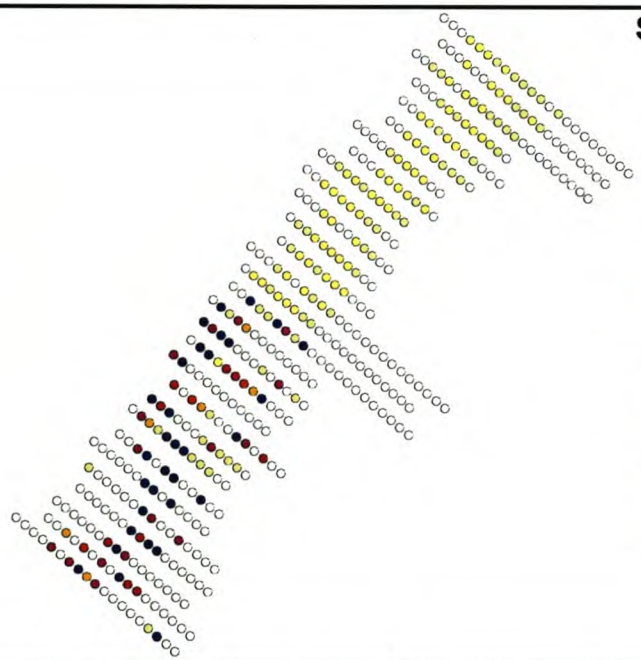
Froude No.

- 0.0000 - 0.0171
- 0.0172 - 0.0531
- 0.0532 - 0.0939
- 0.0940 - 0.1440
- 0.1441 - 0.1999
- 0.2000 - 0.2737
- 0.2738 - 0.3725
- 0.3726 - 0.5268
- 0.5269 - 0.7024
- 0.7025 - 1.2452

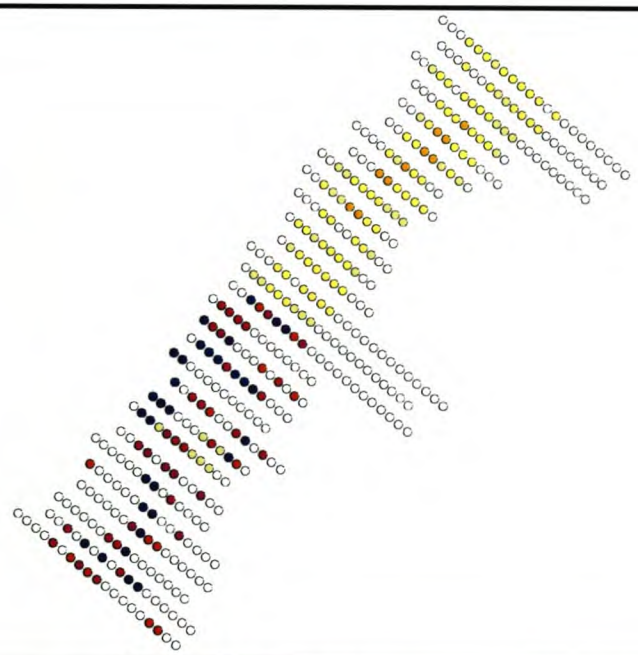
Reynolds No.

- 0 - 2105
- 2106 - 5614
- 5615 - 10526
- 10527 - 16140
- 16141 - 23158
- 23159 - 31579
- 31580 - 43860
- 43861 - 63860
- 63861 - 88421
- 88422 - 141228



Stream Power

- 0.00 - 0.21
- 0.22 - 0.68
- 0.69 - 2.47
- 2.48 - 7.40
- 7.41 - 12.34
- 12.35 - 24.67
- 24.68 - 52.43
- 52.44 - 81.42
- 81.43 - 115.96
- 115.97 - 192.45



Bed Shear

- 0.000 - 0.015
- 0.016 - 0.036
- 0.037 - 0.061
- 0.062 - 0.089
- 0.090 - 0.742
- 0.743 - 1.761
- 1.762 - 2.767
- 2.768 - 4.527
- 4.528 - 8.048
- 8.049 - 12.576

Figure B2c
Base Flow Conditions
Berg River Study Site
2004

WRC K5/1411
The Determination of Substrata Maintenance Flows in Cobble and Boulder Bed Rivers:
Ecological and Hydraulic Considerations

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Appendix C: Field Notes from Flood Event Data Collection

MOLENAARS RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE 2003

First season set-up stone data - June 2004

riginal set-up stone data - 9-14 June 2003

	Offset from 0	stone no.	invert sample	Putty Magnt Koki	description	hydraulic shelter	flow type	Stone Categories	Stone x (mm)	Stone y (mm)	Stone z (mm)	revs / 60 sec (mini)	depth (cm)	Velocity (m/s) From rating tables	none: movement post flood of July 9-10; field visit 13 July	7 moved: movement post flood of July 18-19; field visit 24 July	2 moved: movement post flood of July 24-25; field visit 27 July	10 moved: movement post flood of July 30-Aug 1; field visit 3 + 6 Aug	26 moved: movement post flood of Aug 8-10; field visit 16 Aug	115 moved: movement post flood of Aug 17-25 (to peaks); field visit 31 Aug
1	8	1	no	(P)	Immovable Boulder	veg. Overhang	rsf	MB		570		(maxi)	11	0.013						
1	9	2	full samp	M	invert sample white&red stone	u/str +d/str	rsf	LC	175	165	114	(maxi)	10	0.062						
1	10	3	no	(P)	smooth immovable orange boulder		rsf	SB		410		(maxi)	58	0.026						
1	11	4	full samp	M	white&red stone	u+d/str	rsf	LC	245	245	145	(maxi)	60	0.051						
1	12	5	no	(P)	Immov.LargeBoulder with hollow eyes; overlapping #6		rsf	MB		710		(maxi)	10	0.051						
1	13	6	no	(P)	Immov. Adjacent stone #5	imbedded h+rh	rsf	MB		660		(maxi)	18	0.051						
1	14	7	full samp	M		in B field,but not immed	rsf	SB	274	380	215	(maxi)	41	0.026					[illegible]	
1	15	8	no	P	Immov. Its pt lands on d/str edge of golden B	u/str hs	bpf	MB		680		(maxi)	25	0.026						
1	16	9	full samp	P	grey round stone	u/str hs	rsf	LC	220	220	186	(maxi)	48	0.073						[illegible]
1	17	10	full samp	M	small and grey stone, betw LCs	u/str + d/str hs	rsf	SC	129	70	165	(maxi)	50	0.084				[illegible]	[illegible]	OUT
1	18	11	no	P	Immovable-mottled light cream irreg		rsf	MB		605		(maxi)	17	0.073						
1	19	12	full samp	M			rsf	LC	244	156	105	(maxi)	51	0.039						[illegible]
1	20	13	no	P	Immovable		rsf	MB		690		(maxi)	17	0.026						
1	21	14	full samp	M		u/str hs	bpf	CG	126	52	51	(maxi)	50	0.013						OUT
1	22	15	full sample	M			nf	SB	350	305	150	(maxi)	30	0.000						
1	23	16	sample = top surface + overlying sand	M	stone embedded	embededded in sand immov. B.	nf	LC	300	235		(maxi)	26	0.013						
2	9	17	full samp	M		u/str hs	bpf	LC	230	214	117	25	32	0.133						
2	10	18	full samp	M			rsf	LC	167	150	83	21	32	0.113						
2	11	19	full samp	M		u/str d/str hs	rsf from sbt	SC	163	123	65	51	40	0.263						
2	12	20	no	P	immovable;2 blobs; may be a bit out of horizontal line		rsf	SB		450		50	23	0.257						
2	13	21	full samp	M		u+d/str hs	rsf	SB	355	316	163	13	32	0.073						
2	14	22	no	P		u/str hs	bpf	SB		285		2	32	0.015						
2	15	23	no	P	golden B with white eye, u/str of emergent lichen B	d/str lichen B hs	upwell against lichen B	SB		405		9	51	0.053						
2	16	24	no	P	crack in top		rsf	MB		650		69	18	0.350						
2	17	25	no	P	large B,mottled brownish,adjacent to golden B with lines		rsf	MB		520		67	30	0.340						
2	18	26	full samp	PM			rsf	LC	309	236	135	68	54	0.345						[illegible]
2	19	27	no	P	whitish angular - small but lodged	u/str + d/str hs	bpf	LC		230		15	48	0.083						
2	20	28	full samp	P	under emergent B	u+d/str hs under emergent B	bpf	LC	248	245	105	8	26	0.048						
2	21	29		P	overlapped by u/str sB	u/str hs	rsf	SB		500		14	3	0.078						
2	22	30	full samp	P-off	round, putty no magnet (too big)		nf	SB	328	310	188	0	1	0.000						
3	8	31	full samp	PM	orange + whitye; under isolepis	isolepis	flow thro veg	SC	155	115	89	11	18	0.063						
3	9.5	32	no	P	golden oval boulder		rsf	MB		605		0	1	0.000						
3	11	33	no	P	flattish, golden with few small cracks		rsf	SB		500		44	27	0.227						
3	12.5	34	full samp	M	reddish		rsf out of bsw	LC	234	206	154	106	34	0.536						OUT
3	14	35	full samp	M	partially overlapped by Red x Boulder	u/str hs	chure	LC	367	225	164	117	14	0.591						
3	15.5	36	full samp	M	reddish	u/str hs LC emergent B u/str	bsw	LC	170	130	67	162	24	0.813						[illegible]
3	17	37	full samp	M	sub triangular	under gold with eye u/str hs	bpf	LC	193	168	115	21	48	0.113						
3	18.5	38	no	m	immovable whitish gold, triangular		rsf just d/str of usw	SB		419		100	22	0.506						
3	20	39	no	P	orange x Boulder on subm. Portion of putty on u/water bit		rsf	MB		750		30	14	0.157						
3	21.5	40	full samp	M	in crevice between 2 B	u/str + d/str hs	rsf	LC	205	158	135	13	34	0.073						
4	8.5	41	inv = up stone surf	M	took inverts only from surface Immovable smallish whitish gold embedded under grass		rsf	LC		192		45	44	0.232						
4	10	42	full samp	P	whitish flat face	u|str h|son one side	bpf	LC	290	250	80	6	34	0.038				[illegible]	[illegible]	[illegible]
4	11.5	43	full samp	P	flat stone	ut d|str hs	bpf	SB	303	282	120	18	24	0.098						[illegible]
4	13	44	no	P	oval orange in Boulder in B clump d/str of emergent B w lichen;	u|str hs =lichen B	rsf	SB		400		10	2	0.058						
4	14.5	45	no	P	next to very large white/gold B. Motttled brown w ridge on LHS		rsf	SB		425		120	12	0.606						
4	16	46	no	P	Golden; Long oval with two riders		rsf to bsw	SB		300		93	26	0.471						
4	17.5	47	no	P	next to Large B; Brownish B.with tip emerging		dry, bsw around	MB		585		0	dry	0.000						
4	19	48	full samp	P	Large brown, pear shaped, 2spots putty 'cos too big		bsw	SB	500	342	185	110	28	0.556						
4	20.5	49	no	P	brown triangular, d/str of emergent B	u|str hs =B	rsf	SB		473		38	4	0.197						
4	23	50	full samp	M	angular stone, narrow side faces upward	ustr hs =sB	rsf	LC	196	130	63	33	17	0.172						
5	8	51	full samp	M	white stone with red underneath; embedded along long axis + narrow side upward		rsf fast	LC	269	150	87	38	52	0.197						
5	9.5	52	no	P	golden oval B; w u|str LC&B,but not as big,just sitting on top of bed	u|str C + B	rsf	MB		570		22	16	0.118						
5	11	53	no	P	flat; overlaped u|str+d|str	u|str + d|str	rsf	SB		395		49	2	0.252						
5	12.5	54	full samp	M	reddish, small, in small space between 2 stones	d|str h|s	rsf	SC	163	106	71	22	26	0.118		[illegible]				OUT
5	14	55	full samp	M	small, on gravel, u|str h|s is to one side+ partly exposed	partial u|str h|s	rsf	SC	115	73	64	19	21	0.103					[illegible]	OUT
5	15.5	56	no	P	large round B with eyes +holes	u|str hs-B field	rsf to bsw	MB		736		62	14	0.315						
5	17	57	full samp	M	grey, in depression all round	hs all round but large B,only d|str hs=B	rsf	LC	201	170	167	96	36	0.486						OUT
5	18.5	58	no	P	Emergent Brown B.	u|str hs=B	upwell betw 2B	MB		510		0	dry	0.000						
5	20	59	no	P	very Large white B with lichen	emergent		MB		780		0	dry	0.000						
5	21.5	60	no	P	submerged gold B d|str of emergent red B	u|str+lateral hs	upwell into rsf	MB		501		17	10	0.093						
5	23	61	full samp	M	grey		rsf	LC	270	160	138	48	27	0.247						
R6	8	62	full samp	K	on bed of moss /roots+isolepis; few lichen spots;grey	u|str + lat hs	nf	SB	423	271	193	0	emerg	0.000						
R6	9.5	63	no	P	emergent round white +orange B w fissures	u|str B but smaller	rsf around stone	MB		795		0	emerg	0.000						
R6	11	64	full samp	M	off round; brown		bsw|rsf	SB	306	251	163	80	19	0.405						
R6	12.5	65	no	P	submerged grey	overlap LHS+RHS	rsf to bpf	SB		415		37	28	0.192						
R6	14	66	full samp	P	white SC, part embedded under LC	overlap u|str by LC/SB	rsf to bpf	SC	110	65	35	67	26	0.340						OUT
R6	15.5	67	full samp	P	greyish veined	d|str B	frf	SC	134	110	70	51	32	0.263						[illegible]
R6	17	68	full samp	P	brownish	none	bsw to frf	LC	259	197	140	131	36	0.666					[illegible]	
R6	18.5	69	no	P	large greenish yellowish white flattish top		bsw to rsf	SB		490		37	18	0.192						
R6	20	70	full samp	P	no magnet-too large to move out	slightly larger stone ,d|str	rsf-bpf	SC		220		35	18	0.182					[illegible]	[illegible]
R6	21.5	71	no	K	emergent white boulder	lodged against stack	bsw u|str	MB		510		0	dry	0.000						
R6	23	72	full samp	P	LG tucked under LHS of round orange LC	d|str B+ overlap LC	rsf around stone	CG	70	50	41	30	25	0.157						OUT
R7	10	73	inv = sa net	M	large Golden embedded B	none	rsf	MB		805		36	5	0.187						
R7	11.5	74	no	P	Large rectangle that surf emergent; light brown	none	rsf around #74	MB		540		0	emergent	0.000						
R7	13	75	full samp	M	whiteish grey,half moon	B d|str=hs	rsf	LC	225	136	109	38	20	0.197						OUT
R7	14.5	76	bottom sa only	M	dry stone w/ flow u/ neath only rectangle	expossed but at d|str end of B feeld	rsf under #76	LC	220	168	136	0	emergent	0.000				[illegible]		OUT
R7	16	77	full samp	M	brownish semi oval	ditto	rsf	SC	168	118	73	30	19	0.157		[illegible]			[illegible]	OUT
R7	17.5	78	no		immovable; pinned all around by stones, Green to wh. R	u+d/str 1c+ B=hs	bsw	LC		250	29	29	24	0.153						
R7	19	79	full samp	M	long axis perpendicular to current - dark grey d/str dogs orange LC	slight - ic u|str hs+B ro rt d/str	bsw	SC	190	71	62	53	38	0.273						
R7	20.5	80	full samp	M (# on dstr side	white to green stone,orange d/str sB,small orange B; part of # off; big, u/str flat submg orange B which is adj to emerg LB	none	bsw	LC	271	235	172	105	28	0.531						OUT
R7	22.5	81	full samp	P	large orange LC too big to move	none	rsf	SB	528	357	238	55	10	0.283						[illegible]
R8	11	82	no	Paint+ K	write on koki + paint; emergent pyramid shape	u|str hs=b grass dump	rsf	MB		628		0	dry	0.000						

riginal set-up stone data - 9-14 June 2003

	Offset from 0	stone no.	invert sample	Putty Magnt Koki	description	hydraulic shelter	flow type	Stone Categories	Stone x (mm)	Stone y (mm)	Stone z (mm)	revs / 60 sec (mini)	depth (cm)	Velocity (m/s) From rating tables	none movement post flood of July 9-10; field visit 13 July	7 moved movement post flood of July 18-19; field visit 24 July	2 moved movement post flood of July 24-25; field visit 27 July	10 moved movement post flood of July 30-Aug 1; field visit 3 + 6 Aug	26 moved movement post flood of Aug 8-10; field visit 16 Aug	115 moved movement post flood of Aug 17 25 (to peaks); field visit 31 Aug
:8	12.5	83 24, 27 jul	full samp	PM	white. irreg shape sc		bsw	SC	115	90	47	3	34	0.023		TO	TO		OUT	New stone
:8	14	84	full samp	K+P	portion of stone out of water at edge of B clump	overlapped u/str by sb	chute to bsw	SB	436	380	238	0	just emerge nt	0.000						OUT
:8	15.5	85	no	P	large, white submerged in B field wth grey veins	2 u/str B forming chute,+iat hs	frf out of bsw	MB		637		7	8	0.043						
:8	17	86	no	K	large, reddish in lichen	LB overlaps on lhs	rsf under #86	MB		798		0	dry	0.000						
:8	18.5	87	no	P	orange ovalish w planes in splash zone	overlapped on rhs by LB	bsw around #87	SB		410		0	dry	0.000						
:8	20	88	no	K	golden, protruding at angle with scratches	u/str smaller but overlap	#88 = barrier to flow; chutes around	MB		763		0	emerge nt	0.000						
:8	21.5	89	full samp	m	suboval brownish with black bits - hard to see - paint splotch just u/str of emergent red gold B	d/str B lhs	bsw rapid	LC	243	185	123	212	50	1.060						OUT
:8	23	90	full samp	M	greyish, round but flat	u/str B=hs	rsf	SC	130	125	55	24	6	0.128						
:8	24.5	91	full samp	M	dark brown overlapped+ Wedged in by square-ish white, veined lc	u/str & d/str B=hs	rsf	LC	228	184	113	26	4	0.138						OUT
:9	12	92	no		large oval creamy with lichen spots	u/str B group	rsf around #92 (edge of run)	SB		460		0	dry	0.000						
:9	13.5	93	no	P	reddish with patcy white + little lichen, squareish	mid cascade	bsw breaking over #93	SB		385		0	<1cm	0.000						
:9	15	94	inv = sa net	P	oval white B sampled surface area only - submerged	d/str B's on either side	chute sideways over B	SB		435		143	8	0.726						
:9	16.5	95	full samp	P M K	flat oval tilted at angle;light brown		rsf	SB	436	304	110	46	6	0.237						
:9	18	96	full samp	M	red + cream, notch on upper surface,just u/str of lichen	d/str hs=B emergent	bsw to rsf	LC	257	196	168	48	4	0.247						
:9	19.5	97	no	P	submerged Red/Brown B with small eyes, adjacent 2 emergent B's on RHS	none	rsf	MB		501		80	6	0.405						
:9	21	98	full samp	M	just d/str+right of B with eyes	hs=u/str emergent B	bsw	LC	226	159	15	97	32	0.491						OUT
:9	22.5	99	full samp	P M K	brown oval, just u/str slightly emergent B	hs=d/str B + u/str sb	bsw	LC	403	223	208	67	18	0.340						
:9	24	100	full samp	P M K	oval; light brown, flattish face up, long if axis parallel to current	at bottom clute no hs	chute to bsw	LC	319	238	168	110	10	0.556						
:9	25.5	101	no	K	blockish emergent cream with lichen	in b. field,but smaller +=hs	trickle thro packed lc+sb	SB		465		0	dry	0.000						
:10	11.5	102	no	P	golden irregular + flat planes	embedded+sb overlap u/str=hs	rsf	LC		237		34	8	0.177						
:10	13	103	inv = 1/2 tot stone area	P	triangular with flat surface; immovable but not imbedded		rsf	LC		235		33	4	0.172						
:10	14.5	104	no	K	whitey cream with dry moss, emergent roundish triang B	N B field + SB on top=hs	in dry bed	SB		468		0	dry	0.000						
:10	16	105	full samp	M	small orangey wedged between 2B-one with orange X	d/str+iat B's=hs	chute	SC	142	127	115	47	8	0.242						TO
:10	17.5	106	full samp	M	just d/str brown round B with 2 eyes just emergent	d/strB=hs + u/str sb		LC	164	148	67	24	26	0.128						
:10	19	107	full samp	PMK	u/str of large emergent B with holes	d/str B = hs	rsf from bsw	SB		280		0	emerge nt	0.000						
:10	20.5	108	no	K	flat round medium brown B d/str of emergent B+- 30cm u/str	u/str B=hs	dry but rsf around	MB		630		0	dry	0.000						
:10	22	109	full samp	M	mc	d/str = 2 sb=+-hs	rsf	LC	186	161	124	36	24	0.187		TO				OUT
:10	23.5	110	no	P	sub circular, submerged, with "face" from crevices looking d/str	overlap u/str by same size LC / SB =hs	fast rsf- nearly bsw	SB		415		123	14	0.621						
:10	25	111	full samp	M	orange rounded rectangle flat face looking up perpendicular to flow (long-axis)	no hs	rsf	LC	295	156	86	58	38	0.298						
:10	26.5	112	no	K	emergent whitish reddish elongated B	d/str LC = hs (smaller,but wedged)	vsf around	MB		528		0	dry	0.000						
:11	12	113	inv = bottom sa; sewage fung	M	emergent in stagnant water+isolepis	huge B u/str=hs	nf	LC	214	146	91	0	dry	0.000						
:11	13.5	114	full samp	M	elongated long oval with flat surface	u/str gold B=hs	rsf	SC	189	101	77	37	15	0.192						OUT
:11	15	115	no	K	huge lichen boulder	makes B field	tr thro' B field	MB		870		0	dry	0.000						
:11	16.5	116	full samp	M	small flat	d/str+u/str lc=hs	bpf	SC	116	83	61	14	10	0.078						OUT
:11	18	117	full samp	M	Rhomboid, grey upper surface, just protruding with eye on side	d/str B=hs	rsf	SB	320	294	159	44	2	0.227						OUT
:11	19.5	118	no	P - 2 blobs	flat round, orange-greenish, overlapped by u/str lc +on LHS by gold SB w chip	overlap u/str LC=hs	rsf	SB		290		47	16	0.242						
:11	21	119	full samp	M	white rectangular, flat face with red splotsh on u/str end.	d/str B = hs	rsf	LC	311	214	136	58	28	0.298						
:11	22.5	120	no	K	tape catches u/str edge of MB; emergent, oval,flat, whitish red. #120 overlaps the d/str B, but it still acts as hs 'cos angle	d/str B = overlap	rsf around B	MB		590		0	dry	0.000						
:11	24	121	full samp	M	round flat orange LC on rt of emergent orange/gold B	not much, u/str flat sb	deep rsf	LC	210	185	94	166	42	0.833						
:11	25.5	122	no	K	large emergent B(reddish white) with lichen at edge	u/str B line = hs	rsf around #122	MB		535		0	dry	0.000						
:11	27	123	no	K	large white B, some lichen	hs=u/str B	rsf around #123	MB		620		0	dry	0.000						
:11	28.5	124	inv = sa bottom and sides	M	while flat oval, top emergent	hs=B side	nf	LC	315	209	97	0	emerge nt,lappi ng water	0.000						
:12	14	125	full samp	M	tiny flat; to rt of stone marked by Verno; just d/str + betw 2 lichen Bs	u/str+d/str hs = emergent B	rsf	SC	76	65	42	10	7	0.058						OUT
:12	15.5	126	full samp	M	tiny round greeny,overlaped by lc	u/str+d/str hs = emergent B +emergend lc	rsf	SC	115	94	81	96	13	0.486		TO			TO	OUT
:12	17	127	no	K	large emergent lichen B in B field	B field = hs	tr under B	MB		590		0	dry	0.000						
:12	18.5	128	no	P	greenish submerged +overlaped	B u/str +d/str = hs	rsf to usw	SB		300		100	16	0.506						
:12	20	129	full samp	PMK	yellow brown large flat oval deeply submerged flat surface. No paint; # off but 2 blobs	no hs really	rsf	SB	450	429	180	85	14	0.431						
:12	21.5	130	inv = area of triang sides 14 cm	P	grey, deep, adjacent to emergent orange B -immovable slight white patch	orange B to side = hs embedded	rsf	LC		190		66	38	0.335						
:12	23	131	full samp	M	flat orange oval slightly overlapped by u/str green mc; # underneath-ish	no real hs	bsw to rsf	SB	393	292	100	86	20	0.435					OUT	new stone
:12	24.5	132	full samp	M	orange, flat, narrow side-up,makes line between 2 B's to RHS	B's to RHS provide u+d/str hs	circling flow on side of usw + bpf	LC	302	184	82	27	24	0.143						TO
:12	26	133	no	P- off	round green, large flat surface with natural white marks across	no hs	bsw + rsf	MB		550		193	12	0.973						
:12	27.5	134	no	K	oval orange + lichen, emergent	mid B field = hs	dry in b/w	SB		375		0	dry	0.000						
:13	14	135	full samp	M	reddish angled with crevices partly embedded under golden tree ring boulder	lc + sb u/str + d/str=hs	rsf	LC	213	183	116	19	7	0.103						
:13	15.5	136	full samp	M	brown, half oval, flattish sides angled nearby under lichen boulder with 3 large eyes+tuft of moss	B d/str + lc u/str	rsf	SC	161	110	54	26	8	0.138						
:13	17	137	full samp	M	small flat white rectangle; flat on bed	no hs	rsf	LC	175	131	60	66	13	0.335						OUT

riginal set-up stone data - 9-14 June 2003

	Offset from 0	stone no.	invert sample	Putty Magn t Koki	description	hydraulic shelter	flow type	Stone Categories	Stone x (mm)	Stone y (mm)	Stone z (mm)	revs / 60 sec (mini)	depth (cm)	Velocity (m/s) From rating tables	none movement post flood of July 9-10; field visit 13 July	7 moved movement post flood of July 18-19; field visit 24 July	2 moved movement post flood of July 24-25; field visit 27 July	10 moved movement post flood of July 30-Aug 1; field visit 3 + 6 Aug	26 moved movement post flood of Aug 8-10; field visit 16 Aug	115 moved movement post flood of Aug 17 25 (to peaks); field visit 31 Aug
13	18.5	138	full samp	PM	firmly wedged between 2 emergent boulders on u/str +d/str sides, sub oval (too small to drill)	2B=hs(wedged)	bsw	CG	112	58	41	34	15	0.177						OUT
13	20	139	full samp	PMK	light brown, large cobble,semi-oval, flat slightly pointed ,long axis perpendicular to flow,pointed end d/str, u/str lc slightly overlaps #139 (too big to bring out)	semi hs by same size u/str lc	rsf	SB	385	325	205	225	8	1.130						OUT
13	21.5	140	inv = 1/2 surf area stone	P	white, squareish, lots of ridges on surface; some gold, overlaped by other cobbles (immovable)	overlaped on u/str + both sides = hs	rsf	SB	335	305	190	79	17	0.400						
13	23	141	full samp	PM 2 blobs	large oval, bright orange, flat surface up (to big to bring out)	no hs immed u/str	bsw	SB	475	460	420	67	5	0.340						
13	24.5	142	full samp	PM	(too small to drill) small rectangle, wedged between 2 lc's (in crevice), long axis into bed; betw striated B and greeny B, all submergd	in "hole" = hs	chute	SC	120	66	42	101	30	0.511						
13	26	143	no	P	light gold fat, rounded end u/str, rounded point d/str	no hs	sheet flw, bsw on sides	MB		590		74	2	0.375						
13	27.5	144	no	K	blockish, red, emergent creviced	partially wedged by smaller d/str B=hs	dry, rsf under Bs	MB		740		0	dry	0.000						
14	14	145	no	K	suboval,sticking out of water at angle; lichen spots + 2 eyes on side	overlapped by stacked B u/str=hs	shallow rsf around #145	SB		490		0	dry	0.000						
14	15.5	146	full samp	M	flat round browny-red, flat face up; adjacent triangul LC = just emergent	B field to rt u/str=+-hs	rsf	LC	190	172	80	40	6	0.207						
14	17	147	no	K	light sb, bottom of long B field, overlapped u/str; emergent	B field = hs	bpf around #147	SB		455		0	dry	0.000						
14	18.5	148	full samp	M	white rectangular, flat face up, perpendicular to direction of flow	B field u/str but to left =+-hs	frf	LC	340	245	150	38	4	0.197						OUT
14	20	149	inv = sa net	P - off	oval orange, lighter on upstream surface, immovable stone (Putty gone but colouring clear)	no hs	usw to bsw	?MB		600		124	11	0.626						
14	21.5	150	inv = sa net	P	submerged large oval-ish with planes+ crevices	2B d/str =hs	sbt to bsw	MB		545		115	15	0.581						
14	23	151	no	P	rect-oval, reddish, scratchy surf 1/2 of it= u/str of large emergent lichen B	pinned by d/str B over1/2 length=hs	sbt	SB		340		57	8	0.293						
14	24.5	152	no	K	large lichen B with orange X well out of water	d/str of	sbt around #152	MB		705		0	dry	0.000						
14	26	153	full samp	M	flat rectangle, narrow side up, long axis perpendicular to current, just u/str of flat gold submerged	lc u/str + sb d/str = hs	sbt	SC	220	127	70	57	38	0.293						OUT
14	27.5	154	full samp	M	flat brown triangular among sc+mc, surrounded by sb's - all submerged	sb+lc u/str+sides = hs	rsf	LC	172	170	90	26	20	0.138						
14	29	155	no	K	white irregular shape, flat surface emergent amoung a cluster of lc's	overlap lc on side = hs	dry, nf around	SB		350		0	dry	0.000						
15	13	156	full samp	M	flat, reddish, small with planes+ridges Boulders d/str in shallow b/w	d/str B's=hs	nf in b/w	LC	158	137	70	4	4	0.028						OUT
15	15.5	157	full samp	M	rectangle, lodged between sb & lc, narrow side facing up stream, orangy brown	in hole of B=hs	bpf	LC	221	132	70	61	3	0.310						OUT
15	17	158	no	K	immovable, dry, oval, turd-shaped, creamy-red with thin veins	overlap B's in B field = hs	dry; trickle thro B field	SB		365		0	dry	0.000						
15	18.5	159	full samp	M	circular; flat with ridges on narrow part of stone facing up stream; only half emergent lodged d/str of lichen B with orange eggs	wedged between B=hs	none, nf under	LC	208	169	88	0	dry	0.000						
15	20	160	inv = 1/2 tot stone area	P	irregular shaped rectangle, in hole formed by 3 emergent lc & boulders, wobbly but not movable which means pinned down on sides(in tunnel)	tunnel of lc +B hs + on LHS	rsf bubbling up from B tunnel	LC	320	185	145	64	12	0.325						OUT
15	21.5	161	no	K	flat, irregular, with ridge & crevices	none	dry; rsf around	MB		722		0	dry	0.000						
15	23	162	no	P	triangular, whitish-red, submerged	none	rsf	SB		399		64	4	0.325						
15	24.5	163	full samp	M	triangular in profile, flat side up	none	rsf	LC	228	139	129	84	32	0.425						
15	26	164	inv = sa net	P	flat, deeply submerged, pear shaped, greenish pinned down by just emerg pinky B with arrow written on it	pinned +deep-lying =hs	rsf into swirling sbt	SB		494		88	36	0.445						
15	27.5	165	full samp	PM	deeply lying, round B- with flattish surface, pear shaped golden-red on top, red under ,next to large flat B. nearly emergent	side B = part hs	rsf	SB	463	346	230	55	8	0.283						
15	29	166	inv = excl 1/3 top sa	K	flat round sb, on edge of channel , b/w formed by boulders up stream ,just top emergent .	d/str+u/str B=hs	nf in b/w	SB	473	385	180	0	dry	0.000						
16	13	167	full samp	M	rect-oval browny fawn with ridges	u + d/str lc+sb=hs	bpf	LC	123	158	115	6	6	0.038						
16	14.5	168	inv = sa net?=top surf area?	PM	diamond shape ,overlapped by angled u/str LC	pinned by lc=hs	rsf	SB		349		61	14	0.310						
16	16	169	2/3 stone; top 1/3 = dry	PM	red semi rectangle sc in bed of sand	u/str+d/str B = hs in B field	bpf	SC	126	85	74	29	4	0.153						OUT
16	17.5	170	no	K	rocky red +pink, irregular, pinned by lichen B	in B field = hs	nf	SB		336		0	dry	0.000						
16	19	171	no	K	orange pear shaped, tip emergent	on edge of B field, wedged u/+d/str next to sb's	rsf	SB		460		94	10	0.476						
16	20.5	172	full samp	M	brownish oval - all adjacent = submerged	u/str sb = hs	rsf	LC	256	224	158	69	15	0.350						OUT
16	22	173	full samp	M	mottled grey granity oval next to red stone with white O in centre	d/str lc = hs	rsf	LC	202	129	119	85	14	0.431						OUT
16	23.5	174	full samp	M	pear shaped, greenish with flat top,"rings" of dark ,but faint ; a bit off the line at last sample but not recorded as moved....?	no real hs	rsf	LC	302	238	173	52	30	0.268						
16	25	175	no	K	greyish-white block, tip out of water	hs=u/str+d/str= B or lc,same size,but in a line	dry; rsf around	MB		532		0	emerge nt	0.000						OUT
16	26.5	176	full samp	M	large just d/str of cream B with orange back+ squiggly stripe	u/str B = hs	rsf to nearly bsw	SC	145	127	81	38	46	0.197						OUT
16	28	177	full samp	M	small white round at the edge of a V made by 2 emergent white B's	hs= partly B's, also lc on d/str end	bpf	SC	135	119	104	1	33	0.013						OUT
16	29.5	178	full samp	PM	tiny flat white (LG size) stone among mc	hs=SC+ MC, some overlapping	nf	SC	80	74	33	0	6	0.000						
17	11	179	no	M	half-moon white stone in stranded flow	d/+u/str B=hs	dry; stagnant nf around	LC	220	136	120	0	dry	0.000						
17	12.5	180	inv = excl top sa	M	round, white, in b/w w isolepis	in dip between u/str +d/str B=hs	dry; nf around	SC	163	119	112	0	dry	0.000						OUT
17	14	181	full samp	M	flat,squarish white stone with few ridges	up/str hs= slightly emergent sb	rsf out of frf	LC	287	245	124	184	4	0.923						
17	15.5	182	no	K	dry lichen B pinned down by very big lichen B in B field		nf	MB		540		0	dry	0.000						
17	17	183	full samp	M	rectangle reddish stone underneath dark red mc	between lc & sb+pinned by red stone	rsf	SC	163	96	67	12	14	0.068						OUT
17	18.5	184	no	PM	grey-green, submerged, sub-triangular, u/str of orangy lichen B	pinned down on both sides,on left by lc	bpf	SB		392		9	13	0.053						

riginal set-up stone data - 9-14 June 2003

Offset from 0	stone no.	invert sample	Putty Magn t Koki	description	hydraulic shelter	flow type	Stone Categories	Stone x (mm)	Stone y (mm)	Stone z (mm)	revs / 60 sec (mini)	depth (cm)	Velocity (m/s) From rating tables	none movement post flood of July 9-10; field visit 13 July	7 moved movement post flood of July 18-19; field visit 24 July	2 moved movement post flood of July 24-25; field visit 27 July	10 moved movement post flood of July 30-Aug 1; field visit 3 + 6 Aug	26 moved movement post flood of Aug 8-10; field visit 16 Aug	115 moved movement post flood of Aug 17 25 (to peaks); field visit 31 Aug
20	186	full samp	M	flat, grey, sub-oval, pinned down u/str by lc	b. u/str,d/str & to left =HS	frf	LC	259	212	164	85	13	0.431						
21.5	186	inv = ? sa net	P	oval, rectangle with flat faced; pinned on each side by lc or sb	lodged + pinned between lc at LHS +RHS = hs	rsf	LC		222		68	20	0.345						
23	187	no	PM	emergent white sb, just upstream of large lichen b.	hs=d/str boulder	dry; rsf around	MB		549		0	dry	0.000						
24.5	188	full samp	K	greenish-white round lc with semi flat face	hs=d/str just emergent white sb	rsf	SB	325	264	228	177	24	0.893						
26	189	full samp	PM	rectangi-ish red+orange flat surface angled up a bit at d/str side	no hs	rsf	SB	344	277	173	95	28	0.481						[illegible]
27.5	190	full samp	M	red+white SC immed to left of lichen B- see note on that B	u/str hs sort of, but far -not really hs	rsf	SC	158	115	89	92	30	0.466						[illegible]
29	191	full samp	M	orange triangular, in dip below packed mc+lc; just u/str of striking red + white mc	hs = u/str lc+mc packed	rsf	SC	138	112	69	23	22	0.123						
12	192	full samp	M	pale gold, sub-oval, long axis diagonally pointing d/str; betw gold B u/str & reddish angled lc d/str to left	hs = u/str b	b/w	SB	320	253	119	0	dry	0.000						OUT
13.5	193	no	K	dry emergent boulder	u/str hs=lichen boulder	dry; rsf around part; b/w part	SB		490		0	dry	0.000						
15	194	full samp	M	semi round brown orange sc, between submerged sb's (in hole)	u/str hs=submerged lc	nf in b/w	SC	100	66	66	16	25	0.088					TO	[illegible]
16.5	195	no	K	lichen B hidden in B field	hs = boulder field	dry in B field	MB		612		0	dry	0.000						
18	196	full samp	PM	orange-red; semi-sq; just to rt of B field; ridges on upper flat surface	no hs	rsf	SB	410	273	180	57	14	0.293						[illegible]
19.5	197	no	K	large, protruding lichen B	no hs	dry; rsf around	MB		772		0	dry	0.000						
21	198	no	PM	submerged white lc , embedded with other lc		frf	SB		380		35	14	0.182						
22.5	199	full samp	M	sm triangular white cobble	hs u/str = angular pinkish white LC	frf	SC	132	104	96	15	15	0.083						OUT
24	200	full samp	M	brown sc in deep riffle	hs slight = embedded mc u/str	frf	SC	104	90	72	79	29	0.400						OUT
25.5	201	full samp	M	orange oval flat mc in deep riffle slightly pinned down by redish angular "log" stone lying on top of smooth creamy flat boulder	hs=pinned down by lc u/str & mc	frf	LC	200	159	110	74	28	0.375						OUT
27	202	full samp	M	red+black patchy sc if deep run	d/str hs = submerged B	rsf rom frf	SC	125	104	82	159	42	0.803						
28.5	203	no	PM	large irregshape, flat faced grey lc with face angled	no hs	bpf	SB		479		22	2	0.118						
30	204	no	K	sb - embedded in bank	b + bank = hs	nf	SB		374		0	dry	0.000						
13	205	full samp	M	semi oval, greyish mc,surround by isolepis	hs u/str = B adj to bank	nf in b/w	SB	259	253	171	0	dry	0.000						
14.5	206	full samp	PM	round reddish mc with flat top + ridges	u/str lc also submg. = +- hs	bpf - rsf	SB	379	339	184	21	2	0.113						
16	207	no		white cream, irregular shape at top of B field	d/str B field = hs	tr thro B field	LC		227		0	dry	0.000						
17.5	208	full samp	M	squarish dark red; in gap between submerged + emergent sb's on either side	d/str b = hs	rsf	SC	175	127	127	35	6	0.182						
19	209	full samp	PM	creamwith lots of darkbrown mottle, sub-oval between 2 lichen B. pencil #	not really B at side but does not overlap	rsf	LC	446	174	122	52	14	0.268						
20.5	210	no	P	large round flat with ridges creamy colour	no hs	rsf	MB		682		32	18	0.167						
22	211	full samp	M	square white sc d/str of 2 stones, lc + sb, both submerged; pencil #	u/str hs = lc	rsf	LC	146	140	118	38	31	0.197					[illegible]	OUT
23.5	212	full samp	M	grey flat oval in fast shall run	no hs	??rsf	SB	336	262	99	109	12	0.551						OUT
25	213	full samp	M	flat greyish pink semi-oval, ridge in face, back edge slightly angled upward; pencil #	d/str sb = hs	rsf	SB	337	267	116	34	37	0.177						[illegible]
26.5	214	no	P	long red ridged with patches, perpendic to current	hs = 'cos embedded lower than adj stones	rsf	SB		369		79	17	0.400						
28	215	full samp	M	red, sub-oval, flat face, u/str of emergent lichen B	hs = orange lichen B d/str	bpf	SB	288	257	112	6	10	0.038						
29.5	216	no	K	large cream oval, B embedded, in bank with lichen spots.	hs = embedded in bank, b u/str	nf	MB		570		0	dry	0.000						
13	217	no	K	small embedded but emergent , red; ridged betw big lichen B d/str + red ridged lc u/str	wedged between u/str + d/str B = hs	nf in b/w	SB		320		0	dry	0.000						
14.5	218	no	K	orange lichen boulder pinned by u/str large white boulder	u/str B pinning = hs	rsf under Bs	MB		695		0	dry	0.000						
16	219	full samp	MP	orangy and greenish triangle,flat face, pointed end, between 2 LC; d/str tip emrgent	no hs	rsf	SB	403	311	228	6	2	0.038						[illegible]
17.5	220	full samp	M	brown sc, adj to emergent lichen b. on right; d/str of submerged flat lc, in hole	b. d/str & to right + u/str lc = hs	bpf	SC	130	110	74	14	19	0.078						
19	221	full samp	M	oval rectangle, deeplying mc right next to large emergent lichen b. with step	hs = b's in circle all around u/str & on sides	chute, going into rsf	LC	289	191	85	29	33	0.153						OUT
20.5	222	full samp	M	small with irregular sc, triangle -ish w bits of red	d/str hs = sb +lc submerged	rsf after bsw	LC	170	130	116	87	32	0.441					TO	[illegible]
22	223	full samp	M	brownish grey half circle mc,triangle, with long flat face facing d/str ,to right of submerged orange B	hs = none ,could be d/str lc (quite flat)	rsf	LC	198	156	120	104	37	0.526						OUT
23.5	224	full samp	M	sc. w half cracked edges, flat facing d/str, among other sc & mc; protected by ring of b.'s on d/str side	d/str bit b's = HS	rsf	SC	131	101	96	54	36	0.278						OUT
25	225	full samp	M	round orangy brown mc slighly lower than surrounding mc & lc, 2u/str b.'s with lichen wide apart forms chute, stone in middle of chute, just d/str of flat cream lc	n real hs	rsf	LC	234	168	117	65	14	0.330						OUT
26.5	226	no	K-+-off; paint	round flattish brown b. just d/str of circle of emergent Bs , black smile of lichen; just emergent	hs = circle of b's	trickle thru emergent b.s	SB		387		0	dry	0.000						
28	227	full samp	M	light brown MC, speckleD 1/2 rectangle 1/2 circle; flat face; u/str of lichen B	hs = 2 B down stream	bpf	LC	287	221	171	24	7	0.128						[illegible]
29.5	228	no	K	brown flat lc with little ridge, d/str of large lichen b. embedded in bank	u/str large b. + bank	dry; set in bank	SB		302		0	dry	0.000						OUT
11	229	no	K	lichen lc, dry, at edge af channel immovabe - set into bank	hs=B u/str + bank	dry; in bank, b/w	SB		326		0	dry	0.000						
12.5	230	no	K	large lichen B	ho larger stuff around	trickle thro B	MB		684		0	dry	0.000						
14	231	no	K	dry browny white sb, adjacent large lichen B + u/str another	d/str b=hs	dry; rsf under	SB		391		0	dry	0.000						
15.5	232	full samp	PM	rectangular flat faced, in shelter of lichen B	hs=u/str b.'s	rsf	SB	362	286	149	0	too shallow	0.000						
17	233	no		emergent, light brown, sb with b.'s u/str & d/str	hs=u & d/str b's u/str b. slightly overlapping	dry; rsf around	SB		383		0	dry	0.000						
18.5	234	full samp	PM	large ovalish, flat face orange + cream lc, long axis perpendicular to flow	hs=d/str submerged & emergent b's	rsf	SB	382	264	142	26	20	0.138						
20	235	full samp	M	irregular, angular, mc, set on flat bed among lc & mc	no hs	rsf quite fast	LC	254	163	133	110	30	0.556						

