A RIVER REHABILITATION PLANNING PILOT TRIAL: THE IHLANZA RIVER, EAST LONDON, SOUTH AFRICA BASED ON THE AUSTRALIAN RIVER REHABILITATION GUIDELINES

AC Uys

WRC Report No. 1309/3/04

Water Research Commission

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THE IHLANZA RIVER, EAST LONDON, SOUTH AFRICA
Based on the Australian River Rehabilitation Guidelines

VOLUME 2
Part 2 of 2: Maps, Appendixes, Photographs

by

AC Uys
A Report to the Water Research Commission by
LAUGHING WATERS
Aquatic Research, Consulting and Media

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A River Rehabilitation Planning Pilot Trial: The Ihlanza River, East London, South Africa

Based on the Australian River Rehabilitation Guidelines

PROJECT K5/1309 VOLUME 2
Part 2 of 2: Maps, Appendices, Photographs

Mandy C Uys

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LAUGHING WATERS
Aquatic Research, Consulting and Media

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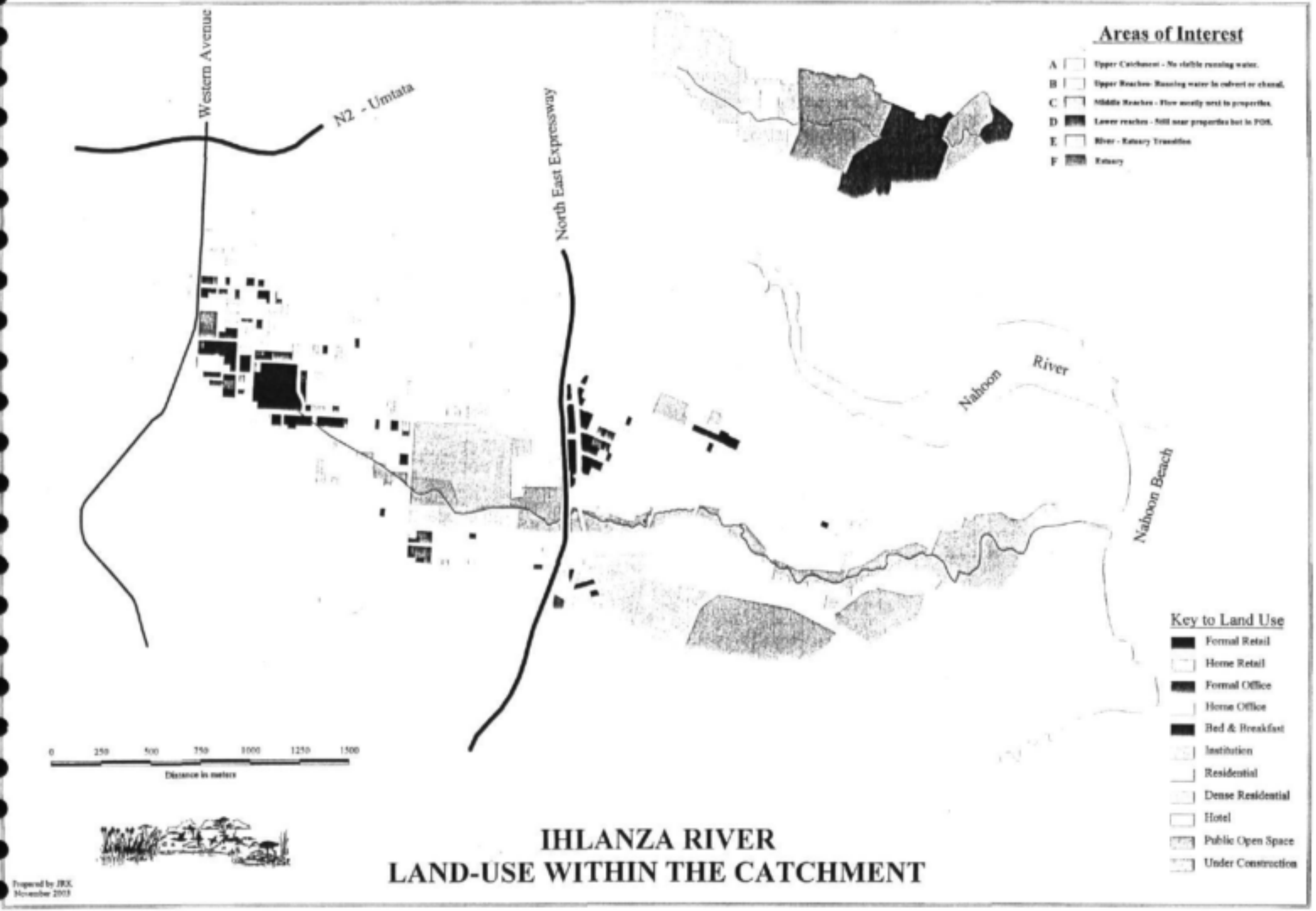
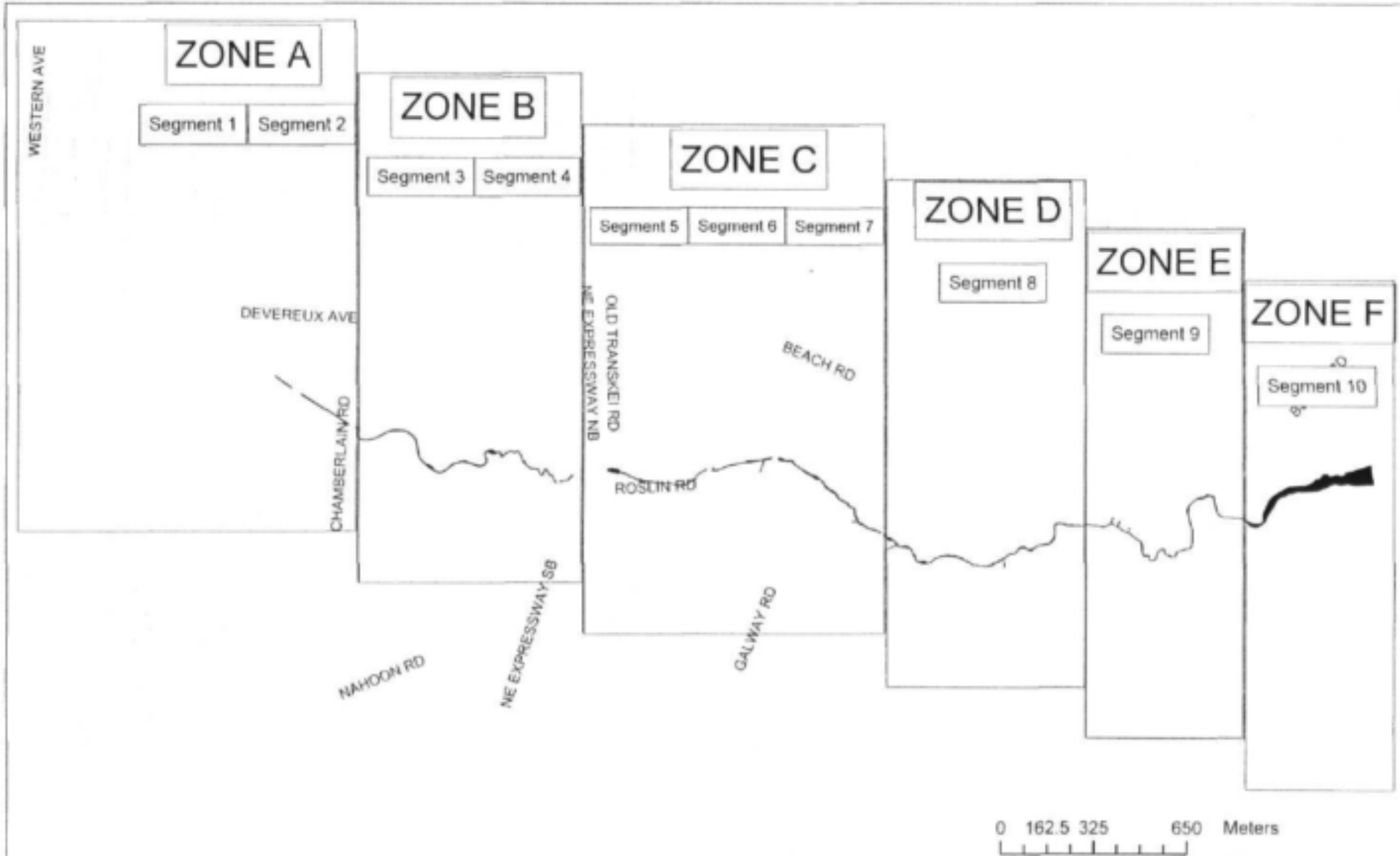
WRC Report No. K5/1309 VOLUME 2.1
2004

MAPS OF THE ZONES AND REACHES SELECTED IN THE IHLANZA RIVER STUDY

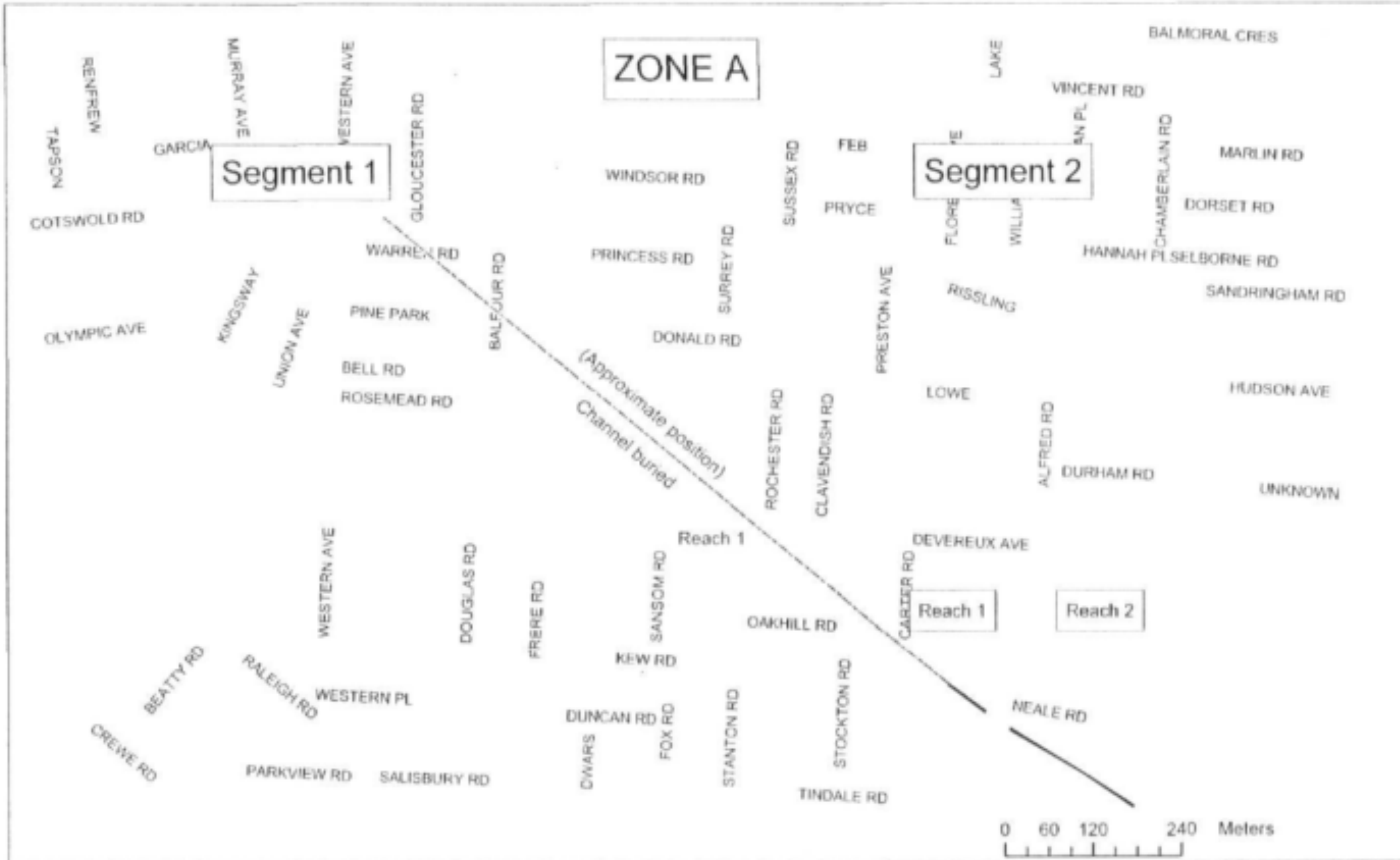


IHLANZA RIVER
LAND-USE WITHIN THE CATCHMENT



MAP NO 1.2

ZONES
PRESENT STATE
IHLANZA RIVER

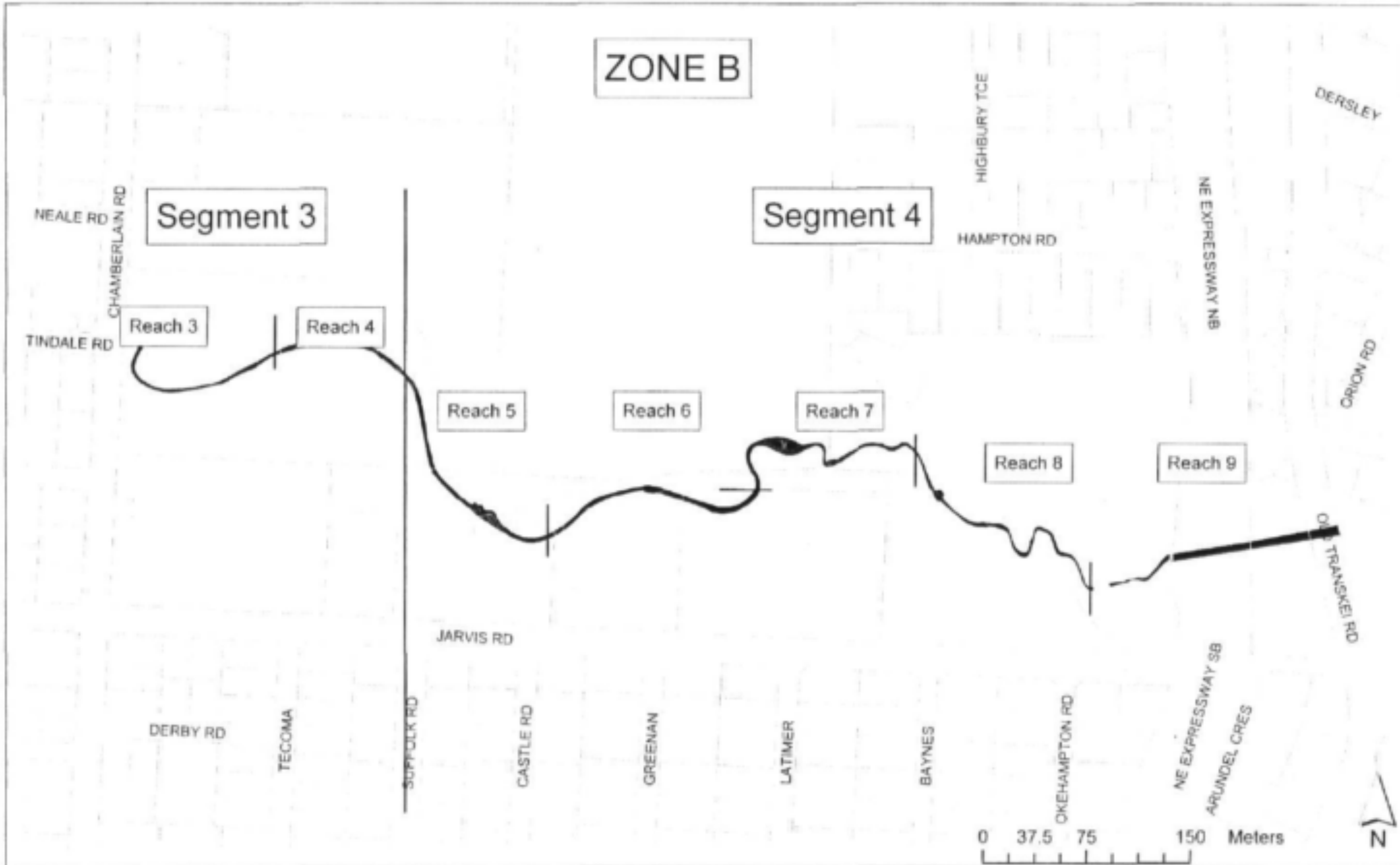


MAP NO 1.2 A

ZONES
PRESENT STATE
IHLANZA RIVER

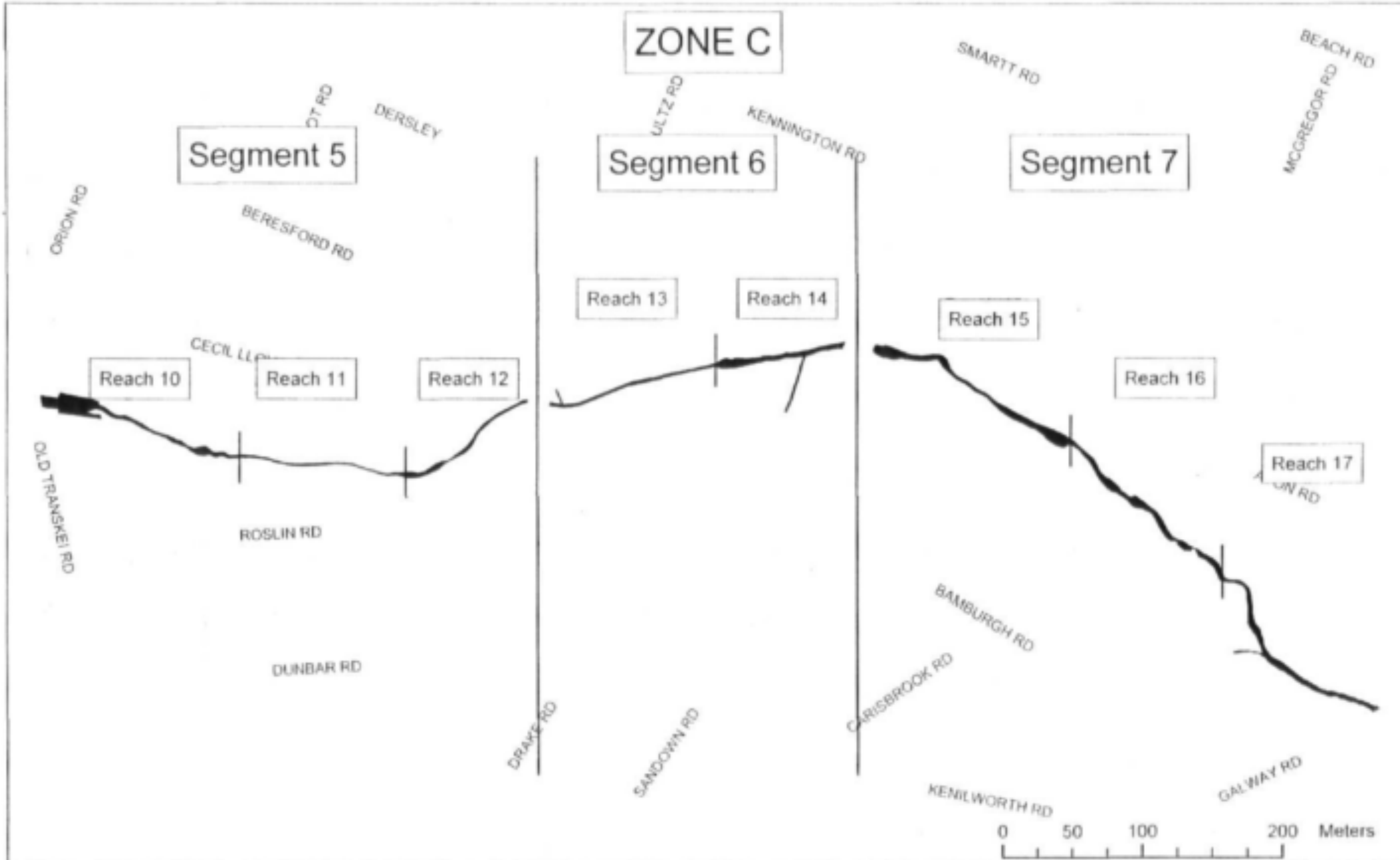
Water Research Commission

Down 2 Earth



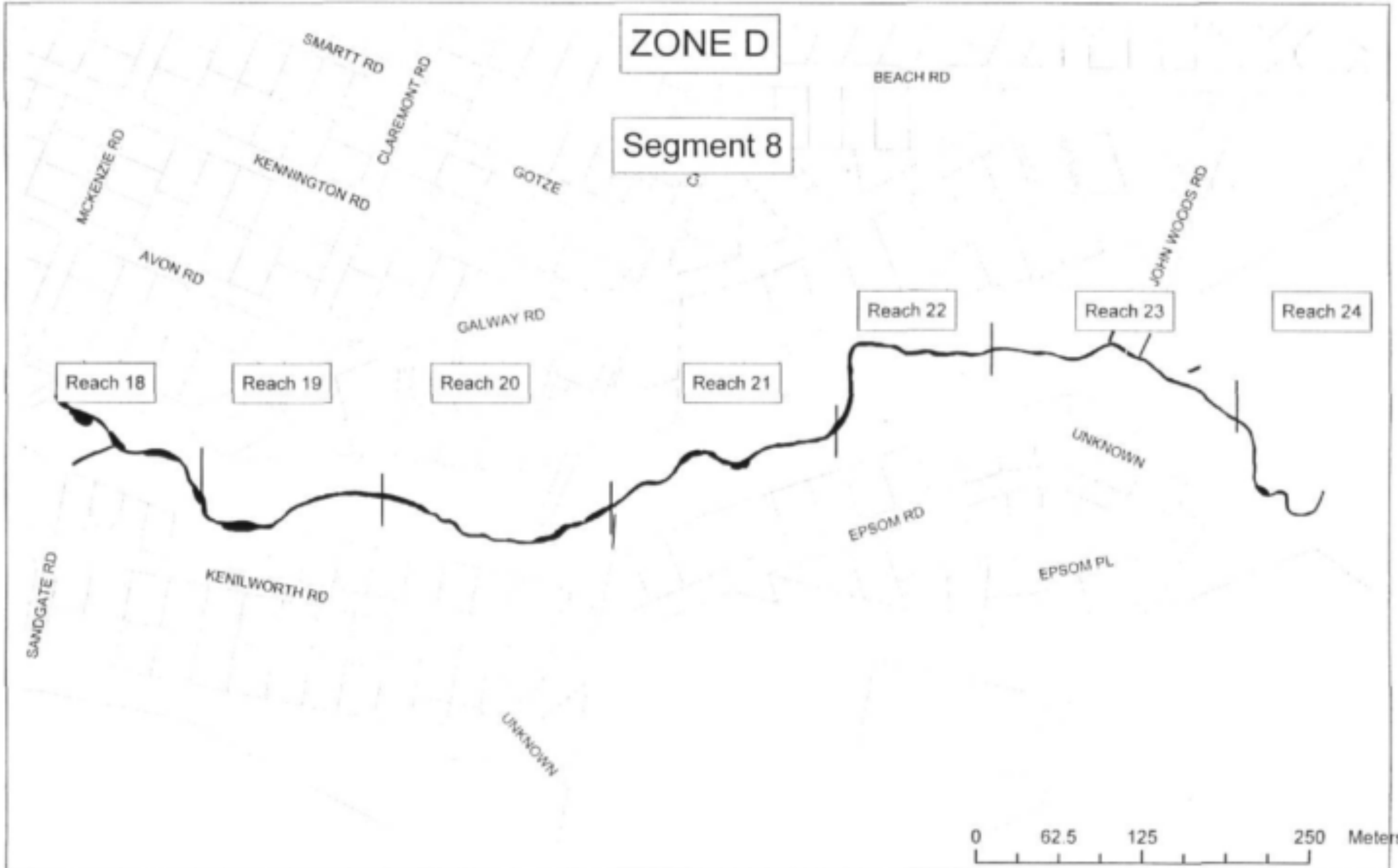
MAP NO 1.2 B

ZONES
PRESENT STATE
IHLANZA RIVER



MAP NO 1.2 C

ZONES
PRESENT STATE
IHLANZA RIVER

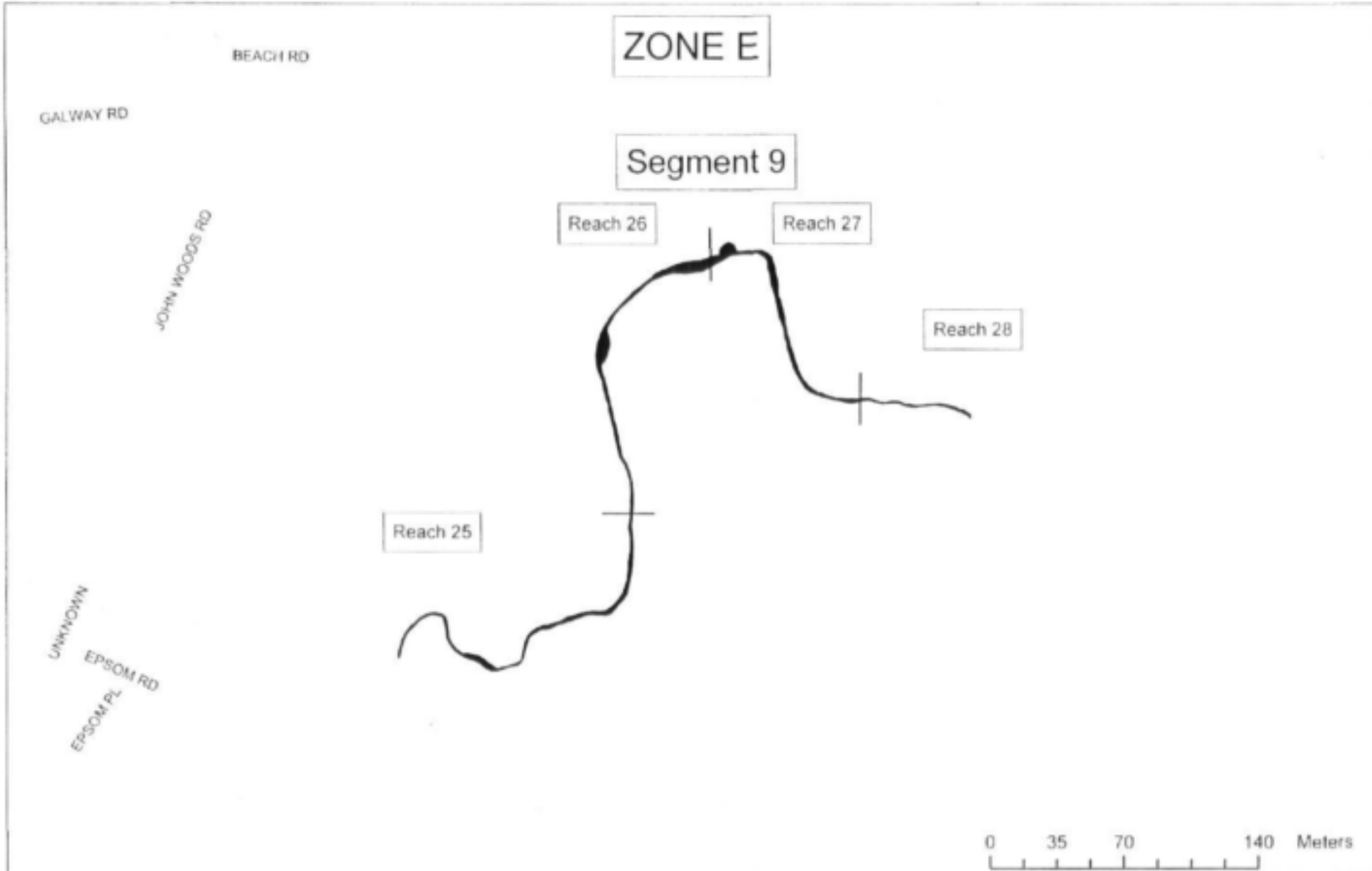


MAP NO 1.2 D

ZONES
PRESENT STATE
IHLANZA RIVER

Water Research Commission

Down 2 Earth

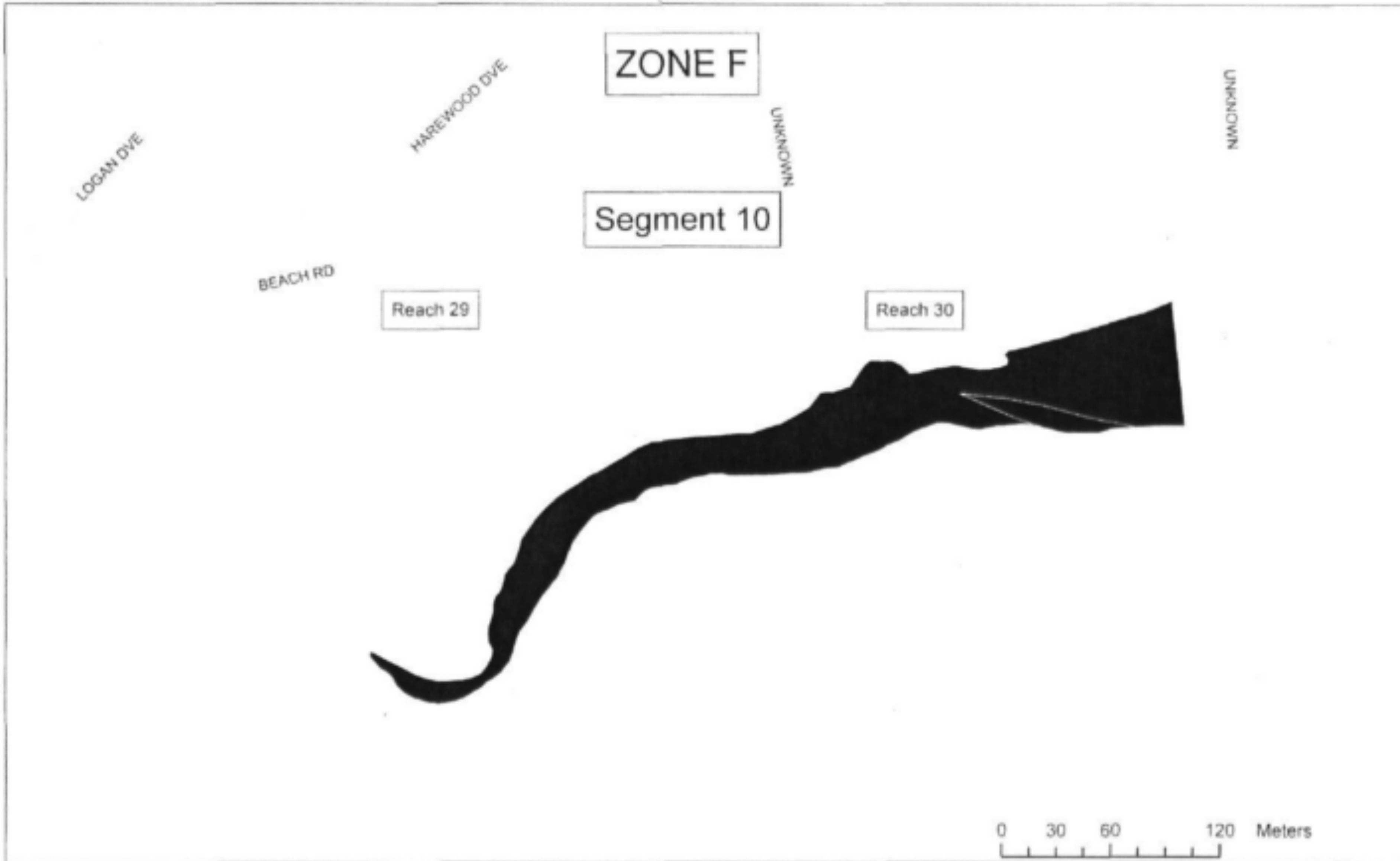


MAP NO 1.2 E

ZONES
PRESENT STATE
IHLANZA RIVER

Water Research Commission

Down 2 Earth



MAP NO 1.2 F

ZONES
PRESENT STATE
IHLANZA RIVER

MAPS ILLUSTRATING PRESENT STATE