riginal set-up stone data - 9-14 June 2003

Offset from 0	stone no.	invert sample	Putty Magn t Koki	description	hydraulic shelter	flow type	Stone Categories	Stone x (mm)	Stone y (mm)	Stone z (mm)	revs / 60 sec (mini)	depth (cm)	Velocity (m/s) From rating tables	none movement post flood of July 9-10; field visit 13 July	7 moved movement post flood of July 18-19; field visit 24 July	2 moved movement post flood of July 24-25; field visit 27 July	10 moved movement post flood of July 30-Aug 1; field visit 3 + 6 Aug	26 moved movement post flood of Aug 8-10; field visit 16 Aug	115 moved movement post flood of Aug 17-25 (to peaks); field visit 31 Aug
21	21.5	236 (24 jul 3 aug)	full samp	M	flat orange squarish mc; narrowside facing up immed u/str of large flatish, whirey golden submerged b.	hs = d/str b.	frf from bsw, going to rsf	LC	250	155	121	119	39	0.601					
21	23	237	full samp	M	angular reddish sc, narrowside up but <'d toward d/str	hs = d/str lc	deep rsf just d/str of bsw	LC	162	138	54	19	39	0.103					
21	24.5	238	full samp	PM	dark brown oval sc, flat face upward, d/str of large long B with orange X	u/str B = hs	rsf (d/str of B)	SC	149	105	71	15	15	0.083					OUT
21	26	239	no	P	orange oval lc, pinned by adjacent white emergent B with lichen	pinned on side + d/str B = hs	rsf to usw caused by lichen B d/str	SB		414		69	9	0.350					
21	27.5	240	inv = sa net	P	flat white submerged with crevice -lines; another flat SB on top of part of the stone; rem = visible; long emerg B on LHS	pinned by B on top = hs	rsf	MB		542		64	7	0.325					
21	29	241	full samp	PM	light pink angular flat LG/sc just u/str of large white B	hs = white B in bank	??	SC	83	69	46	1	7	0.013					OUT
22	11	242	full samp	M	white with deep red teeth/triangle shapes, angular, justd/str of large irregular red raggedy B in b/w	hs= u/str red B	bpf	LC	327	172	102	0	dry	0.000					
22	12.5	243	full samp	M	pretty brown oval flat face s-mc, grey fine lines over long - b/w	hs = u/str +d/str B,but not immed. Adjacent	bpf	LC	184	139	84	0	2	0.000					OUT
22	14	244	no	K	irreg-oval shaped brown B in lichen B	hs = u/str series of lc -sb in line	dry; rsf around	MB		560		0	dry	0.000					
22	15.5	245	no	K	large creamy oval B ,flattish side facing u/str	no immed hs	bpf u/str to rsf sides	MB		644		0	dry	0.000					
22	17	246	full samp	M	square cream + orange mc on gr bed set between 2 submerged B's	in hollow between larger elements = hs	bpf to rsf	LC	202	196	109	16	26	0.088					OUT
22	18.5	247	full samp	M	white irregular ,planar surfaces facing flow which comes sideways between u/str + d/str B's	hs between 2 emergent u & d/str B's	frf	SB	311	257	145	86	2	0.435					
22	20	248	inv = upper 1/2 sa stone	P	large white log like sb/lc with brown splotches + small crevices	2 d/str submerged b's =hs	sbt d/str of bsw	SB		?250		25	15	0.133					
22	21.5	249	full samp	M	brown round cobble	in hollow between 5 B's =hs	frf to bsw	LC	238	172	140	105	43	0.531					OUT
22	23	250	no	K	white-orange round emergent B	d/str B sort of hs but not adjacent	bsw around B	MB		524		0	dry	0.000					
22	24.5	251	full samp	M	brown rectangle-ish flat faced lc amoung flattish bed elements	no hs	rsf	LC	295	244	178	62	17	0.315					
22	26	252	full samp	M	whitish red flat square sc, angled upward at d/str end against large grey embedded B	no hs	rsf	LC	181	178	82	65	16	0.330					
22	27.5	253	full samp	M	whitish + bits of fawn mc, flat face up, a bit under emergent sc that sits on it	hs = flat u/str B-not much	trick over mc	LC	247	207	156	0	<1 cm	0.000					OUT
23	10	254	no	K	brown, flattish tri angularish b.	hs = u/str boulder clump	dry; in b/w	SB		460		0	dry	0.000					
23	11.5	255	inv = 1/2 tot stone area - top and 1/2 sides	P	squarish golden sb., with round top, crags+crevises	d/str emergent b. = hs	rsf	SB	439	369	210	27	4	0.143					
23	13	256	full samp	M	red, rectangularish sc, 1/2 under lichen b. on left	d/str lc = hs	rsf	SC	151	107	103	39	4	0.202					OUT
23	14.5	257	no	K	oval white sb emergent, d/str + to right of red blockish LB	u/str LB	dry; rsf around	SB		313		0	dry	0.000					
24	16	258	full samp	M	greenish brown rectangular mc, where water = slow in "hollow" from u/str+d/str larger elements	in hollow , but no immed larger overlaps etc.	bpf	LC	233	148	127	6	14	0.038					OUT
24	17.5	259	no	K	rectangular white lc/sb with scratchy + irregular top - lying perpendicular to current	u+d/str B+ lc clumps	dry; bpf around	SB		251		0	dry	0.000					
24	19	260	no	P	pear- shaped lc, pointy side facing u/str	u/str B + a bit further d/str = lichen B = hs	rsf	SB		346		71	6	0.361					
24	20.5	261	full samp	M	grey mc in bubbly bsw d/str of 2 adjacent B's	hs = u/str B's	bsw	LC	210	190	68	232	41	1.160					OUT
24	22	262	full samp	PM	small (actually whitish) grey sc just next to pear shaped golden B, flattish submerged	lc u/str on RHS = partial hs no hs	rsf - fast run	CG	106	60	60	93	46	0.471					OUT
24	23.5	263	no	K	large emergent darkish brown B, whitey-brown on emergent bit	no hs	dry; frf around	MB		587		0	dry	0.000					
25		264	no	P	golden pear shaped, point d/str; deeply submerged overlapping mc at top end, d/str of lichen B -just submerged	lichen B upstream = hs	rsf	SB		315		50	25	0.257					
26.5		265	full samp	M	diamond orange,pinned by lichen B, with scribble - irregular surface; white B on other side	lichen B = hs	shallow chute	SC	252	115	115	60	8	0.305					
10		266	no	K	large irregular red boulder with lichen spots	smaller B u/str + d.str =hs(part)	dry; trickle under B	MB		640		0	dry	0.000					
11.5		267	no	K	flat oval sb,with narrow side facing up at angle	pinned by stacked lc on u/str end + big red sandstone B above this	dry; chute and rsf on sides	SB		400		0	dry	0.000					
13		268	full samp	PM	grey rectangular box like with sharp side facing up, inserted betw join of 2 other stones	in hollow formed by u/str +d/str white emergent b's	slow rsf	SC	119	99	75	32	9	0.167					OUT
14.5		269	no	K	golden sB with ring of lichen above water level		dry; rsf around	SB		465		0	dry	0.000					
16		270	full samp	PM	irregular, white +red blotchy, set with narrow side facing up 1/2 under white lc, pointy side sticking up	hs = u/str +d/str white emergent b.'s	?rsf	SC	166	115	66	77	12	0.390					OUT
17.5		271	full samp	M	oval, flattish brown lc	u/str,d/str sds = hs	frf - shallow	SB	408	308	164	14	3	0.078					OUT
19		272	full samp		flat greenish white round 2 "eyebrows " d/str ridges, smile ridges, big forehead	no hs	rsf from deep frf w bubbly elements	SB	369	333	125	82	22	0.415					
20.5		273	full samp	PM	large round blotchy brown B. ball shaped, 2 white eyes u/str end one deep notch = funny mouth	hs = sortof u/str lc (not bigger ,but higher of b/b	rsf	SB	381	357	177	45	28	0.232					
22		274	no		orangy white(white where dry) emergent b. :spots of lichen around waters edge ,round top w crevice	no hs	dry; rsf around	MB		552		0	dry	0.000					
23.5		275	inv = sa net	PM	large, flat, orange b.,pinned down by emergent purple-ish brownish	pinned down by purple boulder	rsf to sbt	MB		640		73	36	0.370					
25		276	full samp	M	orangy angular sc just right of white +fawn sB in line with 3 white emergent b's just d/str	no hs (d/str b's too far away)	rsf medium depth run	SC	166	101	66	39	37	0.202					OUT
26.5		277	full samp	M	squarish cream+orangy sc.,just under pointy edge of pink lc, with emergent tip	not really (pink lc=sort of hs	rsf	LC	180	147	90	58	12	0.298					OUT
28		278	full samp	PM	tiny grey sc b/w of small bed elements	d/str mcslightly overapping sc	nf	SC	116	109	62	0	1	0.000					OUT
10		279	no	K	large rectangular sandstone b. one of a stack	hs = u/str+d/str stack of b.'s	dry, in b/w, upwell from under, prob frf under B	SB		500		0	dry	0.000					
11.5		280	no	P	orange, bullet -shaped b. ,with flat surface, submerged	d/str of a ridge of large s/stone Bs	rsf	MB		624		41	6	0.212					
13		281	full samp	M	round mc, red on 1 side orange on the other, on top of 2 sc, in V made by orange b.'s, in hole	2 u/str B + d/str emergent B ridge	fast rsf	LC	155	142	91	65	20	0.330					

ginal set-up stone data - 9-14 June 2003

Offset from 0	stone no.	invert sample	Putty Magn t Koki	description	hydraulic shelter	flow type	Stone Categories	Stone x (mm)	Stone y (mm)	Stone z (mm)	revs / 60 sec (mini)	depth (cm)	Velocity (m/s) From rating tables	none: movement post flood of July 9-10; field visit 13 July	7 moved: movement post flood of July 18-19; field visit 24 July	2 moved: movement post flood of July 24-25; field visit 27 July	10 moved: movement post flood of July 30-Aug 1; field visit 3 + 6 Aug	26 moved: movement post flood of Aug 8-10; field visit 16 Aug	115 moved: movement post flood of Aug 17 25 (to peaks); field visit 31 Aug
14.5	282	inv = sa net	P	submerged flat orange oval B, pinned down by huge s/stone ridged B	d/str huge B ridge	rsf going into bsw	MB		566		64	10	0.325						
16	283	full samp	M	irregular red stone -mc - narrowside upwards, lying next to smooth orange +- rectangle lc/sb	not much d/str sb=+ hs	fast rsf	SB	315	275	74	90	30	0.456					TS	OUT
17.5	284	no	P	white LC pinned down by emergent s/stone B; red +white ;irregular	hs = sandstone pinning B	deep fast frf	LC		246		70	20	0.355						
19	285	no	P	another flat orange rectangular B, submerged	hs u/str = lichen B	frf+sbt	SB		426		49	14	0.252						
20.5	286	full samp	PM	round pinkish orange mc-lc, between 2 white lc, but d/str end open	u/str lc =hs	deep frf	SB	339	260	152	99	6	0.501						
22	287	no	P	brown rounded - rectangle, lying perpendicular to flow	no real hs	rsf	SB		358		50	5	0.257						
23.5	288	no	K	large but submerged white B, d/str of even larger white emergent lichen B	u/str lichen B = hs	rsf	SB		462		0	< 1cm	0.000						
25	289	no	K	creamy lichen B		dry; rsf around	MB		548		0	dry	0.000						
26.5	290	no	K	creamy lichen B		dry, nf around; in b/w	MB		658		0	dry	0.000						
10	291	full samp	PM	red irregular sc set among mc just beyond isolepis bank	no real hs	bpf	SC	130	106	79	16	18	0.088					TS	OUT
11.5	292	full samp	M	white, semi diamond irregular surface, on sand between embedded B's	hs=lc lichen B d/str	bpf	LC	268	214	128	44	24	0.227						TS
13	294	no	PM	deep embedded orange lc, pinned by emergent white B with one angular side	B pinning =hs	?	SB		340		50	32	0.257						
14.5	295	inv = 1/2 tot stone area	PM	whitish fawn lc on gravel with 3 emergent B's upstream	u/str B's =hs	rsf	SB	414	399	187	51	12	0.263						
17	296	full samp	M	orangey, slightly triang mc, long side at lower edge facing up, just to RHS of emergent orange B	hs = sort of d/str lc but only a bit	sbt out of deep riffle	LC	216	170	170	93	28	0.471						2.8 m
18.5	297	no	K	emergent orange B eith pointed top	hs=:: if packed against d/str sb+lichen B	dry; chute around	SB		444		0	dry	0.000						
19	298	no	P	grey flat circular, with 2 white spots downstream tip(in addit to putty)	somewhat embedded between lc=+-hs	frf	SB		458		79	22	0.400						
20.5	299	inv = sa net	P	large fawn B with scratchy tip just submerged	hs=part -other emergent u/str B's	rsf to almost frf	MB		762		43	2	0.222						
22	300	no	P	large orange B; embedded	hs = emergent u/+d/str white B(bigger d/str)	shall rsf	MB		605		39	6	0.202						
23.5	301	inv = 1/2 tot stone area - samp discarded	P	embedded ????elongated dark brown sc, just next to 2 greenish submerged SB's	hs = u/str green B	bpf	MB	1092	776	398	21	16	0.113						
25	302	full samp	M	whitish sc with red blush on RHS + crack out of LHS; set below sc + mc	no hs	bpf	LC	161	148	109	25	29	0.133						
26.5	303	full samp	M	red + gey mc just d/str of submerged lc/sb	hs=u/str	nf; b/w formed by Bs at Tr 27	LC	229	180	120	0	12	0.000						
10	304	full samp	P	lg-angualr fawn, in V between 2 B's, with mc just d/str -suspect it will go	u/str + d/str mc's,plus B's on either side =part hs	rsf	SC	97	82	55	28	12	0.148						OUT
11.5	305	full samp	P	oval brown sc in almost middle of 2 lichen B's,one wth orange X		shallow slow rsf	SC	112	81	65	54	3	0.278						OUT
13	306	full samp	P	oblong with flatter side d/str perpendicular to current ,partially pinned by dark red scraggly B; emergent with tiny salix shoot	u/str white/ yellow sb on lhs + emerg red B =hs; also d/str hs = submg Goldn B	fast rsf	SB	529	309	164	73	24	0.370						
14.5	307	no		deeply submerged greenish sb, oval with patch of red +2 white spots pinned both sides d/str by lc+sb	pinned by 2B + 1 lc (d/str) = hs	fast rsf to nearly sbt	SB		430		74	36	0.375						
16	308	inv = sa net		large oval,flattish top, submg golden B w fissures	pinned slightly on edge by sb (not bigger)	usw to bsw over B	MB		782		121	10	0.611						
17.5	309	inv = sa net		reddish gold B with tip just submerged under sheet flow to bsw	series of u/str B's = hs	frf	SB		482		47	4	0.242						
19	310	full samp	M	semi triangular golden brown mc, set among others ,just below flat/round B causing riffle, stone long side // to B; at 7 O clock d/str +lhs of lichen B	u/str round flat B with ++simuliidae	frf	SB	297	255	185	40	6	0.021						
20.5	311	inv = 2/3 tot stone area		gold lc with ++ black lichen, altho' submerged (flow at angle to channel)	wedged btw d/str emergent + 2 on sides	deep frf	SB	482	435	233	94	8	0.476						?OUT OR LOST LABEL
22	312	no		submerged greenish orange round flattend top,next to larger oblong B which is just emergent tip	embedded = hs	rsf	MB		536		36	24	0.187						
23.5	313	full samp	M	brown round flattish mc, in hollowish part of channel = deep run	no hs	rsf	LC	198	157	71	33	40	0.172						OUT
25	314	full samp	PM	rectangular, flattend sides sc set with a whole bunch just below large lc+ an embedded lc to rhs	u/str lc but no real hs at top flow	nf	SC	134	103	64	0	19	0.000					0.8 m	OUT
26.5	316	inv = sa net	P	embedded oval very flat sb, in b/water	embedded in clump of B's forming b/w	nf	SB		443		5	5	0.033						
11	316	no	K	jaggedy lichen-topped (grey) red sand stone rock	pinned by u/str sand rock = hs	dry; rsf around	SB		472		0	dry	0.000						
12.5	317	inv = sa net	P	oval orange sB with flat face,d/str of emergent brown B,broken water over face of #317	u/str emergent B = HS	frf	SB		491		154	10	0.773						
14	318	full samp	M	oval white-green mc/lc sitting pretty proud adjacent to sB's, on sc bed	NO HS	rsf out of frf	LC	287	239	214	51	33	0.263						0.8 m
15.5	319	no	K	white-fawn emergent B with few lichen spots on edge of the mid chann B clump	nothing bigger immed, but in line of stacked lc+B	dry; swirling rsf around	MB		670		0	dry	0.000						
17	320	inv = sa top + 1/2 sides	P	small white flattish sc u/str of emergent fawn-orange B in same clump. #320 is deep, in hollow formed by surroud B's	(++ hs = surround B's)	frf	SB	306	252	145	46	14	0.237						
18.5	321	full samp	M	small orange oval sc flat sides, in hole formed by surrounding lc+B's	(++ hs = surround lc+B's)	rsf	LC	148	138	67	17	29	0.093				TS	TS	OUT
20	322	no	K	large white -brown B emergent with orange X	nothing larger ,but clump u+d/str+ to RHS	dry; rsf around	MB		810		0	dry	0.000						
21.5	323	full samp	M	white grey oval sc/mc just d.str of emergent brownish oblong sB - creating riffle area	B u/str = hs	frf	LC	198	154	114	43	5	0.222						2.8 m
23	324	full samp	M	greyish triangular immed. U/str of lichen B ,just to left of the apex of the lichen B	d/str lichen B = hs	rsf out of riffle area	SC	187	101	98	67	40	0.340						OUT
24.5	325	no	K	oblong, rounded top ,embedded white-gold B,tip just emerg., with "eye"	embedded + d/str B(not immed)=hs	dry; rsf around	SB		410		0	dry	0.000						
10	326	full samp	P	very small piece of gravel on sand in b/w formed by u/str sandstone rock (just u/str of TR30)	hs=lc + embedded rocksarround ,but small stone	nf	SC	85	76	69	0	20	0.000						OUT

ginal set-up stone data - 9-14 June 2003

Offset from 0	stone no.	invert sample	Putty Magn t Koki	description	hydraulic shelter	flow type	Stone Categories	Stone x (mm)	Stone y (mm)	Stone z (mm)	revs / 60 sec (mini)	depth (cm)	Velocity (m/s) From rating tables	none movement post flood of July 9-10; field visit 13 July	7 moved movement post flood of July 18-19; field visit 24 July	2 moved movement post flood of July 24-25; field visit 27 July	10 moved movement post flood of July 30-Aug 1; field visit 3 + 6 Aug	26 moved movement post flood of Aug 8-10; field visit 16 Aug	115 moved movement post flood of Aug 17-25 (to peaks); field visit 31 Aug
11.5	327	full samp	M	dark brown oval 'wedge'- z-axis = flat band facing d/str . Hole in centre of upper surface, with pebble-looks like eye	stone = in hole:> d/str row of B's = hs	bpf	LC	337	171	230	62	40	0.315						
13	328	no	K	sandstone ragged oblong red rock lying perpendicular to flow, lichen +moss	d/str golden B d/str not really hs	deep rsf u/str - frf	MB		625		0	dry	0.000						
14.5	329	full samp	MP	greenish white lc just u/str of chute formed by #328+ lichen B on either side	d/str submerged B = hs	deep rsf (nearly sbt) going to chute	LC	322	227	186	76	25	0.385						
16	330	full samp	M	angular red brown mc , long axis perpendicular to direction of flow = chute formed by upstream B + lichen B the LHS of #330	just below point of meeting of B's; B = hs at high flow	chute	LC	298	141	133	105	20	0.531						OUT
17.5	331	inv = sa net	P	flat round orange B. submerged + embedded, d/str of clump of emergent B's	u/str B clump = hs	rsf/frf	MB		615		46	6	0.237						
19	332	full samp	M	oval, flat mc, narrow side facing upwards,d/str of oblong brown B, tip just emerging	u.stream B = hs	rsf just out of frf	LC	247	178	128	92	14	0.466				1.16m		OUT
20.5	333	no	P	large golden submerged B, well set into river bed	hs = emdedded + emergent B's u/str	?rsf	MB		730		42	4	0.217						
22	334	full samp	M	whitish grey sc just to left of brown B (emergent) - backing up water to form chutes	d/str row B's lc's = hs	rsf u/str going into chutes around	LC	184	129	144	33	10	0.172				0.5 m	TS	OUT
23.5	335	inv = 1/2 tot stone area	P	pinkish, white splotches mc, flat face tilted up at back, small spot of lichen on d/str end	+- hs = slight overlapping stone of same size	shallow frf	LC	275	235	130	53	4	0.273						
10	336	full samp	P	flat while round sc in b/w formed by s/stone + lichen SB's	hs = u/str B's	nf; in b/w	SC	118	107	53	0	16	0.000					TO	OUT
11.5	337	no	P	deep - lying flat, square-ish sb, crack line, immovable	overlapped by u/str B = hs	bpf in b/w	SB		415		14	38	0.078						
13	338	full samp	M	blotchy red+white round mc mostly exposed a little d/str of flattish oval deep, gold B	no real hs	deep run rsf	LC	170	156	133	54	51	0.278						OUT
14.5	339	full samp	M	angular triangularish mc, goldygreen, set amoung other mc	u/str+d/str hs = sB+B respect	deep run rsf	LC	247	186	164	30	44	0.157						OUT
16	340	full samp	P	oval brown sc, triangle wedge broke out of stone facing d/str. Below golden B	check stone details!!!!	slow run bpf	SC	195	70	86	42	52	0.217						
17.5	341	no	K	oval light brown, dull sB, facing d/str but propped against d/str stacked B's		dry; bpf around	SB		410		0	dry	0.000						
19	342	full samp	P	narrow, oval sc, whitish brown, narrow side up, wedged between B u/str +lc d/str		bpf	SC	128	119	58	40	22	0.207				TO		OUT
20.5	343	full samp	P	flat white irregular sc just left of embedded white B with tip out of water - lichen		rsf	LC	159	131	69	23	14	0.123						
22	344	no	P	golden brown with whitish patches flat top sb,overlain by white lc + sc		frf to rsf	SB		426		62	11	0.315						
23.5	345	full samp	M	white sc/mc set between 2 white sB's, rectangular/round, angled surface up long axis perpendicular to channel /flow		trickle thro B + cobble	LC		??129		0	dry	0.000						

MOLENAARS RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE 2004

Second season set-up stone data - May 2004 green shading indicates stones that were lost in 2003 and replaced during setup 2004 ie NEW, yellow that they moved+kept (ie but still same stone in same place) at some time in 2003; light orange - stone from 2003 discarded (NOT necc OUT) for new marked one

Second season set-up stone data - May 2004 green shading indicates stones that were lost in 2003 and replaced during setup 2004

red = corrected measurements for 2003 stones

	stone no.	invert sample	Putty (P) Paint (PT)	description	hydraulic shelter	Stone Categories	Stone x (mm)	Stone y (mm)	Stone z (mm)	revs / 60 sec (bucket type)	depth (cm)	Velocity (m/s) From rating tables
TR1	1	no	(P)	immovable Boulder	veg. Overhang	MB		570				
TR1	[illegible]	X	Pt	invert sample white&red stone	u/str +d/str	LC	175	165	114			
TR1	3	no	(P)	smooth immovable orange boulder		SB		410				
TR1	4	X	Pt	white&red stone	u+d/str	LC	245	190	125			
TR1	5	no	(P)	Immov.LargeBoulder with hollow eyes. overlapping #6		MB		710				
TR1	6	no	(P)	immov. Adjacent stone #5	imbedded h+m	MB		660				
TR1	7	X	Pt		in B field,but not immed	SB	385	283	185			
TR1	8	X	Pt	Angular, whitish w dimple, 1 m d/str of RH corner of lichen B, just u/str deeply submg golden B w red patches			205	140	144			
TR1	9	X	Pt	Long grey oval, long axis perp to flow, slightly beyond edge B field d/str + to left = ang white patchy lc + making line at 7o'clock w large immov brown B			375	153	145			
TR1	10	no	P Pt	Dark brown heart shped, to RHS of scratchy white/cr B, +/- 0.5m u/str of lined red-brown B			440	329	293			
TR1	11	no	P	Immovable-mottled light cream irreg		MB	780	470	-			
TR1	12	no	P	immov, at dstr end of orange puttied B		LC	780	580	-			
TR1	13	no	P	as above		MB	500	365	-			
TR1	14	X	Pt	lg dstr orange oval B		CG	91	55	48			
TR1	[illegible]	X	Pt				295	245	135			
TR1	16	no	P	white stone embedded in bank + Isolepis, 2 putty eyes	embededded in sand immov B	LC	270	265				
TR2	[illegible]	X	Pt	oval orange, flat face, no partic hs			356	281	130			
TR2	18	X	Pt	white, small, squareish, set among LC			168	120	90			
TR2	19	X	P	brownish oval, submerged, immov 3 blobs, one in "crater" on lhs			NB NEED TO MEASURE					
TR2	20	no	P	immovable 2 blobs; may be a bit out of horizontal line		SB		450				
TR2	[illegible]	X	Pt									
TR2	22	no	P	oval angular, overlapped by flat ridged B	u/str hs overlap	SB		285				
TR2	23	no	P	golden B with white eye, u/str of emergent lichen B	d/str lichen B hs	SB		405				
TR2	24	no	P	round orange, crack in top		MB		650				
TR2	25	no	P	large B,mottled brownish,adjacent to golden B with lines, 3 blobs in triangle		MB		520				
TR2	26	X	Pt	oval brown w scratches on top, hs=set under mottled white blockish B, overlapped on rhs			345	210	130			
TR2	27	no	P	small but lodged	in V betw Bs		220	150				
TR2	28	no	P Pt	emergent but immov			680	500	290			
TR2	29		P	overlapped by u/str sB	u/str hs	SB	570	500				
TR2	30	X	P	round, 3 blobs putty brown, flat face, under lichen B in bank		SB	328	310	188			
TR3	[illegible]	X	Pt	sc set at edge of eroded Isolep line	isolepis		115	115	45			
TR3	32	no	P	golden oval boulder		MB		605				
TR3	33	no	P	flattish, golden with few small cracks; 2 eyes		SB		500				
TR3	[illegible]	X	Pt	dark brown Oval w some cut faces, quartz band	no hs; in path of chute		178	165	120			
TR3	35	X	P Pt	oval, brown-gold, dstr at 4 o clock to orange X B; dstr chute below subm lichen white B		LC	367	250	180			
TR3	36	X	Pt	small brown grav, dstr to + lhs of emergent light brown w thin red rings			79	57	33			
TR3	[illegible]	X	Pt	red mottled round/oval, under B w eye	under gold with eye u/str hs		125	97	50			
TR3	38	no	P - 2 blobs	immovable whitish gold, triangular		SB		419				
TR3	39	no	P	orange x Boulder on subm. Portion of putty on u/water bit		MB		750				
TR3	40	X	Pt	whitish triang under 2 Bs, standing against each other	u/str + d/str hs		134	110	51			
TR4	41	inv = up stone surf	P	took inverts only from surface. Immovable smallish whitish gold embedded under grass	++ hs			192				
TR4	42	X	P	flat ablong, standing on side; on rhs= pale round B w faint lines			320	187	95			
TR4	43	X	P	flat stone			280	225	107			
TR4	44	no	P	oval orange in Boulder in B clump d/str of emergent B w lichen.	u/str hs =lichen B w paint splodge	SB		400				
TR4	45	no	P	next to very large white/gold B. Motttled brown w ridge on LHS		SB		425				
TR4	46	no	P	Golden, Long oval with two riders		SB		300				
TR4	47	no	P	Brownish B with tip emerging, next to Large B w paint splodge		MB		585				
TR4	48	X	P	Large brown, pear shaped, 2spots putty 'cos too big		SB	500	342	185			
TR4	49	no	P	brown triangular, d/str of emergent B	u/str hs =B	SB		473				
TR4	50	X	Pt	light brown, oblong-rounded, immed dstr SB			NB NEED TO MEASURE					
TR5	[illegible]	X	Pt	overhanging grass, in a deeper channel of run, lhs of triang B at the end of its left hand point			153	100	90			
TR5	52	X	Pt	white rounded cobble, overlapped on lhs by golden B + B edge facing up			182	140	110			
TR5	53	no	P	flat; overlaped u/str+d/str, pinned by lichen B dstr	u/str + d/str	SB		395				
TR5	[illegible]	X	Pt	rounded granite cobb, dtrs is flat white just emergent B stained brown at sidesa w dstr lines			190	112	105			
TR5	55	no	P	embedded red/gold oblong w sharp left side; embedd right side; dstr = grey B w white quartz spots. Dtrs green small B			430	240	?			
TR5	56	no	P	large round B with gaping eyes +holes	u/str hs-B field	MB		736				
TR5	57	X	Pt	immed dstr B			205	135	110			
TR5	58	no	P	Emergent Brown B.	u/str hs=B	MB		510				
TR5	59	no	P	very Large white B with lichen	emergent	MB		780				
TR5	60	no	P	submerged gold B d/str of emergent red B	u/str+lateral hs	MB		501				
TR5	[illegible]	X	Pt	wedged between submerged B on lhs + emerg Bw eye of rhs			260	160	140			
TR6	62	X	Pt	totally overgrown w isolepis; few lichen spots;grey	u/str + lat hs	SB	423	271	193			
TR6	63	no	P	emergent round white +orange B w fissures	u/str B but smaller	MB		795				
TR6	64	X	Pt	off round; dark green/grey flat-oval, long side perp to flow		SB	300	290	275			
TR6	65	no	P	oval w pointy side facing ustr, set on rhs of B field		SB		415				
TR6	66	X	Pt	angular oblong, planar sides, immed dstr emergent lichen oval B + "under eaves" of flat SB on rhs			325	175	170			
TR6	67	X	Pt	perfect little round "owls egg" at dstr end of B bar, in patch of LG betw 2 flattish sbmerged Bs			64	60	55			
TR6	[illegible]	X	Pt	no hs; ustr large flat lichen B			290	235	165			
TR6	69	no	P	large greenish yellowish white flattish top, no lichen		SB		490				
TR6	70	X	P	1/2 under flat greeny yellow stone which = immed dstr orange X B	slightly larger stone ,d/str		260	225	155			
TR6	71	no	Pt	immov emergent white boulder	lodged against stack	MB		510				
TR6	72	X	Pt	flat square sc set among patch of SC, w ring of LC/SB around - hs= that it's in a "inlet" off main flow path			105	85	40			
TR7	73	inv = sa net	P	immov large Golden embedded B	none	MB		805				
TR7	74	no	P	Large rectangle that surf emergent, light brown	none	MB	855	520				
TR7	75	no	P Pt	emergent round flattish B, black/grey lines perp to flow, light brown, surrounded on rhs by smaller B and on lhs by angled emerg grey B w white lines			886	668	?			

2004 FLOODS blue = moved; pink = OUT; — green shading = stones lost in 2003, replaced at setup in 2004 — old stone size incl, followed by NEW **stone size** where replaced

TRANSECT 1 tie tape at 6.7 m on tree to line up with zero at RHS peg

FLOOD 1 - 10 Jun	BIG FLOOD 2 - 25 Jun	FLOOD 3 - 1 JULY SEARCH	FLOOD 4 - 16 JULY SEARCH	FLOOD 5- 8 August Search	stone no.	potential for invert sample	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost	Stone x (mm)	Stone y (mm)	Stone z (mm)
					1	no	(P)	Immovable Boulder		570	
	[illegible]			[illegible]	2	X	Pt	invert sample white&red stone;	175	165	114
					3	no	(P)	smooth immovable orange boulder		410	
	OUT: new stone		[illegible]	[illegible]	4	X	Pt	white&red stone **NEW 25 Jun: brown LC on rhs of gold SB round + flat**	245 new: 260	190 new: 180	125 new: 85
					5	no	(P)	Immov.LargeBoulder with hollow eyes. overlapping #6		710	
					6	no	(P)	Immov. Adjacent stone #5		660	
					7	X	Pt	D-shaped brown and fawn LC, in depresstion betw 4 submrg SBs, sort of in B field, but not immediately (?)	385	283	185
			?? If not TO, then perhaps error? Mov 10cm; repl	Out	8	X	Pt	Angular, whitish w dimple, 1 m d/str of RH corner of lichen B, just u/str deeply submg golden B w red patches	205	140	144
					9	X	Pt	Long grey oval, long axis perp to flow, slightly beyond edge B field d/str + to left = ang white patchy lc + making line at 7o'clock w large immov brown B	375	153	145
	reputtied ? No marker			[illegible]	10	no	P Pt	Dark brown heart shped, to RHS of scratchy white/cr B, +/- 0.5m u/str of lined red-brown B. **16 Jul:** found 2 stones: 1 w paint, fits description and = betw the 2 Bs, the other = orange brown oval SB w 2 blobs putty, submrg but ≠ embed, long axis perp flow, to rhs of 2 Bs described (i.e reputtied wrongly on 25 June (they identified the wrong one as present but w-out putty!!	440	329	293
					11	no	P	Immovable-mottled light cream irreg	780	470	-
					12	no	P	immov, at dstr end of orange puttied B	780	580	-
					13	no	P	as above	500	365	-
	OUT: new stone				14	X	Pt	old = lg dstr orange oval B. **NEW 25 Jun: putty marker, oval submerged embedded SB lying transverse to flow**	91 new: 630	55 new: 390	48 new: ?emb
	[illegible]				15	X	Pt	dark brown round, flat side up; in bouldery section at margin	295	245	135
					16	no	P	white stone embedded in bank + Isolepis, 2 putty eyes	270	265	
Transect 2											
	[illegible]				17	X	Pt	oval orange, flat face, no partic hs	355	281	130
			[illegible]	OUT	18	X	Pt	white, small, squareish, set among LC	168	120	90
					19	X	P	brownish oval, submerged, immov 3 blobs, one in "crater" on lhs	610	420	emb
			repl putty		20	no	P	immovable;2 blobs, may be a bit out of horizontal line		450	
	[illegible]			[illegible]	21	X	Pt	at 15.4 m; has magnet from old, 20 cm u/str of emergent brown B; **16 Jul - has** a putty rock 20cm ustr & to rhs	370	328	218
					22	no	P	oval angular, overlapped by flat ridged B		285	
					23	no	P	golden B with white eye, u/str of emergent lichen B		405	
					24	no	P	round orange, crack in top		650	
					25	no	P	large B,mottled brownish,adjacent to golden B with lines, 3 blobs in triangle		520	
					26	X	Pt	oval brown w scratches on top; hs=set under mottled white blockish B, overlapped on rhs	345	210	130
putty faint					27	no	P	small but lodged **??? On 25 Jun,** Bruce found OUT and repl, but ≠ measure; this new stone (lat SC) was not found on 16 Jul (i.e. OUT, but lost data ∵ ≠ measure) but found the original without putty - ie no movement of original to date	220	150	lodg'd
					28	no	P Pt	emergent but immov	680	500	290
			putty off ?repl		29		P	overlapped by u/str sB	570	500	
					30	X	P	round, 3 blobs putty brown, flat face, under lichen B in bank	328	310	188
	[illegible]			OUT	31	X	Pt	sc set at edge of eroded Isolep line	115	115	45
					32	no	P	golden oval boulder		605	
					33	no	P	flattish, golden with few small cracks; 2 eyes		500	
	[illegible]			[illegible]	34	X	Pt	dark brown Oval w some cut faces, quartz band	178	165	120
					35	X	P Pt	oval, brown-gold, dstr at 4 o clock to orange X B; dstr chute below subm lichen white B	367	250	180
		OUT: new stone	[illegible]	OUT	36	X	Pt	small brown grav, dstr to + lhs of emergent light brown w thin red rings. **NEW 1 JULY: triang s/mc, grey/brown, under s.wave caused by ustr orange SB. 16 Jul** replaced stone on lhs dstr of orange SB (= same) that causes standing wave	79 new: 145	57 new: 90	33 new: 60
	[illegible]			OUT	37	X	Pt	red mottled round/oval, under B w eye	125	97	50
					38	no	P - 2 blobs	immovable whitish gold, triangular		419	
					39	no	P	orange x Boulder on subm. Portion of putty on u/water bit		750	
	OUT: new stone		NB ≠ add new stone sizes	OUT: SIZE NOT RECORDED - discard data POINT	40	X	Pt	whitish triang, under 2 Bs, standing against each other, effectively underneath them. **NEW 25 Jun: flat SB, round, Fractures on 1 side**	134 new: ?	110 new: ?	51 new: ?
					41	inv = up stone surf	P	took inverts only from surface. Immovable smallish whitish gold embedded under grass		192	
					42	X	P	flat ablong, standing on side; on rhs= pale round B w faint lines	320	187	95
					43	X	Pt	orange mc, fractured ustr side and sccop on rhs, rhs = lifted, +43 = 30 cm dstr of large piunk B w lichen, emergent; #43 = on rhs of a channel which is transverse to flow	280	225	107
					44	no	P	oval orange in Boulder in B clump d/str of emergent B w lichen;		400	
					45	no	P	next to very large white/gold B. Motttled brown w ridge on LHS		425	
				couldn't find; covered?	46	no	P	Golden, Long oval with two riders		300	
					47	no	P	Brownish B with tip emerging; next to Large B w paint splodge		585	
					48	X	P	Large brown, pear shaped, 2spots putty 'cos too big	500	342	185
					49	no	P	brown triangular, d/str of emergent B		473	
					50	X	Pt	light brown, oblong-rounded, immed dstr SB	420	260	120
	[illegible]	[illegible]	[illegible]	[illegible]	51	X	Pt	overhanging grass, in a deeper channel of run, lhs of triang B at the end of its left hand point	153	100	90
				OUT	52	X	Pt	white rounded cobble, overlapped on lhs by golden B + B edge facing up	182	140	110
					53	no	P	flat; overlaped u/str+d/str, pinned by lichen B dstr		395	
	[illegible]			OUT	54	X	Pt	rounded granite cobb, dtrs is flat white just emergent B stained brown at sidesa w dstr lines	190	112	105
					55	no	P	embedded red/gold oblong w sharp left side, embedd right side; dstr = grey B w white quartz spots. Dtrs green small B	430	240	?
					56	no	P	large round B with gaping eyes +holes		736	
	OUT: new stone			OUT	57	X	Pt	old =immed dstr B. **NEW 25 Jun: SC, brown, angular, just in front of B w white eye in the entrnance to small hole**	205 new 130	135 new 75	110 new: 55
					58	no	P	Emergent Brown B.		510	
					59	no	P	very Large white B with lichen		780	
					60	no	P	submerged gold B d/str of emergent red B		501	
	[illegible]			OUT	61	X	Pt	wedged between submerged B on lhs + emerg Bw eye of rhs	260	160	140
					62	X	Pt	totally overgrown w isolepis, few lichen spots;grey	423	271	193
					63	no	P	emergent round white +orange B w fissures		795	
				OUT	64	X	Pt	off round; dark green/grey flat-oval, long side perp to flow	300	290	275
					65	no	P	oval w pointy side facing ustr; set on rhs of B field		415	
					66	X	Pt	angular obliong, planar sides, immed dstr emergent lichen oval B + "under eaves" of flat SB on rhs	325	175	170
	OUT: new stone				67	X	Pt	old = perfect little round "owls egg" at dstr end of B bar, in patch of LG betw 2 flattish sbmerged Bs; **NEW 25 Jun: squarish flat yellow orange LC, immov. Pinned down at ustr end by pnt of grey triang B which itself = pinned ustr; NEW marker = putty**	64 new: 260	60 new: 190	55 new: emb
	[illegible]			OUT	68	X	Pt	greeny-grey, roundish-oval, flat top + bottom, no hs; 10 cm ustr large flat lichen B which has been puttied (erroneously)	290	235	165
					69	no	P	large greenish yellowish white flattish top, no lichen		490	
check for M				[illegible]	70	X	P	1/2 under flat greeny yellow stone which = immed dstr orange X B	260	225	155
					71	no	Pt	immov emergent white boulder		510	
	OUT: new stone			OUT	72	X	Pt	old = flat square sc set among patch of SC, w ring of LC/SB around - hs= that it's in a "inlet" off main flow path; **NEW 25 Jun: triang brown sc, one edge fractured**	105 new:120	85 new: 95	40 new: 45
					73	inv = sa net	P	immov large Golden embedded B		805	
					74	no	P	Large rectangle that surf emergent; light brown	855	520	
					75	no	P Pt	emergent round flattish B, black/grey lines perp to flow, light brown, surrounded on rhs by smaller B and on lhs by angled emerg grey B w white lines	886	668	?

MOLENAARS RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE 2004

Second season set-up stone data - May 2004 green shading indicates stones that were lost in 2003 and replaced during setup 2004(ie NEW); yellow that they moved+repl (ie but still same stone in same place) at some time in 2003; light orange - stone from 2003 discarded (NOT necc OUT) for new marked one

Second season set-up stone data - May 2004 green shading indicates stones that were lost in 2003 and replaced during setup 2004

red = corrected measurements for 2003 stones

2004 FLOODS blue = moved; pink = OUT;

green shading = stones lost in 2003, replaced at setup in 2004

old stone size incl, followed by NEW stone size where replaced

	stone no.	invert sample	Putty (P) Paint (PT)	description	hydraulic shelter	Stone Categories	Stone x (mm)	Stone y (mm)	Stone z (mm)	revs / 60 sec (bucket type)	depth (cm)	Velocity (m/s) From rating tables	FLOOD 1 - 10 Jun	BIG FLOOD 2 - 25 Jun	FLOOD 3 - 1 JULY SEARCH	FLOOD 4 - 16 JULY SEARCH	FLOOD 5- 8 August Search	stone no.	potential for invert sample	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost	Stone x (mm)	Stone y (mm)	Stone z (mm)
TR7	76	no	P Pt	light brown rectangl-squ., flat faced B w ridges and lines; surr. Lhs + rhs dstr by larger B w dstr edge emergent	somewhat pinned but movabl in B field		495	360	?									76	no	P Pt	light brown rectangl-squ , flat faced B w ridges and lines; surr. Lhs + rhs dstr by larger B w dstr edge emergent	495	360	?
TR7	[illegible]	X	Pt	grey-green flat cobb. in bed of cobble			255	142	75					[illegible]		[illegible]	OUT	77	X	Pt	grey-green flat cobb. in bed of cobble	255	142	75
TR7	78	no	P	orange cobble, long axis ll flow (45degr); pinned; red patch on ustr edge. #78= up against emerg pale brown B immed to rhs	immov - pinned + submerged ustr + dstr		350	160	?							replaced putty	OUT	78	no	P	orange cobble, long axis ll flow (45degr); pinned; red patch on ustr edge #78= up against emerg pale brown B immed to rhs	350	160	?
TR7	79	X	Pt	rounded, 30 cm ustr pale B			158	133	85					OUT: new stone			OUT	79	X	Pt	old = rounded, 30 cm ustr pale B; **NEW 25 Jun: SC, speckled brown triang w Y ridge pattern. In hole = hs**	158 new: 105	133 new: 80	85 new: 45
TR7	80	no	P	orange-gold B, immed on rhs of emergent grey-pink LB w narrow flat ridge uppermost			540	510	?									80	no	P	orange-gold B, immed on rhs of emergent grey-pink LB w narrow flat ridge uppermost	540	510	?
TR7	81	X	P	large orange LC too big to move	slightly ustr of line	SB	528	357	238									81	X	P	large orange LC too big to move	528	357	238
TR8	82	no	P Pt	write on koki + paint; emergent pyramid shape	u/str hs=b grass dump	MB		628										82	no	P Pt	write on koki + paint; emergent pyramid shape		628	
TR8	83	X	Pt	small white cobble, set in Y betw 3 Bs, largest, most emergent = at dstr end	NB #82-84=DSTR REST OF THE LINE	SC	125	90	82					[illegible]				83	X	Pt	small white cobble, set in Y betw 3 Bs, largest, most emergent = at dstr end	125	90	82
TR8	[illegible]	X	Pt	rectangl shaped mottled brown; immed dstr of pale emerg B w blunt apex + dgark lines ll flow			NB NEED TO REMEASURE							[illegible]	[illegible]		[illegible]	84	X	Pt	rectangl shaped mottled brown; immed dstr of pale emerg B w blunt apex + dgark lines ll flow	320	175	135
TR8	85	no	P	large, white submerged in B field wth grey veins; NB = a bit higher than start of transect	2 u/str B forming chute,+lat hs	MB		637									looks to be 30cm dstr	85	no	P	large, white submerged in B field wth grey veins, NB = a bit higher than start of transect		637	
TR8	86	no	Pt	large, reddish w lichen	LB overlaps on lhs	MB		798										86	no	Pt	large, reddish w lichen		798	
TR8	87	no	P	orange ovalish w planes in splash zone	overlapped on rhs by LB	SB		410										87	no	P	orange ovalish w planes in splash zone		410	
TR8	88	no	P Pt	golden, protruding at angle with scratches	u/str smaller but overlap	MB		763										88	no	P Pt	golden, protruding at angle with scratches		763	
TR8	89	X	Pt	white, rounded, at base of chute / cascade			NB NEED TO REMEASURE										OUT	89	X	Pt	white, rounded, at base of chute / cascade	290	230	160
TR8	90	X	Pt	angular squareish brown			220	149	75									90	X	Pt	angular squareish brown	220	149	75
TR8	91	X	Pt	brown, heart shaped	covered by boulders		225	170	125									91	X	Pt	brown, heart shaped	225	170	125
TR9	92	no	p	large oval creamy with lichen spots	u/str B group	SB		460										92	no	p	large oval creamy with lichen spots		460	
TR9	93	no	P	reddish with patcy white + little lichen, squareish	mid cascade	SB		385										93	no	P	reddish with patcy white + little lichen, squareish		385	
TR9	94	inv = sa net	P	oval white B w crevice on rhs and few wquartz eyes; sampled surface area only - submerged	d/str B's on either side	SB		435										94	inv = sa net	P	oval white B w crevice on rhs and few wquartz eyes, sampled surface area only - submerged		435	
TR9	95	X	P Pt	flat oval tilted at angle;light brown		SB	436	304	110									95	X	P Pt	flat oval tilted at angle;light brown	436	304	110
TR9	96	X	Pt	angular red mc immed ustyr lichen B, B field ustr	B field		185	140	95					OUT: new stone			[illegible]	96	X	Pt	old =angular red mc immed ustyr lichen B; B field ustr; **NEW 25 Jun green/brown roughly square-shp MC, betw brown B w lichen on dst lhs and gold/yellow/brown B submg on ustr rhs**	185 new: 220	140 new: 195	95 new: 95
TR9	97	no	P	submerged Red/Brown B with small eyes, adjacent 2 emergent B's on RHS	A BIT USTR OF LINE	MB		501									couldn't find	97	no	P	submerged Red/Brown B with small eyes, adjacent 2 emergent B's on RHS		501	
TR9	[illegible]	X	Pt	small round cobbl; rough surface, greenish brown, set in a "hole" of surrounding Bs, the one on the rhs = 1/2 moon + emergent w rough top + eyes	hole		113	93	70				OUT: new stone	[illegible]			OUT	98	X	Pt	old = sc, rough surface, greenish brown, set in a "hole" of surrounding Bs, the one on the rhs = 1/2 moon + emergent w rough top + eyes; **NEW 10 Jun: oval, light organge & brown sc, immed dstr of light creamy orange LC in the chute formed bu this LC and a SB immed to rhs of it**	113 new: 138	93 new: 102	70 new: 67
TR9	99	X	P Pt	brown oval, just u/str slightly emergent light brown lichen B w big eye	hs=d/str B + u/str sb	LC	350	254	125									99	X	P Pt	brown oval, just u/str slightly emergent light brown lichen B w big eye	350	254	125
TR9	100	X	p Pt	oval; light brown, flattish face up, long axis ll to current; just to rhs of patchy red + brown rectangl emergent B	at bottom clute no hs	LC	295	245	142								[illegible]	100	X	p Pt	oval, light brown, flattish face up, long axis ll to current, just to rhs of patchy red + brown rectangl emergent B	295	245	142
TR9	101	no	Pt	blockish emergent immov cream with lichen	in b. field,but smaller +=hs	SB		465										101	no	Pt	blockish emergent immov cream with lichen		465	
TR10	102	no	P	immov golden irregular + flat planes, 2 blobs putty	embedded+sb overlap u/str=hs	LC		237										102	no	P	immov golden irregular + flat planes, 2 blobs putty		237	
TR10	103	inv = 1/2 tot stone area	P	immov triangular with flat surface; immovable but not imbedded		LC		235										103	inv = 1/2 tot stone area	P	immov triangular with flat surface; immovable but not imbedded		235	
TR10	104	no	Pt	whitey cream with dry moss, emergent roundish triang B	N B field + SB on top=hs	SB		468										104	no	Pt	whitey cream with dry moss, emergent roundish triang B		468	
TR10	105	X	Pt	small orangey wedged between 2B-one with orange X	d/str+lat B's=hs	SC	163	110	120								OUT	105	X	Pt	small orangey wedged between 2B-one with orange X	163	110	120
TR10	106	no	P	brown B w pale crescent mark, pointeed end dstr. Just dstr round B w 2 eyes	set deep, pinned by LC/B on ustr + rhs		440	395	?									106	no	P	brown B w pale crescent mark, pointeed end dstr Just dstr round B w 2 eyes	440	395	?
TR10	107	no	Pt	round, mottled brown, emergent B u/str of large emergent B with holes	d/str B = hs	SB	440	280									couldn't find	107	no	Pt	round, mottled brown, emergent B u/str of large emergent B with holes	440	280	
TR10	108	no	P Pt	flat round medium brown B d/str of emergent B+- 30cm u/str	u/str B=hs	MB		630										108	no	P Pt	flat round medium brown B d/str of emergent B+- 30cm u/str		630	
TR10	109	no	Pt	embed, splotched gold + pale brown, rounded B w ridge uppermost ll flow. #109= ustr of MB w white cap and dstr of gold B w black crack			420	340	?									109	no	Pt	embed, splotched gold + pale brown, rounded B w ridge uppermost ll flow. #109= ustr of MB w white cap and dstr of gold B w black crack	420	340	?
TR10	110	no	P	sub circular, submerged, with "face" from crevices looking d/str	overlap u/str by same size flattish LC / SB =hs	SB	470	360							needs putty			110	no	P	sub circular, submerged, with "face" from crevices looking d/str	470	360	
TR10	[illegible]	X	Pt	orange rounded rectangle flat face looking up perpendicular to flow (long-axis)	no hs	LC	220	155	101					[illegible]			[illegible]	111	X	Pt	orange rounded rectangle flat face looking up perpendicular to flow (long-axis)	220	155	101
TR10	112	no	Pt	emergent whitish reddish elongated B, set in bank	d/str LC = hs (smaller,but wedged)	MB		528										112	no	Pt	emergent whitish reddish elongated B, set in bank		528	
TR11	113	inv = bottom sa; sewage fung	X	emergent in stagnant water+isolepis	set in isolepis	LC	214	146	91									113	inv = bottom sa sewage fung	X	emergent in stagnant water+isolepis	214	146	91
TR11	114	no	P	embed pale brown LC, small holes, roughly 3-sided pyramid, overhung by sedge; betw embed LB w black lichen and round gold B; small tree ustr; adj B Bar in dry edge of stream			260	210	?								1 found at #53+1m ustr, with magnet and black koki, no red or white paint	114	no	P	embed pale brown LC, small holes, roughly 3-sided pyramid, overhung by sedge; betw embed LB w black lichen and round gold B; small tree ustr; adj B Bar in dry edge of stream	260	210	?
TR11	115	no	Pt	huge lichen boulder	makes B field	MB		870										115	no	Pt	huge lichen boulder		870	
TR11	116	no	Pt	immov, emerg but set low, round brown B, flattened somewhat; immed ustr large blackened lichen B + dstr pale embed B w black lines perp flow	d/str+u/str lc=hs, both = emergent Bs		405	375	?									116	no	Pt	immov, emerg but set low, round brown B, flattened somewhat; immed ustr large blackened lichen B + dstr pale embed B w black lines perp flow	405	375	?
TR11	117	X	Pt	flattened brown rock, rhs trapped under small round B w line of embedd, round crystals ll flow. #117= ustr of pale embed B w black lichen speckles		SB	320	265	125									117	X	Pt	flattened brown rock, rhs trapped under small round B w line of embedd, round crystals ll flow. #117= ustr of pale embed B w black lichen speckles	320	265	125
TR11	118	no	P - 1 blob	flat round, orange-greenish, overlapped by u/str lc +on RHS by gold SB w chip pointing dstr	overlap u/str LC=hs	SB	440	375									couldn't find	118	no	P - 1 blob	flat round, orange-greenish, overlapped by u/str lc +on RHS by gold SB w chip pointing dstr	440	375	
TR11	119	X	Pt	white rectangular, flat face with red splotsh on u/str end	d/str B = hs	LC	311	214	210									119	X	Pt	white rectangular, flat face with red splotsh on u/str end	311	214	210
TR11	120	no	P Pt	tape catches u/str edge of MB; emergent, oval,flat, whitish red. #120 overlaps the d/str B, but it still acts as hs 'cos angle	d/str B = overlap	MB		590										120	no	P Pt	tape catches u/str edge of MB; emergent, oval,flat, whitish red. #120 overlaps the d/str B, but it still acts as hs 'cos angle		590	
TR11	[illegible]	X	M	round flat orange LC on rt of emergent orange/gold B	not much, u/str flat sb	LC	210	185	94					[illegible]				121	X	M reputt	round flat orange LC on rt of emergent orange/gold B	210	185	94
TR11	122	no	Pt	large emergent B(reddish white) with lichen at edge	u/str B line = hs	MB		535										122	no	Pt	large emergent B(reddish white) with lichen at edge		535	
TR11	123	no	Pt	large white B, some lichen	hs=u/str B	MB		620										123	no	Pt	large white B, some lichen		620	
TR11	124	inv = sa bottom and sides	Pt	while flat oval, top emergent	hs=B side	LC	315	209	97									124	inv = sa bottom and sides	Pt	while flat oval, top emergent	315	209	97
TR12	125	X	Pt	small rectang stone, on gravel ustr = 2 embed B w black lichen spots	u/str+d/str hs = emergent B		95	65	53					OUT: new stone				125	X	Pt	old = small rectang stone, on gravel ustr = 2 embed B w black lichen spots, **NEW 25 Jun square flat fawn LC, pinned ustr by brown B w green cap of lichen, New marker = PUTTY**	95 new: 335	65 new: 310	53 new: embed
TR12	126	X	Pt	flattened speckled olive green/brown 2nd axis facing ustr; unusual cavities in the rock edge facing ustr. Wedged by pale brown emerg B on dst/rhs, on LHS = embed B w thick crescent lichen, dstr small round B w cracks	u/str+d/str hs = emergent B +emergend lc		303	270	109								[illegible]	126	X	Pt	flattened speckled olive green/brown 2nd axis facing ustr; unusual cavities in the rock edge facing ustr. Wedged by pale brown emerg B on dstr/rhs, on LHS = embed B w thick crescent lichen, dstr small round B w cracks	303	270	109
TR12	127	no	Pt	large emergent lichen B in B field	B field = hs	MB		590										127	no	Pt	large emergent lichen B in B field		590	
TR12	128	no	P	greenish submerged +overlaped; in straight line betw lichen B ustr and oval B w pointy ridge dstr. NB another submg red/brown blotchy flat B just ustr at 2 o clock was also puttied	B u/str +d/str = hs	SB		300										128	no	P	greenish submerged +overlaped; in straight line betw lichen B ustr and oval B w pointy ridge dstr. NB another submg red/brown blotchy flat B just ustr at 2 o clock was also puttied		300	
TR12	129	no	Pt	immov emerg orange embed LB	no hs really	B	815	680	?								[illegible]	129	no	Pt	immov emerg orange embed LB	815	680	?
TR12	130	no	Pt	emerg orange B, deeply set, rectangular, w smaller lichen B dstr		LB	945	575	?									130	no	Pt	emerg orange B, deeply set, rectangular, w smaller lichen B dstr	945	575	?
TR12	[illegible]	X	Pt	flat orange oval slightly overlapped by u/str green mc; # underneath-ish	no real hs	SB	393	292	100					[illegible]			[illegible]	131	X	Pt	flat orange oval slightly overlapped by u/str green mc; # underneath-ish	393	292	100
TR12	132	X	Pt	orange, flat, narrow side-up,makes line between 2 B's to LHS. NB ustr of the lichen B that = hs is a puttied B, displaced from ustr	B's to RHS provide u+d/str hs	LC	302	184	82									132	X	Pt	orange, flat, narrow side-up,makes line between 2 B's to LHS. NB ustr of the lichen B that = hs is a puttied B, displaced from ustr	302	184	82
TR12	133	no	P	round green, large flat surface with natural white marks across	no hs	MB		550										133	no	P	round green, large flat surface with natural white marks across		550	
TR12	134	no	Pt	oval orange + lichen, emergent; w white X and red splodges	mid B field = hs	SB		375										134	no	Pt	oval orange + lichen, emergent; w white X and red splodges		375	
TR13	135	X	Pt	reddish angled with crevices partly embedded under lichen B	lc + sb u/str + d/str=hs	LC	213	183	116									135	X	Pt	reddish angled with crevices partly embedded under lichen B	213	183	116
TR13	136	X	Pt	brown, half oval, flattish sides angled under lichen boulder with 3 large eyes	B d/str + lc u/str	SC	161	110	54								[illegible]	136	X	Pt	brown, half oval, flattish sides angled under lichen boulder with 3 large eyes	161	110	54
TR13	137	X	Pt	small squareish granite, overshadowed ustr by small embed dirty brown B w lines and elevated end dstr; MB on LHS of #137 has distinct quartz spot at dstr point; #137 = in V betw these 2	no hs		95	65	39					OUT: new stone				137	X	Pt	small squareish granite, overshadowed ustr by small embed dirty brown B w lines and elevated end dstr; MB on LHS of #137 has distinct quartz spot at dstr point; #137 = in V betw these 2. **NEW 25 June: pear -shaped, brown-gold, embed, immov, submrg B, New marker = PUTTY**	95 new 575	65 new: 430	53 new: emb
TR13	[illegible]	X	Pt	small round stone w large eye, wedged betw Bs	2B=hs(wedged)		83	65	44				OUT: new stone	[illegible]		[illegible]	OUT	138	X	Pt	old = small round stone w large eye, wedged betw Bs, **NEW 10 June: green large gravel, white quartz mark; note 16 JulL: repl on ustr rhs of B w fracture on it**	83 NEW: 46	65 NEW: 42	44 NEW: 32
TR13	139	no	P	immov, orange + green, flat face, w deep ridge/cut	semi hs by deep setting		535	440	?									139	no	P	immov, orange + green, flat face, w deep ridge/cut	535	440	?

MOLENAARS RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE 2004

Second season set-up stone data - May 2004 green shading indicates stones that were lost in 2003 and replaced during setup 2004 in NEW yellow that they moved+repl (?) but still (same stone in same place) at some time in 2003; light orange - stone from 2003 discarded (NOT necc OUT) for new marked one

Second season set-up stone data - May 2004 green shading indicates stones that were lost in 2003 and replaced during setup 2004

red = corrected measurements for 2003 stones

	stone no.	invert sample	Putty (P) Paint (PT)	description	hydraulic shelter	Stone Categories	Stone x (mm)	Stone y (mm)	Stone z (mm)	revs / 60 sec (bucket type)	depth (cm)	Velocity (m/s) From rating tables
TR13	140	inv = 1/2 surf area stone	P	white, squareish, lots of ridges on surface some gold, overlaped by other cobbles (immovable)	overlaped on u/str + both sides = hs	SB	335	305	190			
TR13	141	X	PM 2 blobs	large oval, bright orange, flat surface up (nearly too big to sample)	no hs immed u/str	SB	475	460	420			
TR13	142	X	Pt	(too small to drill) small rectangle, wedged between 2 lc's (in crevice), long axis into bed, betw striated B and greeny B, all submergd	in "hole" = hs	SC	120	66	42			
TR13	143	no	P	light gold fat, rounded end u/str, rounded point d/str	no hs	MB		590				
TR13	144	no	Pt	blockish, red, emergent creviced	partially wedged by smaller d/str B=hs	MB		740				
TR14	145	no	P Pt	suboval sticking out of water at angle, lichen spots + 2 eyes on side	overlapped by stacked B u/str=hs	SB		490				
TR14	146	X	Pt	flat round browny-red, flat face up, adjacent triangul LC = just emergent	B field u/str=+-hs but gap bewt Bs immed ustr	LC	190	172	80			
TR14	147	no	Pt	light sb, bottom of long B field, overlapped u/str, emergent	B field = hs	SB		455				
TR14	[illegible]	X	Pt	rounded, flat, brownish MC, lying on cobbl bed, immed to right = flat khaki brown cobble, which itself = embed under emerg pink LB w scratches	B field u/str but to left =+-hs		210	149	90			
TR14	149	inv = sa net	P	oval orange, lighter on upstream surface, immovable stone, dstr= flat greenish MB	no hs	MB		600				
TR14	150	inv = sa net	P - 2 blobs	submerged large oval-ish with planes+ crevices, fractured hole on top	2B d/str =hs	MB		545				
TR14	151	X	P Pt	round, light, speckled brown LC w greenish tinge, dstr end = embed under large emerg B w 3 eyes on its upper surface			350	235	210			
TR14	152	no	Pt	large lichen B with orange X well out of water	d/str of	MB		705				
TR14	153	X	Pt	olive brown w black specks, #153= 2nd cobble ustr from bright orange B, on LHS dstr = B w rounded apex, 2-tone w darker orange on dstr side; on bed of cobble			273	165	82			
TR14	154	X	Pt	flat brown triangular among sc+mc, surrounded by sb's - all submerged	sb+lc u/str+sides = hs	LC	172	170	90			
TR14	155	no	Pt	white irregular shape, flat surface emergent amoung a cluster of lc's	overlap lc on side = hs	SB		350				
TR15	[illegible]	X	Pt	cube shaped, v angular, fractured edges, embed under cob in small cobb bed, ustr = embed oval rock, dstr = emerg angular cobble	d/str B's=hs		161	120	111			
TR15	157	no	Pt	immov, embed pale B w mottled brown-orange, cracks / fissures, few black lichen spots; long axis perp flow, lower half = orange	in B field = hs	B	661	570	?			
TR15	158	no	Pt	immovable, emerg white rounded B, in mid B bar, flattish on top. Dry-resting on LC/B; thin black lines on ustr end; overlaps enidge of str B	overlap B's in B field = hs	SB	520	480	275			
TR15	[illegible]	X	Pt	circular; flat with ridges on narrow part of stone facing up stream, only half emergent lodged d/str of lichen B with orange X	wedged between B=hs	LC	208	169	88			
TR15	160	no	Pt	too large to sample, oval, long axis perp flow, immed ustr on lhs = sub triangular embed submg B w very flat end facing #160	open ustr, no hs		545	385	220			
TR15	161	X	Pt	submerged pear-shaped, flat, pointed end facing dstr, yellowy brown on rhs, distinct brown half on lhs, also quartz patches, on grav bed	none		245	152	105			
TR15	162	no	P - 2 blobs	triangular, whitish-red, submerged, small hole on dstr edge	none	SB		399				
TR15	163	X	Pt	rectang. cube, olive-brown, lies in notch formed by meeting of 2 ustr Bs of = size round SB embed, RH B = flatter than LH B	none		115	80	80			
TR15	164	inv = sa net	P	flat, deeply submerged, pear shaped, greenish pinned down by just emerg pinky B with arrow written on it	pinned +deep-lying =hs	SB		494				
TR15	165	X	Pt	oval, flat topped w eye + crevice on dstr end; set immed dstr of golden submg rectangl, flat B, with ustr of that B = emergent scraggly pink B	++ hs = Bs ustr + to lhs		440	275	170			
TR15	166	inv = excl 1/3 top sa	Pt	flat round sb, on edge of channel , b/w formed by boulders up stream, top of #166 just emergent	d/str+u/str B=hs	SB	473	385	180			
TR16	167	X	Pt	oboval SC, dstr of oblong reddy LC/SB w patch of lichen spots on rhs			270	180	116			
TR16	168	inv = sa net?=top surf area?	Pt?	diamond shape ,overlapped by angled u/str LC	pinned by lc=hs	SB		349				
TR16	169	X	Pt	shield/triang shaped, dstr portion angled up and dry, ustr portion submerg, pointy end facing dstr; B embedding #169 = lichen blackened on rhs, clean + striated on lhs			375	265	112			
TR16	170	no	P Pt	rocky red +pink, irregular, pinned by lichen B	in B field = hs	SB		336				
TR16	171	no	Pt	orange pear shaped, tip emergent ustr end	on edge of B field, wedged u/+d/str next to sb's	SB		460				
TR16	172	X	Pt	angular cube, immed dstr of embed SB w tip sticking out; the SB = dirty brown on ustr side, white on dstr side	u/str sb = hs		77	76	62			
TR16	173	X	Pt	small rectangl-flat, narrow side up; 20 cm ustr gold B w "branching eye" on rhs	d/str B = hs		158	115	53			
TR16	174	no	P	oval-pear, embed ustr, dstr end angled up; orange top distinct from gold side by line, shallow scoop on dstr rhs of stone	no real hs		no NEED TO MEASURE					
TR16	175	X	Pt	SC immed on LHS of greyish B w shallow wide scoop on top, top emergent			69	63	35			
TR16	176	X	Pt	30 cm dstr of golden submrg B w pale top and orange streak	u/str B = hs		87	69	39			
TR16	177	no	P	pink submerged SB w flat scooped top, wedged betw 2 emerg B: lhs emerg and angled dstr, rhs pink pyramid w rounded apex	hs= partly B's		no NEED TO MEASURE					
TR16	178	X	Pt	tiny flat white (LG size) stone among mc, white arrow points to it	hs=SC+ MC, some overlapping		70	67	40			
TR17	179	?X	Pt	half-moon white stone in stranded flow	d/+u/str B=hs	LC	220	136	120			
TR17	180	no	P Pt	immov embed MC under (on dstr side) round flat white B w black lichen splotches ??# or lichen B?? = set at angle in bed, has emergent, rounded apex and 3 distinct peg-like holes on rhs dstr end				270				
TR17	[illegible]	X	Pt	flat,squarish white stone with few ridges	up/str hs= slightly emergent sb	LC	287	245	124			
TR17	182	no	Pt	dry lichen B pinned down by very big lichen B in B field		MB		540				
TR17	183	no	P	immov MC deeply embed under stones; grey w striations almost ll flow; pinned by pale brown embed B w cracks near top	between lc & sb+pinned by B		255	130	?			
TR17	184	X	Pt	light gold oval/rectangl, shallow scoop on top; ustr of orange B w lichen splodges; on LHS of grtey/green submrged B w pale line along its equator	pinned down on both sides,on left by lc		365	245	195			
TR17	185	X	Pt	flat, grey, sub-oval, dstr of large emerg fawn B w 1 small lichen spot	b. u/str,d/str & to left =HS	LC	259	212	164			
TR17	186	inv = ? sa net	?P	oval, rectangle with flat faced, prev (in 2003 was, but no longer pinned -stands loose)	hs = size		415	325	150			
TR17	187	no	P	emergent white sb, just upstream of large lichen b	hs=d/str boulder	MB		549				
TR17	[illegible]	X	P Pt	greenish-white round lc with semi flat face	hs=d/str just emergent white sb	SB	325	264	228			
TR17	[illegible]	X	P Pt	rectangl-ish red+orange flat surface angled up a bit at d/str side	no hs	SB	344	277	173			
TR17	190	no	P	immov round-oval, flattish embedd emergent B w ++black lichen, stands on side and at angle facing dstr, just ustr of dark grey/green submrg + embed B w orange line running perp flow			745	615	325			
TR17	191	X	Pt	orange triangular, in dip below packed mc+lc, just u/str of striking red + white mc	hs = u/str lc+mc packed	SC	138	112	69			
TR18	192	no	P	brown w red veins + streaks, fan shape w point facing dstr, deeply embedded w isolepis around	embed		285	275	emb			
TR18	193	no	Pt	dry emergent boulder	u/str hs=lichen boulder	SB		490				
TR18	[illegible]	X	Pt	flat sc under pale orange LC w black veins perp tp flow, this LC half pinned on LHS by emerg lichen B angled dstr	not much, in channel on rhs B field		123	113	43			

2004 FLOODS blue = moved; pink = OUT; — green shading = stones lost in 2003, replaced at setup in 2004 — old stone size incl, followed by NEW stone size where replaced

FLOOD 1 - 10 Jun	BIG FLOOD 2 - 25 Jun	FLOOD 3 - 1 JULY SEARCH	FLOOD 4 - 16 JULY SEARCH	FLOOD 5- 8 August Search	stone no.	potential for invert sample	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost	Stone x (mm)	Stone y (mm)	Stone z (mm)
					140	inv = 1/2 surf area stone	P	white, squareish, lots of ridges on surface, some gold, overlaped by other cobbles (immovable)	335	305	190
					141	X	PM 2 blobs	large oval, bright orange, flat surface up (nearly too big to sample)	475	460	420
	OUT: new stone			OUT	142	X	Pt	old = small rectangle, wedged between 2 lc's (in crevice), long axis into bed, betw striated B and greeny B, all submergd; **NEW 25 Jun: squarish s/stone, angul w planes, fawn + brown, in same place as old**	120 new: 160	66 new:135	42 new: 80
					143	no	P	light gold fat, rounded end u/str, rounded point d/str		590	
					144	no	Pt	blockish, red, emergent creviced		740	
					145	no	P Pt	suboval sticking out of water at angle, lichen spots + 2 eyes on side		490	
					146	X	Pt	flat round browny-red, flat face up, adjacent triangul LC = just emergent	190	172	80
					147	no	Pt	light sb, bottom of long B field, overlapped u/str, emergent		455	
	[illegible]			[illegible]	148	X	Pt	rounded, flat, brownish MC, lying on cobbl bed; immed to right = flat khaki brown cobble, which itself = embed under emerg pink LB w scratches	210	149	90
					149	inv = sa net	P	oval orange, lighter on upstream surface, immovable stone, dstr= flat greenish MB		600	
					150	inv = sa net	P - 2 blobs	submerged large oval-ish with planes+ crevices; fractured hole on top		545	
					151	X	P Pt	round, light, speckled brown LC w greenish tinge; dstr end = embed under large emerg B w 3 eyes on its upper surface	350	235	210
					152	no	Pt	large lichen B with orange X well out of water		705	
					153	X	Pt	olive brown w black specks, #153= 2nd cobble ustr from bright orange B, on LHS dstr = B w rounded apex, 2-tone w darker orange on dstr side; on bed of cobble	273	165	82
				OUT	154	X	Pt	flat brown triangular among sc+mc, surrounded by sb's - all submerged	172	170	90
					155	no	Pt	white irregular shape, flat surface emergent amoung a cluster of lc's		350	
	[illegible]			[illegible]	156	X	Pt	cube shaped, v angular, fractured edges, embed under cob in small cobb bed; ustr = embed oval rock; dstr = emerg angular cobble	161	120	111
					157	no	Pt	immov, embed pale B w mottled brown-orange, cracks / fissures, few black lichen spots, long axis perp flow, lower half = orange	661	570	?
					158	no	Pt	immovable, emerg white rounded B, in mid B bar; flattish on top. Dry-resting on LC/B, thin black lines on ustr end; overlaps enidge of str B	520	480	275
	[illegible]			[illegible]	159	X	Pt	circular; flat with ridges on narrow part of stone facing up stream, only half emergent lodged d/str of lichen B with orange X	208	169	88
				couldn't find	160	no	Pt	too large to sample, oval, long axis perp flow; immed ustr on lhs = sub triangular embed submg B w very flat end facing #160	545	385	220
	OUT - not replaced	replaced this visit ie NO DATA for 30 June flood	[illegible]	[illegible]	161	X	Pt	old = submerged pear-shaped, flat, pointed end facing dstr; yellowy brown on rhs, distinct brown half on lhs, also quartz patches; on grav bed - big hole in river here, prev B's missing; **NEW 25 Jun (repl 1 Jul): light brown oval flattened LC in a channel caused by Bs ustr - little hs**	245 new 325	152 new 280	105 new 125
					162	no	P - 2 blobs	triangular, whitish-red, submerged, small hole on dstr edge		399	
	OUT - not replaced	replaced this visit ie NO DATA for 30 June flood		[illegible]	163	X	Pt	old = rectang, in notch formed by meeting of 2 ustr Bs of = size: round SB embed, RH B = flatter than LHB, **NEW 25 Jun (repl 1 Jul): oval brown/fawn rugby ball MC on other MC; immed dstr of olive brown B w distinctive scoop on ustr point; no hs**	115 new 285	80 new 215	80 new 130
					164	inv = sa net	P	flat, deeply submerged, pear shaped, greenish pinned down by just emerg pinky B with arrow written on it		494	
					165	X	Pt	oval, flat topped w eye + crevice on dstr end; set immed dstr of golden submg rectangl, flat B, with ustr of that B = emergent scraggly pink B	440	275	170
					166	inv = excl 1/3 top sa	Pt	flat round sb, on edge of channel , b/w formed by boulders up stream, top of #166 just emergent	473	385	180
				[illegible]	167	X	Pt	oboval SC, dstr of oblong reddy LC/SB w patch of lichen spots on rhs	270	180	116
				OUT	168	inv = sa net?=top surf area?	Pt?	diamond shape ,overlapped by angled u/str LC		349	
		LC now rolled on top		[illegible]	169	X	Pt	shield/triang shaped, dstr portion angled up and dry, ustr portion submerg, pointy end facing dstr; B embedding #169 = lichen blackened on rhs, clean + striated on lhs	375	265	112
					170	no	P Pt	rocky red +pink, irregular, pinned by lichen B		336	
					171	no	Pt	orange pear shaped, tip emergent ustr end, re-marked		460	
	NOT OUT: but new stone also marked - BOTH IN PLACE				172	X	Pt (old) Pu (new)	old = angular cube; immed dstr of embed SB w tip sticking out; the SB = dirty brown on ustr side, white on dstr side. **NEW 25 Jun: triangul yellow B lifted on dstr side, 1 mm dstr & touching orange/brown SB w black lichen/moss. Puttied on dstr edge**	77 new 430	76 new: 310	62 new ??
	OUT: new stone			[illegible]	173	X	Pt	old = small rectangl-flat, narrow side up, 20 cm ustr gold B w "branching eye" on rhs. **NEW 25 Jun: brown SB, oval & flat on top, immed dstr yell/brown/greeny SB lifted on dstr edge and perp flow**	158 new:340	115 new:310	53 new:220
					174	no	P	oval-pear, embed ustr, dstr end angled up; orange top distinct from gold side by line, shallow scoop on dstr rhs of stone	640	430	emb
	OUT: new stone			OUT	175	X	Pt	old =SC immed on LHS of greyish B w shallow wide scoop on top, top emergent; **NEW 15 Jun: s/mc, green w brown blotches or speckles, angular, longer than wide**	69 new:100	63 new:65	35 new:55
	OUT: new stone				176	X	Pt	old = 30 cm dstr of golden submrg B w pale top and orange streak; **NEW 25 Jun: green/brown triangular MC, flat end ustr**	87 new:310	69 new:150	39 new:75
					177	no	P	pink submerged SB w flat scooped top, wedged betw 2 emerg B: lhs emerg and angled dstr, rhs pink pyramid w rounded apex	520	410	emb
				OUT	178	X	Pt	tiny flat white (LG size) stone among mc, white arrow points to it	70	67	40
					179	?X	Pt	half-moon white stone in stranded flow	220	136	120
					180	no	P Pt	immov embed MC under (on dstr side) round flat white B w black lichen splotches ??# or lichen B?? = set at angle in bed, has emergent, rounded apex and 3 distinct peg-like holes on rhs dstr end		270	
	[illegible]				181	X	Pt	flat,squarish white stone with few ridges	287	245	124
					182	no	Pt	dry lichen B pinned down by very big lichen B in B field		540	
					183	no	P	immov MC deeply embed under stones; grey w striations almost ll flow; pinned by pale brown embed B w cracks near top	255	130	?
	[illegible]				184	X	Pt	light gold oval/rectangl, shallow scoop on top, ustr of orange B w lichen splodges; on LHS of grtey/green submrged B w pale line along its equator	365	245	195
				[illegible]	185	X	Pt	flat, grey, sub-oval, dstr of large emerg fawn B w 1 small lichen spot	259	212	164
	OUT: new stone			[illegible]	186	inv = ? sa net	?P	old = oval, rectangle with flat faced, prev (in 2003 was, but no longer pinned -stands loose). **NEW 25 Jun: round - triang, flat, light orange brown MC; no hs; on bed of MC in FRF**	415 new:280	325 new:270	150 new:110
					187	no	P	emergent white sb, just upstream of large lichen b		549	
	[illegible]		[illegible]	[illegible]	188	X	P Pt	greenish-white round lc with semi flat face	325	264	228
	[illegible]				189	X	P Pt	rectangl-ish red+orange flat surface angled up a bit at d/str side	344	277	173
					190	no	P	immov round-oval, flattish embedd emergent B w ++black lichen, stands on side and at angle facing dstr, just ustr of dark grey/green submrg + embed B w orange line running perp flow	745	615	325
					191	X	Pt	orange triangular, in dip below packed mc+lc, just u/str of striking red + white mc	138	112	69
					192	no	P	brown w red veins + streaks, fan shape w point facing dstr, deeply embedded w isolepis around. **16 Jul:** less isolep. covered by 1 cm	285	275	emb
					193	no	Pt	dry emergent boulder		490	
	[illegible]	[illegible]	[illegible]	OUT	194	X	Pt	flat sc under pale orange LC w black veins perp tp flow, this LC half pinned on LHS by emerg lichen B angled dstr	123	113	43

MOLENAARS RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE 2004

Second season set-up stone data - May 2004 green shading indicates stones that were lost in 2003 & replaced during setup 2004 red = corrected measurements for 2003 stones 2004 FLOODS blue = moved; pink = OUT; green shading = stones lost in 2003, replaced at setup in 2004 old stone size incl. followed by NEW stone size where replaced

stone no.	invert sample	Putty (P) Paint (PT)	description	hydraulic shelter	Stone Categories	Stone x (mm)	Stone y (mm)	Stone z (mm)	revs / 60 sec (bucket type)	depth (cm)	Velocity (m/s) From rating tables	FLOOD 1 - 10 Jun	BIG FLOOD 2 - 25 Jun	FLOOD 3 - 1 JULY SEARCH	FLOOD 4 - 16 JULY SEARCH	FLOOD 5- 8 August Search
TR18	195	no	P Pt	immov lichen B hidden in B field	hs = boulder field	MB		612								
TR18	196	X	P Pt	orange-red, semi-sq, just to rt of B field; ridges on upper flat surface	big lichen B turned over last winter now + hs, plus white lichn B	SB	410	273	180							
TR18	197	no	Pt	large, protruding lichen B	no hs	MB		772								
TR18	[illegible]	X	Pt	oblong, purple w green + white veins, v striking, dstr tip[points up but submerged; on top of large LC	no real hs		375	191	104				[illegible]			[illegible]
TR18	199	X	Pt	squaresh grey MC, narrow end up, mostly embed in gravel; #199 = dstr and rhs of pink LC w orange striations ll flow and rhd of smaller pink MC w weaker striations			295	210	204							OUT
TR18	[illegible]	X	Pt	round grey flat mc w old magnet plug v distinct; immed dstr of orange SB which = slightly embed and has cracks on rhs	hs = SB		335	265	95				[illegible]			[illegible]
TR18	[illegible]	X	Pt	subovat, med brown, flattish top, immed dstr white/red emergent log-like B			255	190	120				[illegible]			[illegible]
TR18	202	X	Pt	red+black patchy sc in deep run, just dstr of oblong greeny brown LC w long axis perp to flow	d/str hs = submerged B, but 0.5 m dstr	SC	125	104	82							OUT
TR18	203	no	P Pt	large irregshape, flat faced grey lc with face angled	no hs	SB		479								
TR18	204	no	P Pt	sb - embedded in bank	b + bank = hs	SB		374								
TR19	205	X	Pt	semi oval, greyish mc surround by isolepis	hs u/str = B adj to bank	SB	214	249	155							
TR19	[illegible]	X	P Pt	round reddish mc with flat top + ridges, just slightly emergent	u/str lc also submg = + hs	SB	379	339	184				[illegible]			
TR19	207	?X	Pt	emergent white cream, irregular shape at top of B field, wedged ustr of 2 embed Bs w lichen	d/str B field = hs	LC	410	227	195							
TR19	208	X	Pt	rect-oval flat dirty brown LC w whiter band on top, the dstr rhs = embed under olive brown/green LC. immed dstr = pale grey SB just emergent and w striations ll flow and holes on rhs of B	d/str b = hs		315	229	100							
TR19	209	X	?P	creamwith lots of darkbrown mottle, sub-oval between 2 lichen B, pencil #	not really B at side but does not overlap	LC	446	174	122							
TR19	210	no	P	large round flat with ridges creamy colour	no hs	MB		682								
TR19	211	?X	Pt	oval creamy green LC, on SC/MC bed; immed ustr of dirty brown creamy LC w large single quartz eye			306	230	164							
TR19	212	?X	Pt	(=old stone #251) creamy brown oval flat faced lc w striations, on LHS = orange submrg B w open hole on its rh surface and this B forms ihs of chute	no hs		310	250	185				OUT: new stone			
TR19	213	no	P	immov embed submerged pink/grey B w plane on upstr rh surface and eye on dstr end w putty, surrounded by SC			435	300	?							
TR19	214	no	P	long red ridged with patches, perpendic to current, embedd	hs = 'cos embedded lower than adj stones	SB		369								
TR19	215	X	Pt	red, sub-oval, flat face, u/str of emergent lichen B	hs = orange lichen B d/str	SB	295	257	112							
TR19	216	no	Pt	immov large cream oval, B embedded, in bank with lichen spots	hs = embedded in bank, b u/str	MB		570								
TR20	217	no	P Pt	small embedded but emergent , red, ridged betw big lichen B d/str + red ridged lc u/str	wedged between u/str + d/str B = hs	SB	305	190								
TR20	218	no	P Pt	immov orange lichen boulder pinned by u/str large white boulder	u/str B pinning = hs	MB	600	695								
TR20	[illegible]	X	P Pt	orangy red triangle flat face, pointed end, between 2 LC, d/str bp emrgent	no hs	SB	490	320	190				[illegible]		[illegible]	
TR20	220	X	Pt	brown sc, in crook betw 2 emergent lichen Bs, on right, d/str of submerged flat lc, in hole	b d/str & to right + u/str lc = hs	SC	130	110	74				OUT: new stone			OUT
TR20	221	no	P Pt	immov, embed B, lichen, largest in vicinity	hs = smaller Bs d/str which are also shielded by it		1300	1100	?							
TR20	222	no	P	flat oval gold MC, pinned ustr by oval flattish orange-brown SB w crescent crevice on ihs, top of cresc points to hole			470	270	?							
TR20	[illegible]	X	Pt	brown flat broadly pear-shaped w point dstr and lines on dstr top surface; immed left of orange SB w deep fracture on its rh surface; dstr = creamy pink LC w flat face and dstr edge angled up	in chute betw Bs - orange + white at 1 o clock		360	335	92				[illegible]		[illegible]	[illegible]
TR20	224	X	Pt	flattish round creamy grey green, on rhs of grey brown submerged B w smooth top; #224 =ustr of emerg rectangl SB w some cracks and dstr edge angled up; on cobbl bed	d/str + ihs = hs of Bs		410	360	145							
TR20	225	X	Pt	red brown flat MC (prev displaced magnet rock), 30 cm dstr of chute betw embed lichen B rhs one w striations ll flow, LLHS one orange w ridge	no hs - in chute betw Bs		220	182	90							
TR20	226	no	Pt	embedd, round flattish brown b just d/str of circle of emergent Bs just emergent	hs = circle of b's, ustr Bs emerg	SB	475	387								
TR20	227	X	Pt	light brown MC, speckleD 1/2 rectangle 1/2 circle, flat face, u/str of lichen B	hs = 2 B down stream on ihs, none on rhs	LC	287	221	171							
TR20	228	no	?P Pt	immov flat cream brown LC embed into bank; dstr of oval flat lichen B	set in bank		475	310								
TR21	229	no	P Pt	lichen lc, dry, at edge af channel immovabe - set into bank	hs=B u/str + bank	?	255	230								
TR21	230	no	P Pt	large lichen B	no larger stuff around	MB	935	720								
TR21	231	no	P Pt	dry browny white sb, adjacent large smooth lichen B + u/str another red lichen B	d/str b=hs	SB	505	391								
TR21	232	X	P	rectangular flat faced, in shelter of 2 lichen Bs	hs=u/str b.'s	SB	362	286	149							
TR21	233	no	P Pt	emergent, light brown, sb with b.'s u/str & d/str	hs=u & d/str b's u/str b. slightly over/lapping	SB	500	475								
TR21	234	X	Pt	large ovalish, flat face orange + cream B, w concave reddish bit on dstr side, long axis perpendicular to flow	hs=d/str submerged & emergent b's	SB	382	305	142							
TR21	235	no	P - 2 blobs	immov golden brown round MC, flat topand black spots on ustr edge; pinned ustr by creamy green rectangl LC w orange dot on ihs	pinned		370	305	150							
TR21	236	no	P	immov large, flattish wirey golden submerged B	no hs but big		805	775	?							
TR21	237	X	Pt	round flat brown speckled SC immed ustr grey pear shaped MC, point on dstr end; # 237 on LHS of flat round orange subm SB. #237 and pear = more deeply set	not much		147	127	73				OUT: new stone			
TR21	238	no	P - 2 blobs	immov + embed angular-rectang orang + pink at 45 degr to flow; ustr end in grav, dstr end in cobble. Slightly dtrs of t/sect	u/str orange X B = hs		470	165	165							
TR21	239	no	P - 3 blobs	orange oval lc, pinned by adjacent white emergent B with lichen; the no. on the putty = partially offl/smudged	pinned on side + d/str B = hs	SB		414								
TR21	240	inv = sa net	P	flat white + orange submerged with crevice lines, another flat SB on top of part of the stone; rem = visible; long emerg B on LHS	pinned by B on top = hs	MB		542								
TR21	241	X	Pt	angular brown + pink emergent; betw 2 embed white lichen spotted Bs, both embed in bank	hs = white B in bank		235	200	120							
TR22	242	X	Pt	emergent white with deep red teeth/triangle shapes, angular, just/d/str of large irregular red raggedy B in b/w	hs= u/str red B	LC	327	172	102							OUT
TR22	243	X	Pt	angular rectang cube, quartz + red marbled, dstr end up, off LHS point of emerg pink lichen B, ustr ?= olive brown rock	no		149	133	100							OUT
TR22	244	no	?P Pt	embedd immov irreg-oval shaped brown B in lichen B	hs = u/str series of lc -sb in line	MB		560								
TR22	245	no	Pt	large creamy oval B, flattish side facing u/str; smaller Bs packed at dstr side	no immed hs	MB		844								
TR22	246	no	P	olive grey-green, triangular embed submerg SB, planes on rh side and large "nose" scratched in surface; #246 = ustr and on rhs of orange X B			765	600	?							
TR22	247	X	Pt	white irregular, planar surfaces facing flow which comes sideways between u/str + d/str B's. Huge lichen B sits proud on tope of 2 Bs just ustr + on either side of #247, w flow underneath lichen B	hs between 2 emergent u & rhs B's, open dstr	SB	311	222	145							
TR22	[illegible]	X	Pt	oval greeny-orange, flat topped LC, ustr + to LHS of dirty white LC, on LHS of orange brown emerg LC	2 d/str submerged b's (not big) =lshly hs		425	285	235				[illegible]			[illegible]
TR22	249	no	P	large submerged yellow-gold round + domed immov B, sits lower than Bs around it	just u/str = smaller orange B, but sitting higher in the bed		970	710	?							
TR22	250	no	Pt	immov white-orange round emergent B	d/str B sort of hs but not adjacent	MB		524								
TR22	251	X	Pt	white flat mc, 10 cm ustr = v flat round orange-green plate-like B and 3 cm dstr = light grey pyramid log	no hs		152	145	63				OUT: new stone			
TR22	252	X	Pt	whitish red flat square sc, angled upward at d/str end against large grey embedded B	no hs	LC	180	178	82				OUT: new stone			[illegible]
TR22	[illegible]	X	Pt	orange white w red splash, angular, narrow end facing up = rectangular; dstr of emerg embed white B w dstr end angeld up	hs = flat u/str B-not much		138	73	53				[illegible]			[illegible]
TR23	254	no	P Pt	emergent brown, flattish tri angularish b	hs = u/str boulder clump	SB		460								