REACHES 1- 30 (Corresponding to maps 4.1 to 4.30)

Tree symbols

- *Acacia karoo*
- *Adenopodia spicata*
- Alien
- Other indigenous
- *Araucaria*
- *Canthium obovatum*
- *Cordia caffra*
- *Ekebergia capensis*
- *Erythrina caffra*
- *Ficus sur*
- *Ficus thonningii*
- *Harpephyllum caffrum*
- *Nuxia*
- *Phoenix reclinata*
- *Pittosporum*
- *Podocarpus*
- *Protorhus*
- *Rhus*
- *Schotia*
- *Sideroxylon inerme*
- *Strelitzia nicolai*
- *Strelitzia reginae*
- *Vepris undulata*

Alien vegetation

Indigenous forest / thicket

Photopoint direction

N

LEGENDS

IHLANZA RIVER

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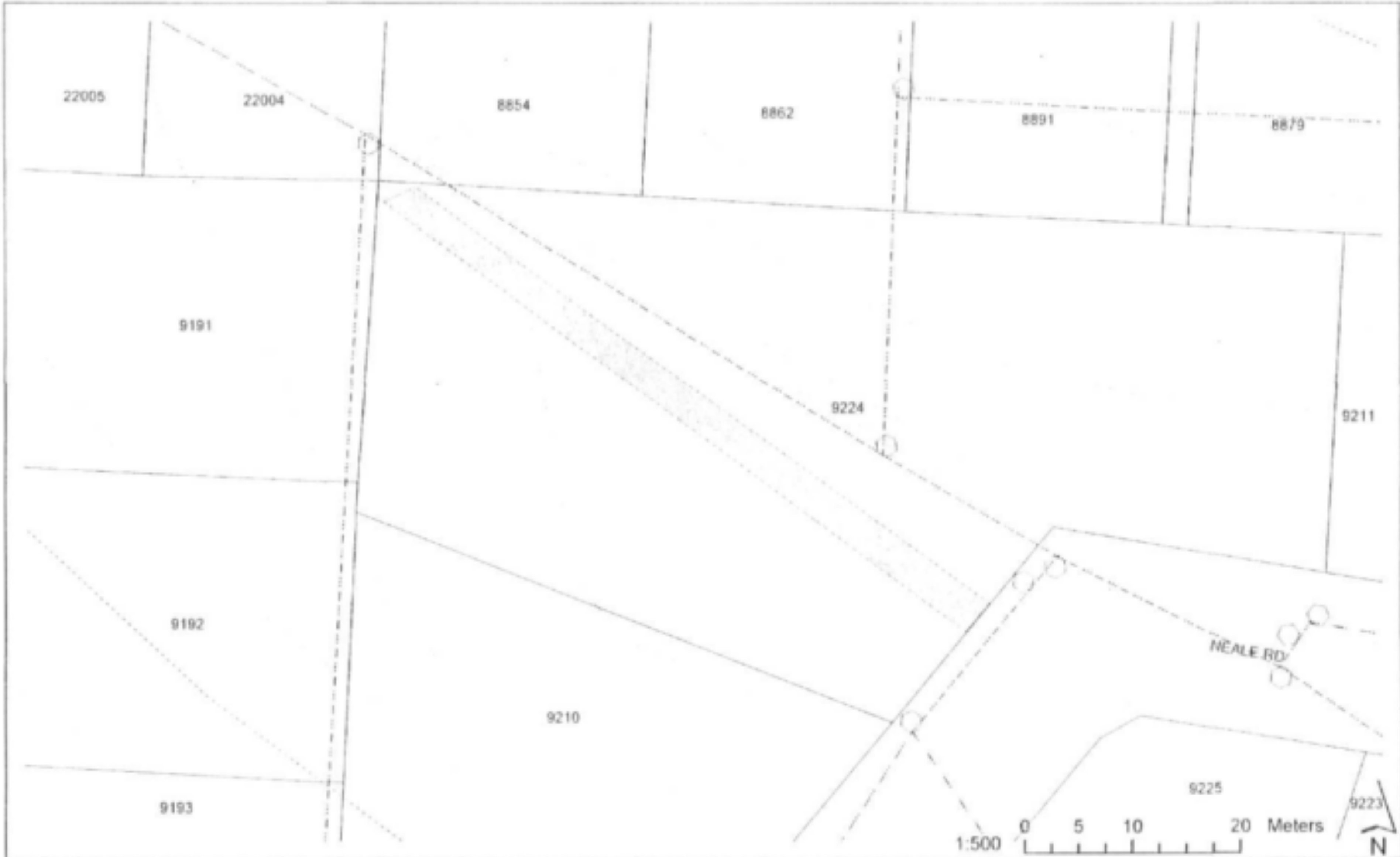
Down 2 Earth



Concrete canal

Sew_manholes

Sew_pipes

MAP NO 4.1

REACH 1
PRESENT STATE
IHLANZA RIVER

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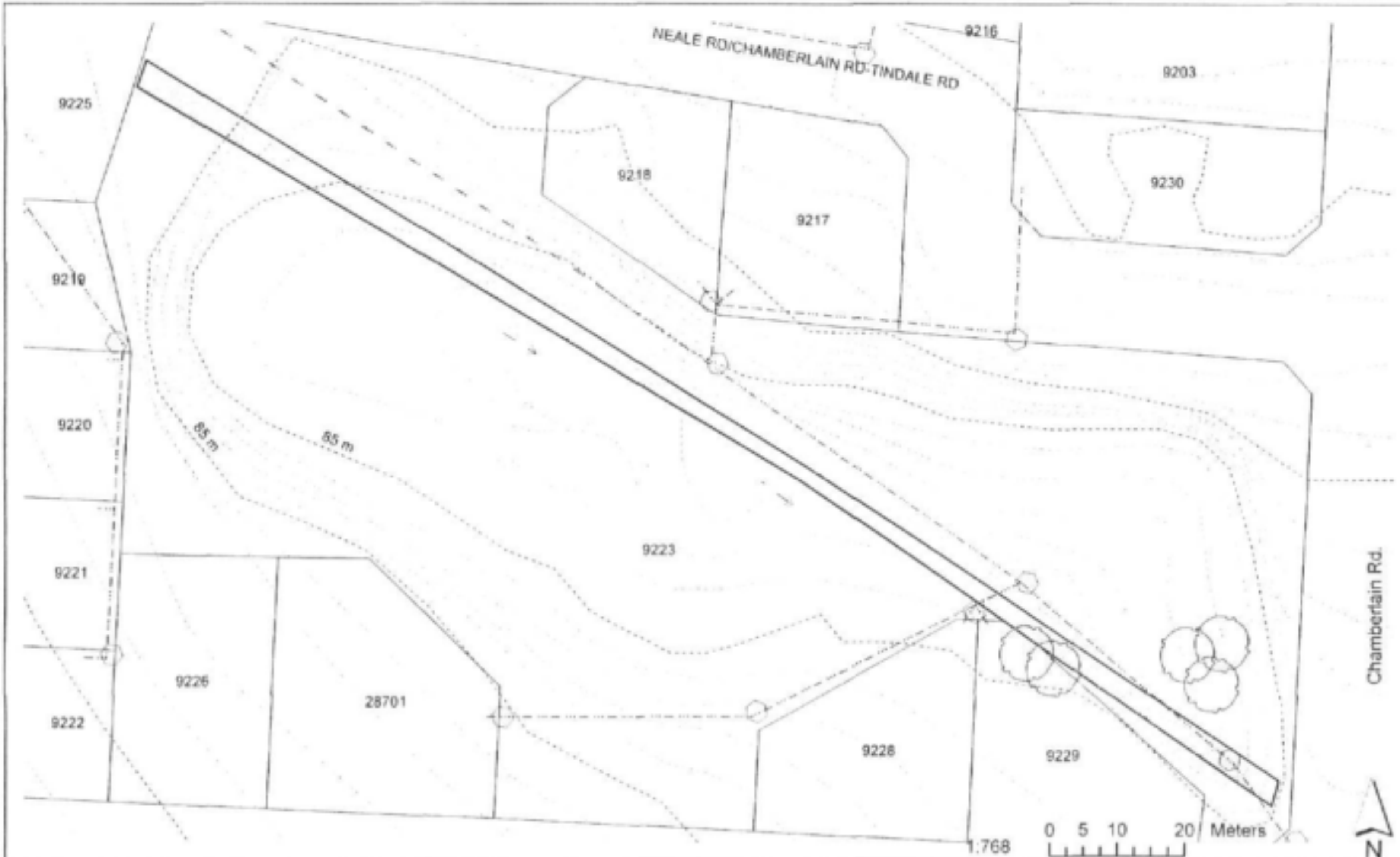
Down 2 Earth