stone no.	potential for invert sample	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost	Stone x (mm)	Stone y (mm)	Stone z (mm)
195	no	P Pt	immov lichen B hidden in B field		612	
196	X	P Pt	orange-red, semi-sq, just to rt of B field; ridges on upper flat surface	410	273	180
197	no	Pt	large, protruding lichen B		772	
198	X	Pt	oblong, purple w green + white veins, v striking, dstr tip[points up but submerged; on top of large LC	375	191	104
199	X	Pt	squaresh grey MC, narrow end up, mostly embed in gravel; #199 = dstr and rhs of pink LC w orange striations ll flow and rhd of smaller pink MC w weaker striations	295	210	204
200	X	Pt	round grey flat mc w old magnet plug v distinct; immed dstr of orange SB which = slightly embed and has cracks on rhs	335	265	95
201	X	Pt	subovat, med brown, flattish top, immed dstr white/red emergent log-like B	255	190	120
202	X	Pt	red+black patchy sc in deep run, just dstr of oblong greeny brown LC w long axis perp to flow	125	104	82
203	no	P Pt	large irregshape, flat faced grey lc with face angled		479	
204	no	P Pt	sb - embedded in bank		374	
205	X	Pt	semi oval, greyish mc surround by isolepis	214	249	155
206	X	P Pt	round reddish mc with flat top + ridges, just slightly emergent	379	339	184
207	?X	Pt	emergent white cream, irregular shape at top of B field, wedged ustr of 2 embed Bs w lichen	410	227	195
208	X	Pt	rect-oval flat dirty brown LC w whiter band on top, the dstr rhs = embed under olive brown/green LC. immed dstr = pale grey SB just emergent and w striations ll flow and holes on rhs of B	315	229	100
209	X	?P	creamwith lots of darkbrown mottle, sub-oval between 2 lichen B, pencil #	446	174	122
210	no	P	large round flat with ridges creamy colour		682	
211	?X	Pt	oval creamy green LC, on SC/MC bed; immed ustr of dirty brown creamy LC w large single quartz eye	306	230	164
212	?X	Pt	old = (=old stone #251) creamy brown oval flat faced lc w striations, on LHS = orange submrg B w open hole on its rh surface and this B forms ihs of chute. **NEW 25 Jun: oval, brown, 1 m dstr of yellow SB**	310 new:100	250 new:95	185 new:80
213	no	P	immov embed submerged pink/grey B w plane on upstr rh surface and eye on dstr end w putty, surrounded by SC	435	300	?
214	no	P	long red ridged with patches, perpendic to current, embedd		369	
215	X	Pt	red, sub-oval, flat face, u/str of emergent lichen B	295	257	112
216	no	Pt	immov large cream oval, B embedded, in bank with lichen spots		570	
217	no	P Pt	small embedded but emergent , red, ridged betw big lichen B d/str + red ridged lc u/str	305	190	
218	no	P Pt	immov orange lichen boulder pinned by u/str large white boulder	600	695	
219	X	P Pt	orangy red triangle flat face, pointed end, between 2 LC, d/str bp emrgent	490	320	190
220	X	Pt	old = brown sc, in crook betw 2 emergent lichen Bs, on right, d/str of submerged flat lc, in hole; **NEW 25 Jun: round dirty brown SC**	130 new:100	110 new:75	74 new:50
221	no	P Pt	immov, embed B, lichen, largest in vicinity	1300	1100	?
222	no	P	flat oval gold MC, pinned ustr by oval flattish orange-brown SB w crescent crevice on ihs, top of cresc points to hole	470	270	?
223	X	Pt	brown flat broadly pear-shaped w point dstr and lines on dstr top surface; immed left of orange SB w deep fracture on its rh surface; dstr = creamy pink LC w flat face and dstr edge angled up	360	335	92
224	X	Pt	flattish round creamy grey green, on rhs of grey brown submerged B w smooth top; #224 =ustr of emerg rectangl SB w some cracks and dstr edge angled up; on cobbl bed	410	360	145
225	X	Pt	red brown flat MC (prev displaced magnet rock), 30 cm dstr of chute betw embed lichen B rhs one w striations ll flow LLHS one orange w ridge	220	182	90
226	no	Pt	embedd, round flattish brown b just d/str of circle of emergent Bs just emergent	475	387	
227	X	Pt	light brown MC, speckleD 1/2 rectangle 1/2 circle, flat face, u/str of lichen B	287	221	171
228	no	?P Pt	immov flat cream brown LC embed into bank; dstr of oval flat lichen B	475	310	
229	no	P Pt	lichen lc, dry, at edge af channel immovabe - set into bank	255	230	
230	no	P Pt	large lichen B	935	720	
231	no	P Pt	dry browny white sb, adjacent large smooth lichen B + u/str another red lichen B	505	391	
232	X	P	rectangular flat faced, in shelter of 2 lichen Bs	362	286	149
233	no	P Pt	emergent, light brown, sb with b.'s u/str & d/str	500	475	
234	X	Pt	large ovalish, flat face orange + cream B, w concave reddish bit on dstr side, long axis perpendicular to flow	382	305	142
235	no	P - 2 blobs	immov golden brown round MC, flat topand black spots on ustr edge; pinned ustr by creamy green rectangl LC w orange dot on ihs	370	305	150
236	no	P	immov large, flattish wirey golden submerged B	805	775	?
237	X	Pt	old = round flat brown speckled SC immed ustr grey pear shaped MC, point on dstr end; # 237 on LHS of flat round orange subm SB. #237 and pear = more deeply set; **NEW 25 Jun triang fawn SC immed ustr of round flat MC**	147 new:130	127 new:110	73 new:65
238	no	P - 2 blobs	immov + embed angular-rectang orang + pink at 45 degr to flow; ustr end in grav, dstr end in cobble. Slightly dtrs of t/sect	470	165	165
239	no	P - 3 blobs	orange oval lc, pinned by adjacent white emergent B with lichen; the no. on the putty = partially offl/smudged		414	
240	inv = sa net	P	flat white + orange submerged with crevice lines, another flat SB on top of part of the stone; rem = visible; long emerg B on LHS		542	
241	X	Pt	angular brown + pink emergent; betw 2 embed white lichen spotted Bs, both embed in bank	235	200	120
242	X	Pt	emergent white with deep red teeth/triangle shapes, angular, just/d/str of large irregular red raggedy B in b/w	327	172	102
243	X	Pt	angular rectang cube, quartz + red marbled, dstr end up, off LHS point of emerg pink lichen B, ustr ?= olive brown rock	149	133	100
244	no	?P Pt	embedd immov irreg-oval shaped brown B in lichen B		560	
245	no	Pt	large creamy oval B, flattish side facing u/str; smaller Bs packed at dstr side		844	
246	no	P	olive grey-green, triangular embed submerg SB, planes on rh side and large "nose" scratched in surface; #246 = ustr and on rhs of orange X B	765	600	?
247	X	Pt	white irregular, planar surfaces facing flow which comes sideways between u/str + d/str B's. Huge lichen B sits proud on tope of 2 Bs just ustr + on either side of #247, w flow underneath lichen B	311	222	145
248	X	Pt	oval greeny-orange, flat topped LC, ustr + to LHS of dirty white LC, on LHS of orange brown emerg LC	425	285	235
249	no	P	large submerged yellow-gold round + domed immov B, sits lower than Bs around it	970	710	?
250	no	Pt	immov white-orange round emergent B		524	
251	X	Pt	old = white flat mc, 10 cm ustr = v flat round orange-green plate-like B and 3 cm dstr = light grey pyramid log; **NEW 25 Jun: reotl, flat fawn MC**	152 new:250	145 new:155	63 new:90
252	X	Pt	old = whitish red flat square sc, angled upward at d/str end against large grey embedded B; **NEW 25 Jun: round brown flat SC w rough edges**	180 new:155	178 new:150	82 new:65
253	X	Pt	orange white w red splash, angular, narrow end facing up = rectangular; dstr of emerg embed white B w dstr end angeld up	136	73	53
254	no	P Pt	emergent brown, flattish tri angularish b		460	

Second season set-up stone data - May 2004 green shading indicates stones that were lost in 2003 ... light orange - stone from 2003 discarded (NOT necc OUT) for new marked one

Second season set-up stone data - May 2004 green shading indicates stones that were lost in 2003 and replaced during setup 2004 | red = corrected measurements for 2003 stones | 2004 FLOODS blue = moved; pink = OUT; | green shading = stones lost in 2003, replaced at setup in 2004 | old stone size incl. followed by NEW **stone size** where replaced

	stone no.	invert sample	Putty (P) Paint (PT)	description	hydraulic shelter	Stone Categories	Stone x (mm)	Stone y (mm)	Stone z (mm)	revs / 60 sec (bucket type)	depth (cm)	Velocity (m/s) From rating tables	FLOOD 1 - 10 Jun	BIG FLOOD 2 - 25 Jun	FLOOD 3 - 1 JULY SEARCH	FLOOD 4 - 16 JULY SEARCH	FLOOD 5- 8 August Search	stone no.	potential for invert sample	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost	Stone x (mm)	Stone y (mm)	Stone z (mm)
TR23	255	inv = 1/2 tot stone area - top and 1/2 sides	Pt	squarish golden sb., with round top, crags+crevises, tip emergent, under Salix and almost covered by isolepis	d/str emerg B = 0.5 m away. 2m ustr transect = large sandstone Bs	SB	439	369	210									255	inv = 1/2 tot stone area - top and 1/2 sides	Pt	squarish golden sb., with round top, crags+crevises, tip emergent, under Salix and almost covered by isolepis	439	369	210
TR23	256	?X	Pt	white round, flat top; dstr of orange embed B w striations + dstr lichen pink LB; on SC	no real hs except Sstone Bs ustr		425	425	240									256	?X	Pt	white round, flat top, dstr of orange embed B w striations + dstr lichen pink LB, on SC	425	425	240
TR23	257	no	Pt	oval white sb emergent, d/str + to right of red blockish Sstone LB	u/str LB, dstr = open	SB	435	313	175									257	no	Pt	oval white sb emergent, d/str + to right of red blockish Sstone LB	435	313	175
TR23	258	X	Pt	brown flat rectangl on LHS of oblong orange embed which lies transverse to flow, w lighter ustr end, and dstr of round flat B w crevice. Both these Bs = submerged	betw these Bs = emerg brown scraggly oval B, which = 20 cm ustr of #258 (main hs)		410	255	115								[illegible]	258	X	Pt	brown flat rectangl on LHS of oblong orange embed which lies transverse to flow, w lighter ustr end, and dstr of round flat B w crevice. Both these Bs = submerged	410	255	115
TR23	259	no	Pt	emergent rectangular white lc/sb with scratchy + irregular top - lying perpendicular to current	u+d/str B+ lc clumps	SB	535	251	?									259	no	Pt	emergent rectangular white lc/sb with scratchy + irregular top - lying perpendicular to current	535	251	?
TR23	260	no	? P or Pt	pear- shaped lc, pointy side facing u/str, immed dstr of + touching oval orange submerg B	not much - u/str B, + 1m d/str = lichen B	SB	495	346	159									260	no	? P or Pt	pear- shaped lc, pointy side facing u/str, immed dstr of + touching oval orange submerg B	495	346	159
TR23	261	no	P	just submerged, too big to sampl. White dirty on top, round, flattop: Grey B on rhs = same size and emergent	no		720	565	?									261	no	P	just submerged; too big to sampl. White dirty on top, round, flattop; Grey B on rhs = same size and emergent	720	565	?
TR23	262	X	Pt	flat red brown sc, immed ustr submerged orange SB which has dstr end angled up, on SC bed	no real hs: 40 cm ustr = in line w #262 = whitish submg B w lich spots		181	140	70					OUT: new stone			[illegible]	262	X	Pt	old = flat red brown sc, immed ustr submerged orange SB which has dstr end angled up, on SC bed; **NEW 25 Jun: rectL white SC**	181 new:200	140 new:150	70 new:70
TR23	263	no	Pt	large emergent darkish brown B, whitey-brown on emergent bit	no hs, except has collected LCs around it	MB		587										263	no	Pt	large emergent darkish brown B, whitey-brown on emergent bit		587	
TR23	264	no	P	emergent golden pear shaped, point d/str, deeply submerged w overlapping mc at top end, d/str of lichen B	lichen B upstream = hs; also #264 = deeply set	SB		315										264	no	P	emergent golden pear shaped, point d/str, deeply submerged w overlapping mc at top end, d/str of lichen B		315	
TR23	265	no	P	diamond orange,pinned by lichen B, with scribble - irregular surface; white B on other side w prominent holes! (could sample in 2003, but now immov)	wedged betw 2 Bs	SC	252	115	115									265	no	P	diamond orange,pinned by lichen B, with scribble - irregular surface; white B on other side w prominent holes! (could sample in 2003, but now immov)	252	115	115
TR24	266	no	Pt	emergent large irregular red boulder with lichen spots	smaller B u/str + d str =hs(part)	MB		640										266	no	Pt	emergent large irregular red boulder with lichen spots		640	
TR24	267	no	Pt	emergent flat oval sb,with narrow side facing up at angle; pinned by stacked lc on u/str end + big red sandstone B above this	pinned	SB		400							B now on top			267	no	Pt	emergent flat oval sb,with narrow side facing up at angle; pinned by stacked lc on u/str end + big red sandstone B above this		400	
TR24	268	X	Pt	emergent, angular, irreg, pink, narrow side up, slightly embedd ustr under flat orange B, itself pinned by 2 large Sstone Bs; but #268 protrudes futher than the flat orange B	in gap betw Sstone Bs		500	305	180									268	X	Pt	emergent, angular, irreg, pink, narrow side up; slightly embedd ustr under flat orange B, itself pinned by 2 large Sstone Bs, but #268 protrudes furher than the flat orange B	500	305	180
TR24	269	no	Pt	emerg golden sB with ring of lichen above water level		SB		465										269	no	Pt	emerg golden sB with ring of lichen above water level		465	
TR24	270	X	Pt	round, flat top, immed dstr emb + emerg white B, + ustr of deeply submrg orange B to left; on grav bed	hs = u/str, sides + dstr = open		220	182	125					OUT: new stone				270	X	Pt	old = round, flat top, immed dstr emb + emerg white B, + ustr of deeply submrg orange B to left; on grav bed; **NEW 25 Jun: oval brown SC, rounded not flat**	220 new:170	182 new:115	125 new:85
TR24	271	no	Pt	emergent red Sstone triangular SB, broad base up ie standing on apex	no		600	380	230									271	no	Pt	emergent red Sstone triangular SB, broad base up ie standing on apex	600	380	230
TR24	272	X	Pt	round-oval red brown, dstr of light gold SB, itslef pinned by emerg brown SB = hs; on LHS of #272 = grey embedd LC	emerg brown SB isolated - not much hs		330	270	245								OUT	272	X	Pt	round-oval red brown, dstr of light gold SB, itslef pinned by emerg brown SB = hs; on LHS of #272 = grey embedd LC	330	270	245
TR24	273	X	Pt	irreg shap, dstr of creamy orange LC and LHS of flatteneed grey pear shaped irreg MC. # 273 = exactly dstr of 30 cm gap betw 1 orange (tip emerg) and 1 brown (just submrg) Bs - should form chute	no		235	188	120					NOT OUT: but new stone also marked - BOTH IN PLACE			[illegible]	273	X	Pt	old = irreg shap, dstr of creamy orange LC and LHS of flatteneed grey pear shaped irreg MC. # 273 = exactly dstr of 30 cm gap betw 1 orange (tip emerg) and 1 brown (just submrg) Bs - should form chute. **NEW 25 Jun: round brown B, submgd immov, pinned on ustr end by orange splotchy SB, new marker = PUTTY. 16 JUL - both found in place - ie cont to monitor both**	235 new:420	188 new:270	120 new: emb
TR24	274	X	Pt	oblong grey 1/2 french loaf, at RH point of grey diamond embed submrg B; on LHS of orange + white patchy LC. Dstr of #274 = submrg oblong obelisk, itself next to emergent dark brown triang B w small eyes	no hs		230	114	87					[illegible]			OUT	274	X	Pt	oblong grey 1/2 french loaf, at RH point of grey diamond embed submrg B; on LHS of orange + white patchy LC. Dstr of #274 = submrg oblong obelisk, itself next to emergent dark brown triang B w small eyes	230	114	87
TR24	275	inv = sa net	P - 2 blobs	orange, deeply embed on LHS, plane on lhs. Immed ustr of the orange B pinned down by purple-brown emergent B, (larger orange B dstr ?= old stone, lost marking)	deep setting = hs		575	450	?							putty off	couldn't find	275	inv = sa net	P - 2 blobs	orange, **deeply** embed on LHS, plane on lhs. Immed ustr of the orange B pinned down by purple-brown emergent B, (larger orange B dstr ?= old stone, lost marking)	575	450	?
TR24	276	X	Pt	angular white prev (2003) displaced, on LHS of just submrg orange/white B w scoop on top, dstr of round embedd LC, orange on top, grey rh surface	in hole formed by Bs but hole too big to be hs		160	148	110					[illegible]			[illegible]	276	X	Pt	angular white prev (2003) displaced, on LHS of just submrg orange/white B w scoop on top, dstr of round embedd LC, orange on top, grey rh surface	160	148	110
TR24	277	no	Pt	emergent light brown LC amongs gravel; immed ustr of embed orange LC w white striations at 45 degr to flow	no		460	415	200									277	no	Pt	emergent light brown LC amongs gravel; immed ustr of embed orange LC w white striations at 45 degr to flow	460	415	200
TR24	278	X	Pt	oblong grey gravel, ustr + on rhs of emergent splotchy white + brown, deeply embedded MC. #278 = at 7 o clock and 1 m from stage pipe	close to bank, no real hs		88	46	29								OUT	278	X	Pt	oblong grey gravel, ustr + on rhs of emergent splotchy white + brown, deeply embedded MC. #278 = at 7 o clock and 1 m from stage pipe	88	46	29
TR25	279	no	Pt	large rectangular sandstone b. one of a stack	hs = u/str+d/str stack of b 's	SB		500										279	no	Pt	large rectangular sandstone b. one of a stack		500	
TR25	280	no	P Pt	orange, bullet -shaped b. ,with flat surface, just emergent; lhs of stone w fracture on corner	d/str of a ridge of large s/stone Bs	MB		624										280	no	P Pt	orange, bullet -shaped b. ,with flat surface, just emergent; lhs of stone w fracture on corner		624	
TR25	281	X	Pt	orange sc in hole - 2 Bs lying next a short dist apart u/dstr from each other create deeper transverse channel ie perp to flow: #281 in there	in transverse hole = ? Hs		130	105	60					OUT: new stone				281	X	Pt	u/dstr from each other create deeper transverse channel ie perp to flow: #281 in there; **NEW 25 Jun: submg flat B w cracks on top; #281 = dstr + left of red/fawn angul S/stone B**	130 new:570	105 new:475	60 new:emb
TR25	282	inv = sa net	P	submerged flat orange oval B, pinned down by huge s/stone ridged B	d/str huge B ridge	MB		566										282	inv = sa net	P	submerged flat orange oval B, pinned down by huge s/stone ridged B		566	
TR25	283	X	Pt	oblong, brown-gold in circle of MC/LC, largest of ring = on rhs and ustr	no hs		390	290	199									283	X	Pt	oblong, brown-gold in cricle of MC/LC, largest of ring = on rhs and ustr	390	290	199
TR25	284	no	P	embedd submerged orange + white irreg B, +/- pear shaped w point facing dstr: pinned down by emergent white scraggly B.	hs = white pinning B	B	515	360	190									284	no	P	embedd submerged orange + white irreg B, +/- pear shaped w point facing dstr; pinned down by emergent white scraggly B.	515	360	190
TR25	285	no	P	another flat orange rectangular B, submerged	emergent oval lichen B	SB	760	465	325									285	no	P	another flat orange rectangular B, submerged	760	465	325
TR25	286	X	Pt	round pinkish orange mc-lc, between 2 white lc, but d/str end open	not much	SB	339	260	152					[illegible]				286	X	Pt	round pinkish orange mc-lc, between 2 white lc, but d/str end open	339	260	152
TR25	287	X	Pt	round-oval green flat, ustr of orange emergent B. Ustr of #287 = v large flat v. gold + red submrg B, round /pear shaped, flat top. On LHS of #287 = v blocky white LC	no real hs		245	206	110								OUT	287	X	Pt	round-oval green flat, ustr of orange emergent B. Ustr of #287 = v large flat v. gold + red submrg B, round /pear shaped, flat top. On LHS of #287 = v blocky white LC	245	206	110
TR25	288	no	?Pt	large but tip emergent, white B, d/str of even larger white emergent lichen B	u/str lichen B = hs	SB	590	462	370									288	no	?Pt	large but tip emergent, white B, d/str of even larger white emergent lichen B	590	462	370
TR25	289	no	Pt	emergent creamy lichen B	dstre emergent B	MB		548										289	no	Pt	emergent creamy lichen B		548	
TR25	290	no	Pt	emergent creamy lichen B	none, but BIG	MB		658										290	no	Pt	emergent creamy lichen B		658	
TR26	291	X	Pt	brown oval rounded top, axis perp to flow; covered by isolepis, resting on RHS of submrg orange B w 2 small distinct quartz spots	no real hs		307	155	141					[illegible]				291	X	Pt	brown oval rounded top, axis perp to flow, covered by isolepis, resting on RHS of submrg orange B w 2 small distinct quartz spots	307	155	141
TR26	292	X	Pt	white, semi diamond irregular surface, on sand between embedded B's	hs=not much: lichen B d/str	LC	290	214	128									292	X	Pt	white, semi diamond irregular surface, on sand between embedded B's	290	214	128
TR26	294	no	P - 1 blob	deep embedded orange lc, pinned by emergent white B with one angular side	B pinning =hs	SB		340										294	no	P - 1 blob	deep embedded orange lc, pinned by emergent white B with one angular side		340	
TR26	295	inv = 1/2 tot stone area	P	immov whitish fawn lc on gravel with 3 emergent B's upstream	u/str B's =hs	SB	367	285	165									295	inv = 1/2 tot stone area	P	immov whitish fawn lc on gravel with 3 emergent B's upstream	367	285	165
TR26	296	X	Pt	white oblong, almost traingle, purple patches in fractured scoops; in deep hole ustr of V formed by 2 emerg white Bs: RH one w lichen on top	hs = 2 large emerg Bs, one w lichen		455	245	195									296	X	Pt	white oblong, almost traingle, purple patches in fractured scoops, in deep hole ustr of V formed by 2 emerg white Bs RH one w lichen on top	455	245	195
TR26	297	no	P	tip-emergent, orange B with pointed top	hs=because the B= packed against d/str sb+lichen B	SB	735	545	135									297	no	P	tip-emergent, orange B with pointed top	735	545	135
TR26	298	no	P	immov, submerged, grey flat circular, with 2 white spots downstream tip (in addit to putty)	somewhat embedded between lc=+-hs	SB	345	315	127									298	no	P	immov, submerged, grey flat circular, with 2 white spots downstream tip (in addit to putty)	345	315	127
TR26	299	inv = sa net	Pt P	large embedded fawn B with scratchy tip just emergent	hs=part -other emergent u/str B's	MB	895	535	322				-					299	inv = sa net	Pt P	large embedded fawn B with scratchy tip just emergent	895	535	322
TR26	300	no	P	submerged large orange B, embedded. NB 2 m from #299	hs = emergent u/+d/str white B(bigger d/str)	MB	1005	605	225									300	no	P	submerged large orange B; embedded. NB 2 m from #299	1005	605	225
TR26	301	X	Pt	exactly next to oint edge of #300; oboval w fracture, set in semi hollow nest to #300	no hs		220	180	130					NOT OUT: but new stone also marked - BOTH IN PLACE	[illegible]		OUT	301	X	Pt	old = exactly next to pointed edge of #300: oboval w fracture, set in semi hollow nest to #300. **NEW 25 Jun: triang brown SC**	220 new:120	180 new:100	130 new:70
TR26	302	X	Pt	whitish sc with red blush on RHS + crack out of LHS; set below sc + mc	no hs	LC	161	148	109								OUT	302	X	Pt	whitish sc with red blush on RHS + crack out of LHS; set below sc + mc	161	148	109
TR26	303	X	Pt	red + gey mc just d/str of submerged lc/sb	hs=u/str	LC	229	180	120									303	X	Pt	red + gey mc just d/str of submerged lc/sb	229	180	120
TR27	304	X	Pt	whiter triangl, tightly packed betw red/pink Sstone LC and "tree trunk" embedd in bank, overhung by grass, on edge bank	u/str + d/str mc's,plus B's on either side =part hs		157	153	97					[illegible]				304	X	Pt	whiter triangl, tightly packed betw red/pink Sstone LC and "tree trunk" embedd in bank, overhung by grass, on edge bank	157	153	97
TR27	305	X	Pt	grey-green oval, slightly larger than rugby ball, set deep, partly beneath +immed ustr + on lhs of brown "orange X" B	hs = Orang X B + ustr Sstoen B		430	255	175								[illegible]	305	X	Pt	grey-green oval, slightly larger than rugby ball, set deep, partly beneath +immed ustr + on lhs of brown "orange X" B	430	255	175
TR27	306	X	Pt	oblong with flatter side d/str perpendicular to current ,partially pinned by dark red scraggly Sstone B; emergent with tiny salix shoot	ured whiter yellow sb on rhs + emerg red B =hs; also d/str hs = submg Green/goldn B	SB	529	309	164									306	X	Pt	oblong with flatter side d/str perpendicular to current ,partially pinned by dark red scraggly Sstone B, emergent with tiny salix shoot	529	309	164
TR27	307	no	P	deeply submerged greenish sb, oval with patch of red +2 white spots pinned both sides d/str by lc+sb	pinned by 2B + 1 lc (d/str) = hs		280	250	?									307	no	P	deeply submerged greenish sb, oval with patch of red +2 white spots pinned both sides d/str by lc+sb	280	250	?
TR27	308	inv = sa net	P	large oval flattish top, submg golden B w fissures	pinned slightly on edge by sb (not bigger)	MB	860	710	185									308	inv = sa net	P	large oval,flattish top, submg golden B w fissures	860	710	185
TR27	309	inv = sa net	P	reddish gold B with tip just submerged under sheet flow to bsw	series of u/str B's = hs	SB	815	482	225									309	inv = sa net	P	reddish gold B with tip just submerged under sheet flow to bsw	815	482	225
TR27	310	X	Pt	semi triangular golden brown mc, set among others, w 2 overlapping Bs ustr (1=grey/brown emergent + further ustr overlapping it = flat round orange B, one side emergent)	overlapping Bs = hs	SB	297	255	185									310	X	Pt	semi triangular golden brown mc, set among others, w 2 overlapping Bs ustr (1=grey/brown emergent + further ustr overlapping it = flat round orange B, one side emergent)	297	255	185

Second season set-up stone data - May 2004 green shading indicates stones that were lost in 2003 and replaced during setup 2004 red = corrected measurements for 2003 stones 2004 FLOODS blue = moved; pink = OUT; green shading = stones lost in 2003, replaced at setup in 2004 old stone size incl. followed by NEW stone size where replaced

	stone no.	invert sample	Putty (P) Paint (PT)	description	hydraulic shelter	Stone Categories	Stone x (mm)	Stone y (mm)	Stone z (mm)	revs / 60 sec (bucket type)	depth (cm)	Velocity (m/s) From rating tables	FLOOD 1 - 10 Jun	BIG FLOOD 2 - 25 Jun	FLOOD 3 - 1 JULY SEARCH	FLOOD 4 - 18 JULY SEARCH	FLOOD 5- 8 August Search	stone no.	potential for invert sample	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost	Stone x (mm)	Stone y (mm)	Stone z (mm)
TR27	311	X	Pt (M)	round grey mc (prev displaced magnet), in hole immed ustr + LHS of emerg pink B w denser lichen on ustr side; Ustr + on RHS = flat golden submerg B, w baseflow flowing transverse (sideways) over this gold B	pxel ustr of V formed by big Lichen B + smaller one on RHS, also emerg = hs or chute?		240	169	120					OUT: new stone			couldn't find	311	X	Pt (M)	old = round grey mc (prev displaced magnet), in hole immed ustr + LHS of emerg pink B w denser lichen on ustr side; Ustr + on RHS = flat golden submerg B, w baseflow flowing transverse (sideways) over this gold B. NEW 25 Jun: round fawn orange LC, pinned ustr by round orang emergetn B w lichen, NEW marker + putty	240 new:490	169 new:440	120 new:? Emb
TR27	312	no	P	deeply submerged greenish orange round flattend top,next to larger oblong B which is just emergent tip	deep + embedded = hs	MB	515	425	159									312	no	P	deeply submerged greenish orange round flattend top,next to larger oblong B which is just emergent tip; has a few crevices; 1 on dstr end like a smile	515	425	159
TR27	313	X	Pt (M)	(prev displaced magnet stone) rectangl MC betw 2 SB; RHS one + orange, dstr end angled up; LHS one + round flat v gold, scoop out of dstr ths edge. #313= resting on brown rectangl embedd SB which is perp to flow	no real hs - Bs on either side+/-		235	119	135					OUT: new stone				313	X	Pt (M)	old = "(prev displaced magnet stone) rectangl MC betw 2 SB; RHS one + orange, dstr end angled up; LHS one + round flat v gold, scoop out of dstr ths edge. #313= resting on brown rectangl embedd SB which is perp to flow. NEW 25 Jun: brick-like fawn MC	235 new:200	119 new:90	135 new:60
TR27	314	X	Pt	round oval green, on left of oval brown submerged embedd SB w wide cavity on its rhs, White MC immed dstr. #314 = betw this brown B and a big emerg lichen B, but large space betwe these 2 = no real hs	no real hs		210	158	103									314	X	Pt	round oval green, on left of oval brown submerged embedd SB w wide cavity on its rhs, White MC immed dstr. #314 = betw this brown B and a big emerg lichen B, but large space betwe these 2 = no real hs	210	158	103
TR27	315	inv = sa net	P	embedded oval very flat sb, in b/water	clump of B's forming b/w	SB	555	395	105									315	inv = sa net	P	embedded oval very flat sb, in b/water	555	395	105
TR26	316	no	Pt	jaggedy lichen-topped (grey) red sand stone rock	pinned by u/str sand rock = hs	SB	955	472	535									316	no	Pt	jaggedy lichen-topped (grey) red sand stone rock	955	472	535
TR28	317	inv = sa net	P	oval orange sB with flat face,d/str of emergent brown B,broken water over face of #317	u/str emergent B = HS	SB	490	440	175									317	inv = sa net	P	oval orange sB with flat face,d/str of emergent brown B,broken water over face of #317	490	440	175
TR28	318	X	Pt (m)	oval white-green mc/lc sitting pretty proud adjacent to sB's, on sc bed. NB A BIT UP FROM LINE	NO HS	LC	287	239	214									318	X	Pt (m)	oval white-green mc/lc sitting pretty proud adjacent to sB's, on sc bed. NB A BIT UP FROM LINE	287	239	214
TR28	319	no	Pt (m)	white-fawn emergent B with few lichen spots on edge of the mid chann B clump	nothing bigger immed. but in line of stacked lc+B	MB	630	560	320									319	no	Pt (m)	white-fawn emergent B with few lichen spots on edge of the mid chann B clump	630	560	320
TR28	320	inv = sa top + 1/2 sides	P	immov small white flattish sc u/str of emergent fawn-orange B in same clump. #320 is deep, in hollow formed by surroud B's	(++ hs = surround B's)	SB	275	189	85									320	inv = sa top + 1/2 sides	P	submg immov small white flattish sc u/str of emergent fawn-orange B in same clump. #320 is deep, in hollow formed by surroud B's	275	189	85
TR28	321	X	Pt	angul, rect, immed ustr dirty white LC; 20 cm ustr of grey oval SB w striations II flow; on cobb bed	on thalweg; no hs		242	185	111					OUT: new stone			OUT	321	X	Pt	old = angul, rect, immed ustr dirty white LC; 20 cm ustr of grey oval SB w striations II flow; on cobb bed. NEW 25 Jun: small grey undersized rugby ball	242 new:240	185 new: 135	111 new:95
TR28	322	no	K	large white -brown B emergent with orange X	nothing larger ,but clump u+d/str= to RHS	MB		810										322	no	K	large white -brown B emergent with orange X		810	
TR28	323	X	Pt	green oval flat, immed dstr of emerg brownish B forming riffle	B u/str but open dstr; no real hs		385	242	146									323	X	Pt	green oval flat, immed dstr of emerg brownish B forming riffle	385	242	146
TR28	324	X	Pt	rounded-angular sc (prev displaced magnet stone); adj round grey MC w cavity on rhs and large quartz spos, in deepest part of mixed cobb + grav bed	no hs		191	123	81								present mag rock - 205x115x80	324	X	Pt	rounded-angular sc (prev displaced magnet stone); adj round grey MC w cavity on rhs and large quartz spos, in deepest part of mixed cobb + grav bed. 16 Jul found 2 X #324 - check dimensions of 2nd one ?= old stone from 2003? (descrip was greyish triangular immed. Ustr of lichen B)	191	123	81
TR28	325	no	Pt	oblong, rounded top ,embedded white- gold B,tip just emerg , with "eye"	deep + embedded + d/str B(not immed)hs	SB	785	410	215									325	no	Pt	oblong, rounded top ,embedded white- gold B,tip just emerg , with "eye"	785	410	215
TR29	326	X	Pt	sc among other sc, RHS of orange submerg SB, Ustr of Sstone red, just emergent B	hs+lc + embedded rocks+mund ,but small stone		81	58	41				OUT: new stone	OUT: new stone				326	X	Pt	old = sc among other sc, RHS of orange submerg SB; Ustr of Sstone red, just emergent B. NEW 10 Jun angular triang, narrow side up. NEW 25 Jun: angular SC	orig 81; 10 Jun 142; 25 Jun:104	orig 58; 10 Jun:96; 25 Jun:90	orig 41; 10 Jun:55; 25 Jun:50
TR29	327	X	Pt (M)	dark brown oval 'wedge'- z-axis = flat band facing d/str. Hole in centre of upper surface, with pebble-looks like eye	stone = in hole > d/str row of B's + hs	LC	337	171	230									327	X	Pt (M)	dark brown oval 'wedge'- z-axis = flat band facing d/str. Hole in centre of upper surface, with pebble-looks like eye	337	171	230
TR29	328	no	Pt	sandstone ragged oblong red rock lying perpendicular to flow, lichen +moss	d/str golden B d/str not really hs	MB	1370	535										328	no	Pt	sandstone ragged oblong red rock lying perpendicular to flow, lichen +moss	1370	535	
TR29	329	X	Pt	green angular (prev displaced), equidistant betwe large rectang submerged orange B at ustr end and the one with the quartz eye on dstr end	no - in chute		264	151	120									329	X	Pt	green angular (prev displaced), equidistant betwe large rectang submerged orange B at ustr end and the one with the quartz eye on dstr end	264	151	120
TR29	330	no	P	immov, sc wedged betw orange lichen B on dstr end and white just emergent B on ustr end	wedged			268										330	no	P	immov, sc wedged betw orange lichen B on dstr end and white just emergent B on ustr end		268	
TR29	331	inv = sa net	P	flat round orange B, submerged + embedded, d/str of clump of emergent B's	u/str B clump = hs	MB	700	545	300									331	inv = sa net	P	flat round orange B, submerged + embedded, d/str of clump of emergent B's	700	545	300
TR29	332	no	Pt	emerg + immov grey brown B, elongated dstr end elevated, ustr end + embed under white=brown B	embed + u stream B = hs		810	480	255									332	no	Pt	emerg + immov grey brown B, elongated dstr end elevated; ustr end = embed under white=brown B	810	480	255
TR29	333	no	P	large golden B, well set into river bed, tip just emergent	hs = embedded + emergent B's u/str	MB	975	730	325									333	no	P	large golden B, well set into river bed, tip just emergent	975	730	325
TR29	334	no	Pt	white-brown emergent B, submerg LC on rhs, emergent LC on lhs, ustr = embedd, submerged gold/orange B	d/str row B's lc's = hs		685	473	327									334	no	Pt	white-brown emergent B, submerg LC on rhs, emergent LC on lhs, ustr = embedd, submerged gold/orange B	685	473	327
TR29	335	inv = 1/2 tot stone area	P	firmly embedd in 2003, now free-lying, pinkish, white splotches mc, flat face tilted up at back, small spot of lichen on d/str end, just emergentt	no real hs		395	255	185									335	inv = 1/2 tot stone area	Pt	firmly embedd in 2003, now free-lying, pinkish, white splotches mc, flat face tilted up at back, small spot of lichen on d/str end, just emergentt	395	255	185
TR30	336	X	Pt	small, gravel, in a hole in mid of 4 submerged Sba, 2 of Hem Sstone	hs = B ring		NB NEED TO REMEASURE											336	X	Pt	small, gravel, in a hole in mid of 4 submerged Sba, 2 of Hem Sstone	130	95	55
TR30	337	no	P	deep - lying flat, square-ish sb, crack line, immovable NB a bit dstr of line	overlapped by u/str B = hs	SB		415										337	no	P	deep - lying flat, square-ish sb, crack line, immovable NB a bit dstr of line		415	
TR30	338	X	Pt	oval brown sc w flattened sides, narrow side facing upward, set immed dstr and under submerged white/gold B w large lichen splodges	another golden submerged B downstream w large eye		197	123	77									338	X	Pt	oval brown sc w flattened sides, narrow side facing upward, set immed dstr and under submerged white/gold B w large lichen splodges	197	123	77
TR30	339	no	P	deeply set + embedded semi-triang w planar surfaces, w ridge at top, red top, gold on ustr side face, embedd + pinned by triang sumberged brown B	pinned		380	290	?								couldn't find nor the pinning boulder neither	339	no	P	deeply set + embedded semi-triang w planar surfaces, w ridge at top, red top, gold on ustr side face, embedd + pinned by triang sumberged brown B	380	290	?
TR30	340	X	Pt	light yellow blockish oval SB, uneven, pock-marked surface, set 20 cm ustr of pretty, red + gold submergd (deepl lying) B w scratches	no real hs - dstr B = too deeply set		364	337	243									340	X	Pt	light yellow blockish oval SB, uneven, pock-marked surface, set 20 cm ustr of pretty, red + gold submergd (deepl lying) B w scratches	364	337	243
TR30	341	no	P	submerged, round, embedded red-gold B w flattish top + black lines/crevices on dstr end. +/- 70 cm ustr of V made by 3 emergent Bs, the one at the point of the V w large quartz eye	v-hollow, plus embedd = hs		749	740	350									341	no	P	submerged, round, embedded red-gold B w flattish top + black lines/crevices on dstr end. +/- 70 cm ustr of V made by 3 emergent Bs, the one at the point of the V w large quartz eye	749	740	350
TR30	342	no	P	oboval golden LC w white mirror C at top rhs. Large light emerg B w striations across middle + set at 7 o clock from #343 (this B forms ths of top of V for #341). A submerged red-gold B overshadows #342	embedd at ustr end		513	284	280									342	no	P	oboval golden LC w white mirror C at top rhs. Large light emerg B w striations across middle + set at 7 o clock from #343. (this B forms ths of top of V for #341). A submerged red-gold B overshadows #342 at ustr end	513	284	280
TR30	343	X	Pt	oval round white Mc, set betw 2 emerg lichen B on dstr + rhs, and 1 just emerg fawn B (v thin flow over top) on ths	no real hs		239	190	105								OUT	343	X	Pt	oval round white Mc, set betw 2 emerg lichen B on dstr + rhs, and 1 just emerg fawn B (v thin flow over top) on ths	239	190	105
TR30	344	no	P	golden brown with whitish patches flat top sb,overlain by white lc + sc	stack of Bs + LC u/stream	SB		426										344	no	P	golden brown with whitish patches flat top sb,overlain by white lc + sc		426	
TR30	345	no	Pt	pinkish square flat topm SB w 2 large and 4 small quartz eyes on the corner facing dstr. Emergent, on bed gravel, +se tin ring of other sim size Bs	centre of circle of Bs, but all = same size, not much hs?		445	410	158									345	no	Pt	pinkish square flat topm SB w 2 large and 4 small quartz eyes on the corner facing dstr. Emergent, on bed gravel, +se tin ring of other sim size Bs	445	410	158

BERG RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE

FLOOD COLUMN: blue = moved; pink = OUT; Orange shade check in field, new stone marked yes, but perhaps old not out? INVERT COLUMN: green shade = possible invert / peri sample for after June flood: OLD STONES; pink shade, poss invert samples (must be full samp): NEW STONES, yellow shade, poss invert IMMOV (top surf area only) - TICK WHICH ONES ARE STILL SUITABLE