MAP NO 4.2

REACH 2
PRESENT STATE
IHLANZA RIVER

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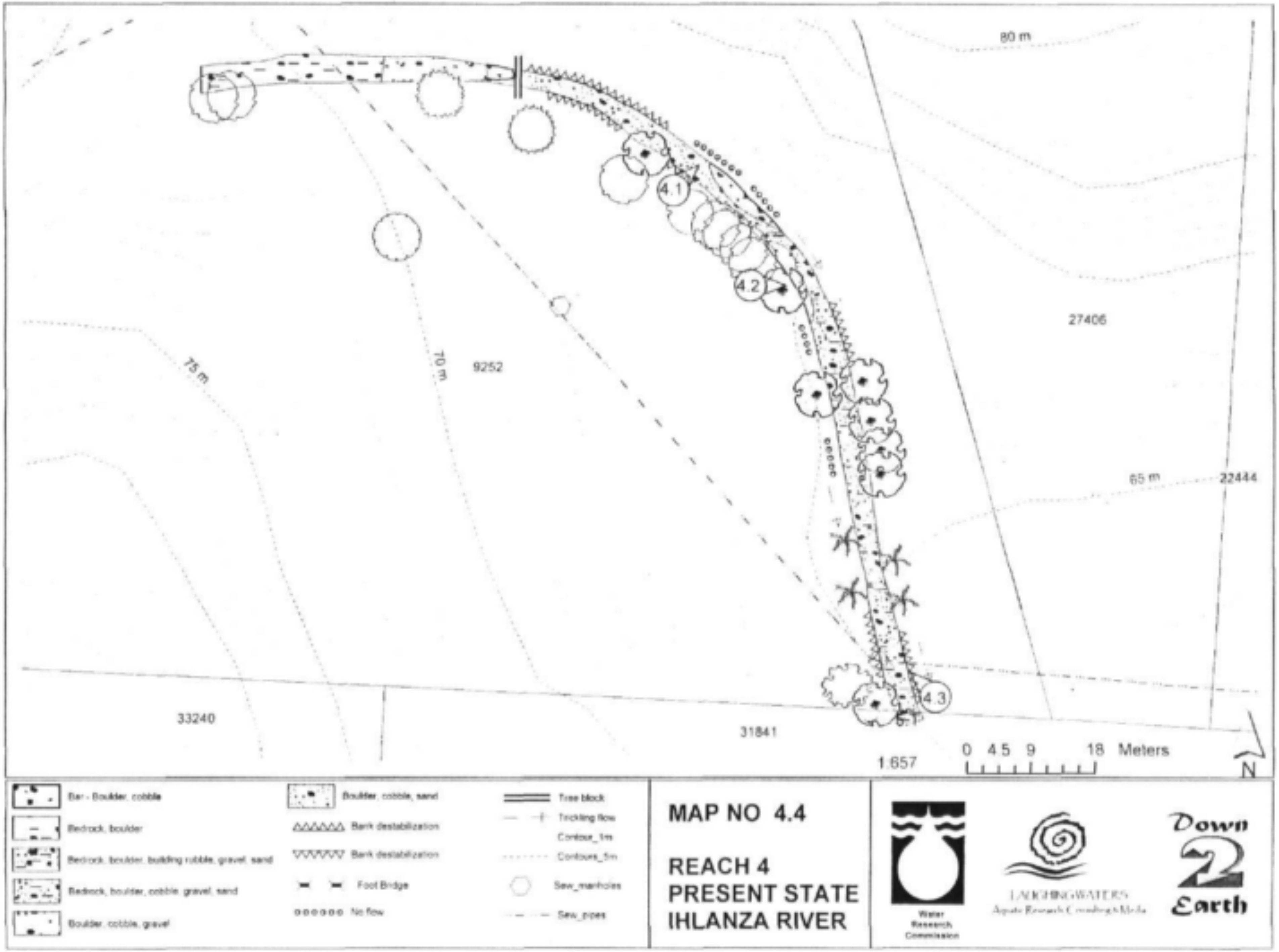
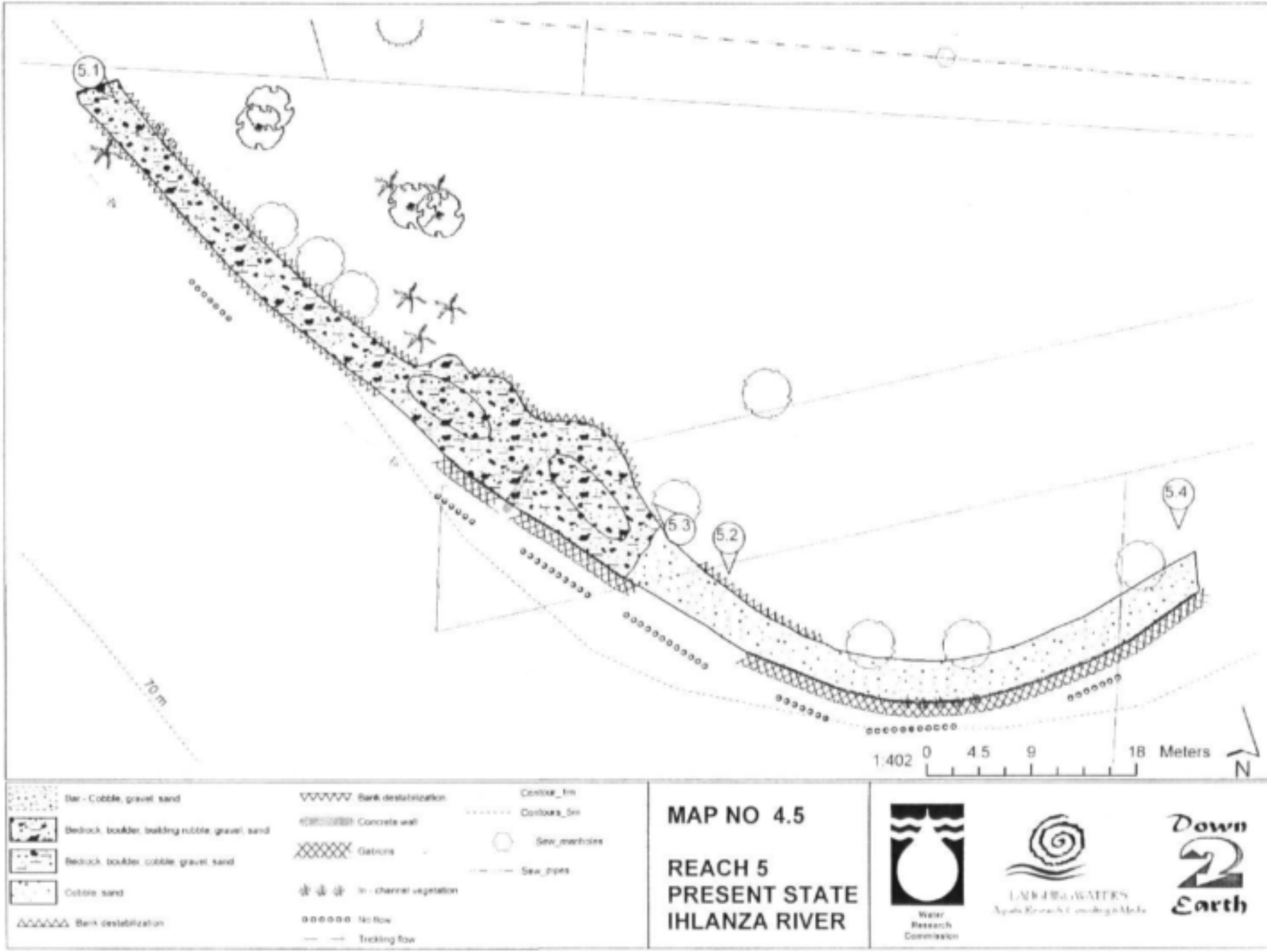
MAP NO 4.3

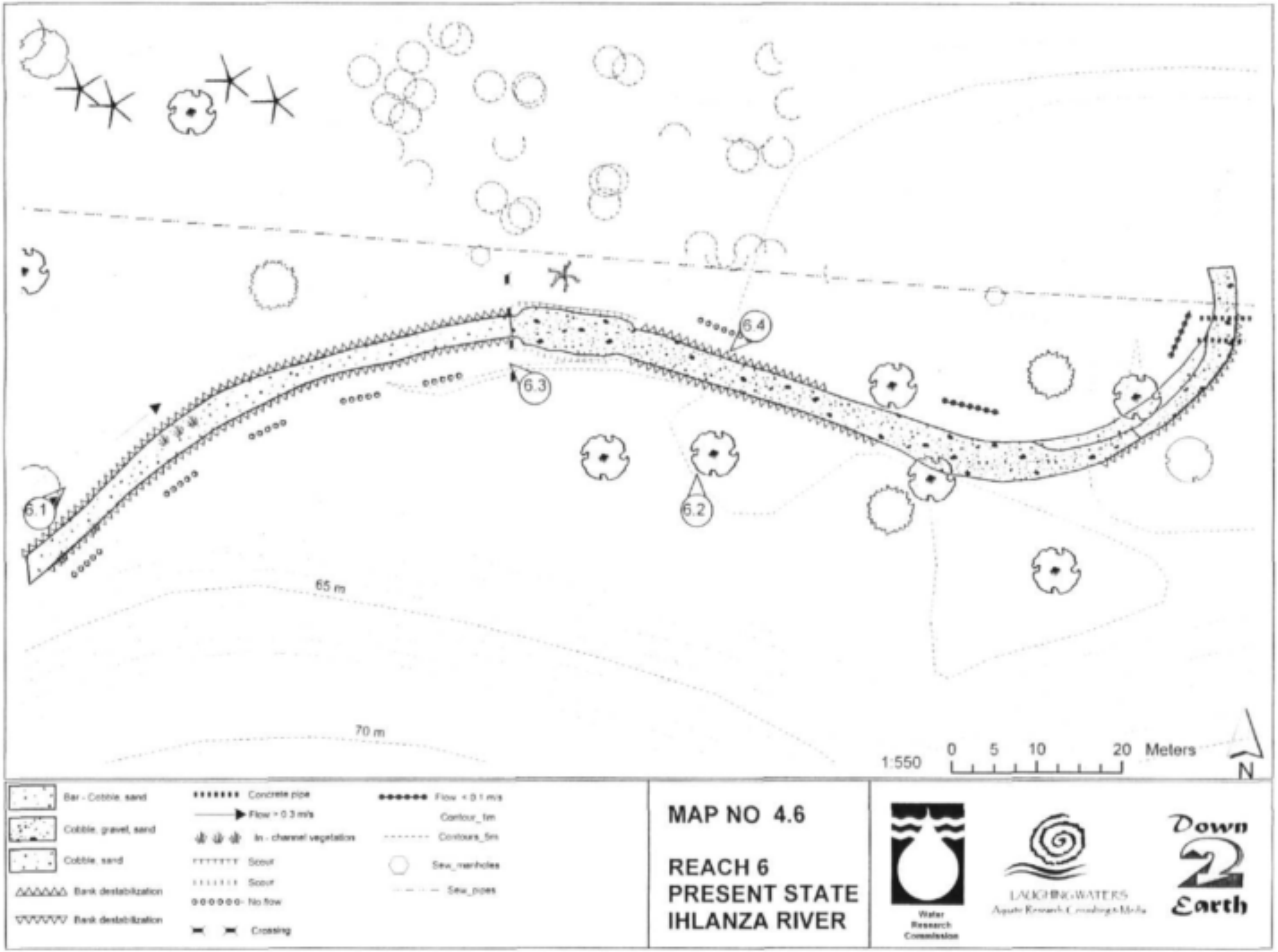
REACH 3
PRESENT STATE
IHLANZA RIVER

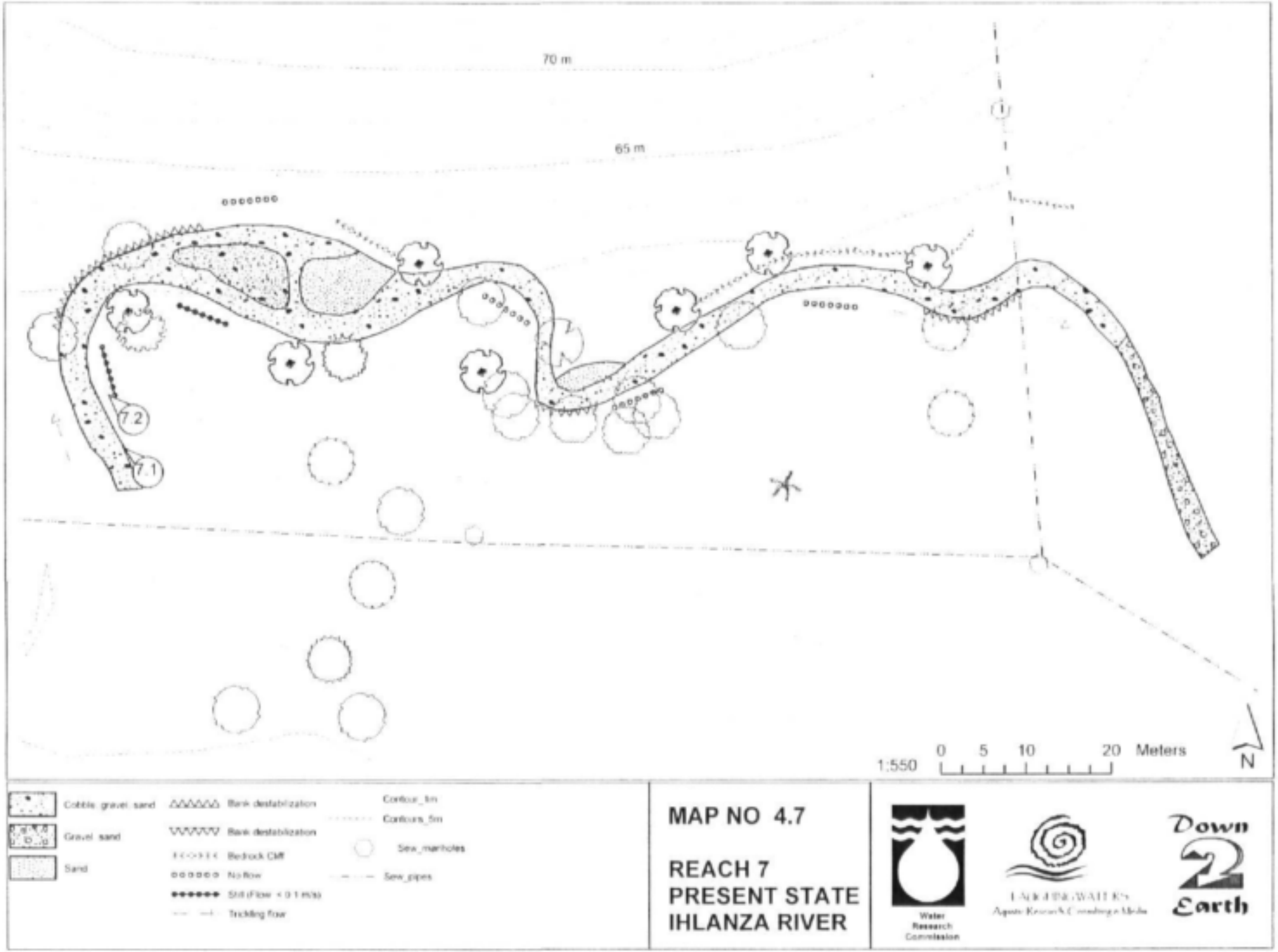
Water Research Commission

Down 2 Earth

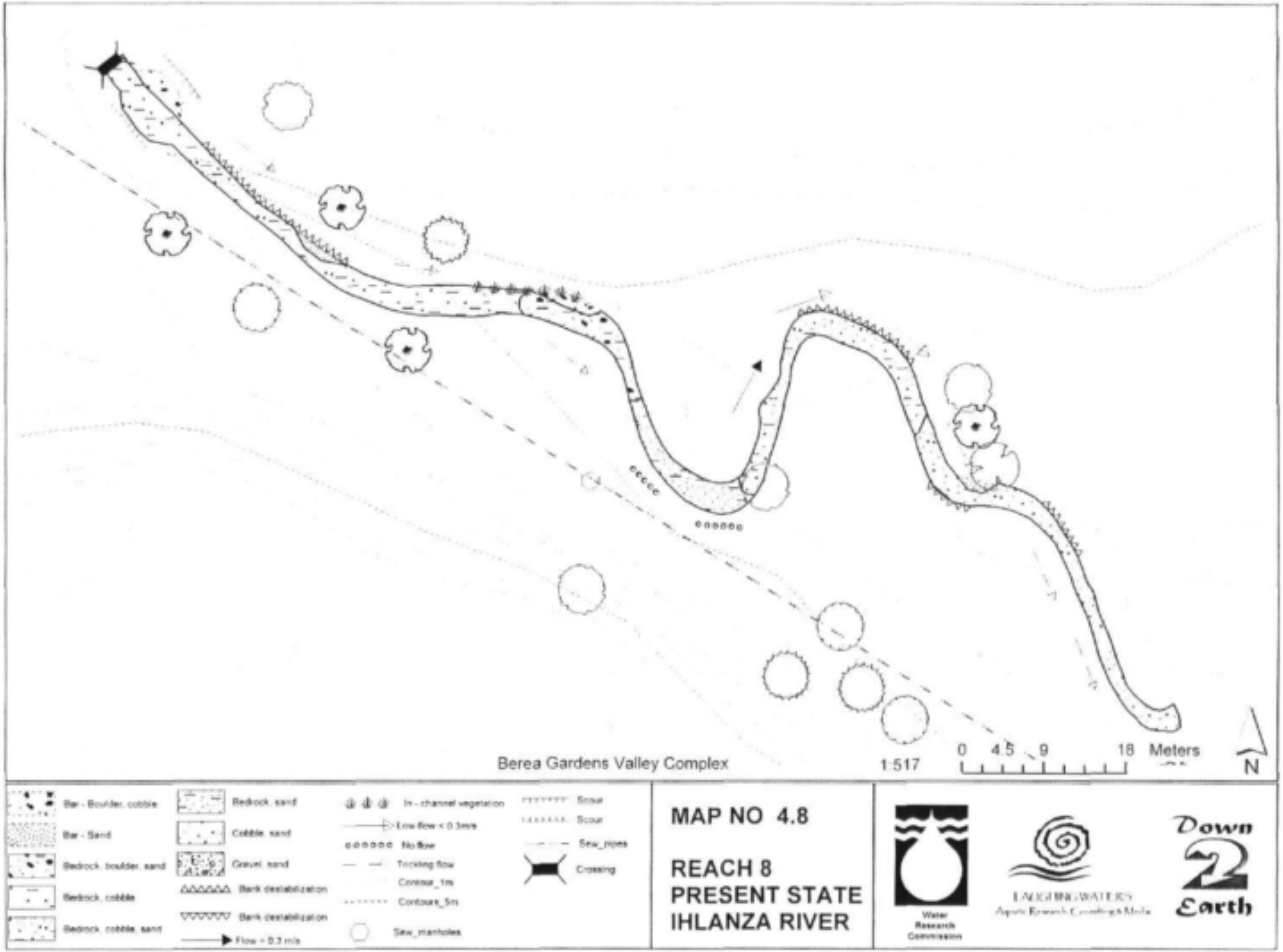

80 m
4.1
4.2
27406
75 m
70 m
9252
65 m
22444
4.3
5.1
33240
31841
1:657
0 4.5 9 18 Meters
N
Bar - Boulder, cobble
Bedrock, boulder
Bedrock, boulder, building rubble, gravel, sand
Bedrock, boulder, cobble, gravel, sand
Boulder, cobble, gravel
Boulder, cobble, sand
Bank destabilization
Bank destabilization
Foot Bridge
No flow
Tree block
Trickling flow
Contour_1m
Contours_5m
Sew_manholes
Sew_pipes
MAP NO 4.4
REACH 4
PRESENT STATE
IHLANZA RIVER
Water
Research
Commission
LAUGHINGWATERS
Down
2
Earth


5.1
5.2
5.3
5.4
70 m
1:402
0
4.5
9
18
Meters
N
Bar - Cobble, gravel, sand
Bedrock, boulder, building rubble, gravel, sand
Bedrock, boulder, cobble, gravel, sand
Cobble, sand
Bank destabilization
Bank destabilization
Concrete wall
Gabions
In - channel vegetation
No flow
Trickling flow
Contour_1m
Contours_5m
Sew_manholes
Sew_pipes
MAP NO 4.5
REACH 5
PRESENT STATE
IHLANZA RIVER
Water
Research
Commission
Down
2
Earth


6.1
6.2
6.3
6.4
65 m
70 m
1:550
0 5 10 20 Meters
N
Bar - Cobble, sand
Cobble, gravel, sand
Cobble, sand
Bank destabilization
Bank destabilization
Concrete pipe
Flow > 0.3 m/s
In - channel vegetation
Scour
Scour
No flow
Crossing
Flow < 0.1 m/s
Contour_1m
Contours_5m
Sew_manholes
Sew_pipes
MAP NO 4.6
REACH 6
PRESENT STATE
IHLANZA RIVER
Water Research Commission
LAUGHING WATERS
Down 2 Earth



70 m
65 m
1
7.2
7.1
1:550
0 5 10 20 Meters
N
Cobble gravel sand
Gravel sand
Sand
Bank destabilization
Bank destabilization
Bedrock Cliff
No flow
Still (Flow < 0.1 m/s)
Trickling flow
Contour_1m
Contours_5m
Sew_manholes
Sew_pipes
MAP NO 4.7
REACH 7
PRESENT STATE
IHLANZA RIVER
Water Research Commission
Down 2 Earth