FLOOD 1 - Jun 10 search	BIG FLOOD 2 Jun 21-23 search (?207 moved)	FLOOD 3 - July 2 search (in heavy rain)	FLOOD 4 - July 18 search	Flood 5	Offset from start	stone no.	X= invert sample, ø = periphyton, imm, emerg = no samp	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost; then if marker has changed (eg putty to paint), new marker type indicated	Stone x (mm) (old stone size incl. followed by NEW stone size where replaced)	Stone y (mm)	Stone z (mm)	flow/depth taken during SETUP (low baseflow) ie refers to all initial stones; link to initial Tritan survey: depth (cm)	velocity Vel (m/s)	flow/depth taken ON 25 JUNE (med baseflow) ie refers to all remaining / new stones; linked to resurvey by Tritan: depth (cm)	velocity Vel (m/s)	Comment
					TR1 Tape start 0												
					5.3	1	dry	pt	White v large pear shaped B with large orange X	1420	935	emb					bank
	OUT: new stone			OUT	6.3	2	dry	pt	flat white subrect sc, 10cm to lhs of #1 **NEW 25 Jun: lg - brown Africa shaped, located just ustr of the lhs point of #1**	112 new: 65	75 new:40	55 new: 10					bank
					7.3	3	dry	pt	Engineers' #78 in black/yellow paint; slightly embedded in sand/gr from flood on 21 June	450	300	140					bank
	OUT: new stone				8.3	4	dry	pt	semi-circ flat-top sc. **NEW 25 Jun: white rectangular lc, slightly curved top, somewhat imbedd - sand deposits from flood, around it.**	120 new: 335	88 new: 285	new: 140					bank
				Buried?	9.3	5	dry	pt	embed. oval, white-orange. patterns on upstr. rhs. upstr and rt of oblong wh /grey sb w lichen upstr of small cobs. After flood = deep in sand, only top window emergent	450	300	emb					bank
	OUT: new stone			OUT	10.3	6	dry	pt	sc in gravel, ringed by 1 SB + other sc's. **NEW 25 Jun: flat red & fawn rectang mc. under grass.**	75 new: 150	64 new: 145	24 new: 55			9	0.02	
	OUT: new stone			Buried?	11.3	7	dry	pt	oblong sc. immed ustr wh+brown MC. #7 has thin black crack running 45° to flow. **NEW 25 Jun: oblong wh. transverse to flow. embedd. on lhs under orange & fawn lc. just dstr & rhs of oval br orange speckly lc = hs a little.**	180 new: 255	110 new: 125	70 new: 65			15	0.09	
					12.3	8	X - top 1/4 emerg	pt	lc. round flat top w planes, red patches + striations. lhs of round lc/sc = red/pink and with lichen. dstr of pink sb sub-rectang. in circle of s/mc. after flood with sand dep's betw stones	350	300	120			14	0.06	
	OUT: new stone				13.3	9	full - XØ	pt	white + reddish patches on lhs underneath. in V formed by 2 deep orange mc/lc. ustr= slight hs. **NEW 25 Jun: mc - wh with pits. roundly triang. in V on upstream side of 2 embedd & subm. Sb: rhs= brown, lhs = green. no hs.**	99 new: 125	95 new: 105	40 new: 90	13	0.01	28	0.46	
					14.3	10	none - dry	pt	oblong emmerg. sb // flow. lichen stripe //flow. #10 = dstr of 2 pink/wh mc/lc. #10 pins upstr cob which is square. has 2 kinds lich	650	320	220			4	0	
					15.3	11	yellow net	pu	deeply subm. sb. oblong // flow. green sides, whiter ridge on top. to left is mc bed in deep water. cob-bed on rhs is shallower. #11 touches pink emerg mc dstr. rhs	945	395	emb	8	0.07	29	0.37	
	[illegible]				16.3	12	full - XØ	pt	fawn/orange + white blotchy diamond-shaped mc. w irreg upper surf and "nose", long axis perp. to flow. #12 = immed dstr embed light orang oval LC/SB	320	200	100	26	0	46	0	
	OUT (later found 11.5 m dstr but discard)				17.3	13	full - XØ	pt	yellow/wh flat-top round mc. green on edges. lichen on top lhs; 2nd stone dstr of emerg B w lichen cap. **NEW 25 Jun: blockish wh+fawn mc; #12 and #13 = on rhs and lhs of emerg B clumps - just to edge of their hydraulic shadow as indicated by gravel deposits.**	180 new: 275	165 new: 225	65 new: 115	14	0	14	0.23	
	OUT: new stone		reputtied		18.3	14	full - XØ	pt	oblong white LC // flow, straight & angular, on lhs = very round SB, on rhs = orange. #14 = immed dstr tring white LC wpoint ustr end; 314 = dstr + to rhs of round SB. **NEW 25 Jun: embed. submerg immov. lc/sb oblong angular greeny grey. // flow; straight on lhs, scooped on rhs; 10cm to rhs of brown deeply embed flat sb. lichen Sb which = immed ustr to lhs. New marker = putty**	105 new: 307	100 new: 205	50 new: emb	22	0.032			
			some MCs now overlapping		19.3	15	full - XØ	pt	oval. brown mc with flat top; scoop on widest end. immed dstr. of yellow/brown flat mc. on lhs of larger rounded sb = brown + wh spots on its lhs. #15 = 1m upstr largest emergent b on transect.	315	195	110	24	0.25	36	0.44	
					20.3	16	full - XØ	pt	lc/sb brown & green. dstr embed. subm. lc + emerg. sb. perp. flow. under lc upstr which has red band. immed. dstr. is yellow sb with c-cuts.	402	300	107	5	0.01	24	0.02	
	OUT (later found 6 m dstr but discard)			[illegible]	21.3	17	full - XØ	pt	lg in deepest part of run, lies betw emergent rectang pink SB on lower lhs of run and fawn submg. SB on rhs. **NEW 25 Jun: lc/sb round orange & dark brown slotches. fractured top. hole in lhs flat. touches ustr rhs of square flat yellow sb. touches mb = submerged, lt brown on dstr lhs of mb.**	90 new: 195	80 new: 160	85 new: 80	28	0.17	44	0.13	
	OUT (later found 9.5 m dstr but discard)			[illegible]	22.3	18	full - XØ	pt	in run on cobb bed; off the lhs point of emerg pink SB which = oblong + perp to flow. **NEW 25 Jun: mc - orange brown oval flat. in deep run. immed lhs of slightly dstr of br triang embed lc. surrounded by similar cobble bed elements**	180 new: 200	120 new: 107	80 new: 90	12	0.45	42	0.6	
	OUT: new stone				23.3	19	full - XØ	pt	sc dstr of 2 LC which = hs; rhs one = brown/grey w green dense lich and round, flat, dstr end lifted; lhs LC = pink emerg, w black lich spots. **NEW 25 Jun: embed flat dirty grey lc/sb described in original. New marker = putty**	200 new: 450	180 new: 350	120 new: emb	10	0.14	35	0.13	
					24.3	20	bank - dry	pt	brown lc. half circle, hole in mid. top. in circle of lc. resting on clump of sedge	365	285	120					bank
					25.3	21	bank - dry	pt	grey b. embed. back. lifted up at dstr end; SB resting on top (? of it) small sapling growing from under it	540	360	130					bank
	OUT: new stone				26.3	22	bank - dry	pt	lg below oval SB which has koki arrow pointitng to #22. **NEW 25 Jun: sb with koki arrow from original description**	70 new: 545	54 new: 445	31 new: 180					bank
					TR2 Tape start 2				**NO #23 - EXCLUDE FROM NUMBERS**								
				5cm covered sand/gr	7	24	none - dry	pt	round sc. brown w grooves. on sand & gravel. 10cm ustr of grey pear SB which = 2nd sb downslope from flood pipe After flood = deeply embed in sand, only tip w # emerg	170	135	80					bank
				10cm covered sand/gr	8	25	none - dry	pt	irreg. lc. grey & pink, embed. roughly elbow shaped	410	370	2					emerg in b/w
					9	26	none - dry	pt	wh lc/sb embed. black striat. // flow. larger sb with small hole on top adjacent upstr. gravel built up on lhs	400	230	emb					bank
	[illegible]			[illegible]	10	27	none - dry	pt	embed. grey oval flattish mc. pinned by sc left & right. **18 July note** - prev was embedd (could not measure z-axis, but now loose)	260	170	85					bank
					11	28	none - dry	pt	mc deep red & lt brown marbled sstone. triang. flat top. After flood 21 Jun slightly embed w sand.	320	220	est210					bank
					12	29	none - dry	pt	grey angular. bi striat. perp. to flow. triang. block	320	290	160					bank
					13	30	none - dry	pt	round pink. angular. lightly embed MC, 20cm upstr. of white 1/2 moon shaped embed. lc	240	220	135					emerg
					14	31	none - dry	pt	pear sh. grey speckled B. d/str tip pointed up. facing dstr across channel	900	510	295					emerg
	OUT: new stone			[illegible]	15	32	imm	pu	red & gold patchy mc white flat face lc overhangs it ustr. **NEW 25 Jun: white/grey triang. Broad side facing dstr. Painted**	165 new: 185	80 new 135	emb new 60	10	0.1	32	0.57	
	OUT: new stone				16	33	imm	pu	fawn, subm. mc. embed under dstr upturned end of oblong wh & red lc. **NEW 25 Jun: reddish brown, square on top. Between 2 immovable stones - new marker = paint.**	200 new: 130	50 new: 90	emb new:75	8	0.16	24	0.51	
	OUT: new stone				17	34	full - XØ	pt	small brown cob. left of sb w cap of dense lich. upstr end of this b pinned by larger lich b. **NEW 25 Jun: white grey oval. Broad side facing dstr.**	110 new: 215	90 new: 155	50 new: 90	14	0.05	30	0.32	
		slightly dstr line			18	35	net area - dark	pu	pink sb oblong perp. flow grey striat. perp. flow	660	325	emb	13	0.06	33	0.19	
	OUT: new stone		[illegible]	OUT	19	36	full - XØ	pt	sc lt brown. upstr. side of emerg. lb which is 2nd in line of 3. lhs of b. resting on grey mc that is buried by sc. **NEW 25 Jun: small round brown.**	100 new: 40	70 new: 40	60 new: 25	6	0.16	44	0.35	
	[illegible]				20	37	full - XØ	pt	brown rect LC; long axis faces dstr; dstr end nearly touches lhs tip of emerg wh b., round with few lich spots	440	140	140	1	0.21	30	0.65	
	OUT: new stone	reputtied			21	38	full - XØ	pt	round - triang. sc set deeply just dstr of submerg. flat fawn diamond b. to the rhs of this in line w 38 = oval topped lt fawn b w prominent quartz stripe perp flow. **NEW 25 Jun: grey, round flat embedded, immovable; new marker = putty**	190 new: 530	140 new: 500	85 new: emb	24	0.38	36	0.6	
					22	39	emerg	pt	v. large lichen emerg b. like a mountain w 2 planes. extra flange submerged on dstr side	2200	1100	emb					emerg
					23	40	"	pt	same stone		same stone						emerg
	[illegible]				24	41	full - XØ	pt	pear sh. flat topped red sb. pointy side dstr. in gap b2 39/40 and irreg sstone b w lichen tip emerg	420	260	130	14	0.52	34	0.62	
					25	42	bank - dry	pt	"tall". emerg. wh blockish b w rounded top. 2 smaller emerg. lich b/lcs dstr. chipped portion on rhs	930	560	emb					emerg
					26	43	bank - dry	pt	sim to 42. rounder. 42+43 form backw. at ch. edge. 43 lodge against fissured +fract. white b dstr	610	460	300					emerg
	replaced -from where?				27	44	bank - dry	pt	pinky with. lich. flat faced B. triang/circular; dstr side lifted; 1/3 wayup bank; dstr stack of Bs = ++ hs	690	600	est 290					bank
					TR3 Tape start 2												
find old + new on 1st July or only new - are there 2 there??		still covered by sand, but can just see			7	45	b bar - dry	pt	mg among sc and sand - close to edge of bankful, 15 cm to lhs of grass clump. **NEW 25 Jun: dark brown, scratched surface**	55 new 110	55 new 95	45 new 55					emerg in b/w
					8	46	b bar - dry	pt	squarish flat sstone red w notch on top lhs. dstr end lifted	360	300	130					bank
					9	47	b bar - dry	pt	rough surface white oval deeply emb. in gravel. post June flood = ++ sand	230	200	emb					bank
					10	48	b bar - dry	pt	flat faced squareish pink & white, w crevice, 80% embed in sand + gr	280	250	80					bank
	OUT (later found 4m dstr and discarded)			OUT	11	49	b bar - dry	pt	white triang mc w pink patch and grey atch. resting on mc's. **NEW 25 Jun: light brown/grey flat round sc on sand**	290 new: 85	170 new: 60	115 new: 50					bank
	[illegible]			[illegible]	12	50	b bar - dry	pt	wh mc. hole near top on upstr side. pinned on lhs by pink & wh lc that is curved inwards. dstr of well embed. grey sb.	310	165	140					bank
	OUT ?pinned				13	51	b bar - dry	pt	white mc, pinned on lhs by pink & wh LC which = curved inwards; #50 has deep hole near top on ustr end; #50 = dstr of well-emb grey SB. **NEW 25 Jun: embed sb in front of original 51**	510 new: 730	310 new: est 445	emb new: est 310					emerg
					14	52	b bar - dry	pt	pink sb/lc lhs has destinct red patch & wh spot. embed. lc/sb on lhs has red crescent scour on top	340	250	200 est					emerg
					15	53	b bar - dry	pt	v. pink orange lc w wh patch on lhs, embed. on rhs in bank in gravel. lhs resting on mc/lc =grey/brown w crack on top and touches water	390	210	190					emerg
	OUT: new stone				16	54	full - XØ	pt	red-brown MC w fawn lower half; touches dark br mc **NEW 25 Jun: fawn & orange flat-top lc, oval/circ; 10cm ustr of oval flat br sb which is lifted dstr; #54 = betw a) embed submerged dark orange brown MB with base lighter cup with hole on upstr face lhs and b) white SB on rhs which = emerg. & not embed.**	220 new: 360	165 new: 290	100 new: 100	5	0.01	18	0.22	
					17	55	full - XØ	pt	square w rounded edges. crevice on ustr lhs. smile brown w lighter left 1/4. striat. immed ustr emerg. embed. lich b w 3 eyes in triang near bed	320	260	100	1		21	0.26	

BERG RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE

FLOOD COLUMN: blue = moved; pink = OUT; Orange sh[illegible] … INVERT COLUMN: green shade = possible invert / peri sample for after June flood: OLD STONES; pink shade, poss invert samples (must be full samp): NEW STONES, yellow shade, poss invert IMMOV (top surf area only) - TICK WHICH ONES ARE STILL SUITABLE

old stone size incl. followed by NEW stone size where replaced

flow/depth taken during SETUP (low baseflow) ie refers to all initial stones; link to initial Tritan survey

flow/depth taken ON 25 JUNE (med baseflow) ie refers to all remaining / new stones; linked to resurvey by Tritan

FLOOD 1 - Jun 10 search	BIG FLOOD 2 - Jun 21-23 search (?207 moved)	FLOOD 3 - July 2 search (in heavy rain)	FLOOD 4 - July 18 search	Flood 5	Offset from start	stone no.	X= invert sample, ø = periphyton, imm, emerg = no samp	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost; then if marker has changed (eg putty to paint), new marker type indicated	Stone x (mm)	Stone y (mm)	Stone z (mm)	depth (setup)	velocity (setup)	depth (25 June)	velocity (25 June)	Comment
	OUT: new stone				18	56	full - Xø	pt	rect. w corner cut off med brown set immed dstr wh oval fissured just subm lc in line w emerg lich b ustrm = 40cm away **NEW 25 Jun: blockish dirty-white oval/oblong SB, long axis // flow. Surrounded by smaller cobbles. Upstr 20cm of upstr point of flat brown sb with end slightly up, and lichen on lhs ~hs = embed B 30cm upstr**	300 new: 420	210 new: 260	100 new: 85	6	0.06	11	0.32	
	OUT: new stone			OUT	19	57	full - Xø	pt	sc on sc, immed upstr on lhs edge of pink subm sb w lich. tilted up dstr; open on lhs = no hs **NEW 25 Jun: orangy brown mc. Rough scoop on left and right sides. Touches upstr side of oval yellow brown sb with end lifted dstr. Pinned ustr by slightly larger mc = weak hs.**	70 new: 190	60 new: 157	40 new: 100	21	0.06	37	0.41	
	OUT: new stone		[illegible]	[illegible]	20	58	full - Xø	pt	lg among other lg immed dstr of embedded oval fractured LC which = wh + orange patchy **NEW 25 Jun: round flat orange mc. Covered by small cobbles. Triang orange mc is immediately ustr of #58.**	70 new: 165	25 new: 150	15 new: 55	23	0.14	40	0.56	
					21	59	full - Xø	pt	oval med br SB set among sc. deepest part of trans	375	280	110	17	0.21	39	0.34	
				OUT	22	60	full - Xø	pt	oboval flattened top + bott light lc. 10cm dstr triang wh lich b. immed upstr v. pink sb w lich spots - tip emerg	375	240	160	12	0.2	21	0.53	
					23	61	s.a. dark net	pu	embed. oval lichen b. imm. tip emerg (painted)	700	420	emb			19	0.54	
					24	62	sa. yellow net	pu	immov. embed. submerg. bottle shaped, flat top. wh/pik sb	505	330	emb	16	0.17	38	0.32	
	OUT: new stone				25	63	full - Xø	pt	tiny stone set among lg/sc. all ~25 cm utr of V b2 emerg pink + emerg lichen b's. **NEW 25 Jun: round green flat lc. Sitting on emb. Flat sb. Hs = ustr flat lc.**	60 new 280	55 new: 260	20 new 75	24	0.01	28	0.18	
	OUT: new stone			OUT	26	64	full - Xø	pt	lt brown sc set in hollow dstr of embed emerg lichen b. = pink+wh **NEW 25 Jun: = lg in same place**	110 new 80	60 new 45	60 new: 40	5		30	0.06	
					27	65	bank - dry	none	not monitoring this point - just sand	sand							bank
					28	66	bank - dry	pt	sc pinned b2 2 pink cream b's 2/3 up bank. all 3 dstr striking dark pink striated lich b.	160	130	100					bank
					TR4 Tape start 2												
					15	67	imm. emerg	pt	emerg fawn pink teardrop shaped SB, rounded top, few lichen patches, set into the Bbar, just dstr of pink flattened rectang SB, narrow side up but angled w dstr tip up, this = hs for #67, but lhs and dstr = open	510	370	emb			2		
				[illegible]	16	68	sa. dark net	pu	deeply subm. greeny, irreg triang. B w striat on dstr rhs; fractured along ustr deep lying portion, ustr is pointy orange lc angled transverse - ie it points towards lhs corner of #68. 68 is in line w & 1m ustr of emerg br lich b	550	510	emb	6	0.06	26	0.47	
	OUT: new stone				17	69	full - Xø	pt	light cream sc, set among sc's, immed dstr of triang-oval, deeply embed, flattish-round SB. **NEW 25 Jun: orangy. triang. fracture on dstr side.**	155 new: 160	90 new: 100	60 new: 65	29	0.12	42	0.32	
					18	70	sa. dark net	pu	cream oval subm. even textured, embed. 10cm upstr of larger wh subm b w fissures +sc/lg around	505	340	emb	16	0.16	36	0.53	
			reputtied		19	71	sa. dark net	pu	subm. immov. simil to 70 set same ht in bed, darker dirty gold w few wh patches + large eye ustr rhs.NB putty ridge on #71 = dstr of #70, but the ustr side of #71 = wider at base than top	550	370	emb	17	0.21	38	0.67	
					20	72	sa. dark net	pu	immov. subm. set deeper than 71 flat, greeny gold. sc starting to cover it. small eyes on surface	760	455	emb	36	0.15	54	0.35	
					21	73	sa. dark net	pu	immov. subm. not embed. half circle w flat side on rhs // flow wh w orange patch on top. set on bed surf. in + rhs of 1m gap b2 emerg lich b (ustr 1 has more lich)	600	330	emb	8	0.08	28	0.08	
	OUT: new stone				22	74	full - Xø	pt	white, squareish sc, some surface crevices, 20 cm to lhs of emergent fawn/lichen B and just dstr + to left of spotted lich submg oval LC, w planar surfaces **NEW 25 Jun: oval green embed; 20cm left of beautiful spotty rock; long axis // flow**	190 new: 440	135 new: 320	70 new: 165	26	0.15	36	0.18	
					23	75	sa. dark net	pu	light brown B, dstr end lifted up, pinned by #76; lhs = under #76, pale grey stripe thro' ustr end	520	360	emb	10	0.01	32	0.11	
					24	76	bank - dry	pt	large lich b set in bank, white w small lich spots	800	690	emb					emerg
					25	77	bank - dry	pt	mc among lc. against hole in center; dstr pinky LC = hs	240	220	180					bank
					26	78	bank - dry	pt	sc in hole surrounded lc/sb 2/3 up bank.	140	95	95					bank
					TR5 Tape start 0												
					13	79	bank - dry	pt	wh ang mc w red/pink cap mid-way b2 3 sb's (1 upstr only one w lichen, this could be hs, but prob too far)	155	130	emb					emerg in b/w
	[illegible]				14	80	emerg: bottom surf area only - Xø	pt	emerg rect br mc. marked #31 in yellow on bottom side; fract on top; resting on sg. in bw drying out after rain	235	155	105					emerg str
	OUT: new stone				15	81	bottom surf area + 1/4 sides - Xø	pt	dark brown oval LC w fawn striations; set in shallow nf on ridge separating bw from channel. **NEW 25 Jun: rect flat. yellow/white lc. 30cm upstr of pink sb with sapling on rhs.**	120 new: 280	90 new: 210	55 new: 85			9	0.12	
OUT: new stone	OUT (18 Jul found 4m dstr at #57, Tr3) repl. alongside newly marked stone			10 June stone - OUT 25 June still there	16	82	gravel samp - X	pt	old = 20 pieces med gravel painted; NEW **10 Jun:** pear=shaped s/mc, broad end up; **NEW 25 Jun: brown mc flat narrow side up; in V betw 2 wh SBs on dstr side; 2 cuts on top side; NB 10 June stone placed immmed ustr of new #82, but w long axis // flow,**	20 mg, 10 Jun 250, new: 145	20 mg, 10 Jun 150, new: 130	20 mg, 10 Jun 105, new: 55	10	0.01	23	0.19	
	OUT: new stone				17	83	full - Xø	pt	greeny angular round sc on rhs of browny green embed lc w striations, on bed of lg/sc. **NEW 25 Jun:rusty red lc, ang flat top; surrounded by smaller cobb.**	165 new: 385	120 new: 220	new: 110	24	0.07	43	0.44	
			reputtied		18	84	net sized ??which	pu	flat round subm. embed green/gold/brown SB, immed dstr of irreg flat B also embed.	855	670	emb	22	0.17	44	0.36	
	OUT: new stone				19	85	full - Xø	pt	brown sc, flat; long axis perp flow; touches rhs of oblong B, axis perp current, slight hs = ustr fractured B but not much. **NEW 25 Jun: fawn/grey oval B, flattish/round top; long axis perp to flow; on rhs of submerged B w domed top. NB REMEASURE X + Y AXES!!!**	130 new: 420	80 new: 825	50 new: 110	42	0.23	52	0.44	
	OUT: new stone				20	86	top surface only X	pu	immov, deeply submg (=hs) yellow/orangmc, touches ustr side of yellow embedd submg SB w large fracture on ustr lhs. #86 has gravel ustr, also rough + cracked top. **NEW 25 Jun: green & orange flattened oval rhs of green oblong flat sb. lies on cobble ; new marker = paint** , NB #86 & #89 = in line, a bit ustr of Tr line	200 new: 140	190 new: 110	emb new: 90	40	0.01	62	0.39	
					21	87	net sized top	pu	subm. B, distinctive grey on rhs and brown lichen on lhs, triang w apex dstr; flat top	740	520	emb	14	0.15	34	0.5	
					22	88	net sized top	pu	immov. subm. heartsh B; br pnt to lhs; pinned by emerg. wh B which looks pinched at top +has more lich upstr than dstr. #88 = dstr of line	800	620	emb	6	0.17	27	0.31	
	[illegible]			[illegible]	23	89	bottom 1/2 stone -X	pt	emerg. Slightly orange mc resting in ring of 4 mc/B that inc in size clockwise (smallest uspst) # 89 rests end up gainst 2nd +1st largest B. Hs = 2 large white lichen Bs ustr to rhs, but #89 = elevated + loose	190	180	70			30	0.25	
					24	90	dry -bank edge	pt	Bottom of B just touch water, flattish face upstr; grey w lichen spots; on lhs of v. flat pink mc that is lifted slightly dstr	750	700	320					emerg
					TR 6 Tape start 0												
	[illegible]			OUT	15	91	bottom 1/2 - Xø	pt	wh & br mc, emerg, round, domed top, scooped on dstr side	240	240	140			6	0.02	
	OUT: new stone				16	92	full - Xø	pt	yell br + orang angular mc, flat top, touches rhs of distinct orange wh mc w 2 strong wh veins. **NEW 25 Jun: triangular orange white lc standing on apex, pointing into channel & dstr; immed ustr of flat half circle SB, red + white (ie white patch in centre like gingerbread icing) .**	240 new: 410	150 new: 270	130 new: 175	6	0.1	12	0.07	
	OUT: new stone			[illegible]	17	93	full - Xø	pt	sc orange w red nose up. against upstr side of orang-red lc, flat square yell. + pear shaped yell lc on rhs, upstr = ang w 2 noses 2 opp sides flat, other 2 sides triang. **NEW 25 Jun: pink mc. Oval. In ring of lc on sb = hs**	110 new = 165	60 new = 100	45 new = 60	18	0.08	46	0.23	
	reputtied	reputtied orange SB, note white SB wrongly puttied		[illegible]	18	94	net sized top	pu	orange sb, subm. not embed; roughly triang + some scratches, long axis perp flow, dstr of triangular white B w top emerg, #94 touches upstr side and pins it + dark-orange bowl-sh embedd submg B. On rhs of #94 = fawn lc w 2 holes like nostrils	650	390	360	4	0.01	12	0.57	
	OUT: new stone			OUT	19	95	full - Xø	pt	ang dark orange br. sc flat top. touches yell embed. subm. sb on b's. #95= lhs +dstr of b. on sc bed. **NEW 25 Jun: brown rectangular mc. Long axis // flow. 10cm upstr of grey embed sb which = lifted on ds end and which also has lichen on dstr nose.**	125 new: 230	70 new: 140	60 new: 65	32	0.25	50	0.56	
	OUT: new stone				20	96	full - Xø	pt	round, softball sized, sandpapery, flat top, green-grey + or-br in mid s/mc bed; 40cm to lhs of ustr pnt of yell submg B; in line w upstr pnt of br lc which = 5cm left of #96. #96 = left of yell sc/mc w a perfectly circlular hole in top. **NEW 25 Jun: oblong mc. White and red. Narrow end up, against lhs of brown lc which is lifted upstr.**	140 new: 165	130 new:100	75 new:75	36	0.23	54	0.59	
	OUT: new stone				21	97	full - Xø	pt new: putty	green ang sc. red line on top. touching ustr side of lb = yell, just emerg. + dstr side of bluntly pnted emb br b. **NEW 25 Jun: triang. Grey; embeded. Between yellow boulder upstr and large yellow boulder dstr with scoop on top, hs = b upstr and embed. New marker = putty**	120 new: 690	90 new: 410	75 new: emb	22	0.18	42	0.37	
	[illegible]			[illegible]	22	98	full - Xø	pt	deep orange mc -rugby ball. imm ustr + touching flat oval fawn-br subm b. dstr gold oval. all 3 stones same ht in bed but not deep set; #98 = on lg	320	230	90	24	0.18	36	0.47	
					23	99	imm. emerg	pt	large round white emerg lich b. w eye on dstr lhs - sedge growing inside it, no hs	820	570	440					emerg
	[illegible]				24	100	emerg pinned	pt	Was it pink wh mc emerg pinned by trian lich b set in bank; now move + repl under eaves of lichen B; #100 submg	200	150	40			30	0.02	
					TR7 Tape start 2												
					18	101	bank - dry	pt	NEED DESCRIPTION!!	695	535	480					emerg
					19	102	emerg	pt	diamond lichen B sitting mostly out water, touching #103, long pointy ustr end extends into flow	720	530	375				1	emerg

BERG RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE

FLOOD COLUMN: blue = moved; brink = OUT; Orange shade check in field, new stone marked yes, but perhaps old not out?
COLUMN: green shade = possible invert / peri sample for after June flood: OLD STONES; pink shade, poss invert samples (must be full samp): NEW STONES, yellow shade, poss invert IMMOV (top surf area only) - TICK WHICH ONES ARE STILL SUITABLE

INVERT old stone size incl, followed by NEW stone size where replaced

flow/depth taken during SETUP (low baseflow) is refers to all initial stones; link to initial Tritan survey

flow/depth taken ON 25 JUNE (med baseflow) is refers to all remaining / new stones; linked to resurvey by Tritan

FLOOD 1 - Jun 10 search	BIG FLOOD 2 Jun 21-23 search (?207 moved)	FLOOD 3 - July 2 search (in heavy rain)	FLOOD 4 - July 18 search	Flood 5	Offset from start	stone no.	X= invert sample, ø = periphyton, imm, emerg = no samp	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost; then if marker has changed (eg putty to paint), new marker type indicated	Stone x (mm)	Stone y (mm)	Stone z (mm)	depth	velocity	depth	velocity	Comment
					20	103	sa. yellow net	pt	v long oval greenish B. sloping down into channel, pinky lich tip emerg, even surface on rem stone, embedd = hs.	1390	550	emb	12	0.14	24	0.45	
	OUT: new stone				21	104	full - XØ	pt	whitish dirty lg. set in gr patch immed ustr of greeny light brown egg_B which = just submg. no hs. **NEW 25 Jun: lc greeny round scooped on top & ustr end; forms ustr part of large ring of ic's and sb's; has 2 white eyes.**	80 new: 370	55 new: 285	50 new: 150	26	0.23	30	0.69	
	OUT: new stone				22	105	full - XØ	pt	orange sc, angular, almost 5-sided, flattish top, set among lg/sc, to lhs of red-gold submg flat B and ustr of flat oval B w fissure on its lhs, #105 in line w the ustr oval fawn emergent B w grey striations (this = midway betw Tr7&8). **NEW 25 Jun:white/fawn triang lc w rounded base in plan view; flattish top, apex pointed dstr; still in line w orange (fawn) B w striations, but now immed ustr #105 = pear-shaped orang+white LB w small lichen spots.**	230 new: 300	195 new: 260	80 new: 200	30	0.12	32	0.54	
					23	106	sa dark net	pu	white-fawn oval, but planar sides, dimples on flatter face, faces ustr + at angle to the channel, dstr edge = sheer, 10 cm ustr + to lhs of tip- emergent white blockish triangular B w lichen	470	310	265	4	0.19	29	0.7	
	[illegible]				24	107	full - XØ	pt	grey sb w lich spots, tucked dstr of lhs end of oval B w pointy top, emerg + lich (ie #108) #107 on bed of lg/sc & immed ustr subm lt gold b w fracts + striations 18 Jul: Dist from paint spot on #107 to that on #108 = 75 cm	260	220	120	12	0.07	32	0.61	
					25	108	emerg	pt	pinky fawn massive pyramid, shape apex just emerg + lichen	1860	920	emb			13	0.56	
					26	109	DISCARD ANY SAMPLE	pt	emerg oval, flat face, ++ lich standing on narrow side against dstr v large lich b. quartz eye on upper side on lhs. another b on lhs of 109 ~same size, also piled against dstr b	475	405	130			6	0.07	
					27	110	emerg 1/2 total sa samp - Xø	pt	wh squarish, top 1/2 emerg, set in alcove w isolepis, on subm. + embed lo/sb. immed dstr ang dark red + wh rect b lifted dstr --> pointing transverse across channel. also ustr v large grey speckled lich b set above stream level, creating bwat alcove w the b mentioned for 109	240	185	110			14	0.04	
					28	111	bank - dry	pt	orange x b. upper surface in line w bankful	950	670	est 485					emerg
				TR 8 Tape start 0													
					16	112	bank	pt	White-rectangul, blockish, long side perp flow, narrow side up, dstr "face" w large eye and light striats. Up-facing side = pink. #112 is planar, ustr + dstr B's, tho smaller, form gap into which it slots	800	370	emb					emerg
	OUT: new stone			[illegible]	17	113	full - XØ	pt	fawn sc, +- triang and angular, rhs = under but not pinned by grey B w scoops on its rhs. **NEW 25 Jun: white oblong flat face ustr. narrow end up. Betw grey SB on rhs with white spots & white, cut SB on lhs w orange patches; pinned by lhs sb.**	150 new: 340	110 new: 155	90 new: 140	10	0.11	14	0.34	
					18	114	net sized top	pu	yellow green SB deeply embed, somewhat domed top, overlain by s/mc + sb. 1 crack, = perp flow, dstr of #114 = line of 2 sb's w lichen. These hold pink mc betw them --> this mc pins #114 on its dstr end	530	300	emb	18	0.06	40	0.34	
	OUT: new stone			[illegible]	19	115	full - XØ	pt	crescent-shaped sc, dark brown/orange, lies on lhs of oval emb submg orange SB w distinctive whiter spot. #115 touches irreg brown sc on its rhs, which = pinned by the orange SB. **NEW 25 Jun: brown mc. oval ridge on top perp flow, fracture on l&rhs; immed upstr of speckled grey embed lc; #115 = 30 cm dstr (For ustr) of pale green sb scooped on ustr side.**	150 new: 220	120 new: 145	55 new: 95	24	0.19	45	0.35	
	OUT: new stone				20	116	full - XØ	pt	foot-shaped mc, orange on top, "heel" pinned ustr by brown-gold bowl shaped mc, dstr = oval green-grey+orange flat mc. **NEW 25 Jun: round flat grey mc. 10cm ustr of orange sb with green stripes // flow.**	230 new: 270	150 new: 230	70 new: 70	24	0.38	50	0.82	
	OUT: new stone				21	117	full - XØ	pt	brown-orange, cricket ball round sc on other sc, ustr = oval orange-gold LC -orange on dtrs rhs - w lichen, dstr of #117 = square block white mc. **NEW 25 Jun: rectangl red-brown mc, long axis perp flow; distinct c cut; #117 = 10 cm ustr of olive br speckled flat lc.**	100 new: 250	80 new: 145	60 new: 90	36	0.12	47	0.56	
	OUT: new stone			OUT	22	118	full - XØ	pt	square sc, 3 colour bands: orang, gold, fawn. On lhs of yellow diamond, flat-top B. **NEW 25 Jun: oblong white sc; speckled br. brown patch on lhs; in deep water at lhs point of flat top diamond sb.**	85 new: 130	70 new: 65	30 new: 40	36	0.19	53	0.42	
					23	119	sa. dark net	pt	sb v. pink. ridge just emerg. line of lich on ridge. pinned on rhs by pink orange sb narrow side up. Puttied with no. on 18 July	550	350	300			20	0.49	
	Bruce had OUT: repl w puttied immov, in notes, but pt stone found in place - ??Is no mvmt?	emergent?			24	120	full - XØ	pt	orange-red sc, rounded point, sharp tail, lies on top of flat white B w diagonal crack sprouting moss, immed dstr emergent SB w ++ lichen spots. **(NEW 25 July was described as the puttied (ie submg) immov white B w lichen, but ?? wrong) - measurements -> are of old stone**	120	80	70					
					25	121	bank	pt	pinky irreg embed in bank w 3 metrosid plant seedlings immed. upstr	270	175	emb			7	0.16	
				TR9 Tape start 2													
	OUT: new stone			OUT	19	122	full - XØ	pt	triang brown lg, narrow side up, set among other lg, on rhs = embed white lich B, just dstr = plate-like browny-orange flat-top B, no real hs. **NEW 25 Jun: white blocky sc betw (a) round flat, deeply embed SB, emergent but low-lying, w ++ lichen on highest point SB; round pink transverse striations and (b) dstr round pink SB w faint black striat perp to flow.**	70 new: 122	50 new: 90	30 new: 55	1		13	0.12	
	OUT: new stone				20	123	full - XØ	pt	irreg white angular sc w narrower flat top w distinctive red patch, sticking out from under "gingerbread icing" lc (= rectang-oval red/pink + white), both these = dstr of pyramid, v emergent B. **NEW 25 Jun: "gingerbread LC = new stone; sits immed to rhs of ustr point of emergent lichen "peak" B; long axis of #123 lies alongside the margin of this "peak" B.**	160 new: 410	155 new: 290	100 new: 210	6	0.01	10	0.08	
					21	124	sa of dark net	pu	square-pyramid white-green SB, apex on dstr side "falling over", fissure line on ustr lhs. large D-shaped scoop on rhs at low lying point, #124 sits adj to dark brown(?) emerg B w small eye on fracture at top and red smile, no real hs for #124	505	275	emb	6	0.4	28	0.39	
					22	125	sa of or net	pu	immov. oval light brown/cream SB, embedd on ustr bottom part, "nose" lifted up facing dstr, hole in nose, few dark striat // flow, small hole also at upstr edge, #125 lying adj to smaller elements on rhs, but 3 larger deep-lying flat sbs on lhs, upstr 1 reddish w distinctive gouge + dstr 1 grey w ~7 lich spots. #125 no real hs, altho dstr submg B w striations = a bit.	520	330	emb	10	0.13	30	0.48	
	OUT: new stone	[illegible]	[illegible]	[illegible]	23	126	full - XØ	pt	kidney-shaped greeny-white LC w eye on dstr midpoint, #126 lying in centre of 3 embed Bs arranged on either side and ustr, the ustr one = orange, lhs one = orange ustr and distinctively brown dstr, and the B on rhs = oval, red-gold, blotchy w fracture on dstr rhs. **NEW 25 Jun: lrmc - pear shaped, green, flattish mc, crevice line on rhs surface; same position wrt 3 Bs as original #126; also dstr edge of #126 = touching ustr lhs of greeny LB w flat face tipped + facing ustr;**	380 new: 335	200 new: 220	160 new: 115	24	0.49	58	0.76	
	[illegible]				24	127	full - XØ	pt	rectang, rounded, bright orange mc, white patch on top = swan-like; no real hs, dstr = half oval, white-brown lc = a bit hs. #127 = in line w rhs corner of large flat pink B ustr	255	170	120	24	0	53	0.36	
	OUT: new stone			MOVED dstr	25	128	full - XØ	pt	yellow angular sc, flat on top, set among similar elements, immed dstr = scratchy white LC on lhs and white oval submg B to rhs, no hs. **NEW 25 Jun: brown speckled oblong s/mc; center of ring of 4 lcs --> 2 on lhs are grey, 2 on rhs are orange brown. ring is on lhs of dark orange sb = embed. round w crack perp flow; #128 = set on sloping part of channel, going to deepest bit at orange SB w crack; #128 =ustr and to lhs (touching lhs pt) of orange + cream rectang-pentagon w darker side along dstr edge; ustr of #128 and 15 cm to rhs = green + black subm lichen-speckled white SB.**	129 new: 140	95 new: 85	65 new: 50	20	0.24	38	0.63	
	OUT: new stone				26	129	full - XØ	pt	red + gold sc (red rim), set in gap betw ustr pink rectl lichen (tip emerg) B and dstr planar red + white block, tip also emerg, = quite good hs. **NEW 25 Jun: light br. flat almost rectang; same position as original #129 wrt upstr sb, dstr sb out.**	115 new: 210	98 new: 165	65 new: 80	6	0.14	28	0.03	
					27	130	sa yellow net	pt	Distinctive blocky, trunk-like s/stone orange/red & fawn LC, cut/flat dstr face pointing up and tansverse across channel, in isolepis band (sample = net s.a with rock + isolep). Post June flood - isolep scoured, now painted tip = submerged	470	333	119	6	0.03	11	0.66	
					28	131	bank	pt	pinky brown sc, loose in ring of larger cobs (= hs), dstr stones = same pink colour. #131 just outside isolepis band.	180	100	80			2		
					29	132	bank	pt	wh embed oval flat face ustr narrow edge on top. 2/3 up bank, pushed against dstr cobs. fern growing from below #132	500	370	225 emb					bank
				TR10 Tape start 0													
					16	133	bank	pt	oval, triang in vert profile, w scratchy ridge along top of stone perp to flow; white w small fawn patches, embed in patch of lg in lower prtion of bank, dry but inside the sedge line; not very embed ca 30%); ustr = wh pear w distinct thick black line thro middle (not much hs)	530	330	emb					emerg
	[illegible]			[illegible]	17	134	full - XØ	pt	flat triang stone, pink on upper surface; one corner pointing dstr; set amongst sc/mc; 20cm ustr = oval creamy LC (?) w lichen dome top just emerg on rhs (this =slight hs)	185	160	70			13	0.02	
	[illegible]			[illegible]	18	135	full - XØ	pt	flat oval mc, bright orange, set b2 a) subm, irreg, flat lichen B on rhs & b) just emerg, flat white oval lichen B 10cm ustr on lhs, #135 = in line w lhs edge of the lichen dome b described for 134	245	180	30	15	0.06	35	0.23	
					19	136	emerg	pt + pu	~rectang w extra pointy bit on dstr rhs, c-shaped cuts along rhs margin; pointy dome in mid-section, dome w lichen <1/4 embed, #136 = cream w brown speckles all over	880	570	emb	10	0.01	19	0.67	
	OUT: new stone				20	137	full - XØ	pt	orange and red mottled sc, oboval, long side // flow; dstr edge touching distinctive orange and cream patchy subm. rect B which = ~ 15cm from lhs edge of #136. **18 JULY FIELD CHANGE:** description wrong - 2 stones now puttied on lhs of #136, and no old #137. These = STONE 1) white, deep set, angular lc ++ embedd betw 2 higher-set lc's, one on rhs = olive, one on rhs = irreg, planar, fawn + orange, distance from paint on #136 to #137(1) = 85 cm. STONE 2) white, deep set, deeply embed, 5 cm from edge of #136	205 new: 1) 320 2) 185	115 new: 1) 270 2) 130	65 new: 1)emb 2)emb	34	0.16	64	0.75	
					21	138	net sa orange alu handle	pu	subm embed irreg yellow B w red splotches. upstr 1/2 has crack // flow, long axis perp flow. #138 = pinned dstr by flat brown/gold sb which is raised on dstr side. #138 looks like 2 sb, dstr edge of #138 = immed upstr of chip in flat round emerg. B	605	320	emb	32	0.2	54	0.62	

BERG RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE

FLOOD COLUMN: blue = moved; pink = OUT; Orange sh[illegible] INVERT COLUMN: green shade = possible invert / peri sample for after June flood: OLD STONES; pink shade, poss invert samples (must be full samp): NEW STONES, yellow shade, poss invert IMMOV (top surf area only) - TICK WHICH ONES ARE STILL SUITABLE