Berea Gardens Valley Complex
1:517
0 4.5 9 18 Meters
N
Bar - Boulder, cobble
Bar - Sand
Bedrock, boulder, sand
Bedrock, cobble
Bedrock, cobble, sand
Bedrock, sand
Cobble, sand
Gravel, sand
Bank destabilization
Bank destabilization
Flow > 0.3 m/s
In - channel vegetation
Low flow < 0.3m/s
No flow
Trickling flow
Contour_1m
Contours_5m
Sew_manholes
Scour
Scour
Sew_pipes
Crossing
MAP NO 4.8
REACH 8
PRESENT STATE
IHLANZA RIVER
Water Research Commission
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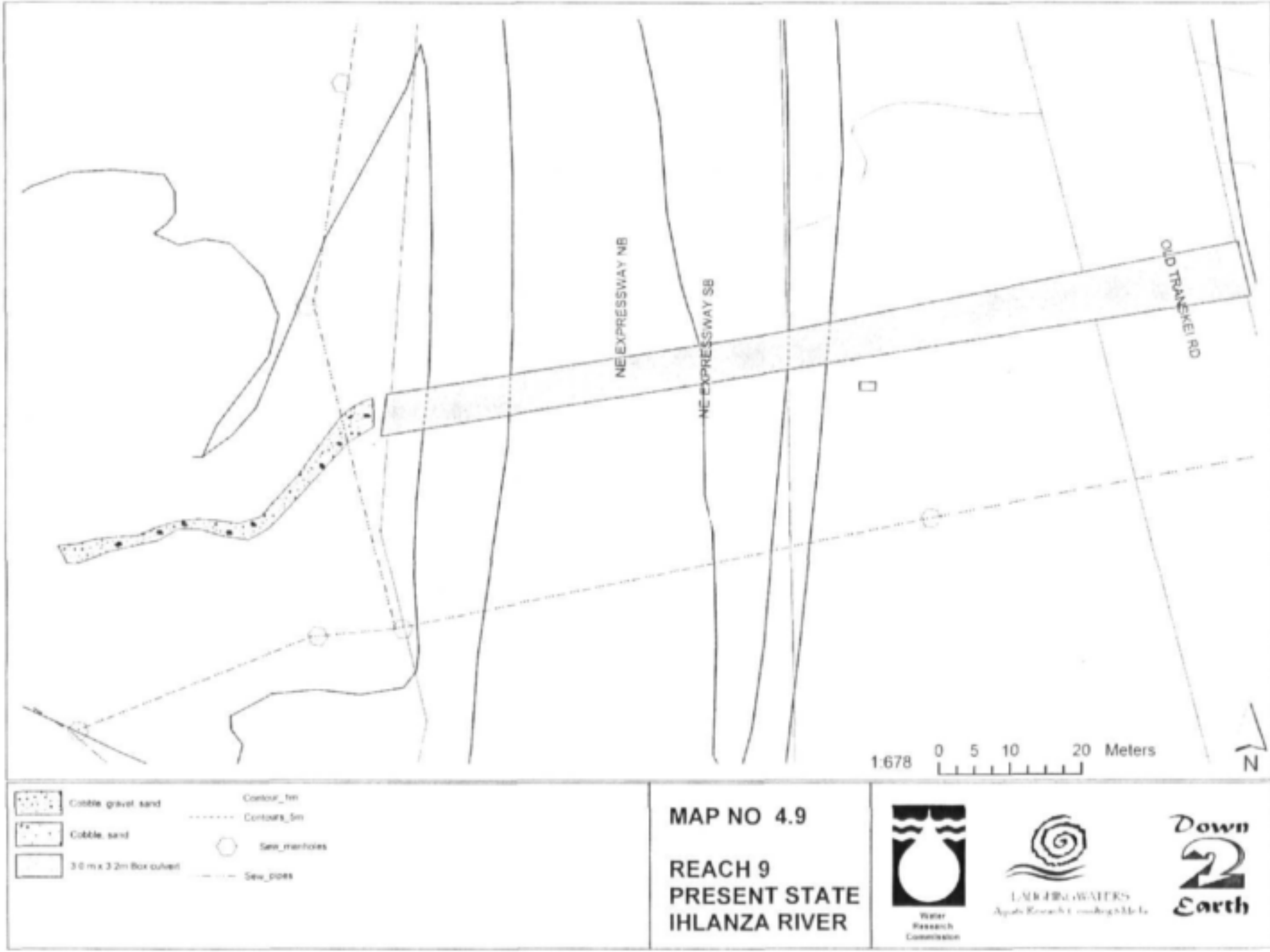
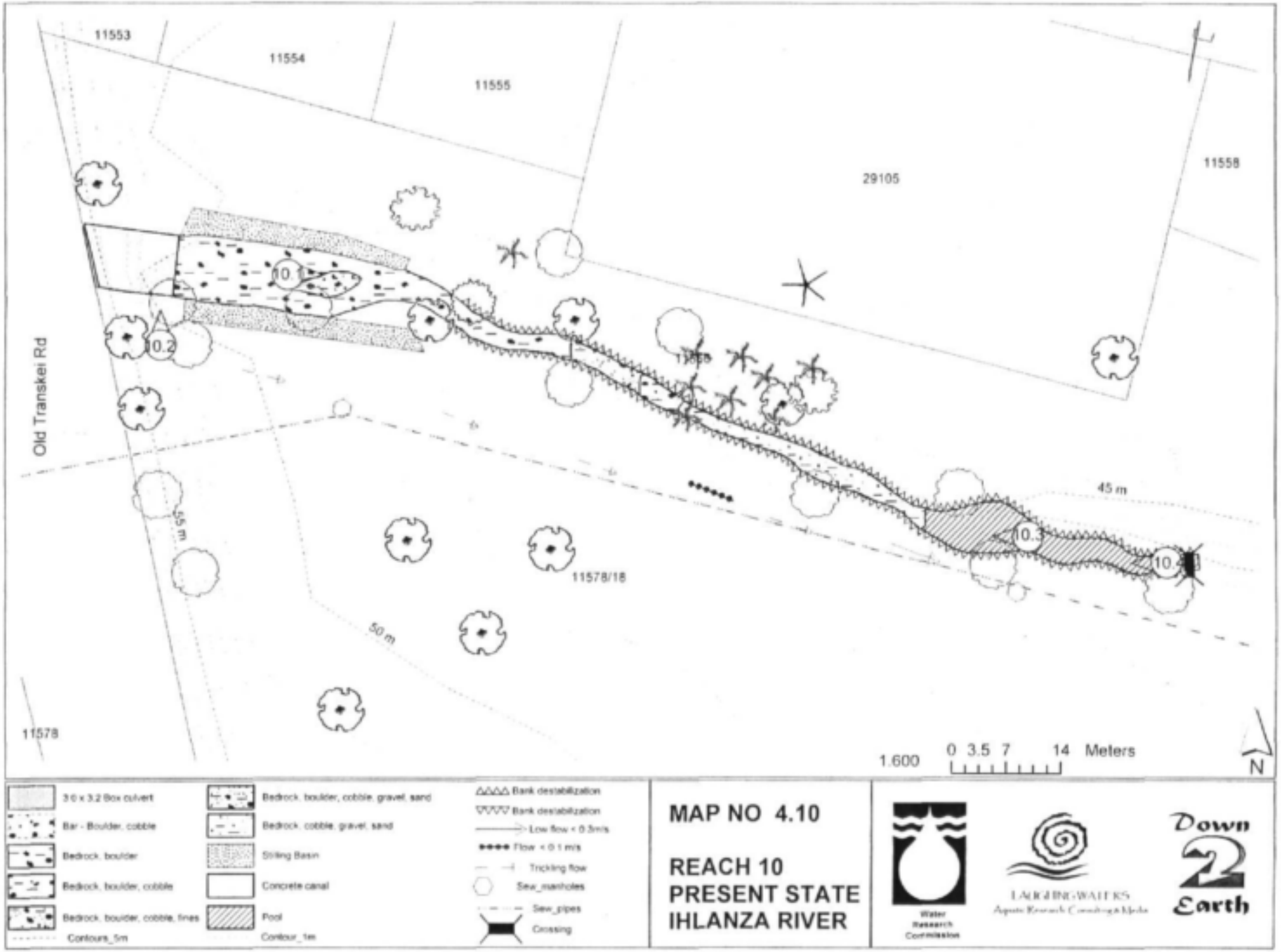
Down 2 Earth



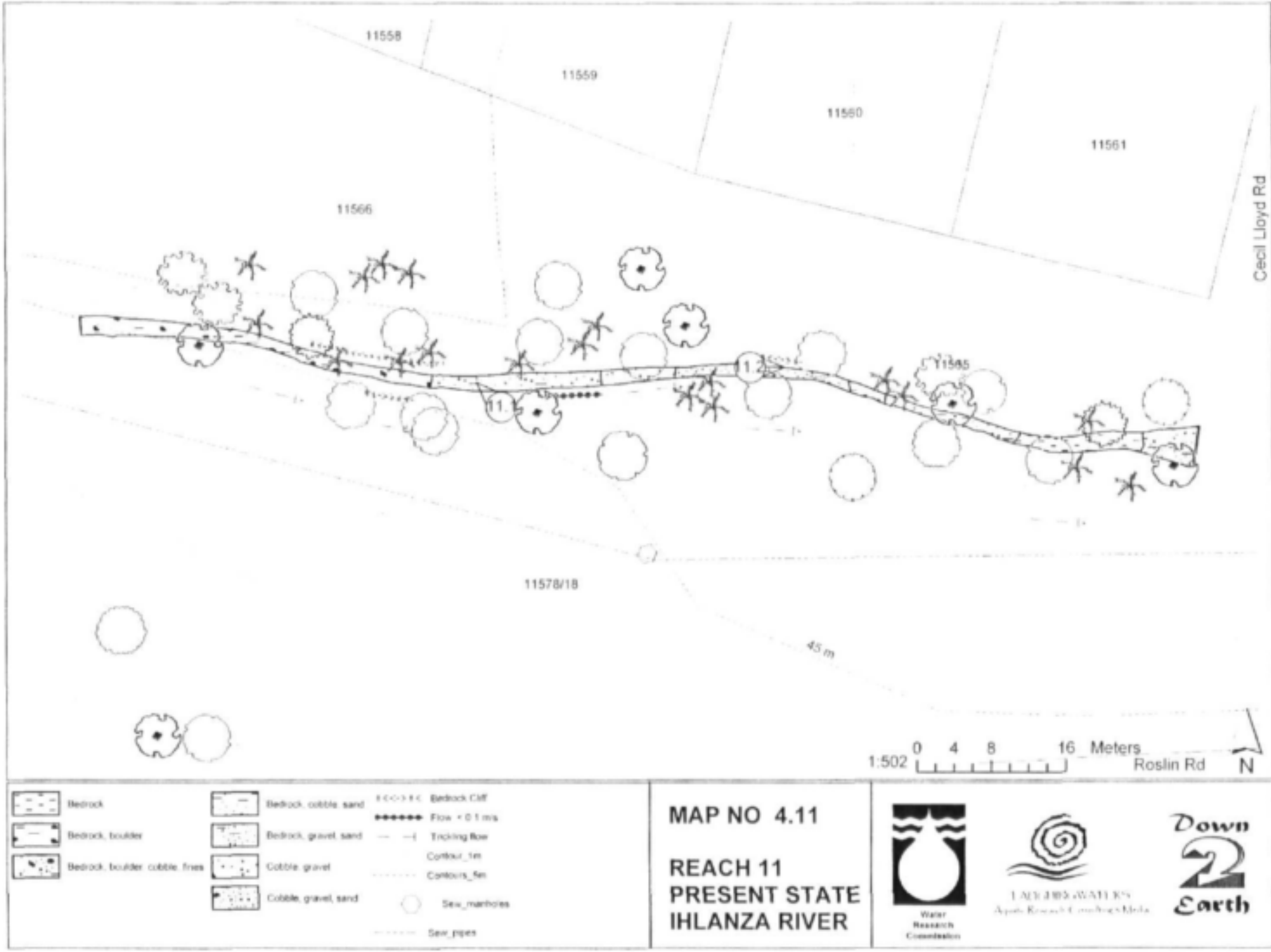
MAP NO 4.9

REACH 9
PRESENT STATE
IHLANZA RIVER



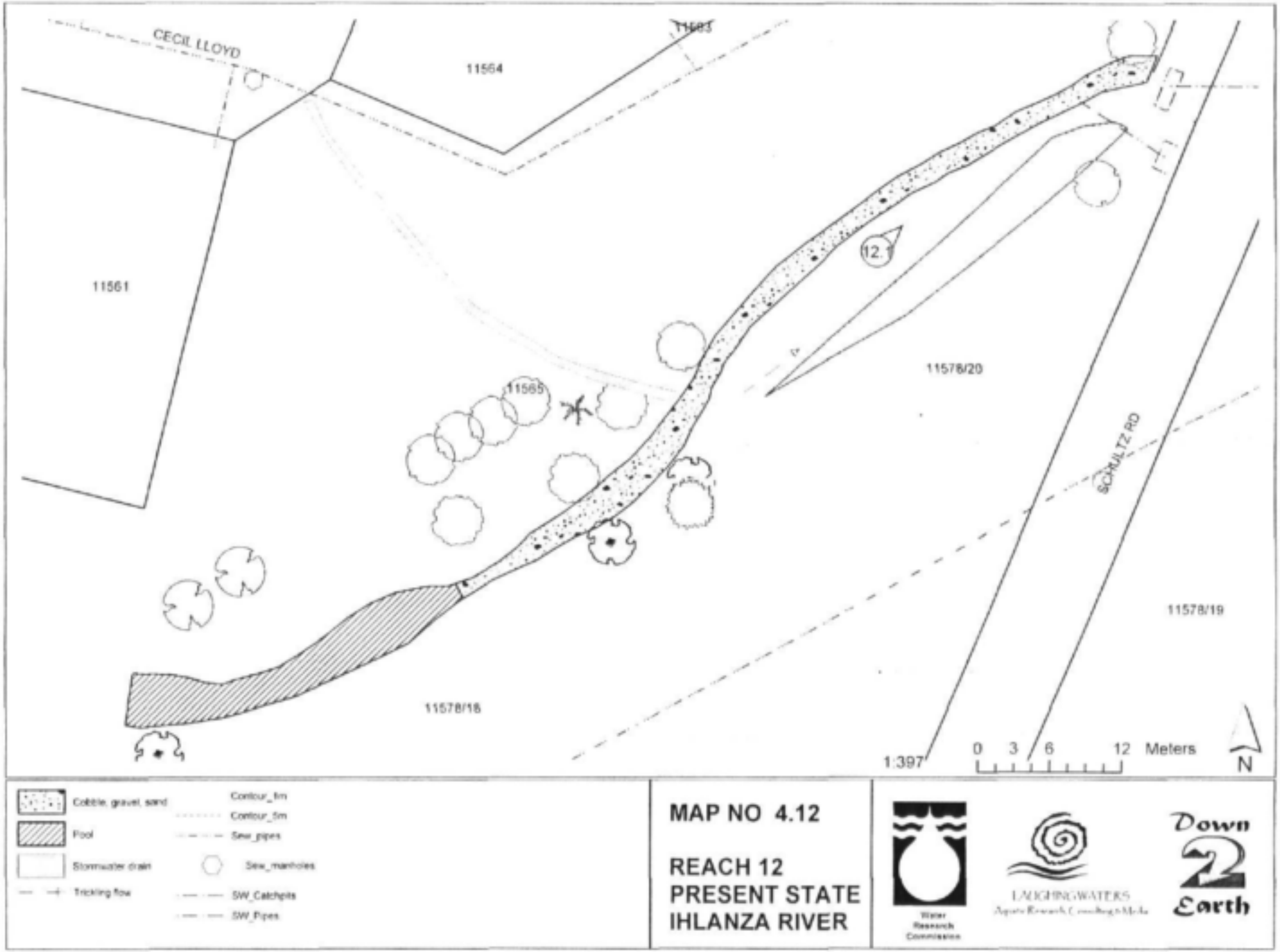
MAP NO 4.10

REACH 10 PRESENT STATE IHLANZA RIVER



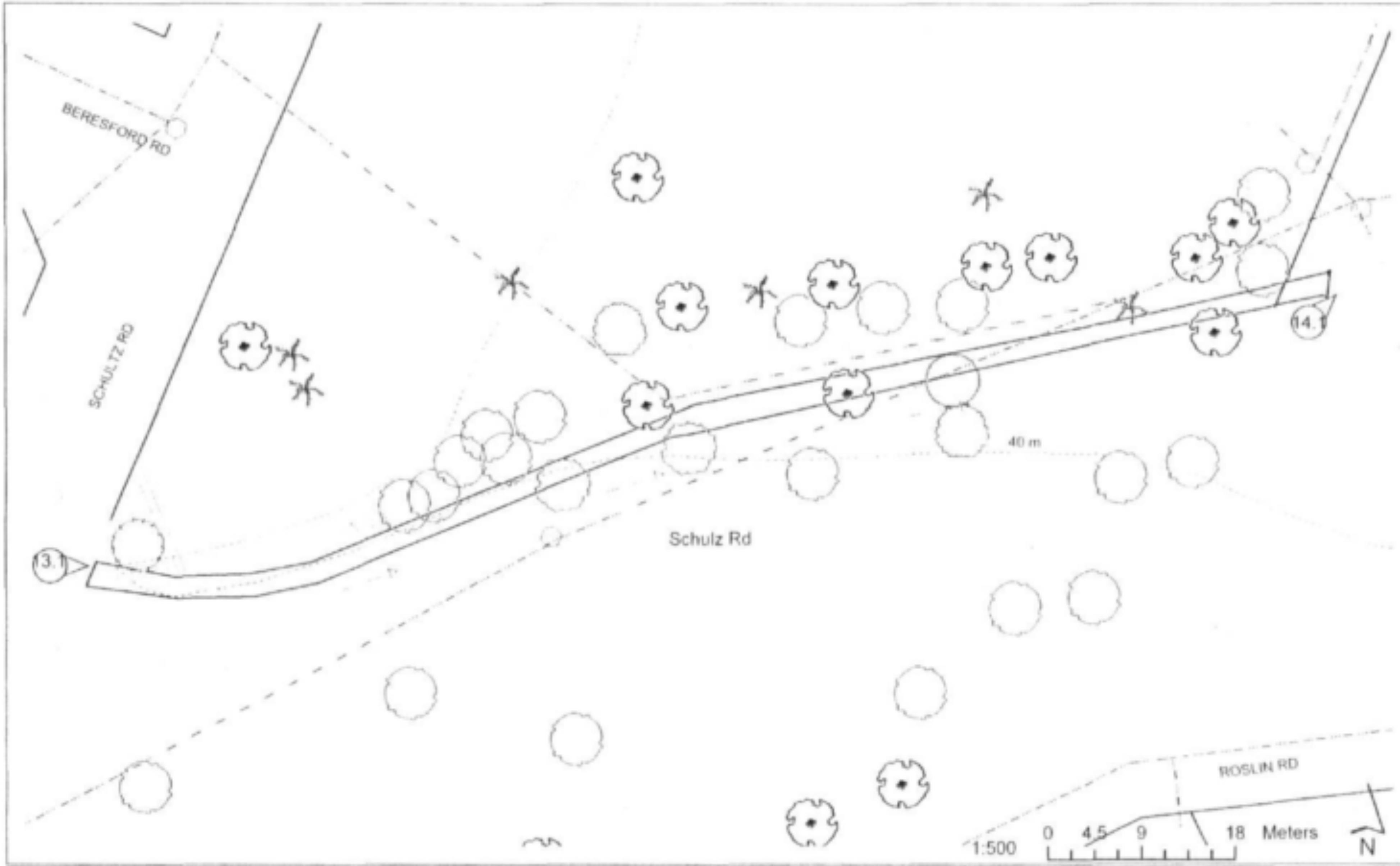
MAP NO 4.11

REACH 11 PRESENT STATE IHLANZA RIVER



MAP NO 4.12

REACH 12
PRESENT STATE
IHLANZA RIVER



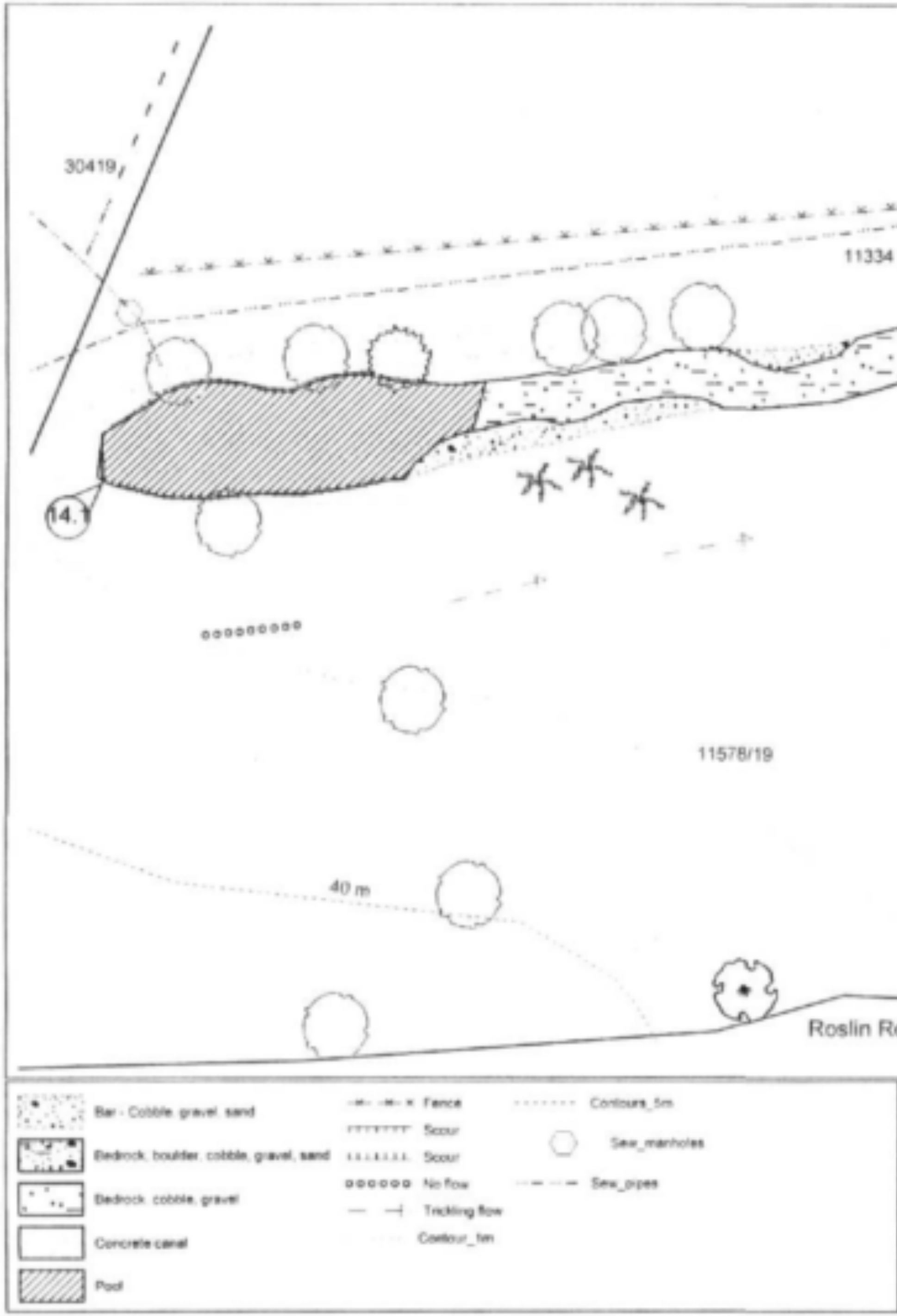
Bedrock boulder cobble gravel sand
Concrete canal
Stormwater drain
Trickling flow
Contour_1m
Contours_5m
Sew_manholes
Sew_pipes