FLOOD 1 - Jun 10 search	BIG FLOOD 2 - Jun 21-23 search (?207 moved)	FLOOD 3 - July 2 search (in heavy rain)	FLOOD 4 - July 18 search	Flood 5	Offset from start	stone no.	X= invert sample, ø = periphyton, imm, emerg = no samp	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost; then if marker has changed (eg putty to paint), new marker type indicated	Stone x (mm) (old stone size incl. followed by NEW stone size where replaced)	Stone y (mm)	Stone z (mm)	depth (flow/depth taken during SETUP (low baseflow) ie refers to all initial stones; link to initial Tritan survey)	velocity	depth (flow/depth taken ON 25 JUNE (med baseflow) ie refers to all remaining / new stones; linked to resurvey by Tritan)	velocity	Comment
	OUT: new stone			MOVED 1m dstr	22	139	full - X (no peri)	pt	submerged yellow SB, D-shaped curve on dstr margin, moss patch on lhs, #139 = just ustr of chip in a flat brown emergent LB **NEW 25 Jun: pink & fawn oval flat mc, set with same elements; #139 = 30cm upstr of big brown b, on the lhs of upstr point of the B.**	545 **new: 245**	415 **new: 180**	225 **new: 60**	6	0.16	43	0.56	
	OUT: new stone				23	140	full - Xø	pt	fawn pyramid mc, embed by 2 emerg SB on lhs, ustr sb = white and pink; dstr one = orange w oval quartz off-centre + hole on dstr end. **NEW 25 Jun: triang flat brown lc, pinned on lhs by creamy orange sb w quartz spot and hole on dstr end. #140 immed upstr of br and orange D shaped embed SB with crack // flow.**	185 **new: 250**	140 **new: 190**	65 **new: 70**	4	0.42	34	0.39	
	OUT: new stone			[illegible]	24	141	full - Xø	pt	brown angular / pentagon sc w pointed angular top + red streak on rhs, slightly grainy texture; betw a) white/pink embed mc w sharp edge and b) embed oval white / green mc. **NEW 25 Jun: orange brown triang lc in middle of run; 30cm upstr of distinct brown & orange emb. submerged sb; slightly pinned by greeny lc on dstr side; dstr side of pinning rock lifted.**	105 **new: 220**	40 **new: 190**	36 **new: 95**	14	0.13	30	0.45	
					25	142	dry	pt	emerg sb, flat topped, raised dstr end, embed in bank; #142 has rough surface + lichen	655	395	emb			6	0.33	
					26	143	dry	pt	lc - pink w grey striations // flow sub-square; 15cm down-hill from rounded pale brown sb w cobb bed above it	295	235	emb					bank
					TR11 Tape start 2												
				15cm covered snad/gr	18	144	dry bank	pt	oblong white embed sb, 30cm dstr from oval dome orange sb; 20cm to lhs of red & wh triang emb sb/lc w sharp pt & red dstr edge	425	270	emb			1		
					19	145	dry bank	pt	white oblong flat SB w scratches // flow, lhs just touches water, 15 cm dstr of wh well emb. B w sloping face upstr, and mostly emerg #145 is center of a cross made up of 1) at ustr end of X, an embedd MB embed w lich on dstr end, 2) at dstr end of X, a square green embedd lc, 3) on rhs, wh sb pyramid, fractured on upstr side; 4) on lhs of X, squarish wh lc w dstr side lifted & few lich spots	505	330	emb			8	0.13	
	[illegible]		[illegible]	[illegible]	20	146	full - Xø	pt	orange-brown mc, triang in plan, long axis perp flow, #146 = ustr of gap betw 2 eremg SB's rhs one = pink, flat, lifted dstr, lhs one = white lichen fan-shaped	245	175	90	4	0.1	20	0.16	
					21	147	emerg	pt?	dstr of oval subm gold & orange m/lc dstr & on lhs of round flattened dark brown mc	755	700	emb	16	0.03			emerg
	Did not move, but replaced by new stone			[illegible]	22	148	top surface invert only - dark net	pu	immovable, pentagon-shaped white-green mc, touches edge of flat red emerg B. #148 = on rhs of white angular SB w lichen, dstr of #148and touching it on lhs = long thin orange embedd LC, ??? this LC or #148 (not sure) = 10 cm dstr of submrg, sub-rectang, orange and fawn flat SB **NEW 25 Jun: dark brown very flat LC, rounded narrow side up, resting on upstr side of orange flat Sb previously described; new marker = paint**	255 **new: 325**	185 **new: 295**	imm **new: 105**	14	0.47	30	0.63	
	[illegible]			[illegible]	23	149	full - Xø	pt	subm fawn & light orange lc angular + triang, overlapped slightly ustr by 2-tone brown subm lc	280	225	210			28	0.96	
					24	150	dry	pt	emerg immov red irreg rectang planar sstone distinctive mottled coppery top w white cream copper patches red x on rhs of 150 @ 24m on tape	1320	820	emb			6	0.5	
					25	151	full - Xø	pt	light orange oval, flatly rounded top; surface pocked & slightly mottled w black; set in sc/lg bed ~ 47cm dstr (from centre of #151 to dstr tip of) of emerg cream sb, this SB has flat face w cracks, dstr end lifted up a lot	335	280	125	8	0.27	34	0.7	
	[illegible]			[illegible]	26	152	full - Xø	pt	brown-orang sc w rough surface, flat face, narrow side up facing ustr and into / across channel, set dstr of slightly larger stones, but still mc/sc, no real hs	135	90	65	22	0.3	46	0.4	
					27	153	immov emerg	pu	cream & pink (more creamy), angular rough surface ~triang, ridged, w ridges at < to bed, slightly embed, lhs point pinned by emerg grey sb w dark striats, which = hs to #153. **18 Jul:** not v embed	490	300	315			20	0.44	
					28	154	bank	pt	oval slightly triang flat top, crevices & gouges where reddish patches on rhs; emerg in v. shallow water's edge. Isolepis around but sparse After June flood - now set in sandy deposits on bank edge (=notes 18 Jul)	295	200	145			8	0.01	
					29	155	bank	pt	diamond shaped white w flush of pink on top surface next to eye w stone in it, 1/2 way up steep bank; 2 metrosid betw #154 & #155, but 40cm upstr of trans line	325	270	emb					bank
					TR12 Tape start 2												
	OUT: new stone			[illegible]	18	156	bank	pt	white sc w fractured fawn dstr part, immed dstr of white lichen B, but #156 = loose and small **NEW 25 Jun: orange flat D shaped mc; has hs but lies loose on bank; #156 = upstr. & to lhs of embed white sb w orange splash of paint (spilt when marking)? ?? where's white lichen B in old descrip?**	78 **new: 270**	64 **new: 155**	35 **new: 100**					emerg
	OUT (later found 6m dstr at Tr9), discarded				19	157	bank	pt	oval white SB w transverse grey stiations, lhs = pointier, facing into channel, no hs **NEW 25 Jun: ++ erosion of bank - now area = backwater; orange, pinkm, flat mc, immed dstr of triang whitey yellow flat sb.**	457 **new: 210**	320 **new: 130**	250 **new: 55**			14	0.34	
	OUT: new stone				20	158	too embed	pu	greeny cream mc, deeply embedd w sc covering most of it, #158 = immed dstr cream oval-triang, just emergent SB w rounded surfaces, #158 hs = ++ embed. **NEW 25 Jun: triang creamy (greeny) SB in prev = new #158 new marker = paint?**	180 **new: 655**	160 **new: 635**	emb **new: emb**	7	0	19	0.27	
	OUT: new stone			[illegible]	21	159	full - Xø	pt	orange sc w cream patch facing ustr; irreg, sort of spear-head shape w point facing dstr; set immed ustr of V formed by large flatly rounded submg orangey B w submg embed whitish cream LC on its rhs; not much hs - bed = LC + gr and the dstr "V" stones = v flat. **NEW 25 Jun: mc - rounded wh/pink mc, touches upstr edge of golden submerged flat B w elevated dstr edge**	145 **new: 180**	78 **new: 160**	75 **new: 65**	23	0.7	55	0.33	
	OUT: new stone				22	160	full - Xø	pt	dark orange - brown rectangul lg set with others ~ 10 cm dstr of submrg cream SB w striking orange bands, no hs **NEW 25 Jun: flat, square-rectang, green and orange SB (= striking cream/orange one in prev), lightly pinned on lhs by greenish white pyramidal sb w white cap + few lichen spots. This = slightly higher than #160, but both rocks = higher than other elements around.**	95 **new: 415**	75 **new: 380**	39 **new: 135**	26	0.21	32	0.73	
	OUT: new stone				23	161	full - Xø	pt	brown triang s/mc, point facing dstr, flat top, set immed dstr embedd orange mc w dark orange patches, all stones set at same level - no hs **NEW 25 Jun: deeply set, yellow flat embed. immov. LC, w 4 fawn spots (1=putty marker); #161 = left of elevated but embed sb/lc w scoop on top + eyes on ustr facing "plane"**	195 **new: 360**	145 **new: 350**	90 **new: emb**	15	0.28	58	0.62	
					24	162	full - Xø	pt	creamy brown mottled rect oval lc w deep fissure along top surface (long axis) perp flow, immed ustr = 2 smaller lc arranged to tie in w rhs and lhs edges; dstr of #162 = wh angular-oval & dstr further = irreg oval orange w brown mottle on dstr side perp flow	450	290	140	8	0.2	24	0.4	
					25	163	full - X (no peri)	pt	blockish white, just subm, small lichen spots, looks a bit downstr of line, but **JULY 18 measure: 16cm (edge to edge) dstr of cream pentagon** w fawn/orange, domed top and orange rings, emerg, this = OK hs for #1163	455	395	230	4	0.31	24	0.61	
	OUT: new stone				26	164	full - Xø	pt	dark brown triang sc/lg set among small stones, dstr + to lhs of brown mottled submg SB, on lhs of #164, just ustr + adj to mottled SB = embedd red-orange flat top fissured lc, no real hs **NEW 25 Jun: oval. dark brown and orange/red sstone LC, immed to lhs of mottled brown (dark br + green) embed round sb (= stones described in prev).**	65 **new: 385**	50 **new: 210**	30 **new: 125**	22	0.04	33	0.59	
					27	165	full - X (no peri)	pt	dinosaur head wh + lichen spots on muzzle, orange patchy cheek ustr pointed side creamy w shallow eye; #165 = "under eves" of emerg b just dstr of it, w moss & embed in bank (5 cm away), the "muzzle" of #165 also ustr but overlaps plate-like orange-green oval submg, embedd LC w crevices, bright orange ustr side, dstr edge lifted up. hs = dstr elements	450	330	150	8	0.05	29	0.19	
					28	166	bank	pt	red rectang block, white patch on lhs, sloping down towards chann, isolepis instr and underneath, #166 = in low part of bank, just outside emerg triang wh b #166 = 0.5m from orange X lc (Julia's), no hs	575	280	210					bank
					TR13 Tape start 0												
	[illegible]			[illegible]	16	167	bank	pt	oval pink & fawn sc; upstr = overlapping white oval sb w flat face upstr + black striat // flow; on lhs (? = or on lhs of?) embed white sb w overlapping planes on upstr side.	205	140	75 ? emb					emerg
	[illegible]			[illegible]	17	168	2/3 sample - bottom and sides Xø	pt	grey sc, 2/3 emerg in slackwater formed by 2 emb sb located ustr of #168: one lichen white, other pink; #168 = adj on rhs to br cream dome mc w quartz at bottom, #168 = dstr & on rhs of orange & fawn embed, just emerg, mc w orange top, Post June flood - sand and isolepis just ustr of #168	140	100	65			15	0.04	
	[illegible]			OUT	18	169	full - Xø	pt	cream pink-brown long triang, roundly angular; #169 = dstr & slightly to lhs of V in 2 SBs, one forming the b/water for #168, the other = pink/brown w lichen **Post flood JULY field:** #169 = ustr & touching, but located at about 5 o clock from the centre of this brown/pink lichen B; small hs no large elements ustr	200	100	80			31	0.22	
	OUT: new stone			[illegible]	19	170	full - Xø	pt	white + red, angular sc, immed ustr of & touching emerg round fawn B w lichen on its rhs and scooped top, #170 = in between square flat yellow submg mc on rhs, and oval flat red-orange mc on lhs **NEW 25 Jun: blocky fawn & orange mc, set w similar sized elements. #170 = 15cm upstr of embed sb with arching top --> fracture in upstr side makes this sb look like an armchair**	115 **new: 245**	95 **new: 205**	70 **new: 145**	18	0.11	30	0.57	
					20	171	sa orange alu handle	pu	s/mb - orange oval <1/5 emerg lifted dstr, round orange submg LC immed ustr	605	600	290	8	0.23	22	0.65	
	[illegible]			[illegible]	21	172	full - X (no peri)	pt	flat olive brown SB, rounded ustr, 3 lobes, dstr quartz spot near center, subm not emb	630	550	220	8	0.4	30	0.75	
					22	173	1/2 orange al net	Pu	yellow 3-sided LC w blunt upwards point, red tip on top point; submg embed; gravel on lhs, cobbles on rhs; #173 = dstr and rhs of emerg dirty wh brown b fractured on rhs; dstr of #173 = a fan shaped orange subm. sb embed & pointed ustr	?emb 290	230	emb	15	0.07	58	0.47	
	[illegible]		[illegible]	[illegible]	23	174	full - Xø	pt	oval, distinctive, marbled block, red, orange fawn mc, On rhs of rounded submg grey brown B w crack upstr & 2 dots on its rhs (clam shaped); #174 = midway betw this and a just-submg, round-square, flat-top lichen B which itself = pinned by large emerg pinky blocky B w scoop out of its elevated (emergent) dstr edge	220	115	75	20	0.33	51	0.55	
	[illegible]			OUT	24	175	full - Xø	pt	dark & light orange rectang/angular/diamond mc w flat top, pinned (not pinned post June flood, but adj) on lhs slighty by red brown oval mc, immed dstr = 2 subm. wh green Bs; ustr of #175 and abutting its ustr edge = pear sh. wh/creamy yellow green submg embed sb	270	190	125	8	0.24	28	0.55	
					25	176	full - Xø	pt	mc yellow and brown, embed, subm fishtail fract dstr side, fish tail pointing dstr and across channel, has 3 stones around on dstr + rhs: 1) on dstr lhs = V emergent creamy white LC w crevices on flattened top surface; 2) on dstr rhs = squarish orange + white submg LC w fractured rhs tip, submg w green + black lichen; 3) on rhs, at level w #176 & extending ustr = white & red (gingerbread) flat squarish submg lc, dstr tip elevated and w ++ black lichen	290	180	90	2	0.05	22	0.25	
					26	177	dry	pt	red fawn black, green s/stone emb sb just dstr of grass clump	440	370	emb					bank
					TR14 Tape start 0												
					6	178	dry	pt	**SAND PATCH on rhs of grey B w 1/2 moon cuts - not incl in sample size**	sand							bank
					7	179	dry	pt	embed grey B w c-cuts; **post June flood** - now nearly covered by sand	920	740	emb					bank

BERG RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE

FLOOD COLUMN: blue = moved; pink = OUT; Orange = [obscured] check in field, conditional marked yes, but perhaps old not gps?; INVERT COLUMN: green shade = possible invert / peri sample for after June flood: OLD STONES; pink shade, poss invert samples (must be full samp): NEW STONES, yellow shade, poss invert IMMOV (top surf area only) - TICK WHICH ONES ARE STILL SUITABLE

Stone size columns: old stone size incl. followed by NEW stone size where replaced

flow/depth taken during SETUP (low baseflow) ie refers to all initial stones; link to initial Tritan survey

flow/depth taken ON 25 JUNE (med baseflow) ie refers to all remaining / new stones; linked to resurvey by Tritan

FLOOD 1 - Jun 10 search	BIG FLOOD 2 - Jun 21-23 search (?207 moved)	FLOOD 3 - July 2 search (in heavy rain)	FLOOD 4 - July 18 search	Flood 5	Offset from start	stone no.	X= invert sample, ø = periphyton, imm, emerg = no samp	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost; then if marker has changed (eg putty to paint), new marker type indicated	Stone x (mm)	Stone y (mm)	Stone z (mm)	depth (setup)	velocity (setup)	depth (25 June)	velocity (25 June)	Comment
	prob. both stones covered by sand; newest dug out to see no.	?? Original = there - covered by sand	covered by sand	Buried	8	180	dry	pt	embed white/grey mc, 30 cm ustr (??of) roundish embedd B w black striations. **NEW 25 Jun: round angular. pinky orange lc in same location as original (presumed buried)**	165 **new: 275**	140 **new: 200**	emb **new: 190**					bank
				3/4 buried	9	181	dry	pt	triang embed B. red patch on rhs. the rest = creamy pink. w. black striats perp flow. **post 3 July flood also covered w sand, now embed**	580	280	140					bank
	[redacted]			[redacted]	10	182	dry	pt	triang white-grey LC w black striations & scoop on ustr side. resting on a v pink embedd SB	350	245	emb est 130					bank
	OUT: new stone			OUT	11	183	dry	pt	sc/lg. set 10 cm dstr of sub-rectang white / cream B. deeply submg. but w high point. embed on lhs. has few black striations. ?#183 resting on gr that overlies orange pointed ??; #183 just ustr and to rhs of angular creamy pink LC w planes (blocky). **NEW 25 Jun: round orangy pink lg set with other gravel**	75 **new: 60**	80 **new: 45**	emb **new:45**					bank
					12	184	dry	pt	wh b w pink tint. black concentric rings. dstr end higher than upstr which is pointed. just dstr of b marked "Baken B" - #184 above transect line	900	680	emb					bank
					13	185	dry	pt	irreg pink B not embed. overlaps bright orange. emb sb on dstr side of #185 - ??ie off dstr point of baken b - #185 above transect line	840	470	240					bank
				[redacted]	14	186	dry	pt	creamy pink flat. ang LC. lhs edge = red. #186 = in deep "hole" area to the lhs of #185	325	225	130					bank
					15	187	dry	pt	domed B pink & fawn. black striations concentric. perp flow on equator. not embed	750	600	480					bank
					16	188	dry	pt	pink emb b smaller than #187. top of #185 = same ht as base of #188. scoop in lhs	645	390	emb					bank
	OUT: new stone				17	189	dry	pt	red/brown gr on gr/sc bed. No hs. **NEW 25 Jun: sb - white. emerg. not embed. cuts and scoop on upstr lhs. resting dstr end- up on 2 white sbs just dstr of it; no real hs**	50 **new: 580**	35 **new: 390**	20 **new: 370**					emerg
					18	190	dry	pt	pink rect b w black lich. domed top. scoop upstr side. lhs overhangs water over gravel; SB on upstr side of #190 = pinned by it	740	570	410					emerg
	[redacted]			[redacted]	19	191	full - Xø	pt	brown. flat mc w dark brown patches. subm. embed but movable; has 1 line fracture dstr. lhs & scoop on upstr rhs. #191 = 10 cm to lhs of sb pinned by #190	230	220	160	8	0.08	23	0	swirl
					20	192	top surf area (x*y) stone - X	pu	orange - brown. subm. emb. brown lichen lhs. long hole in rhs	730	680	emb	16	0.18	40	0.59	
	[redacted]				21	193	full - Xø	pt	flat rect grey lc. fract on lhs; ustr of orange submg lc, immed dstr & touching emerg. cream lichen b which was painted by mistake. long axis //flow	435	280	130	14	0.03	38	0.51	
	[redacted]				22	194	full - Xø	pt	creamy yellow rectang sb, greeny tinge; 30 cm dstr of wh oval b w emerg dome = sprayed by mistake, pointy side of #194 w white dot on slope facing upstr	510	350	155	10	0.4	34	0.63	
					23	195	immov emerg	pt	V emerg. lb lich most on upstr face	740	530	430			6	0.67	
					24	196	full - Xø	pt	D shaped yellow brown lc; on lhs = yellow-green embed lc. on rhs = oval golden lc/sb w white line perp flow. #196 = deep set in deepest part of channel. #196 = dstr of grey - green subm. triang embed LC w brownish top; #196 = about 50 cm to rhs of emergent white lichen B	280	215	130	22	0.16	44	0.62	
	[redacted]			[redacted]	25	197	full - Xø	pt	mc - rect cream. in middle of a triang of stones all subm; 1) striking red + fawn sb at apex. 2) light brown & lich on rhs; 3) wh + spots on lhs; rounded end of #197 = at dstr	215	115	70	8	0.06	28	0.7	
					26	198	bank	pt	large oval light grey w +++ small lich spots. rounded top surface dipped down towards channel. embed into bank on ustr side; 2 large Bs ustr = hs: stacked against #198	730	680	emb est 270					emerg
					27	199	bank	pt	rect wh w small shallow scoops and dents; set in sand 1/3 way up bank. Embed, also piled material ustr = hs	310	215	emb					bank
					28	200	bank	pt	lc square fawn + black lich w flat upper surface. ~1m from pine trunk. angled down steep slope. on top of other smaller stones; no hs	300	230	150					bank
					TR15 Tape start 2												
					9	201	dry	pt	grey lc; oval; long axis perp flow; 30cm ustr from grey b w fract on lhs	380	240	130					bank
					10	202	dry	pt	fawn mc, scoop in top & 2 grey patches. touches red square b on its dstr side	190	135	90					bank
	OUT: new stone				11	203	dry	pt	mg at dstr end of dry "channel", just ustr of pink embedd B w brown concentric lines on dstr end. **NEW 25 Jun: sb - white sb w orange stains. on lhs of sandy channel. scoop on upstr side; dstr end of stone = lifted up**	65 **new: 560**	30 **new: 410(emb)**	20 **new: emb**					bank
	[redacted]			[redacted]	12	204	dry	pt	mc, ustr end = fawn, dstr end = red; on lhs of grey embedd B w red-orange on top; located in what would be in deeper flow during a flood	255	150	150					bank
	OUT ? Or poss sand depositions			sand	13	205	dry	pt	lg on gr/sc bed in middle of 4 SBs. **NEW 25 Jun: SAND - NOT MONITORED**	55 **new: sand**	40 **new: sand**	40 **new: sand**					bank
					14	206	dry	pt	irreg emb wh b w c cuts. smooth on dstr side. hidden hole upstr lhs	945	600	emb					bank
					15	207	dry	pt	flat b grey w bl speckles. large scoop on upstr side. brown patch dstr rhs. not embed. **18 Jul:** now embed a bit	1160	810	270					bank
					16	208	dry	pt	white LC. narrow side up; slightly overlapped on rhs by pink mc w black lines, amongst mc's; lies on dstr side of embed wh-rey sb w cracks & fissures. grey mottle	300	200	70					bank
	OUT: new stone				17	209	dry	pt	pink/orange. roughly triang LC. on lhs of embedd wh B w scours & a few C cuts. **NEW 25 Jun: round embed. rough dirty white LC, midway b2 #210 and embed wh sb with cuts & hole on dstr end.**	390 **new: 240**	300 **new: 220**	120 **new: emb**					bank
					18	210	dry	pt	mb - fawn & red-brown stripe on rhs // flow. forms border of 2 levels of channel bed	670	460	350					bank
					19	211	dry	pt	distinctive oval SB, emb, orange fawn & red-brown patches make a fat broken stripe perp to flow, along the "waiste"	460	395	emb					emerg
					20	212	dry	pt	pink lc embed, long axis // flow; #212 = upstr & lhs of pink b. not emb, w long narrow hole on lhs	335	165	emb					emerg
	[redacted]			[redacted]	21	213	full - Xø	pt	wh angular mc, embed, shallowly subm; #213 = on lhs of wh embed lc, midway betw 2 ++lichen Bs (both black crust lichen). ustr one = just submg & embed, dstr one = v large, oval, emergent	245	195	105	1		17	0.78	
	OUT: new stone			OUT	22	214	full - Xø	pt	dark orange-brown triangular mc w fawn lh corner dstr & dark brown T ustr edge, submg, not embed, just ustr from orange emerg embedd LC/SB. **NEW 25 Jun: mc - pear sh. dirty brown-white; 5 cm dstr of orange rect sb, long axis perp flow, with green lichen**	195 **new: 180**	190 **new: 125**	90 **new: 80**	7	0.01	35	0.3	
	[redacted]				23	215	full - Xø	pt	mc rect flat subm not embed. brown w orange/red bit on lhs; red/orange streak center. black line // flow; lying on fawn mc w orange spots on lhs; on rhs of #215 = orange mc w fawn streaks & 2 white spots. Both mc's = a bit dstr of #215, submg and not embed. no hs	275	240	70	6	0.23	40	0.28	
	[redacted]				24	216	full - Xø	pt	golden squareish sb fractured on dstr end so scraggly bits face dstr. fracts make a holloween face; set about 5cm from submg rect lich B ++ brown spots. The side of #216 runs nearly // to side of lich b	365	225	150	8	0.33	28	0.43	
					25	217	sa stone x*y dimensions - X	`pu	large flat greeny oval embed. B; edges slightly brown/fawn tinge; #217 = 15cm dstr other side lich b described for #216; #217 = deep-set & embedd	540	485	emb	28	0.36	53	0.44	
				Stones on top	26	218	full - Xø	pt?	light yellow fan shaped mc. notch pointing to rhs; crevice on dstr margine; other looser mc's = to all sides; hs = that quite deeply-set	285	225	100	14	0.01	29	0.49	
					27	219	full - Xø	pt	light orange oval angular mc in pointed tip facing ustr, long axis // flow, set in frf; #219 = >1m dstr of main riffle, but about 0.5 m ustr and in line w irreg surface, planar, dark brown emergent SB w crevices supporting moss, no real hs	350	215	105	4	0.11	27	0.13	
	[redacted]			TO	28	220	full - Xø	pt	red and pale flat faced rect sc. w other similar. immed ustr of emerg irreg, rough surface, cream + orange LC w moss patch on lhs dstr corner. This LC = sort of hs	160	95	55	6	0.14	29	0.47	
	OUT: new stone				29	221	bank	pt	tiny white lg on bank in sand/gr; just outside isolepis band; just below where bank steepens and becomed comprised of grey, inset LCs, no hy too small. **NEW 25 Jun: angular brown sc in same position; 30 cm ustr & to lhs of Orange X Boulder**	50 **new: 160**	40 **new: 85**	30 **new: 70**					bank
					TR 16 Tape start 0												
					8	222	bank	pt	ang wh fawn pearshaped mc; flat darker face on lhs ustr; adjacent to lhs of a triang of wh Bs embed in sand	390	220	emb					bank
					9	223	bank	pt	oblong wh & black lich embed. sb. orange markings dstr side. length perp flow. **18 Jul - ?no longer embed or was measurement an estim**	520	270	emb? 220					bank
	[redacted]				10	224	bank	pt	grey sc. On lhs of flat oval grey sb/lc w 2 scoops on top and upstr	125	60	60					bank
					11	225	bank	pt	"Baken a"; oblong LB, long axis perp flow; wh w red-orange splitches upstr	870	340	**?? 315 or embed**					bank
					12	226	bank	pt	emb round flat B, pink striations // flow, crevices cracks on rhs. fractured chip on lhs	630	340	emb					bank
	MOVED: replaced with new stone			OUT	13	227	bank	pt	fawn pear-shaped LC resting on browner, embed SB, immed ustr of orange B. **NEW 25 Jun: sc/lg - white immed dstr & rhs of sb which is embed w round top and orange patch upstr.**	315 **new: 90**	250 **new: 60**	115 **new: 55**					bank
					14	228	bank	pt	grey oblong emb b, small flake on dstr side, on rhs of larger orange flat b	560	100	emb					bank
				[redacted]	15	229	bank	pt	red-orange and fawn marbled mc, = #33 in yellow	180	110	100					bank
	OUT? Double check - pinned prev by the new #7			[redacted]	16	230	bank	pt	brown sc, pinned ustr by mc, itself pinned by creamy orange LC, #230 = embed w other sc's under grass. **NEW 25 Jun: lc/mc - orange white. described as pinning original 230**	120 **new: 220**	95 **new: 160**	emb **new: 90**					bank
	OUT: new stone			OUT	17	231	bank	pt	lg on rhs of brown round mc, pinned under wh LC w flat rhs face. **NEW 25 Jun: sc - angular orange in ??same location**	45 **new: 100**	40 **new: 55**	10 **new: 40**			1		
					18	232	bank	pt	very brown oval SB, on rhs & touching square blocky white sb **NB check measurement**	670	380	190					emerg
	[redacted]			[redacted]	19	233	2/3 stone area - Xø	pt	embedd creamy green mc, top emerg, distinct white line on rhs; on lhs of embed emerg pinky orange LC in bank; on rhs of angular, emerg brown SC	200	180	105			6	0.12	

BERG RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE

FLOOD COLUMN: blue = moved; pink = OUT; Orange shade check in field, new stone marked yes, but perhaps old not out? INVERT COLUMN: green shade = possible invert / peri sample for after June flood: OLD STONES; pink shade, poss invert samples (must be full samp): NEW STONES, yellow shade, poss invert IMMOV (top surf area only) - TICK WHICH ONES ARE STILL SUITABLE

old stone size incl. followed by NEW stone size where replaced

flow/depth taken during SETUP (low baseflow) is refers to all initial stones; link to initial Tritan survey

flow/depth taken ON 25 JUNE (med baseflow) is refers to all remaining / new stones; linked to resurvey by Tritan

FLOOD 1 - Jun 10 search	BIG FLOOD 2 - Jun 21-23 search (?207 moved)	FLOOD 3 - July 2 search (in heavy rain)	FLOOD 4 - July 18 search	Flood 5	Offset from start	stone no.	X= invert sample, ø = periphyton, imm, emerg = no samp	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost; then if marker has changed (eg putty to paint), new marker type indicated	Stone x (mm)	Stone y (mm)	Stone z (mm)	depth	velocity	depth	velocity	Comment
	[illegible]			[illegible]	20	234	full - XØ	pt	ang / triang, greeny brown +red submg creamy mc, long end to lhs, long axis perp flow, #234 = touching brown orange D-shaped B, flat bit of D facing dstr	165	85	50	10	0.33	23	0.58	
	OUT: new stone			OUT	21	235	full - XØ	pt	fawn mc w smaller red patches & green tinge, narrow side up, submerged; Set against ustr side brown emerg SB w green lichen; touches dstr lhs of almost emergent rounded/domed brown-orange B. **NEW 25 Jun: mc - green tinge, subrect; set against upstr side of orange brown SB with green lichen, as prev described**	215 new: 200	180 new: 150	70 new: 60	1		22	1.03	
	[illegible]		[illegible]	[illegible]	22	236	full - XØ	pt	mc gold / pinky-orange PREV: pinned ustr & dstr by gold + yellow br mc, in line w in chute 30 cm ustr caused by mc trapped b2 2 emerg sb causing 2 small chutes, **18 July: stone has no hs; pointier side facing dstr; #236 =** 10 cm dstr & to rhs of apex of rounded rectang white emerg SB w lichen + scratches, also the SB has red band at its base	190	145	50	13	0.18	24	0.22	
					23	237	immov upper sa stone - X	pu	mc pear-triang shaped, fawn, subm, embed, long axis // flow, 15cm dstr brown subm Mc; 5-10 cm ustr upstr of green cream mc w domed / pointy top	300	140	emb	16	0.43	37	-0.02	swirl
					24	238	immov upper sa stone - X	pu	embed immov round fawn orange LC, 2 dark br lich spots, 10 cm ustr of rect sb, just emerg, 2 tone - orange/brown and w green lichen; On lhs of #238 = milky sb w small chip ustr lhs,on rhs = round subm orange pink lc w white chip	440	390	emb	10		34	0.45	
					25	239	full - XØ	pt	2 tone orange fawn SB, nearly emerg, length perp flow, dstr touching emerg lich b w sharp summit ridge; #239 = 50cm ustr of subm milky orange Africa sh sb	405	235	170	1		21	1.07	
	[illegible]			[illegible]	26	240	full - XØ	pt	flat brown + red sc in deep water, on ustr lhs of flat round submrg yellow B w orange centre, #240 = overlaid ustr by oval creamy-green mc	185	100	40	28	0.43	38	1.05	
					27	241	bank	pt	wh emerg embed b into bank, large scoop lhs c-cuts irreg shaped and angular lhs of subm brown sb	580	560	emb			12	0.37	
					28	242	bank	pt	mc brown, under dead branch embed sand very angular, pink mc ustr, wh blocky mc dstr	220	150	85					bank
					TR 17 Tape start 2												
					19	243	dry	pt	wh sb angular not embed fracture ustr side	510	380	270					emerg
	OUT: new stone				20	244	dry	pt	angular - rectang lg w rounded ends, on rhs of angular red-brown mc fractured on dstr end. **NEW 25 Jun: white roughly triang mc, flat top and sides are angular; located with similar elements**	110 new: 250	70 new: 220	60 new: 140					emerg
	MOVED 2m; new stone	[illegible]		OUT	21	245	emerg	pt	clam-shaped SB w hole & scoop dstr, orange tint. **NEW 25 Jun:sc/lg - brown, sits on mc =orange and fawn embed.**	500 new: 60	415 new: 40	230 new: 35			10	0.21	
	replaced- from [illegible]				22	246	emerg	pt	triang - angular sc, orange colouration seperated from wh by purple border trapped by 2 emerg b upstr, one = large domed one = low oblong	150	120	85			10	-0.01	
					23	247	emerg	pt	sb, oblong, black lichen over wh rock, dstr lifted V fracture lhs ustr edge	700	400	240			4		
	OUT (18 July found 4 m dstr; discarded)			OUT	24	248	>1/5 emerg - Xø	pt	oval, brown + dirty cream LC, narrow end up, overlies deep, brown mc around, Betw chisel-shaped orange SB ustr and submrg roundly rectang B dstr w algae. **NEW 25 Jun:brown orange mc b2 2 sbs - a) upstream 1 rectang gold with orange rhs, transverse to flow. b) dstr = olive brown flat triang point facing ustr prob = same stones described in orig**	390 new: 300	280 new: 260	140 new: 120			22	0.88	
					25	249	emerg	pt	just- emerg white SB w green lichen, orange on rhs, flat side faces dstr; part of cluster of 3 emerg Bs plus 1 pointed-top, 2 tone orange B just emerg to lhs of #249	480	290	emb			12	1.01	
					26	250	too emerg	pt	ang emerg white SB, scoop on lhs top, causes split in flow; = upstr part of a B bar	470	320	200			6	0.78	
				[illegible]	27	251	full - XØ	pt	brown and green-grey mc subm not embed flat side up 10cm dstr of emerg yellow domed, 3 colour lichen b: green, brown, grey, #251 = betw and slightly ustr of 2 yellow sc/sb just emerg; there = gravel on rhs of #251	285	270	100	6	0.03	28	0.05	swirl
	NOT OUT - new stone marked, but both = there, will monitor both				28	252	full - XØ	pt	green squarish mc, flat side up, v sand-paperish, white patch on rhs, 1mm ustr of emergent orange-tinted white B, which = the first B in a row // flow; #252 = dstr of red triang LC. **NEW 25 Jun:lc - pear sh. green, brown & fawn. immed. dstr of dirty orange gold sb submerged + embed w scoop on top and moss. need to describe the stones (both there) relative to each other**	280 new: 310	240 new: 220	125 new: 130	6	0.21	18	0.28	
					29	253	full - XØ	pt + pu	cream and orange oval B, pointed side facing ustr ~15cm from very emerg creamy B, ustr end of #253 = just touching embed flat lich b underneath the emergent creamy one #253 has flatish top w lichen spots, & is in the shadow of the B w cascading flow around each side of the B, forming frf over #253 **18 Jul - ?now embed**	590	470	180	4		20	1.68	
	[illegible]				30	254	full - XØ	pt	mottled dark round mc, bubbly surface, set amongst other ms+sc, immed dstr to lhs of subm smooth 8-shaped sb at base of casc; no hs	225	150	70	4	0.44	13	0.28	
					31	255	bank	pt	grey smooth surface irreg oval LC, set into bank; immed upstr and lhs of yellow X lc overlapped slightly by ustr grey LC = slight hs	350	260	emb					emerg
					TR 18 Tape start 2												
					19	256	dry	pt	flat white sb under but not pinned by b dstr Orange, and wh + orange stripes, SBs to lhs	370	300	140					emrg edge of b/w
	OUT: new stone				20	257	full - XØ	pt	brown angular sc, narrow end dstr, betw rough red&white mc on rhs, and emergent, long, rounded orange embedd mc on lhs. **NEW 25 Jun: triang, fawn and orange lc on lg/cob bed; 20cm dstr & to rhs of grey embed. b which is lifted dstr & upstr under bbar of 3 SBs**	80 new: 305	50 new: 230	40 new: 165	1				emerg
					21	258	emerg	pt	emerg wh b w lichen cap lhs straight, rhs pointy; dstr of #258 = brown emerg sb w dstr end up	600	560	emb					emerg
	[illegible]	OUT: new stone		OUT	22	259	full - XØ	pt	round yellow sc, on ustr edge of emb subm brown LC, in hole formed by emergent mc + 2sb. **NEW 2 July: lg in V formed by, 1) on rhs emerg greeny SB, round point dstr and 2) triang -pear shaped orange LC w lichen on dstr side which = broader**	85 new: 100	60 new: 65	50 new: 55	4	0.13			emerg
					23	260	emerg	pt	wh lich B, emerg, ~ rectang, shallow scoop on rhs and ustr end, 2 shallow holes on top **18 Jul ?no longer embed**	680	510	emb? 280					emerg
	[illegible]	[illegible]		nearly embedded	24	261	full - XØ	pt	oval m/sc, yellow chip on rhs, w remainder of rhs orange colour; 3-tone orange just emergent SB w lichen on rhs **(?of #261)**, ustr face of this B = same colour as #261, angular mc to rhs of #261; perp flow **(?which is perp flow).**	155	75	40	2		26	0.27	
					25	262	sa orange alu handle net	pu?	emerg b, orange under water thickly encrusted grey lichen top above water, hollow dstr side & fractured overhang on rhs. "saddle" emerg b on rhs chute on lhs	870	740	emb			6	0.67	
					26	263	full - XØ	pt	brown, oval lc, long axis transverse to flow; small hole on dstr end pinning Bs 1) on dstr rhs - orange, not embed, w lich on lhs 2) on ustr - long, embed, thickly encrusted w lichen, fract on top lhs	340	250	190			13	0.76	
					27	264	emerg	pt	sb - brown end up in b field rougher than neighbours Long axis and striats perp flow flat round face looks upstr	370	280	170					emerg
					28	265	sa orange alu handle net	pu	b - deeply embed gold w 9 lichen spots shallow dome some cracks	600	420	emb	12	0.23	32	0.44	
	[illegible]	1 of the # on stone= writtn as 299		[illegible]	29	266	full - XØ	pt	striking orange red and white rugby ball sh sb red lhs, wh rhs, ustr of #266 = white and orange B not embed, B dstr = brown speckled not embed	320	260	130	10	0.39	24	1.28	
	[illegible]	OUT: new stone		[illegible]	30	267	full - X (no peri)	pt + pu	very angular, rugged sstone brown and fawn #267 = on lhs of white green paddle shaped submg B,. #267 = on rhs of emerg wh b lich specked & w foot under water **NEW 2 July: rough brown LC, irreg surface, trapped betw bootlike emerg wh B on lhs (= speckled w foot in prev) and LCs dstr = hs; #267 = directly beneath broken tip of pine branch**	470 new: 340	450 new: 270	275 new: 200	6	0.15			
	OUT: new stone				31	268	full - XØ	pt	yellow-orange sc in arc formed by 1) emergent B w foot under water (from prev #), 2) brown submg lc to lhs of foot & 3) dstr white rectang almost emergent lc NEW 25 Jun D shaped green flat narrow end up; in same place as prev	130 new: 310	130 new: 200	44 new: 145	18	0.31			
					TR19 Tape start 0												
					19	269	dry	pt	embed wh b, lhs just touches backw, concentric scour rings	580	400	emb					at bank
					20	270	dry	pt	triang wh flat sb, pointed end to lhs, balancing out of water against orange b (not emb) w black cap to its right	520	280	100					emerg
					21	271	dry	pt	1/2-emerged orange+ wh SB, narrow side up perp flow; dstr end up, wh quartz spot on rhs upstr edge; nose of #270 points at #271 #271 diverts flow into 2 around it	550	290	160			14	0.69	
					22	272	full - XØ	pt	greeny wh triang mc, 2 arches in dstr side; pinned on rhs by orange mc; #272 forms upstr point of 4 rocks in diamond arrangement	310	230	155	4	0.37	19	0.26	
					23	273	sa orange alu handle net	pu	yellow creamy green green oval w cracks on upstr lhs; grav ustr, cobble dstr, subm embed, pale brown strat // flow	530	310	emb	14	0.02	31	0.44	
					24	274	full - XØ	pt	fawn LC, imm ustr of brown emerg b w lichen cap and foot to lhs, #274 =subm not embed, has fract dstr end; #274 = on rhs of flat orange/pink LB w streaks and fract rhs	280	240	90	20	0.05	20	0.59	
					25	275	sa orange alu handle net	pu	the orange pink LB described for #274	960	510	emb	20	0.06	32	0.24	
	[illegible]	OUT: new stone		[illegible]	26	276	full - XØ	pt	triang blockish mc, 3 tone -orange and red, overlaps slightly lighter orange sb w striats // flow, this SB almost touches rhs of emerg lich **black?** b w dstr end raised; #276 is 15cm to lhs of emerg b w long V groove on top perp flow **NEW 2 July: striated orange SB prev described, which touches the lichen b dstr itself having a raised dstr point. New marker = putty**	210 new: 475	170 new: 240	155 new: emb	6	0.1			
	OUT: new stone				27	277	full - XØ	pt	fawn + orange mc, deep under "eve" of ustr biggest B on transect, in deepest part of channel **NEW 25 Jun: lc - green oblong. same place under eve**	148 new: 370	100 new: 170	95 new: 180	32	0.01	38	0.48	
		pale fawn MC on top of #278		OUT	28	278	full - XØ	pt	br mc in deepest part of channel, in lhs of V betw 1) mottled br subm B w fract on dstr lhs and 2) pink flat B pinned on its rhs by lb (hard to access - underneath)	175	160	78	50	0.23			under log
					29	279	full - XØ	pt	wh green embed LC betw flat orange sb w yellow x and brown sb w round top ridge	240	185	100	36	0.32	50	0.8	
	[illegible]				30	280	none	pt	emerg white SB, "1A" marked in yellow pt	440	370	250					bank
					TR 20 Tape start 2												
					22	281	emerg	pt	pink b long axis perp flow; black patch rhs + middle; hole on lhs marked in koki; #281 = upstr of domed b w black concentric scours	670	420	210					emerg
					23	282	emerg	pt	pink orange triang pyramid mc w scoop on rhs; = on lhs of orange emerg sb + upstr of pink sb w ridge and hole on its lhs	230	230	150			2		
	OUT: new stone			[illegible]	24	283	full - XØ	pt	brown oblong sc under frf caused by SB/LC bar; #283 = dstr of submrg orange flat B wdistinct grey band // flow, #283 lies about 10cm dstr of this band. **NEW 25 Jun: red & fawn oblong mc in same place**	100 new: 145	45 new: 100	30 new: 60			22	0.15	bubbly

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old stone size incl. followed by NEW stone size where replaced

flow/depth taken during SETUP (low baseflow) ie refers to all initial stones; link to initial Tritan survey

flow/depth taken ON 25 JUNE (med baseflow) ie refers to all remaining / new stones; linked to resurvey by Tritan

FLOOD 1 - Jun 10 search	BIG FLOOD 2 Jun 21-23 search (?207 moved)	FLOOD 3 - July 2 search (in heavy rain)	FLOOD 4 - July 18 search	Flood 5	Offset from start	stone no.	X= invert sample, ø = periphyton, imm, emerg = no samp	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost; then if marker has changed (eg putty to paint), new marker type indicated	Stone x (mm)	Stone y (mm)	Stone z (mm)	depth	velocity	depth	velocity	Comment
					25	284	emerg	pt	sb - deeply embed light pink w black strat Transverse to flow pinned ustr by black mb and dstr by red-orange flakey mb w moss **#284?** has crack on lhs to middle	310	300	emb			10	0.22	
					26	285	emerg	pt	oval sb emerg lying on cobbles On lhs of bbar // flow	405	280	120			14	0.79	
					27	286	full - XØ	pt	white yellow flat subm triang sb w fracture on top rhs = pinned ustr by oblong emerg orange sb which = immed dstr of emerg orange sb w dome top, to rhs **(?of #286)** = flat grey emerg sb on lhs is emerg yellow-orange emerg embed sb	420	355	110			24	1.02	
					28	287	emerg	pt	orange lc/sb fract dstr end oval red lines // flow	420	270	170			14	0.56	
					29	288	emerg	pt	mc orange pink under dstr eve of black emerg b; on rhs of dark red, brown oblong lichen emerg sb	315	260	150			6	0.02	
					30	289	emerg	pt	oval fawn lc/mc dstr of b bar w fract on lhs #289 =on lhs of emerg non-embed pink sb (koki marked)	280	265	150			10	0.52	
				Stones on top	31	290	full - XØ	pt	mc, angular fawn and orange fawn pattern = cocks comb, In deepest part of channel upstr of white triang emerg sb w ledge on lhs	200	120	110			56	0.48	
					32	291	full - X (no peri)	pu	white green sb W 2 eyes looks like a winking alien immov - largest submerged rock in thalweg #291 touches ustr part of submr embed brown SB	500	430	325	14	0.3	28	0.88	
	OUT: new stone			Old one found dstr. New one still there	33	292	full - XØ	pt	round orange lg on gr held up by circle of SBs small no hs **NEW 25 Jun: very red-orange, mottled LC sitting between and propped up by a) grey green sb w distinct scoop on top and b) lc dstr**	65 new: 330	58 new: 265	38 new: 130	16	0.17	22	0.38	
					TR21 Tape start 0												
						293	no such rock		**NO SUCH ROCK - EXCLUDE FROM NUMBERS**								
					18	294	dry	pt	white manhir, pointed end dstr and lifted deep scoop on rhs contoured layers on lhs striations // flow	580	310	180					emerg
	OUT??? - size! (orig written x=70?cm? - DISCARD			OUT	19	295	dry	pt	round flat orange SB dstr end lifted striatns at 45 ° to flow lines very // to each other **NEW 25 Jun: lg/sc - white. in front of embed pink white lc/sb embed w fracture on rhs.**	?700 new: 120	350 new: 70	100 new: 55					emerg
	OUT: new stone			[illegible]	20	296	full - XØ	pt	snugly lying sc speckled pale brown + green in V formed by 2 embedd SBs 1) dstr white + yellow 2)ustr = orange tip emergent both these SBs = under emergent white B w black lichen and quartz spot on ustr end **NEW 25 Jun: lg - square white w brown stains on gravel all same size ?? in rel to old stones?**	110 new: 75	65 new: 55	56 new: 30	6	0.06	9	0.07	
	[illegible]				21	297	emerg	pt	angular, v red/ brown sb w flat dstr face; rests on upstr side of oval oblong pink sb whose lhs = in flow	600	310	280					
	OUT: new stone				22	298	full - XØ	pt	yellow-green rectang mc w wavey rhs = on lhs of yellow pentagon mc w 2 long straight sides, v flat 5cm ustr from emerg brown B **NEW 25 Jun: mc - orange round w flat face up. has hole; on rhs of mcs of the same size; #298 = trapped betw 2Bs: 1) emerg upstr with axis perp flow and 2) olive green lichen; dstr of #298 = smaller B w sim lichen**	175 new: 330	80 new: 200	75 new: 85	14	0.18	25	0.35	
					23	299	sa orange alu handle net	pu	subm embed distinctive orange MB w implanted white quartz betw br b described for 298 and wh emergent B w orange colouration on rhs	550	360	emb	5	0.31	25	0.49	
					24	300	emerg	pt	embed MB large shallow scoop on dstr side; under eve of rhs of #301	900	550	emb					emerg
					25	301	emerg	pt	huge wh b oval w dome on rhs on rh edge of mid channel B bar	1180	680	580					emerg
	OUT: new stone				26	302	full - XØ		lg ustr of but betw 1)v red LC and 2) white emerg embed SB w large& distinctive fracture on dstr lhs, Both Bs = dstr of Bbar which also encircles a hole in the bed w trickle flow and mixed cobble/gravel bed **NEW 25 Jun: sb - grey and orange oval. flattened. part of a dam of sbs on lhs of #301.**	45 new: 520	40 new: 290	25 new: 170	1		1		
	[illegible]	[illegible]	[illegible]	[illegible]	27	303	full - XØ	pt	submerged pear sh mc yellow broad side dstr 1 dark line perp flow in circ of lc and sb; on rhs of #303 = emerg whiteB on lhs = dark orange submg embed B #303 = on rhs of this circ of stones	220	160	90	6	0.02	24	0.33	
	[illegible]			OUT	28	304	full - XØ	pt	oval creamy orange mc 1) dstr of emerg brown mc narrow side up 2) ustr of white SB w black striat // flow and orange patch on lhs #304 = among other sc/mc on edge of main channel/thalweg which goes under fallen tree	200	120	70	5	0.04	19	0.79	
					29	305	emerg	pt	oval light br/cream sb w ++bl and green lich spots; long axis nearly perp flow but pointier rhs faces a bit dstr; #305 =immed dstr large emerg light and lich B = hs	750	330	emb			40	0.41	
					30	306	full - XØ	pt	whitish MC greeny top very flat but irreg top oval underneath pointy end facing ustr flat claved side dstr long axis //flow = on bed of gr among mc #306 = midway betw oval diamond emerg b on rhs and large pinky subm b set into bed and bank on lhs ie center of thalweg NB this pt on transect would be in mid debrsi dam so #306 = exactly 1m ustr #291 from Tr20	220	190	120	25	0.08	62	0.89	
					TR22 Tape start 2												
					22	307	dry	pt	large oval lich top b at innermost part of bay at channel edge	920	660	emb					emerg
					23	308	full - XØ	pt	large flat oval cobb w nose dstr; 2 tone - fawn and orange more orange dstr shallow crevice ustr edge; set on sc bed 15cm ustr of top end of Very lage flat white bedrock slab no hs	450	220	110	1		24	0.3	
					24	309	invert = sa (prob orange alu net??)	pu	oval wh MB v embed at angle tipping to rhs w black stripe on emergent "chimney stacks" flat area of surface peeping out through accumulated sg in hollow 10cm to rhs of emerg chimney stacks **18 July:** gr covering much of flat portion of stone	360	305	emb	14	0	32	0.07	
					25	310	emerg	pu pt	mostly subm white rect SB w emerg tip at about center; excavated creviced section falling away to lhs fine scratches #310 = 10cm dstr of very emerg round dark lich b in lineof 4 such bs	600	360	emb	0		18	0.11	
	[illegible]	[illegible]			26	311	full - XØ	pt	brown triang arrowhead pointed side to rhs lodged dstr of emerg flat grey circ B w flat face lifted up at dstr end no good hs except #311 = somewhat "packed"	250	175	85	5	0.14	14	0.54	
					27	312	full - XØ	pt	orange LC w "icing" of white circular except fractured on dstr rhs gouged at 3 o'clock (looking from upstr) dstr tip emerg + raised ustr end set deeper in bed thus stone = tilted -flat face looks ustr #312 = pinned by B immed to rhs - diamond-shaped lichen-topped emergent B w flat upper surface & w white patch in the lichen, 2 more emergent lich Bs = ustr of this, On rhs of #312 = dark grey orange stripe granite mc tip emerg to the rhs of this = round emerg SB round top fawn w lichen	435	320	190	0		16	0.42	
					28	313	emerg	pt	pink white mb 30cm dstr of large oval black flat b, rhs up scoop on ustr side in water	610	420	emb					emerg
	[illegible]				29	314	emerg	pt	oval sb pointed ustr flat w shaped hole upstr of midpoint #314 = dstr of and touching emerg LB with wide scoop or flat face on upstr rhs	420	320	150					emerg
					30	315	emerg	pt	distinct long narrow orange yellow B w sharp summit ridge transverse to flow also crack causing flake on dstr half 1 small patch of moss	960	310	emb			11	0.27	
					31	316	full - XØ	pt	mc in deep hole betw 2 SB/MB that are aligned // flow ustr B = just submg yellow oval dstr B = white emerg triang top ledge on dstr side the Bs change flow betw them to make it perp to channel flowing from rhs to lhs #316 = under this **18 July:** #316 = quite pinned	250	160	125	18	0.7	49	0.52	
	OUT: new stone	under another stone -diffic to see			32	317	full - XØ	pt	sc under rhs of oblong pink emerg B long axis perp to flow; this B = middle of 3 in longit line; dstr of these = emerg w cicle of moss B w narrow side up #317 =greeny triang in deep water **NEW 25 Jun: triang flat brown + fawn sc where? - near inaccessible betw 2 Bs (?same ones?)**	105 new: 65	75 new: 60	40 new: 25	16	0.07	46	0.24	
	OUT: new stone	reputtied			33	318	full - XØ	pt	brown sc red-brown on lhs long triang broad side embed ustr in deep water under dead branches of flood debris frf at dstr end of chute **NEW 25 Jun: fawn/orange SB, angular blocky, long axis // flow; in channel on rhs of branches**	220 new: 600	100 new: 350	60 new: 330	28	0.31			under tree
					TR23 Tape start 2												
	[illegible]			[illegible]	23	319	emerg	pt	orange lc/sb top emerg round ridge top = on top of speckly brown flat deeply embed b on rhs of #319 is white b embed in bank w black striat perp flow dstr is emerg s/mb w mostly black lichen	300	190	170					emerg
	[illegible]			[illegible]	24	320	full - XØ (only tip just emerg)	pt	oblong grey w orange patch on rhs striat // flow but long axis stone = perp flow looks like pup-tent rhs has square corners lhs more rounded #320 =betw 2 emerg sb - 1) ustr = perp flow w summit ridge 2)dstr=squarish rounded top On lhs of #320 = marbled fawn and red mc on rhs = orange oblong mc	210	100	85			14	-0.05	swirl
					25	321	emerg	pt	round flat white SB partly emerg w distinctive hole scoop on ustr side; dstr end lifted orange ustr end = in water	560	450	emb est370	0				emerg
					26	322	emerg	pt	lb - emerg black and white very domed tall top some cuts and lichen	720	690	emb est 670	0				emerg
					27	323	emerg	pt	oval mb white flat round hole dstr rhs scour lines // flow orange stripe dstr end	840	480	360	0				emerg
	[illegible]			[illegible]	28	324	full - XØ	pt	mc triang 2 tone orange Blocky; lifted up on dstr side on rhs of #324 (where tip = emerg) = embed B w large scoop in dstr side on dstr rhs of #324 is square blocky orange lc/sb #324 touches both	300	200	120	6	0.47	17	0.95	
	[illegible]				29	325	full - XØ	pt	orange oblong mc in bbar #325 = immed upstr of LB black lichen-crusted above water and orange below top pushed over on dstr margin #325 = under bsw caused by this b bsw = at base of chute on lhs of B w curved dstr end **(?scoop)** described for #324 #325 = narrow end up embed loosely by other sc and b	195	90	70	4	0.78	20	0.55	bubbly
					30	326	sa orange alu handle net	pu	lb triang flat brown fawn submerged embed pointed dstr black moss patch on rhs 2 lines of frf merging mirror the shape of the b	720	530	emb	10	0.31	32	0.63	
					31	327	full - XØ	pt	mc orange brown with yellow circle on lhs bordered black roughly triang #327 = pinned under cob + SB ustr on rhs of #327 =part of a sb/lc bed - dirty wh sb w emerg tip ustr of #327 = yellow and red blocky lc dstr = dark orange lc tip emerggreen	390	240	145	0		22	0.72	
	[illegible]			[illegible]	32	328	full - XØ	pt	oval brown mc sandpapery under other mcs directly dstr of #328 = pearsh wh fawn flat mc 2 wh submg mc = left and right of this pearshp mc	140	70	55	12	0.03	24	1.38	
	[illegible]				33	329	full - XØ	pt	oval to triang mc dark red brown "nose" ustr end w pale whiter spots flat top #329 rests on other mc #329 = 20cm to rhs of point of flat diamond brown emerg sb - sb that = balanced on an mc next to the bank	210	170	85	12	0.14	26	0.31	
	OUT: new stone			[illegible]	34	330	emerg	pt	square brown sc (white where dry) in V formed by 1) on lhs yellow orange SB embed submg w "breaking wave" shape on ustr end and 2) white triang SB broad point facing ustr and forming the V #330 = on rhs of (1) **NEW 25 June: lg/sc - grey oval flat, same locality**	155 new: 90	135 new: 60	45 new: 20			28	0.15	
					TR 24 Tape start 0												

BERG RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE

FLOOD COLUMN: blue = moved; pink = OUT; Orange [illegible] COLUMN: green shade = possible invert / peri sample for after June flood: OLD STONES; pink shade, poss invert samples (must be full samp): NEW STONES, yellow shade, poss invert IMMOV (top surf area only) - TICK WHICH ONES ARE STILL SUITABLE

FLOOD 1 - Jun 10 search	BIG FLOOD 2 Jun 21-23 search (?207 moved)	FLOOD 3 - July 2 search (in heavy rain)	FLOOD 4 - July 18 search	Flood 5	Offset from start	stone no.	X= invert sample, ø = periphyton, imm, emerg = no samp	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost; then if marker has changed (eg putty to paint), new marker type indicated	Stone x (mm) (old stone size incl, followed by NEW stone size where replaced)	Stone y (mm)	Stone z (mm)	depth (flow/depth taken during SETUP (low baseflow) ie refers to all initial stones; link to initial Tritan survey)	velocity	depth (flow/depth taken ON 25 JUNE (med baseflow) ie refers to all remaining / new stones; linked to resurvey by Tritan)	velocity	Comment
	[illegible]				21	331	dry	pt	white oval LC, embedd, rhs = in bank, no lichen **18 Jul: may no longer be embed**	430	200	120 ?or embed			4		
	NO movement, but new stone			[illegible]	22	332	dry	pt	pink & brown SB, roundly triang, point facing dstr on lhs = 2 emerg SBs, ustr one = pink square w scoop on top, dstr one = round, embed, orange splotched. **NEW 25 June: orange irreg, ang lc, midway b2 a) white, emb, rough SB w lichen on rhs + b) square block sb w scoop on top lhs (this = prev on ustr side of old stone)**	605 new: 330	310 new: 190	emb new: 80					emerg
					23	333	sa orange alu handle net	pu	subm. emb pointy yellow b pinned under rhs of emerg b w large scoop dstr side (=#334)	730	460	emb	10	0.23	30	0.63	
					24	334	emerg	pt	black LB w large scoop dstr side. overlies #333, square mb touches #334 on its upstr side	1120	730	emb est 500					emerg
					25	335	emerg	pt	lb not embed. round yellow w lichen specks. 2 short black and orange lines on dstr side, "perched", not much hs	860	600	400					emerg
	[illegible]				26	336	full - XØ	pt	orange mc, face with 2 eyes, pistol shaped with barrel to lhs, upstream side + touching = yellow green emebed b w tip emerg and scoop on top, pancake-flat orange MC on ustr side overlapping #336 ??both ustr	220	160	80	8	0.33	22	0.61	
	[illegible]				27	337	full - XØ	pt	grey green mc, immed dstr of very milky pink and grey green submg, embed B w moss, #337 = pivot for 2 SBs dstr of it to rhs+lhs forming "wings" in plan view. lhs one = emergent w lichen, rhs one = almost emergent dirty brown white w moss	340	220	130	10	0.28	24	1.14	
					28	338	emerg	pt	mb - 1/2 emerg. yellow pink w 3/4 lich. forms rhs of channel of frf. 3 black spots in triang on dstr lhs	870	630	emb ? est 270			12	1.14	
	OUT: new stone				29	339	full - XØ	pt	fawn mc, narrow side up; lies against ustr side of oblong orange SB w deep L fracture on top lhs and distinct white O w red centre, long axis perp flow, koki arrow points to position of #339. **NEW 25 June: SB w "O" described above = new #339; koki v faint; new marker = putty**	220 new: 620	185 new: 300	75 new: emb	8	0.75	6	0.57	
	OUT: new stone			[illegible]	30	340	embed, immov	pu	embed, immov, off-white LC, diamond shape, dips downwards toward rhs, 30 cm dstr from red+fawn s/stone; #340 = on lhs of emergent SB w eye-shaped hole on ustr side & lichen on lhs. **NEW 25 June: oblong angular SC with orange ridge; immed to lhs of #339; new marker = paint**	655 new: 140	360 new: 60	270 new: 30	6	0.16	10		
					31	341	dry	pt	grey/pink LC, narrow end up, oval. wedged b2 3 emerg Bs that are adj/ustr of palmiet clump, dstr B = the largest, w C-cuts, less lichen + black striat perp flow	350	270	110					emerg
					32	342	emerg	pt	lc - pink orange triang w dstr corner fractured. 1/2 emerged in slack water, on lhs of /underneath a sideways "V" betw 2 emerg Bs - one = the dstr B described in #341; flood debris branches on lhs	230	215	135			20		
					TR 25, Tape start 2												
					22	343	dry	pt	dry B on bank to rhs of backwater -round w rounded summit	800	540	260					emerg
					23	344	emerg	pt	emergent B - D shaped, flat end of "D" = upstr margin, pinned upstr by long angular B which = elevated on ustr end	760	230	emb			1		
	OUT: new stone				24	345	full - XØ	pt	white SC, tip emerg, in slackwater caused by Bbar ustr, immed to rhs of brown round submrg LC, #345 = betw #344 and another (?emergent) B - oblong, triang in section w narrow base facing up, and which overlies #346. **NEW 25 June: white angular blocky LC immed dstr of "dam wall" of lc's betw 2 Boulders: 1) long black lichen B on lhs (=oblong B above) and 2) orange round sb on rhs extending dstr**	100 new: 240	90 new: 200	50 new: 120			2		
					25	346	emerg	pt	Emergent white b, small patch lichen on top dstr end, #346 = under dstr end of oblong irreg lich B described for #345	780	520	emb			2		
	[illegible]				26	347	full - XØ	pt	red-brown + orange-red, embed, mc, dstr of pale orange ang B which = emerg and has fract chip on rhs, #347 = 10cm ustr of brown sb w submerg ustr point. ??#347 = clam shaped w pointed end ustr	150	120	100	7	0.28	17	0.71	
					27	348	too big	pt	sb. lichen underwater. large scoop lhs ustr, #348 = ustr of emerg orang B w lifted dstr end that has cap of lichen	560	480	emb			16	0.97	
	[illegible]			OUT	28	349	full - XØ	pt	round, 2-tone orange MC, on rhs of submrg yellow B that causes BSW; #349 = immed dstr of fawn SB, embed, w dome and 3 black spots arranged in a large triangle	170	130	110	14	0.6	22	1.59	
	OUT: new stone				29	350	full - XØ	pt	triang brown sc, rough texture, =on lhs of submrg oblong orange SB w moss patch, and on rhs of oblong submrg (roughly triang in section) B in deep part of the flow that is dstr of the BSW caused by yellow B described in #349. **NEW 25 June: orange-red long triang LC, almost pear sh; little bit black lichen; scoop in one corner. 20 cm on rhs of embed. submerg. smooth olive brown sb with 3 black spots, and also = 37cm (edge to edge) dstr of a pink/salmon lichen B**	145 new: 430	120 new: 280	60 new: 140	22	0.58	28	1.03	
					30	351	emerg	pt	brown round emerg lc. immov and pinned ustr lhs by grey ang b	360	180	210			16	0.1	
					31	352	emerg	pt	Emerg triang B, pointed end upstr and embed, dstr end raised. forms rhs of channel	720	700	250					emerg
					32	353	emerg	pt	oval flat b w lich. large shallow scoop rhs. With #352, forms edge of channnel	690	560	emb			21		
	[illegible]				33	354	dry	pt	irreg shape brown-white MC, resting on B field - #354 = the only one of its size without lichen	300	220	130					emerg
	OUT: new stone				34	355	dry	pt	sc white rombic, flat, resting on mc over trickle flow. **NEW 25 June: white MC,angular with ridge on top. Immediately dstr of bar formed by sb with cuts on rhs, and white lc + grey lc/sb on lhs**	140 new: 220	105 new: 140	70 new: 130					splash
					35	356	dry	pt	white-grey MC, roughly circular, immed ustr brown embedd SB, #356 = on rhs of white m/lc w hole on top	250	230	80					emerg
					TR 26 Tape start 0												
	[illegible]			[illegible]	18	357	emerg	pt	white oval LC, long axis perp flow, imm ustr of white sb w narrow fract, orange side facing up; Immed ustr of #357 = oval orange br emerg lc	260	160	130			8	0.36	
					19	358	too emerg	pt	pale orange oval sb, narrow side up, has 2 // lines on top // flow, #358 = resting on upstr side of white mb w c-cuts, #358 = on rhs of round MB standing on SBs	360	290	160			2		
	[illegible]				20	359	(tip emerg) full - XØ	pt	wh ang LC, wide V on top; tip emergent; upstr side orange; not embed. #359 = under upstr lhs of an emerg LB - this is not embed, has flat top and fractured lhs	310	270	170					emerg
	replaced			[illegible]	21	360	too emerg	pt	oval lc. light br. perp flow. lhs of slackw. upstr of lb emerg w scoop and holes on lhs	230	160	100			18	0.02	
	OUT: new stone			OUT	22	361	full - XØ	pt	yellow sc roundly triang. under a paler yellow square blocky mc on rhs. #361 = 10 cm ustr of the lhs edge of br and yellow embed B which itself = pinned under emerg lich b - this lich B = long, rounded, top ridge // flow, has scoops + holes. **NEW 25 June: embed brown lc/sb pinned under lichen boulder previously described.**	80 new: 390	65 new: 220	35 new: emb	11	0.12	37	0.09	
					23	362	too emerg	pt	NEEDS DESCRIPTION emerg MB	880	720	emb?			13	0.44	
					24	363	too emerg	pt	emerg oval lc, long axis perp flow, cracks lhs, resting dstr end up. against the ustr side of fawn and orange sbs that have their dstr ends lifted (ie packed)	350	200	130			18	0.74	
					25	364	top surf immov embed	pu	submrg, embed, fawney oval MC in deeper water; #364 = to lhs of emerg orange SB (w dstrend raised, chip fract dstr, scoop on rhs point, 2 quartz spots), and to rhs of submrg orange black/orange mottled SB; #364 =dstr of orange SB which causes BSW	280	140	emb	14	0.13	14	0.93	
	[illegible]			OUT	26	365	full - XØ	pt	2 tone orange, white/yellow oval mc in deeper water at base of chute-like frf, another same pattern stone = immed dstr, Touching lhs of #365 = brown embed submrg SB. **18 July:** #365 = pinned down	230	150	65	24	0.57	23	1.48	
	[illegible]	[illegible]			27	366	too emerg	pt	sb dirty white. sand papery. rounded top. pinned upstr and dstr by orange sbs, the ustr one = higher thanthe dstr one and has white quartz spots, #366 = in turbul betw the 2 Bs	340	330	200					emerg
					28	367	confirm w bottles - NO SAMP	pu	grey/green sc. on lhs of lc/sb bar which is oriented // flow, #367 = betw subm. yellow and orange sb on upstr lhs, and emerg rounded lc/sb w brown streak; #367 = mostly covered by gr, and = pinned on rhs by l/mc. **18 July:** gr over top surface, pinned	140	80	emb	0		30	0.28	
	[illegible]				29	368	full - Xø	pt	just submerged, yell/green sc/mc, oblong, long axis perp to flow, in line w & 1/2 way betw 1) red emerg oval lc (this stone not embed, and itself dstr of emerg flat B) and 2) submerged embed. yell sb w 1 black dot - this stonme ustr + on lhs of #368; #368 = tightly embed in sc and gr, has v pointed pyramid top	230	180	125	0		14	0.48	
					30	369	too big and dry	pt	arrowhead-shape, point on ustr end, red + cream patches, tip emerg, few lichen spots	560	400	emb			8	0.18	
					31	370	emerg	pt	large rect-oval lichen encrusted SB, wide end on bed, narrow side up; lies on rhs of LB	730	420	190					emerg
					32	371	full - XØ	pt	flat mc. roundly triang. fawn w orange tints. tightly embedded upstr side. 5cm dstr of emerg pink sb/lc which has a "cascade" of gravel on its lhs	330	180	100	1		14	0.34	
					TR27 Tape start 2												
					18	372	too dry	pt	white lc flat round. pinned upstr by loose same sized lcs. in moist patch of gravel	360	300	110			21		
	[illegible]			[illegible]	19	373	too dry	pt	roundly triang. lc/sb. pinned on ustr side by 1) white oval sb with pointy end & 2) purple and wh lc, #372 = on rhs of flat orange clam shaped SB w lichen; **18 Jul:** not pinned by ustr LC (∵ moved prev), but just dstr of and touching it; This LC = itself pinned by 2 emergent lich encrusted LBs that form a V w a small gap in the V - white LC pinned at this V, but #373 = dstr of this and has no hs	340	225	120					emerg
				[illegible]	20	374	too dry	pt	striking grey lc/sb triang with dense black striat. perp flow. orange patch on lhs, dstr end = emergent; #374 = 10 cm dstr of the lhs of a wh B w orange. dstr tip emerg and 2 holes on lhs -this is the only rock with a pointed triang end sticking out 18 July: #374 sits on top of large submrg white LB w creviced, scratchy top; #374 = touching and immed to rhs of pinky-white/fawn ireg oval B which has been pushed over onto narrow side (ie "face" w lichen now looks directly dstr, not upwards); dstr edge of #374 = touching white res\ctangl LC w large hole on top	375	270	125					emerg
	[illegible]			[illegible]	21	375	too dry	pt	mc purple and white blocky. Sort of pinned by tent shape. orange + white patches M/LC ustr of it. #375 = in a tiny "inlet" formed by this ustr LC and a dstr oval. brown/white, flat but narrow side up emergent SB, lichen on its narrow upper surface	160	125	70			10	-0.02	swirl
					22	376	too big and dry	pt	check these: semi triang. white-cream B w lichen on tip - planar	650	635	emb			4		

BERG RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE

FLOOD COLUMN: blue = moved; pink = OUT; Orange shade check in field, new stone marked yes, but perhaps old not out?
COLUMN: green shade = possible invert / peri sample for after June flood: OLD STONES; pink shade, poss invert samples (must be full samp): NEW STONES, yellow shade, poss invert IMMOV (top surf area only) - TICK WHICH ONES ARE STILL SUITABLE

INVERT: old stone size incl. followed by NEW stone size where replaced

flow/depth taken during SETUP (low baseflow) ie refers to all initial stones; link to initial Tritan survey

flow/depth taken ON 25 JUNE (med baseflow) ie refers to all remaining / new stones; linked to reservey by Tritan

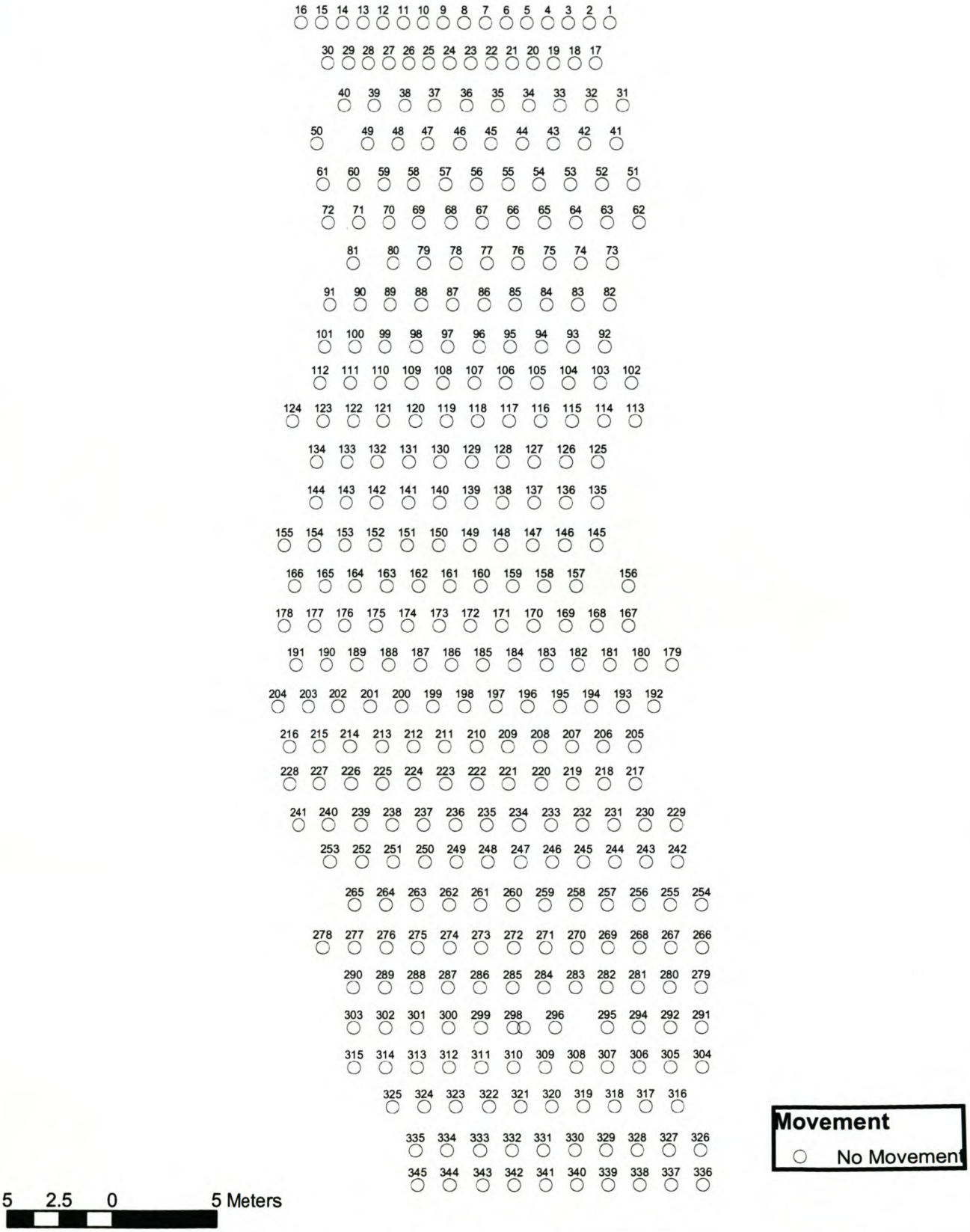
FLOOD 1 - Jun 10 search	BIG FLOOD 2 - Jun 21-23 search (?207 moved)	FLOOD 3 - July 2 search (in heavy rain)	FLOOD 4 - July 18 search	Flood 5	Offset from start	stone no.	X= invert sample, e = periphyton, imm, emerg = no samp	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost; then if marker has changed (eg putty to paint), new marker type indicated	Stone x (mm)	Stone y (mm)	Stone z (mm)	depth	velocity	depth	velocity	Comment
					23	377	full - XØ	pt	gold sb/lc oniong, // flow. upstr end angular. dstr more rounded and a bit embed. upstr of embed emerg B. pale orange/pink with darker orange and w large scooped end dstr. #377 =on rhs of domed yell/orange embedd B w tip emerg, also = pinned ustr rhs by red rectang LC/SB	405	225	150			15	0.06	
	OUT (later found moved 12m, at Tr2/1 and discarded for new stone)				24	378	full - XØ	pt	very flat oval brown sc. 2 wh quartz spots. mostly overlain by gravel, mostly pinned under rhs of orange mc. #378 = betw this. **NEW 25 June: distinctive red + fawn blotchy LC, flat. top, in frf, located 47 cm (edge to edge) dstr of "nice to stand on" stable round flatly-rounded dome B w bit of lichen on dstr edge; #378 = 15 cm to rhs & dstr of bright orange long oval LC w tuft of moss.**	165 new: 315	120 new: 290	25 new: 130	4	0.55	24	0.09	
	OUT: new stone				25	379	full - XØ	pt	sc - brown and red. oval and flat, redder. narrow end up. pinned in hole b2 3 b's --> 1) dstr 1 flat emerg. dstr end yellow w dstr point and cap of lichen dstr. 2) on lhs a T shaped yellow sb 3)on rhs. a yellow angular. fractured top. this B itself pinned ustr by grey oval SB. **NEW 25 June: grey angular sc. immediately upstr of 2 fawn oblong sbs hitting each other end to end - rhs one slightly overlapping (?ref to old Ela)**	130 new: 140	110 new: 80	40 new: 60	2	0.42	35	0.72	
OUT: new stone	OUT: new stone				26	380	full - XØ	pt	green stained. white lg. in triang hole (well) formed by large yellow submg b w moss on lhs. on lhs of well = yellow/orange triang. embed submg Sb. on rhs with pointed end dstr and **(??where this one is)** orange oval sb perp flow causing backwat. dstr -->forms base of well's triang **NEW 25 June: pretty brown/red round mc exactly on rhs point of a deeply submrg triang/diamond-shaped LB, which = yellow w grey striations perp to flow**	45 new: 210	30 new: 180	20 new:90	30	0.1	33	1.85	
	OUT: new stone			OUT	27	381	full - XØ	pt	brown sc. from the top this is a pear. from below a diamond. #381 = loosely pinned under dstr of distinct pearsh wh lc which is flat w hole at pointed upstr tip, and has its broad side dstr. #381 = 20 cm upstr and to rhs of shiny orange flat submerged triang sb, itself pinned under rhs of emerg pink b. **NEW 25 June: red and brown sc, 18 cm ustr of the lhs point of diamond LB in #380, and dstr of the rhs of another cream triangular B, but where the rhs corner of the triang = cut off - this B has a distinct red band 3/4 way up the triang, and a square eye on the dstr lhs point; #381 also = upstr of left hand point of yellow green submerged b with large basin top.**	145 new: 70	90 new: 65	60 new:60	14	0.46	30	0.97	
	OUT: new stone				28	382	full - XØ	pt	sc. speckled brown. long rect and transverse flow. b2 rough embed sb ustr. and smooth pear b emerg dstr. #382 = immed to rhs of ang lc pinned by b's. **NEW 25 June: Emergent. Fawn and grey, rough surface, speckled, w fissure on ustr rhs edge, extending at angle across to lhs; Rough rectangular / log shape, long axis perp flow. Embeded on lhs and pinned by pinky orange sb = hs. #382 = at the ustr rhs of a clump of emerg B's and LCs**	110 new: 651	70 new: 315	40 new:31 0	0				emerg
					29	383	too emerg too big	pt	white sb emerg. light black w dark black lichen. pointed pyramid top. in open "chicken's mouth" formed by 2 sb's both lifted at back.	545	385	emb	0		2		
					30	384	too emerg too big	pt	light pink SB w black striats // flow. has triang point dstr which = lifted. #384 = on rhs of chickens mouth dscribed for #383	480	370	160	0		6	0.59	
					31	385	too emb immov	pu	brown sb. long axis perp flow. immed upstr and on lhs of oval pink emerg emerg sb w long axis perp flow	460	310	emb	0		21	0.31	
	OUT: new stone				32	386	full - XØ	pt	orange-brown sc. under ustr "eye" of emerg wh SB. curved on lhs. supporting dead pine. **NEW 25 June:sc - brown triang; in same place - red arrow on the SB points to spot**	160 new: 80	130 new: 40	90 new: 20	0		24	0.03	
					33	387	too dry	pt	pear -shaped LC. angular underneath. point embed in bank on its lhs. below angular curved SB w broad end (flat face) facing toward rhs	320	160	120	0				emerg
					TR28 Tape start 2												
					19	388	too big embedded		pt cubist style musgroom b embed. on top of this is a clam b	740	630	emb					
	OUT (18 July found 50 m dstr at #61, Tr3); discarded				20	389	emerg	pt	whitish orange mc in a patch of backwater; immed dstr of the rhs edge of embed. emerg SB which = white on top, rust red underneath. **NEW 25 June: brown oval immovable mc ?? where**	155 new: 300	120 new: 120	135 new: emb					
				OUT	21	390	dry	pt	lc - white and purple. embed ustr. lifted dstr. fract on top. betw 1) round flat orange sb on rhs (this = bl on lhs. fract on rhs) & 2) pear sh. embed wh B = black on top w large topside fracture	295	150	120					emerg
	OUT: new stone			OUT	22	391	dry	pt	irreg white mc. some orange spots. on rhs of #391 = oval orange LC. on lhs = and ustr = emb emerg LB w triang hole on its lhs. inside of which = small stone. **NEW 25 June: oval grey mc, same place**	220 new: 190	125 new: 140	120 new: 40			17	0.17	
					23	392	too emerg	pt	flat oval lc. 3 white spots & 1 shallow hole. makes lhs of circle of lc/sb	370	300	110					
					24	393	full - XØ	PT	brown oblong sc. banana shape curve to rhs. lhs flat. Dstr of SBbar, together this Bbar & a dstr yellow angular embed B create backwater area in which #393 = located. #393 = immed dstr & touching orange SB. embed. narrow side up. to lhs of #393 = pink SB w fracture on its lhs	115 new: 610	85 new: 260	45 new: emb					
					25	394	emerg	pt	lb - rough. bl lichen flat top. looks like Australia	1000	640	emb					emerg
					26	395	full - XØ	pt	light brown sc. dstr is striking triang lc w white patch. #395 = on rhs of yellow sb/lc w fractured curve on rhs. #395 is at upstr point of this curve. narrow side up. fracture on top	240	150	60	20	0.2	39	0.53	
					27	396	sa orange alu handle net	pu	sb - pear sh. fawn w spopt of moss. pt dstr and slightly lifted. 3 wh spots on dstr lhs. immovable	550	440	emb	10	0.5	31	0.69	
					28	397	full - XØ	pt	lc - attractive orange and fawn. round flat. dstr end lifted. scooped hole on top & gouged line near dstr end. upstr end of #397 = under yellow sb which = subm. with striat perp flow on lhs. On rhs of #397 = sb. which = orange w dome emerg. #397 = in the dstr V made by these 2 stones	320	280	120	10	0.16	30	0.73	
				OUT	29	398	full - XØ	pt	mc - brown w purple red dstr nose. on lhs of sb circle. #398 = emerg on lhs. submerg rhs	240	115	115	0		20	0.87	
					30	399	top 1/4 emergent, rem sampled - XØ	pt	oval blocky orange and fawn LC on rhs of round flat brown sb. lies on top of subm embed yellow sb. #399 = just under surf. - w emerg part slightly dstr	310	200	150	0		13	0.21	
					31	400	too big too emerg		**no description - large emergent B**	740	500	?emb	0				emerg
					32	401	emerg	pt	flat oval speckled brown SB. wedged loosely b2 lb. 1) lhs one = grey and supports pine tree and 2) white sb domed on rhs	520	400	180	0		6	0.62	
					33	402	emerg	pt	grey B in #401 = stone 402 - forms a slack water dam	910	530	emb					emerg
					34	403	dry	pt	wh sc. in cobble bed. touched on lhs by purple grey lc which is oblong // flow. has blunt upstr and on dstr = pinned on lhs by 1/2 moon sb	140	80	45	0				
					TR 29 Tape start 0												
	?? Not moved - covered by sand?	deep embed by sand	new stone there, still check for old?		16	404	dry	pt	circular-triang sc. pointed side in water; resting on ustr side of emb. emerg/dry SB. in its "scoop" (which = on rhs of SB). **?? Maybe this just got covered?. DIG. NEW 25 June: Grey SB embed in sand and gravel.. 18 July:** on dstr edge of gr bar, deeply emb in sand	160 new: 490	145 new: 380	85 new: emb	0				emerg - sand
	?? Not moved - covered by sand?	#actually see stone, but assumed still coverd	new stone there, still check for old?		17	405	full - XØ	pt	triang sc. fracture in top dstr point. this point touches submrg 2-tone (brown + wh) LC, not embed, which = pinned downon its dstr end by red LC. #405 rests onembed, long yell-orange B on rhs, and on emerg, embed, orange SB w orange striats. **NEW 25 June: sc - brown on other cobbles**	165 new: 103	140 new: 74	80 new: 36					
				buried	18	406	embed, tip emerg	pt	white triang dirty LC. point sticks out of water on lhs. pinned on rhs by lb which is wh & has c cuts	380	270	emb	0				
					19	407	too emerg in shallows	pt	s/mc pink. like labrum. broad end lifted upstr.	230	160	65	0		12	0.17	
					20	408	too big emerg and embed	pt	mb - white with black cap. pinched on upstr side rhs where it touches a brown clam sb	735	705	emb	0				emerg
	OUT: new stone				21	409	full - XØ	pt	brown sc. in middl of 4 SBs. **NEW 25 June: white/fawn triang SB, narrow side up, wedged betw white sb ustr, and on dstr, orange white lc with black striations perp flow.**	90 new: 430	70 new: 270	50 new: 260	0				emerg
	OUT: new stone				22	410	full - XØ	pt	orange-brown and it orang SC. oblong. flat. flat face to rhs. touches ustr side submrg gold LC/SB. narrow side up and fracture on top. this SB = pinned. **NEW 25 June: s/mc - ang. oblong. in V betw 1) light brown lc with white line // flow and 2) lichen SB - green w orange splotch**	180 new: 150	115 new: 100	55 new: 70	22	0.11	30	0.18	
				OUT	23	411	full - XØ	pt	sc - brown orange. surrounded by other br and orange mc's. = on lhs point of a yellow orange submrg SB - this "point" = formed by a flake fracture which points to #411 which = 5cm to left.	145	110	50	22	0.11	26	0.62	
					24	412	sa orange alu handle net	pu	greeny white sb. subm. embed. brown and gold lichen in long triang with pnt dstr = very distinctive compared to neighbours	470	370	emb	9	0.38			
					25	413	full - XØ	pt	sb - br speckled w round corners. Orange tint on upstr side. scoop on rhs. = immed to right of sharp point of triang orange yellow submrg sb	415	350	240	0				
					26	414	invert sampl LOST, but Ø	pt	sc - 10cm upstr of rh end of SB which is flat + oval. and has dstr end up and has distinct brown cap. #414 = on rhs of yellow subrect LC lying on ustr side of brown SB. ustr of #414 = motley yellow/green emb submrg SB w diagonal crack that points to #414	170	140	110	20	0.22			
					27	415	too big	pt	golden emerg b with black cap. pinned upstr by round white and black b w scoop upstr and dstr	1950	600	emb	0		6	0.68	
					28	416	full - XØ	pt	s/mc - yell green triang. w rounded ends. sharp apex on right. #416 = betw 1) on dstr. brown subm SB with large scoop on top and 2)on ustr. browny orange LB with white quartz spots.	180	130	70	22	0.06	22	0.45	
	OUT: new stone				29	417	full - XØ	pt	sc w yellow hole in dstr side. #417 = ustr of orange LC. #417 = 10 cm dstr of emerg white MB. 10 cm to lhs of broad brown B which has emergent fractured tip on its dstr lhs. **NEW 25 June: yellow fawn LC, irreg, 10 cm dstr of koki arrow on white MB (as prev descr.)**	75 new: 415	60 new: 235	50 new: 120	0		13	0.02	
					30	418	full - XØ	pt	triang. speckled brown SC. sharp side to rhs. betw 1) emerg orange lc. embed. narrow side up + 2) B w emergent tip highest. this B has its lhs under tree trunk	170	100	60	9	0.03			

BERG RIVER STUDY SITE : FIELD OBSERVATIONS DATABASE

FLOOD COLUMN: blue = moved; pink = OUT; Orange [illegible] INVERT COLUMN: green shade = possible invert / peri sample for after June flood: OLD STONES; pink shade, poss invert samples (must be full samp): NEW STONES, yellow shade, poss invert IMMOV (top surf area only) - TICK WHICH ONES ARE STILL SUITABLE

FLOOD 1 - Jun 10 search	BIG FLOOD 2 - Jun 21-23 search (?207 moved)	FLOOD 3 - July 2 search (in heavy rain)	FLOOD 4 - July 18 search	Flood 5	Offset from start	stone no.	X= invert sample, ø = periphyton, imm, emerg = no samp	Putty (P) Paint (PT)	Description: original (setup) description, followed by NEW: description where stones have been lost; then if marker has changed (eg putty to paint), new marker type indicated	Stone x (mm) (old stone size incl. followed by NEW stone size where replaced)	Stone y (mm)	Stone z (mm)	depth (flow/depth taken during SETUP (low baseflow) ie refers to all initial stones; link to initial Tritan survey)	velocity	depth (flow/depth taken ON 25 JUNE (med baseflow) ie refers to all remaining / new stones; linked to resurvey by Tritan)	velocity	Comment
					31	419	too emerg	pt	lc - orange oblong blocky black top emerges on lhs of tree trunk #419 = most dstr in line of 3 LC/SBs	320	220	205	0		8		
					32	420	full - Xø	pt	yellow green round domed MC, betw 1) emergent chisel topped brown sb on rhs, and 2) gold yellow oval lc/sb on lhs and upstr	255	210	95			22	0.08	
					TR 30 Tape start2												
	OUT: new stone			MOVED [illegible]	16	421	full - Xø	pt	2-tone red + cream mg, immed dstr and left of flat triang embed B w lichen stripe along irreg dstr rhs margin **NEW 25 June:sc - brown flat (correct number? notes damaged)**	70 new: 160	50 new: 100	25 new: 60	0		8	0.01	
					17	422	immov emerg	pt	oval irreg b, white w lichen stripe on dstr, dome-shaped but "falling over" on dstr side	790	490	emb					emerg
	OUT: new stone				18	423	full - Xø	pt	flat-irreg surface "brain" MC, immed to rhs of square flat SB w large hole on middle of dstr edge **NEW 25 June: the SB - white embed. angular. hole in lhs dstr = new #**	230 new: 640	180 new: 600	85 new: emb	3	0.6			
	replaced - from where?			TO	19	424	full - Xø	pt	mc - red and white patches, red tip facing dstr; no hs sits proudly in bw, 10cm dstr of orange and cream subm sb	230	200	150	2		8	0.02	
	OUT: new stone				20	425	dry	pt	oval, blockish white LC on instream edge of backwater, ie on rhs of bar separating bw from main channel, "face" of #425 slopes down to rhs, #425 = 0.75 m dstr of v large triang blotchy emergetn (proud) red/white B, and immed dstr of this B = submrg white B w taller ridge and roundeed dstr end **NEW 25 June: emerg dry SB w white striations that = transverse and converging lhs**	340 new: 505	225 new: 360	emb new: 275					emerg
	OUT/covered ?? Whats this?			OUT	21	426	dry -bank edge main channel	pt	oval flat pink SB, just dstr of orange end of emerg embed B **NEW 25 June: round white SC ?? more**	506 new: 90	359 new: 70	166 new: 60	0				
	[illegible]			MOVED [illegible]	22	427	full - Xø	pt	sc - pink and red blockish with one longer end pointing dstr + across channel, #327 = midway betw 1) on dstr rhs, emerg oval sb = orange and white, and 2) on ustr lhs, emerg pinky orange lc	145	100	80	0		12	0.11	
	[illegible]			MOVED 2m	23	428	full - Xø	pt	mc - orange and cream oval flattish top orange end facing dstr few cracks on upper surf, esp ustr edge; set immed to lhs of emerg wh/pink ++lich domed b; dstr of #428 =submrg white blockish embed B w brown striations nearly // to flow	230	210	70	0		23	0.13	
	[illegible]			MOVED 2m	24	429	full - Xø	pt	brown and grey angular LC/SB, large fract forms seat on upstr side, sits on top of pear-shaped light and dark orange sb which is raised dstr	405	275	265	0		20	0.48	
	[illegible]			MOVED 2m	25	430	full - Xø	pt	oval light and dark orange LC, not embed submrg; on lhs of yellow triang rock -lhs point of this =pointing slightly dstr red line on rhs perp flow scoop in middle //flow ??of #430 or other?.	395	300	175	8	0.28			
					26	431	sa wire handle net	pu	subm white-yellow triang flat surface apex upstr = cut off dstr point longer on rhs than lhs lhs point most elevated deeply submerged smooth surface	825	815	emb	5	0.03	27	0.53	
	OUT: new stone				27	432	full - Xø	pt	sc in bed of sc + lg, lying betw 1) white/pinky submrg pear-shp SB, w submrg teardrop B on on rhs and 2) dusty pink blockish triang SB,w fractured rhs, #432 = creamy-grey rectangl, long axis perp flow; no hs **NEW 25 June: mc - round green. immed dstr. of browny orange/grey triang lc/sb with point upstream**	not measured new: 215	not measured! new: 200	not measured! new: 90	14	0.43	36	1.07	
	[illegible]				28	433	full - Xø	pt	pink s-mc mid-one of 3 mc's lodged bewteen 3 emerg lich b's - 1) upstr and left, 2) dstr to left, 3) triang, just emerg, lich b dstr and in line w the ustr (1) ie --> forms a channel catching these mc's	300	260	130	3	0.36	16	0.12	bubbly
				TO	29	434	emerg	pt	flat white pink lc/sb, dstr end raised and nesting on lichen emerg b dstr another lichen emergent B, long axis perp flow, = to its rhs	400	395	185			16	0.45	
					30	435	sa orange alu handle net	immov pu	oval brown pinkSB, 2 white lines, transverse-parallel to flow; speckled surface; dstr lifted and = perfect arc, ustr of #435 =oval browny b that partly overlaps it; #435 = also slightly embedd at ustr portion	545	440	emb	6	0.32	54	0.54	
					31	436	emerg	pt	round-oval pink emerg B. embed, on lhs of frf channel	785	495	emb		emerg	26	0.54	
					32	437	tip emerg, but full - Xø	pt	oblong brown sb/lc w concentric brown striations, 2 white eyes just emergent, end raised dstr; it rests on upstr lhs of orange and fawn lc which is dstr immed of brown and marbled white SB	320	220	135	0		12	0.39	
					33	438	emerg	pt	large red b w green moss. supports tree trunk	1010	780	580	0				emerg under tree
					34	439	dry	pt	triang MB, narrow side up and pnted end up scoop on lhs dstr end more pointy	790	560	505	0				emerg

Appendix D: Stone Movement for Individual Flood Events

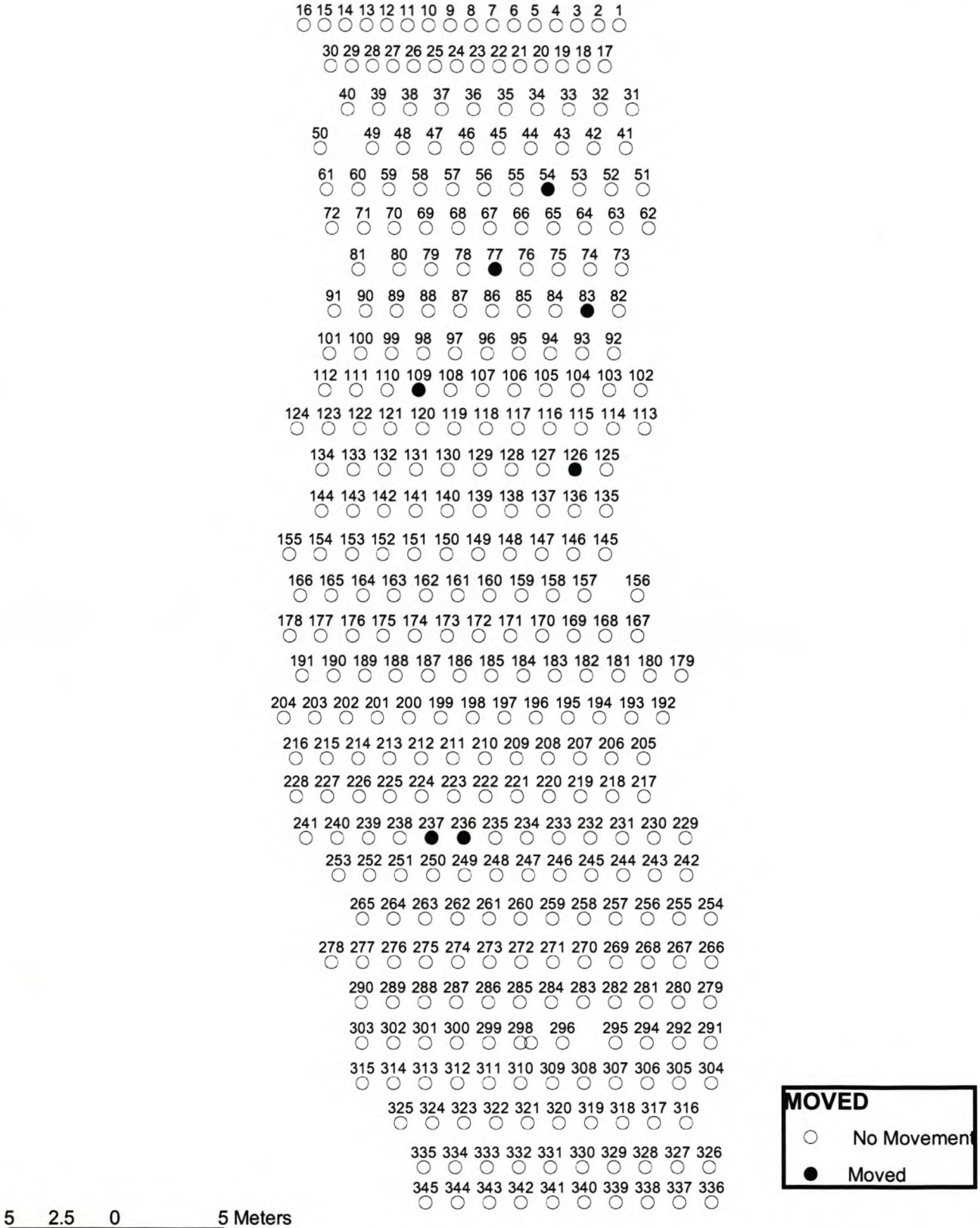


Molenaars River 2003
Stone Movement

Flood 1

WRC K5/1411
The Determination of Substrata Maintenance Flows in Cobble and Boulder Bed Rivers: Ecological and Hydraulic Considerations

Water Research Commission



Molenaars River 2003
Stone Movement

Flood 2

WRC K5/1411
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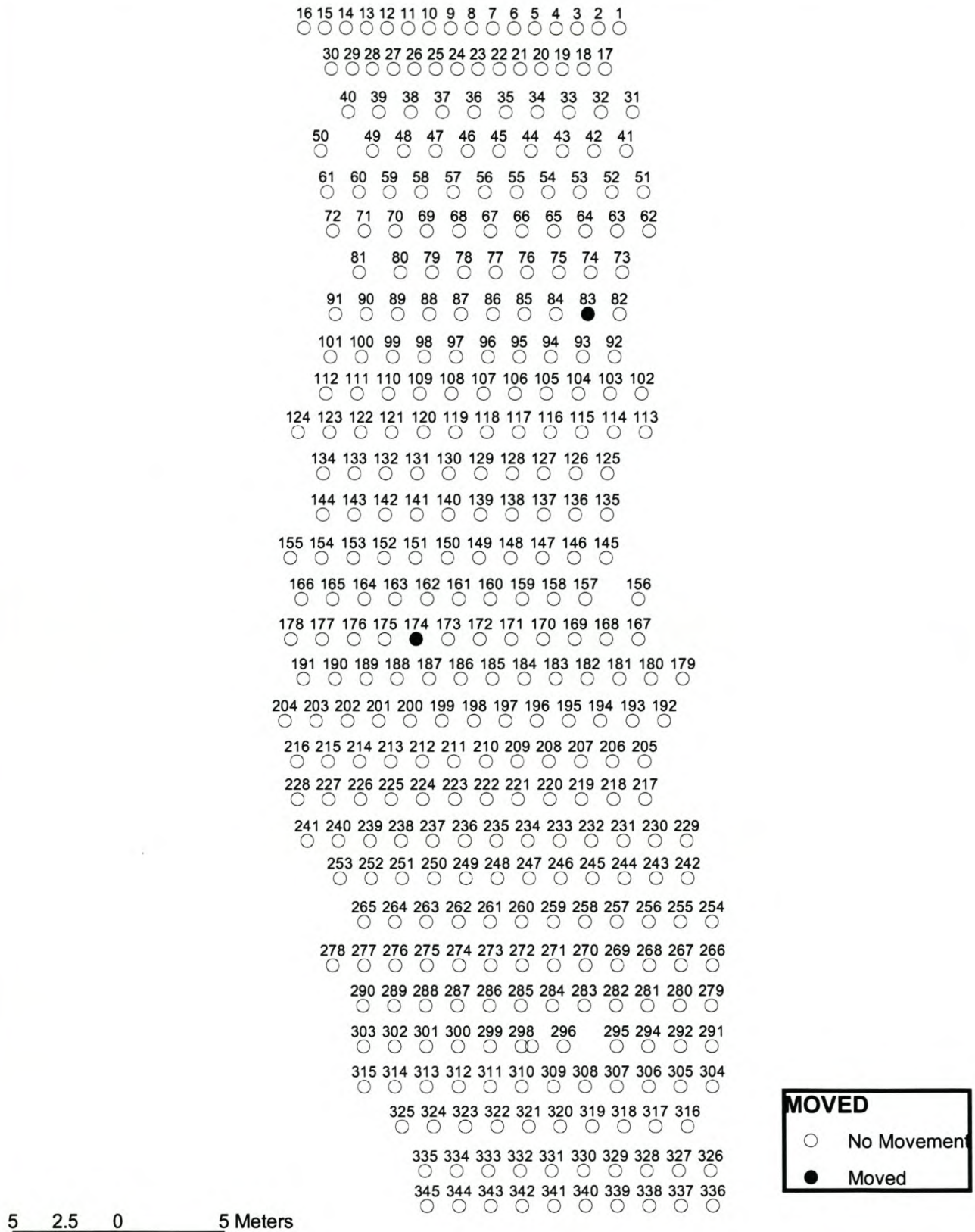
Water Research Commission

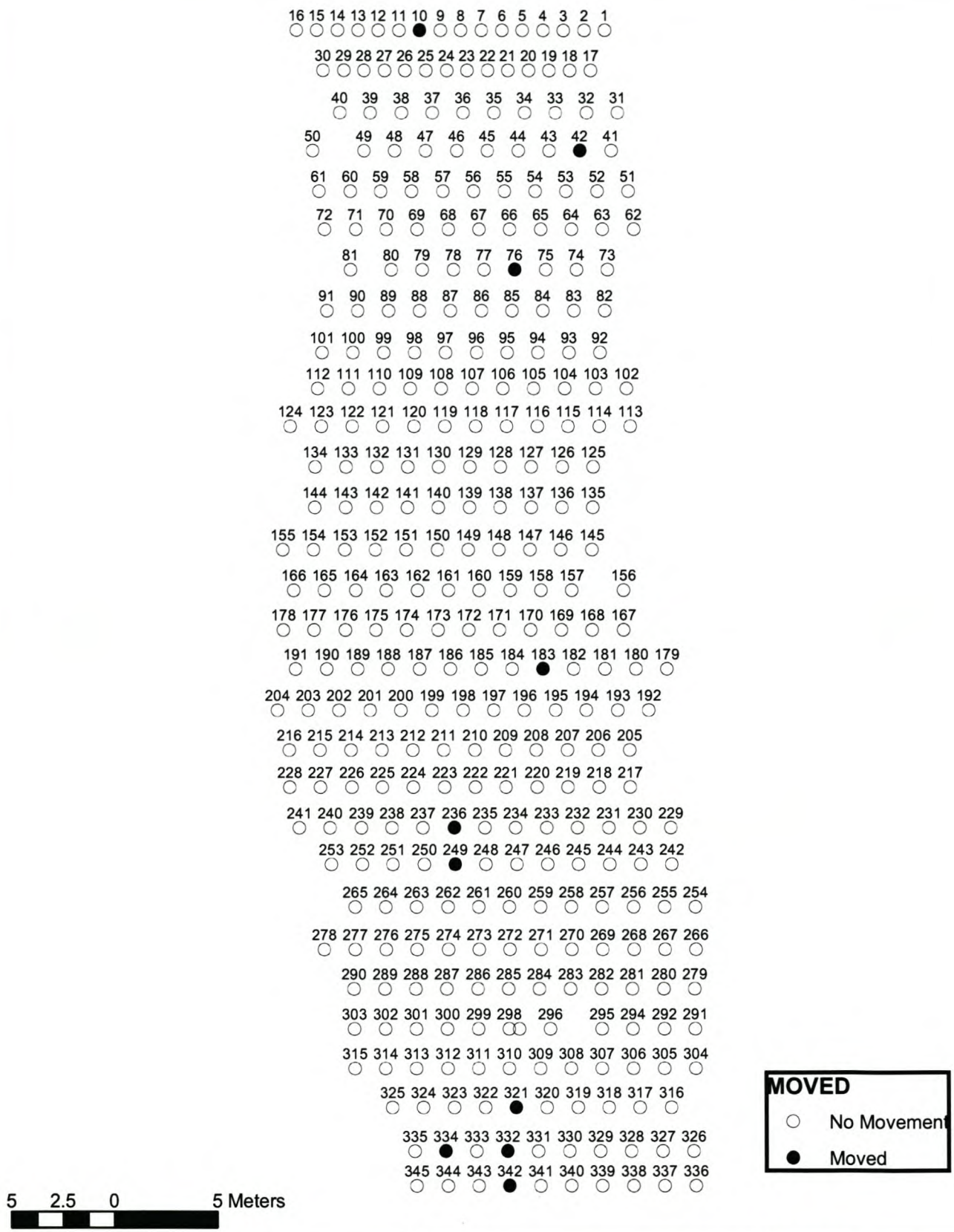


Molenaars River 2003
Stone Movement

Flood 3

WRC K5/1411
The Determination of Substrata Maintenance Flows in Cobble and Boulder Bed Rivers: Ecological and Hydraulic Considerations

Water Research Commission



Molenaars River 2003
Stone Movement

Flood 4

WRC K5/1411
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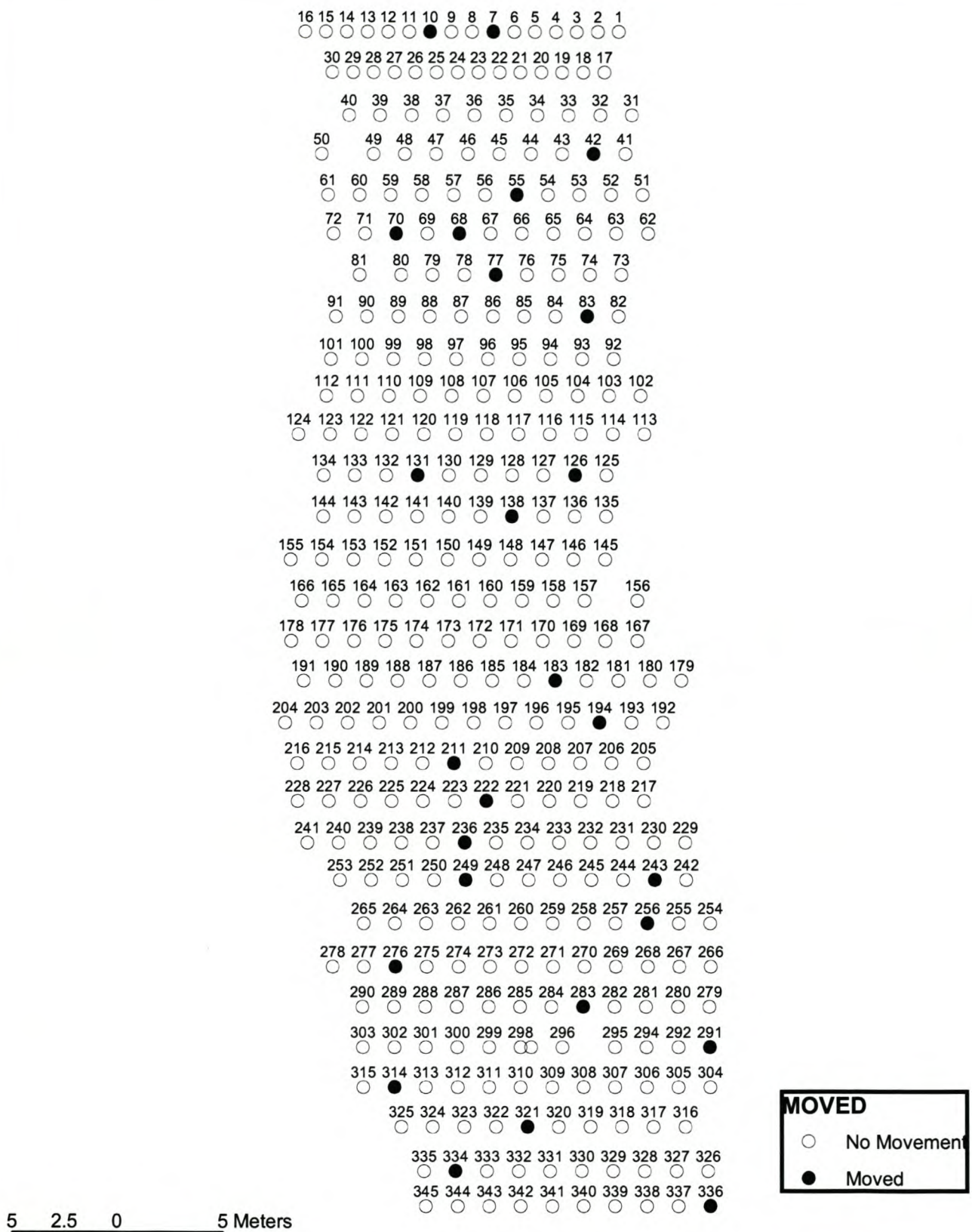
Water Research Commission



Molenaars River 2003
Stone Movement

Flood 5

WRC K5/1411
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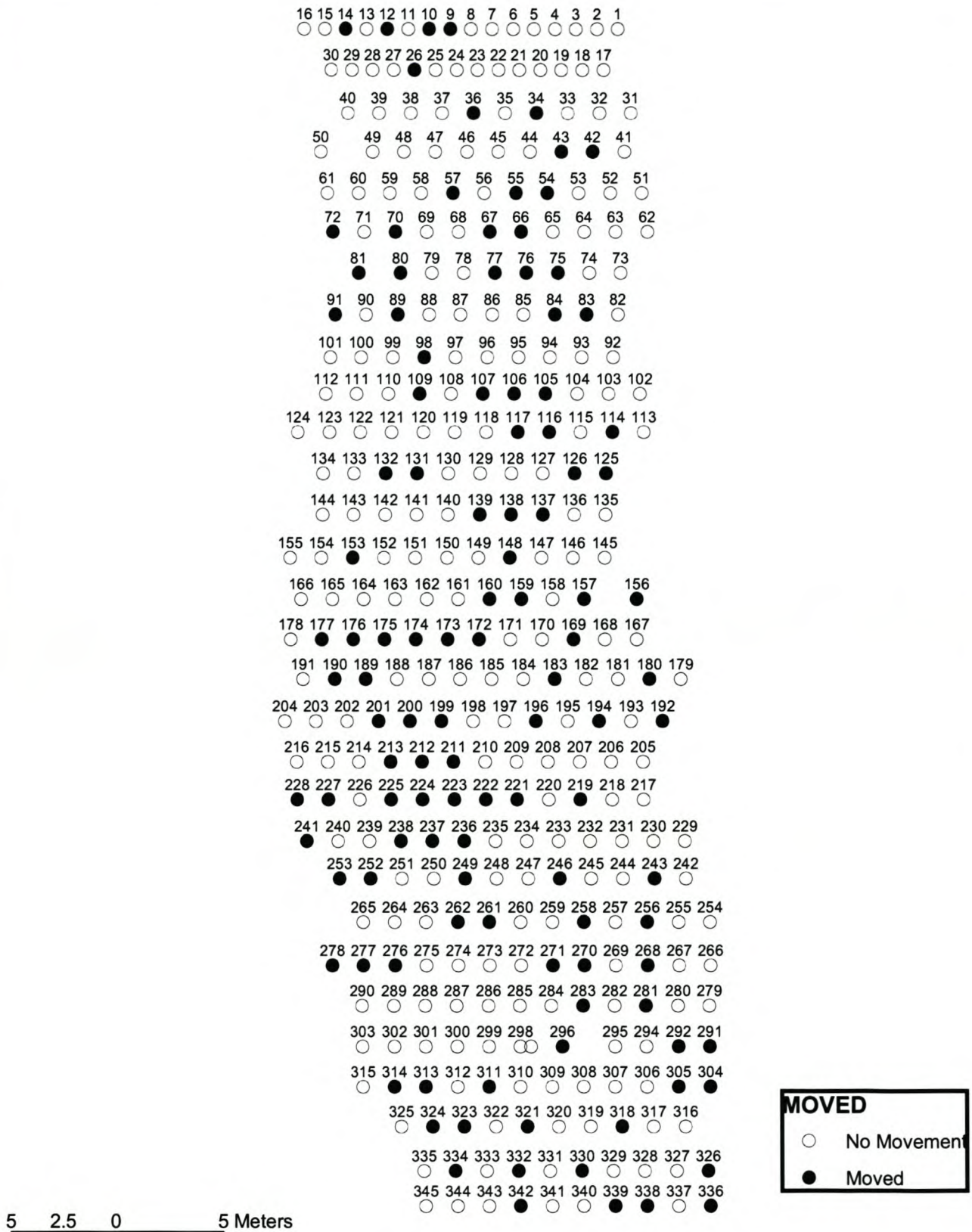
Water Research Commission

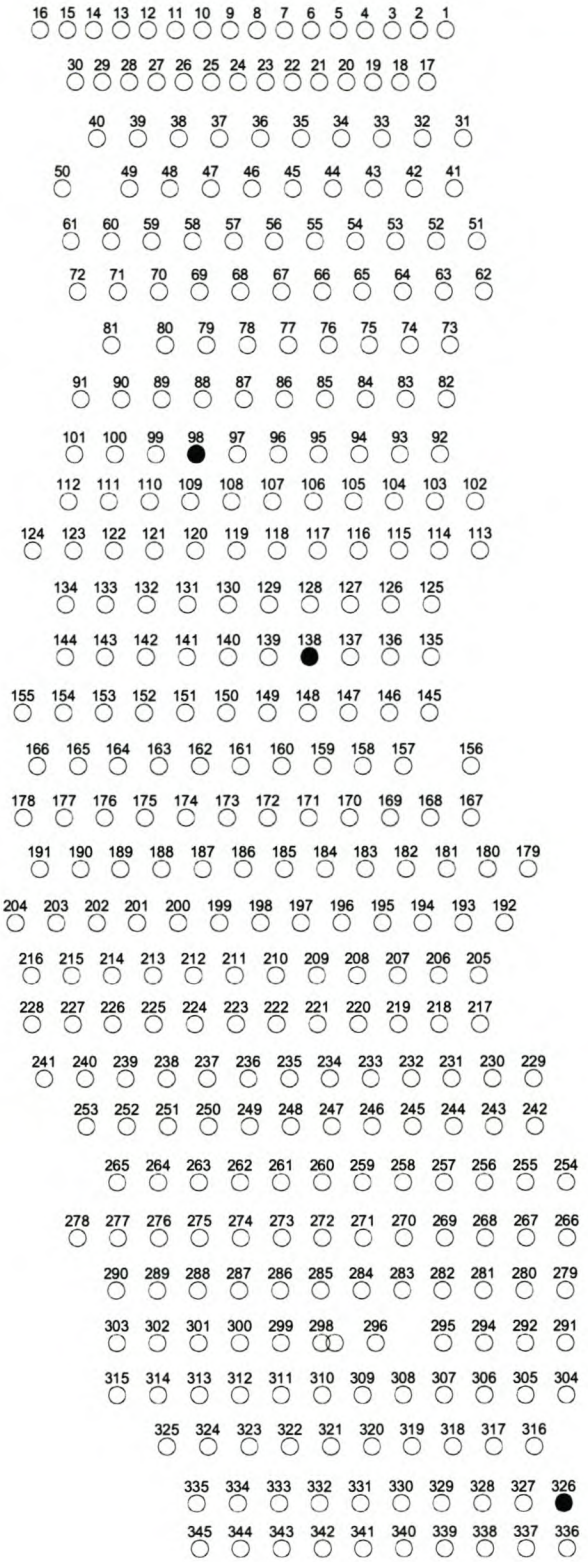


Molenaars River 2003
Stone Movement

Flood 6

WRC K5/1411
The Determination of Substrata Maintenance Flows in Cobble and Boulder Bed Rivers: Ecological and Hydraulic Considerations

Water Research Commission



Molenaars River 2004
Stone Movement

Flood 1

WRC K5/1411
The Determination of Substrata Maintenance Flows in Cobble and Boulder Bed Rivers: Ecological and Hydraulic Considerations

Water Research Commission

Molenaars River 2004
Stone Movement

Flood 2

WRC K5/1411
The Determination of Substrata Maintenance Flows in Cobble and Boulder Bed Rivers: Ecological and Hydraulic Considerations

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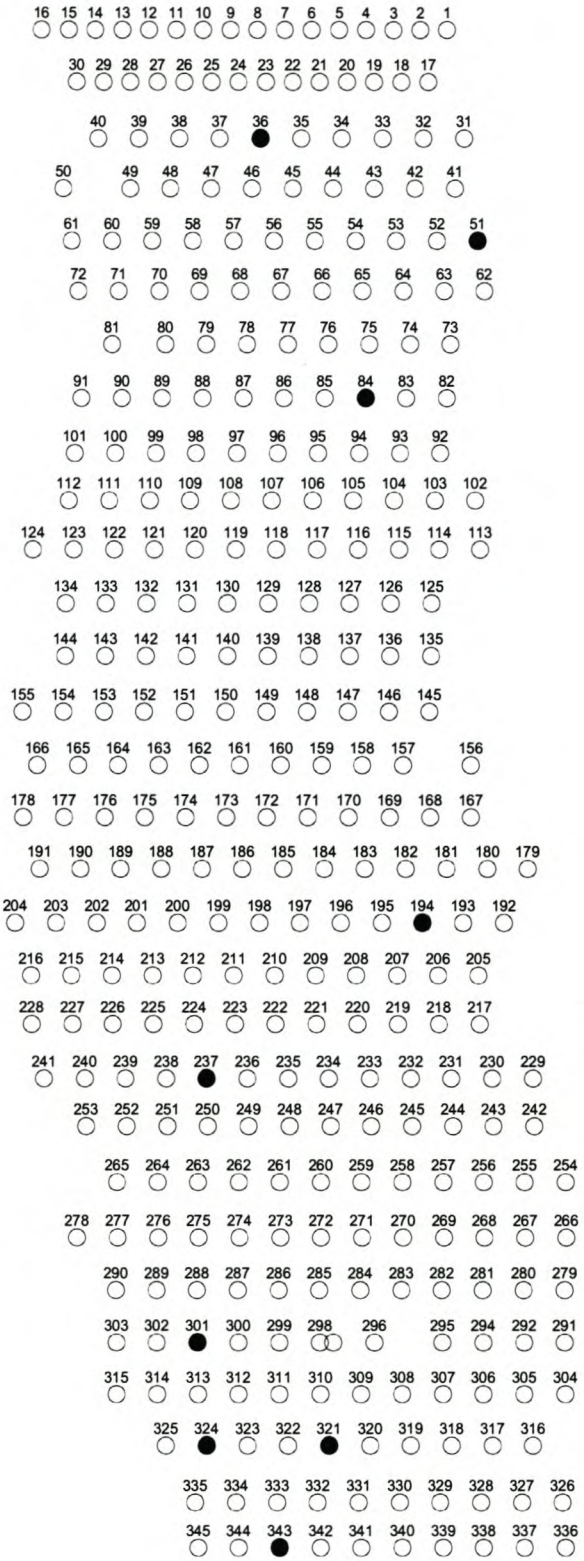

Molenaars River 2004
Stone Movement

Flood 3

WRC K5/1411
The Determination of Substrata Maintenance Flows in Cobble and Boulder Bed Rivers: Ecological and Hydraulic Considerations

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Molenaars River 2004
Stone Movement

Flood 4

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Molenaars River 2004
Stone Movement

Flood 5

WRC K5/1411
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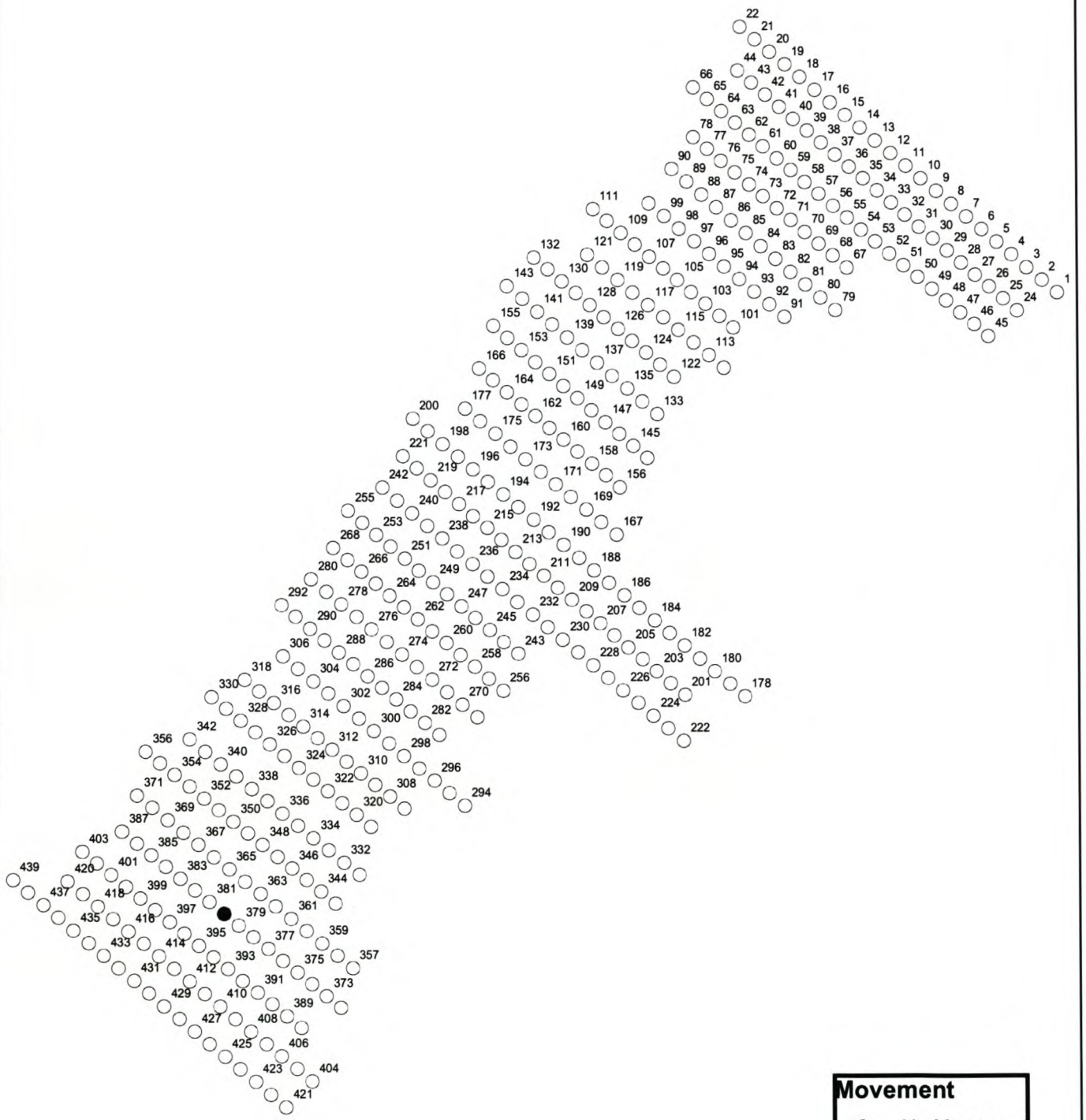
Water Research Commission



Berg River 2004
Stone Movement

Flood 1

WRC K5/1411
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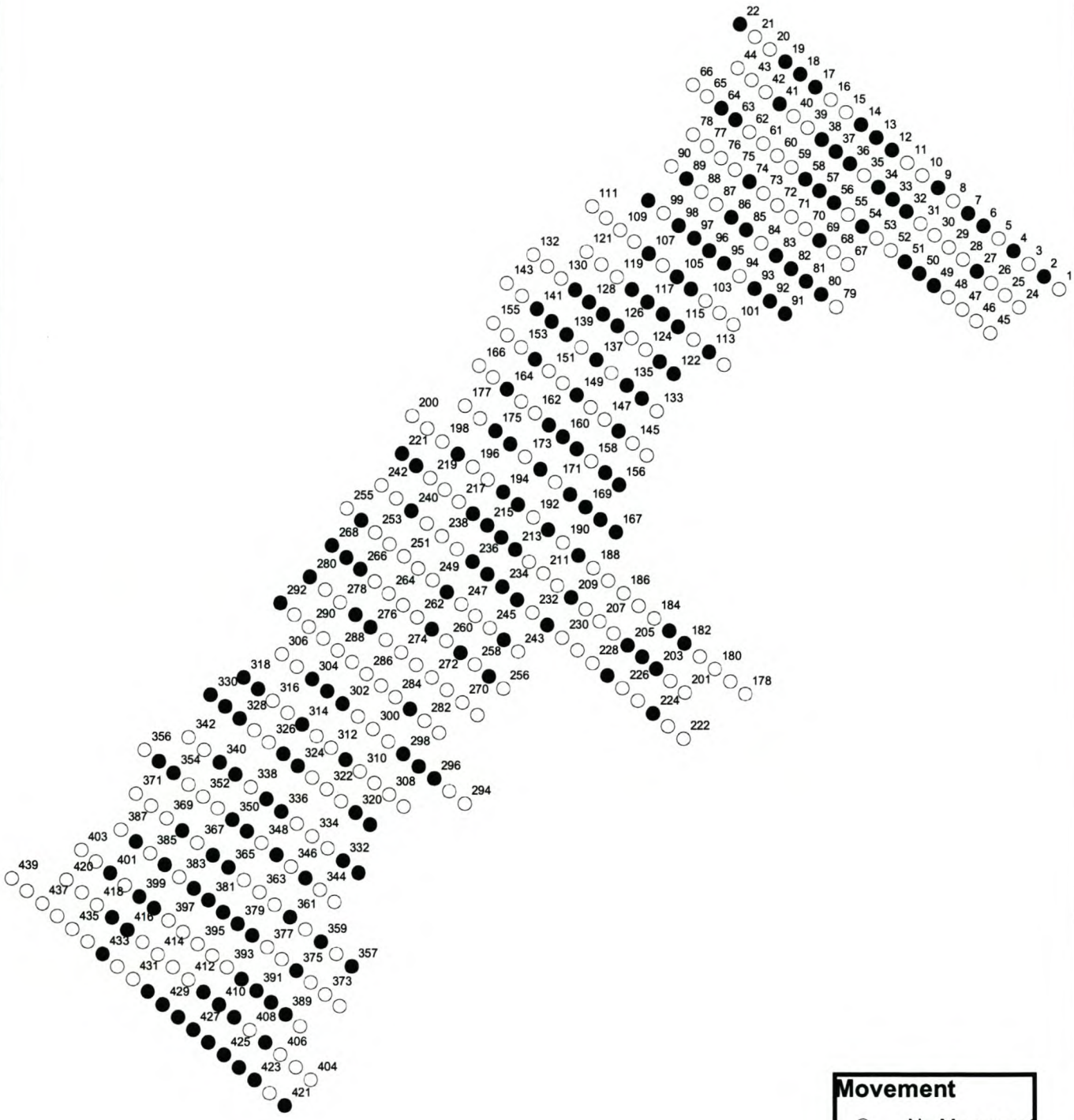
Water Research Commission



Berg River 2004
Stone Movement

Flood 2

WRC K5/1411
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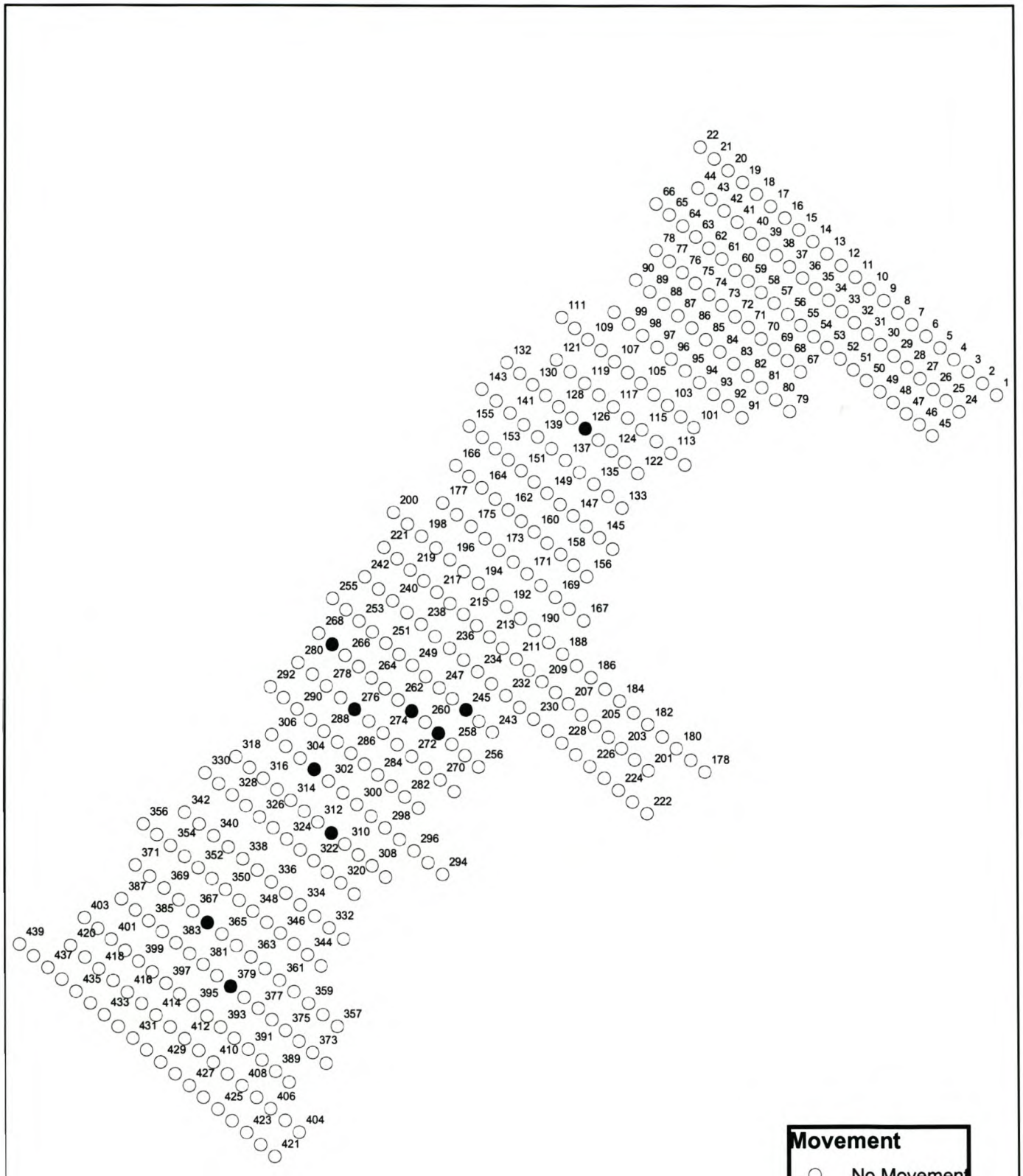
Water Research Commission



Berg River 2004
Stone Movement

Flood 3

WRC K5/1411
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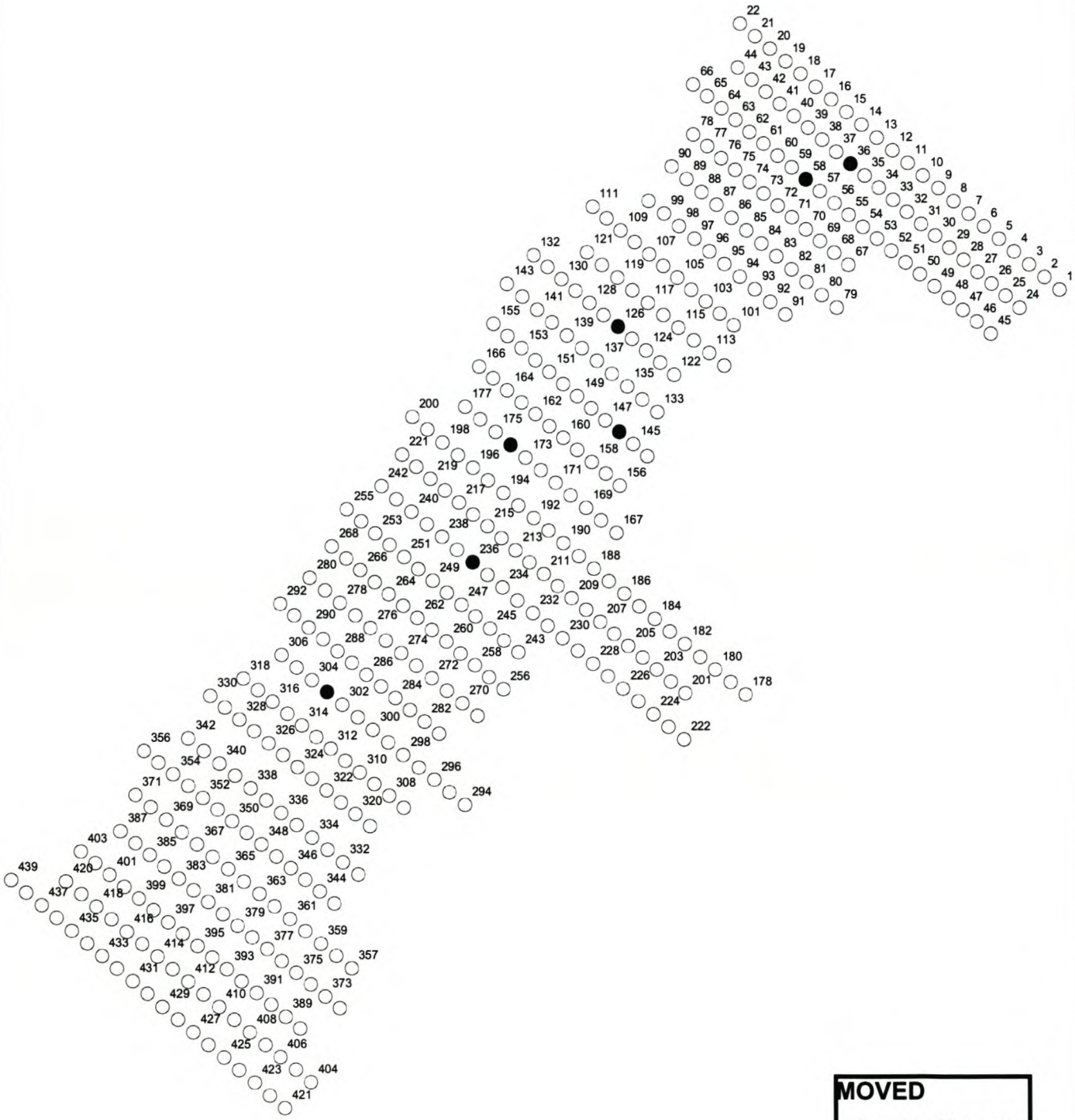
Water Research Commission



Berg River 2004
Stone Movement

Flood 4

WRC K5/1411
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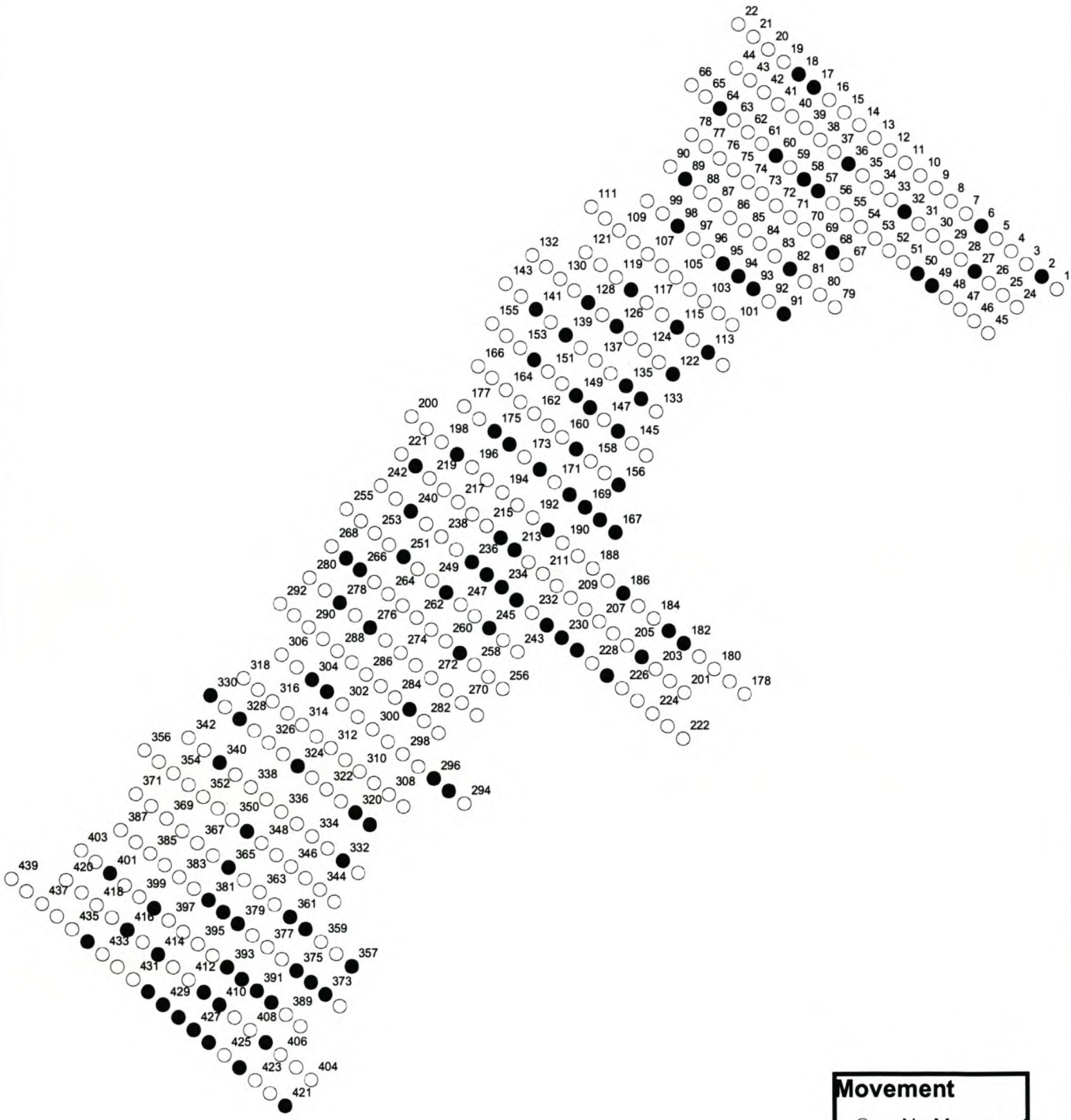
Water Research Commission



Berg River 2004
Stone Movement

Flood 5

WRC K5/1411
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Water Research Commission