MAP NO 4.13

REACH 13
PRESENT STATE
IHLANZA RIVER

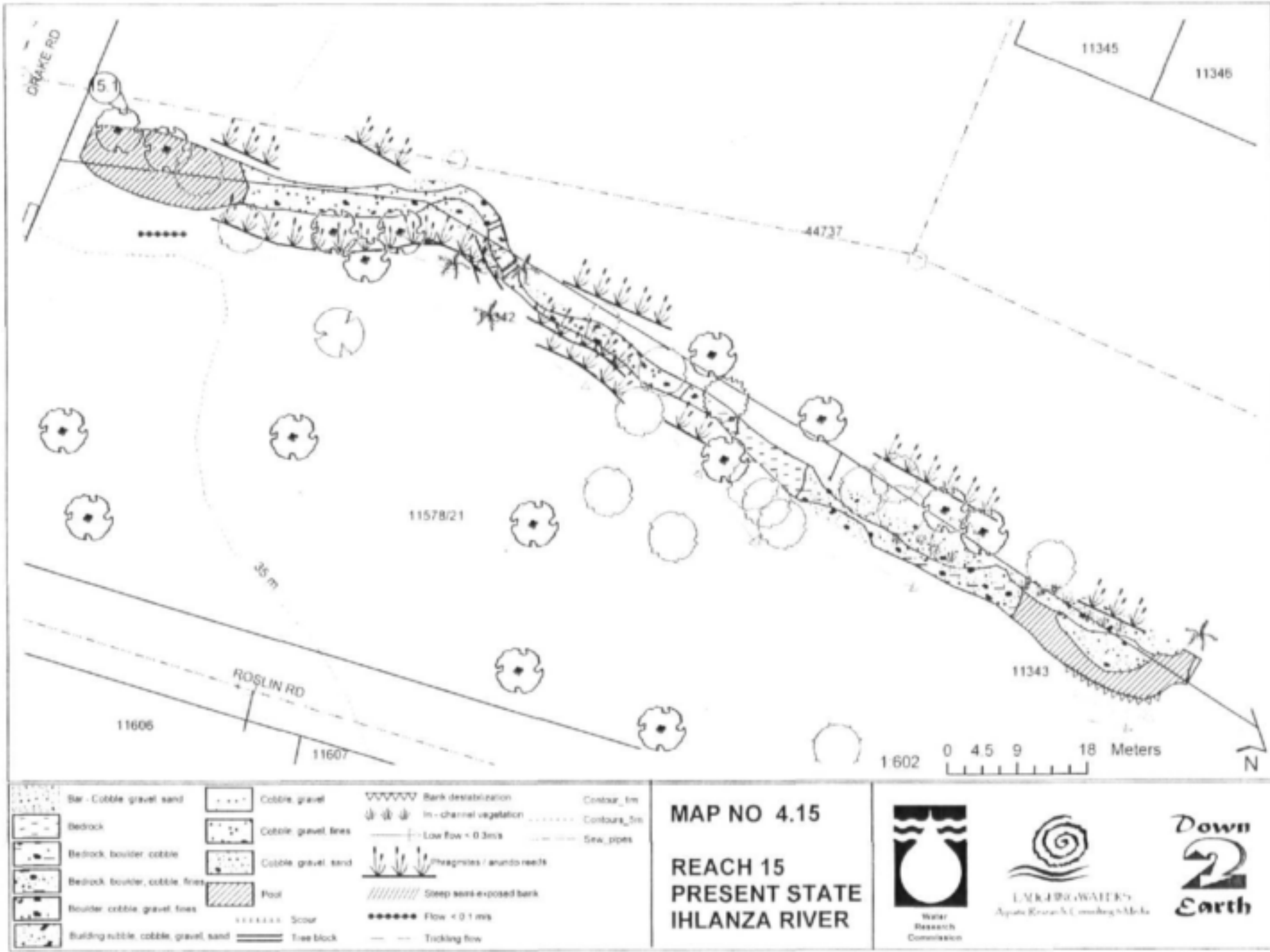
Water Research Commission

Down 2 Earth



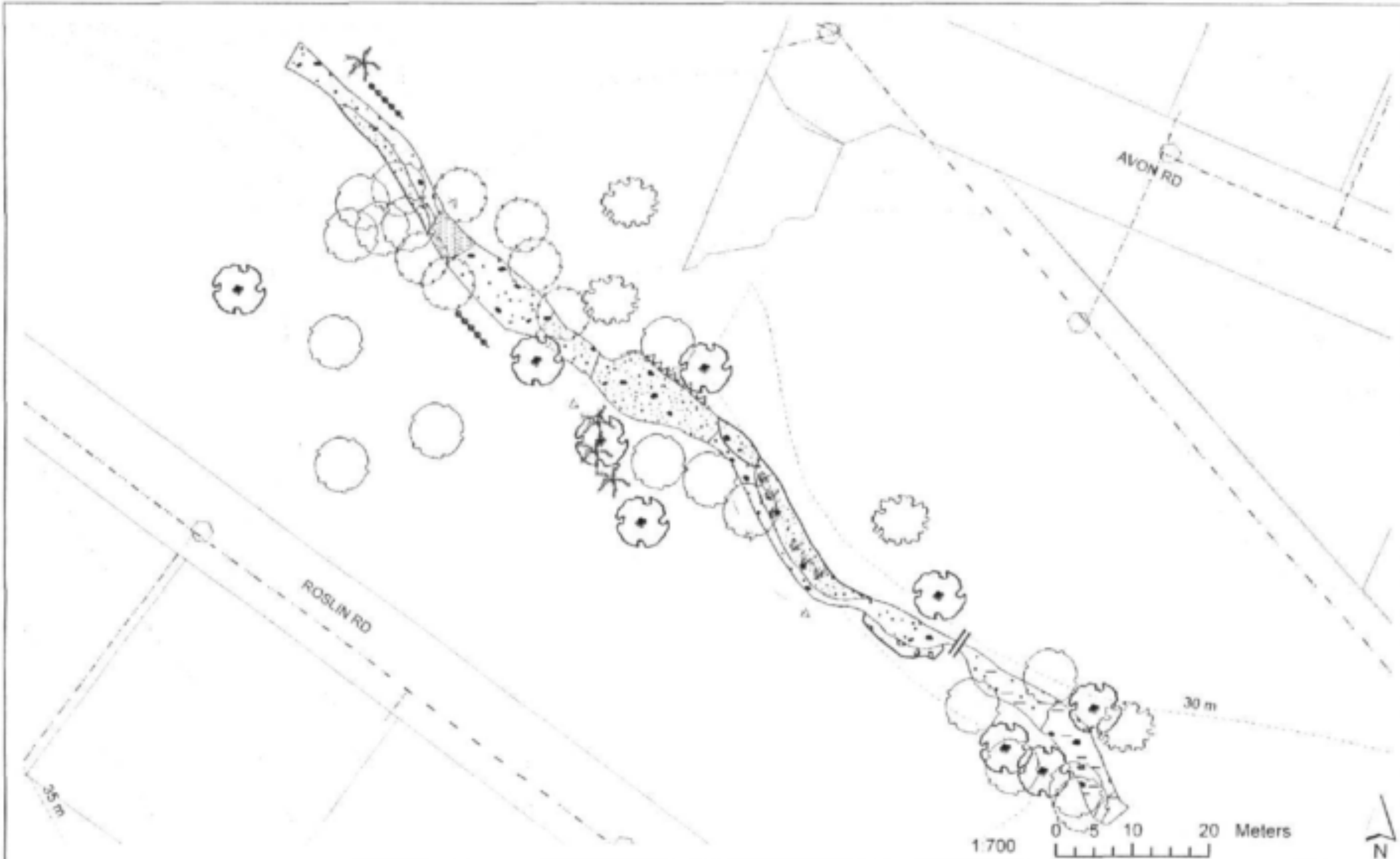
MAP NO 4.14

REACH 14
PRESENT STATE
IHLANZA RIVER



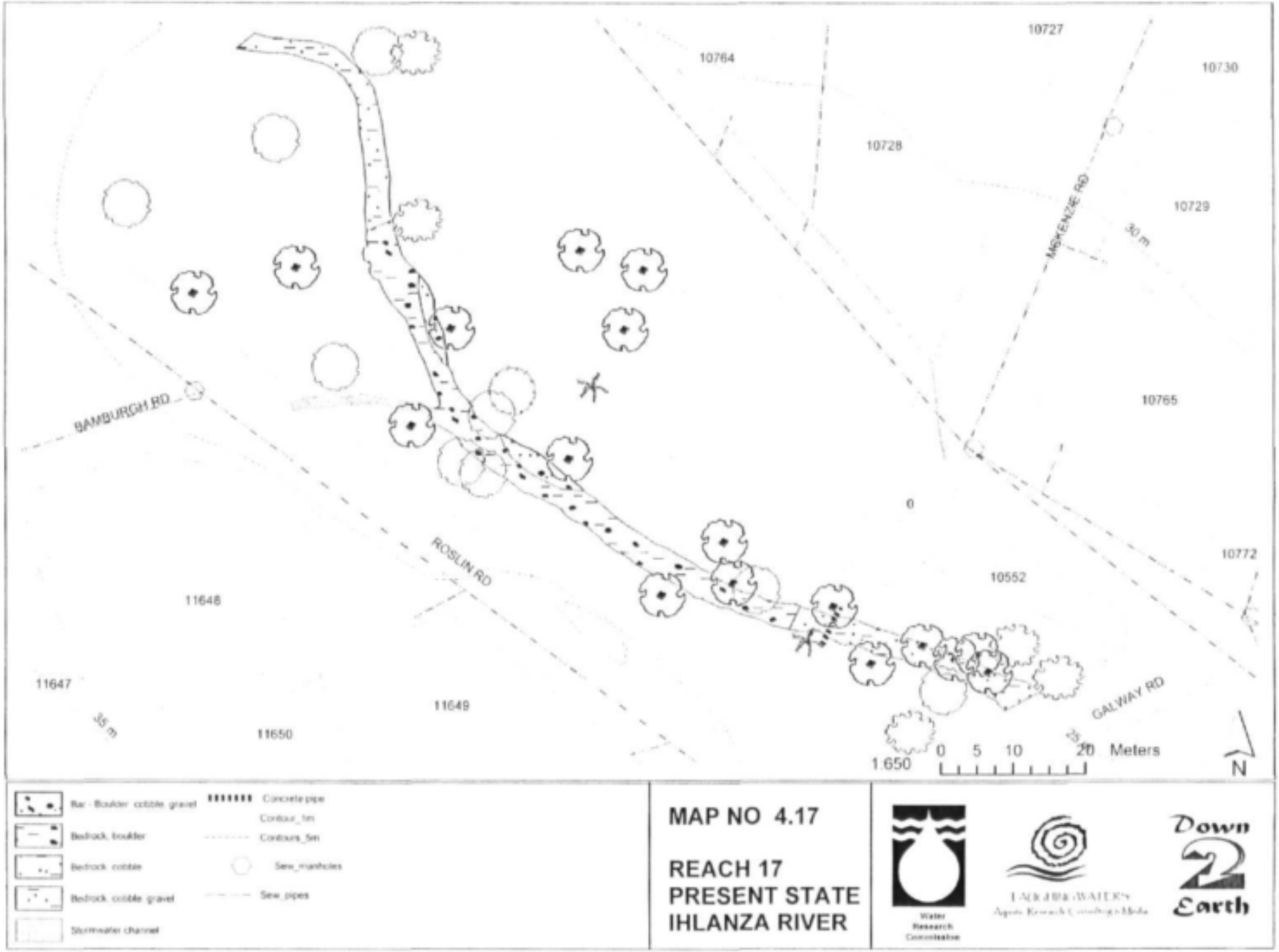
MAP NO 4.15

REACH 15
PRESENT STATE
IHLANZA RIVER



MAP NO 4.16

REACH 16 PRESENT STATE IHLANZA RIVER



MAP NO 4.17

REACH 17
PRESENT STATE
IHLANZA RIVER

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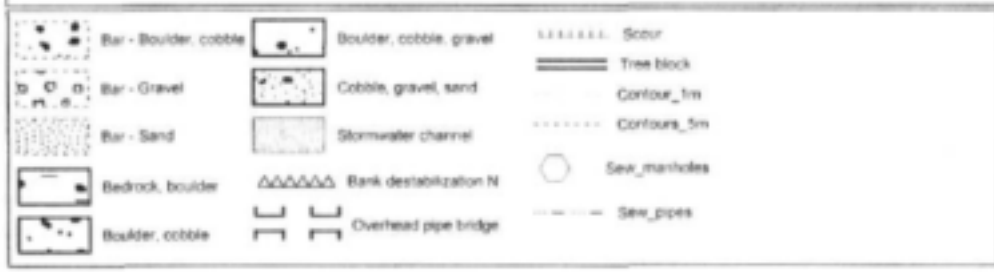

MAP NO 4.18

REACH 18
PRESENT STATE
IHLANZA RIVER

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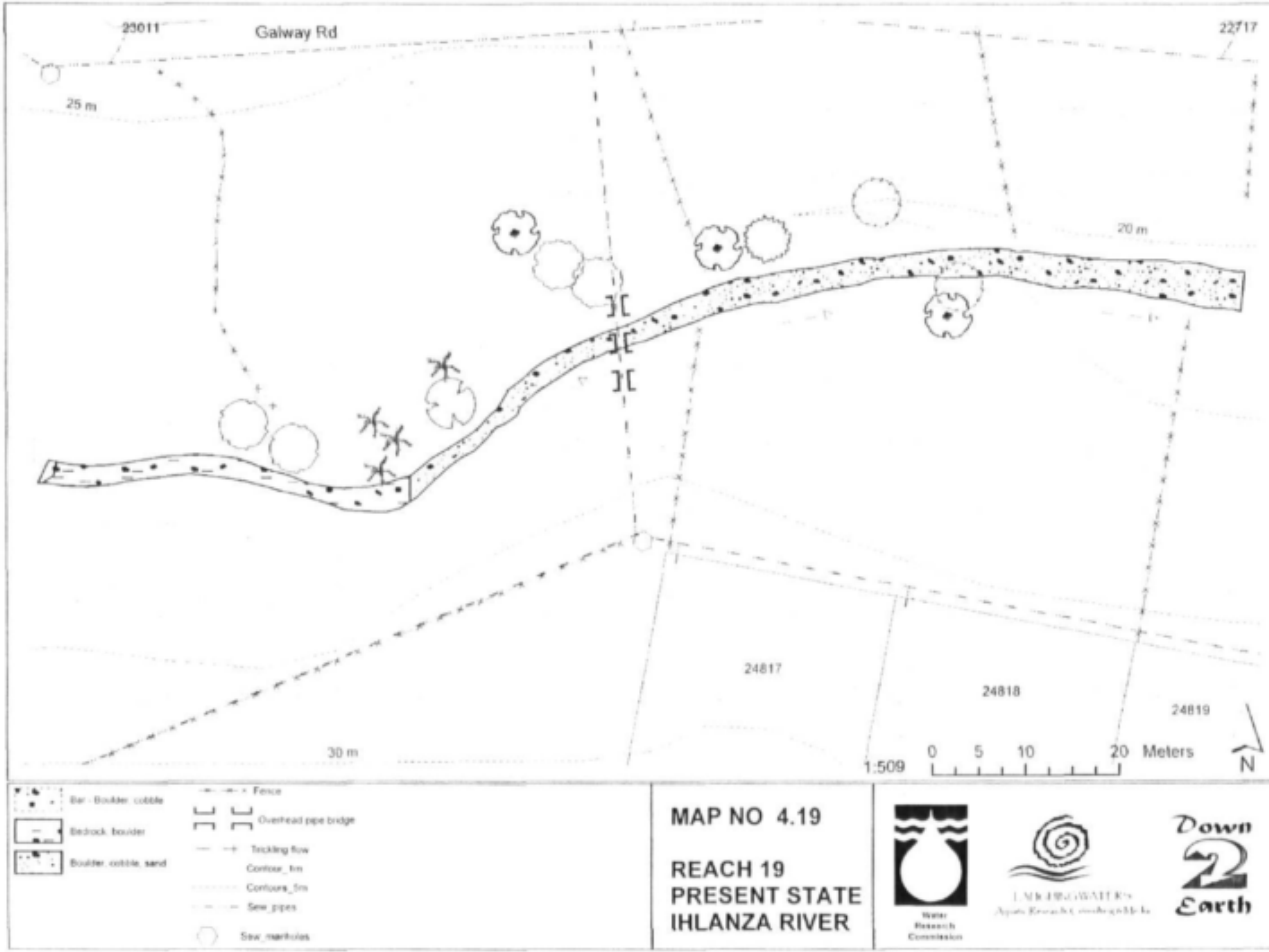
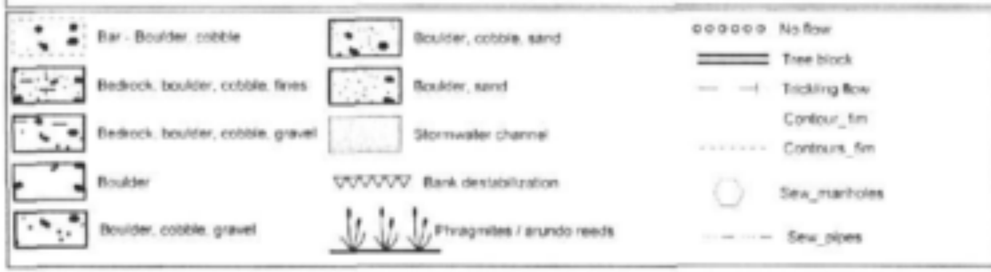


23011
Galway Rd
22717
25 m
20 m
30 m
24817
24818
24819
1:509
0 5 10 20 Meters
N
Bar - Boulder, cobble
Bedrock, boulder
Boulder, cobble, sand
Fence
Overhead pipe bridge
Trickling flow
Contour_5m
Contours_1m
Sew_pipes
Sew_manholes
MAP NO 4.19
REACH 19
PRESENT STATE
IHLANZA RIVER
Water Research Commission
Down 2 Earth

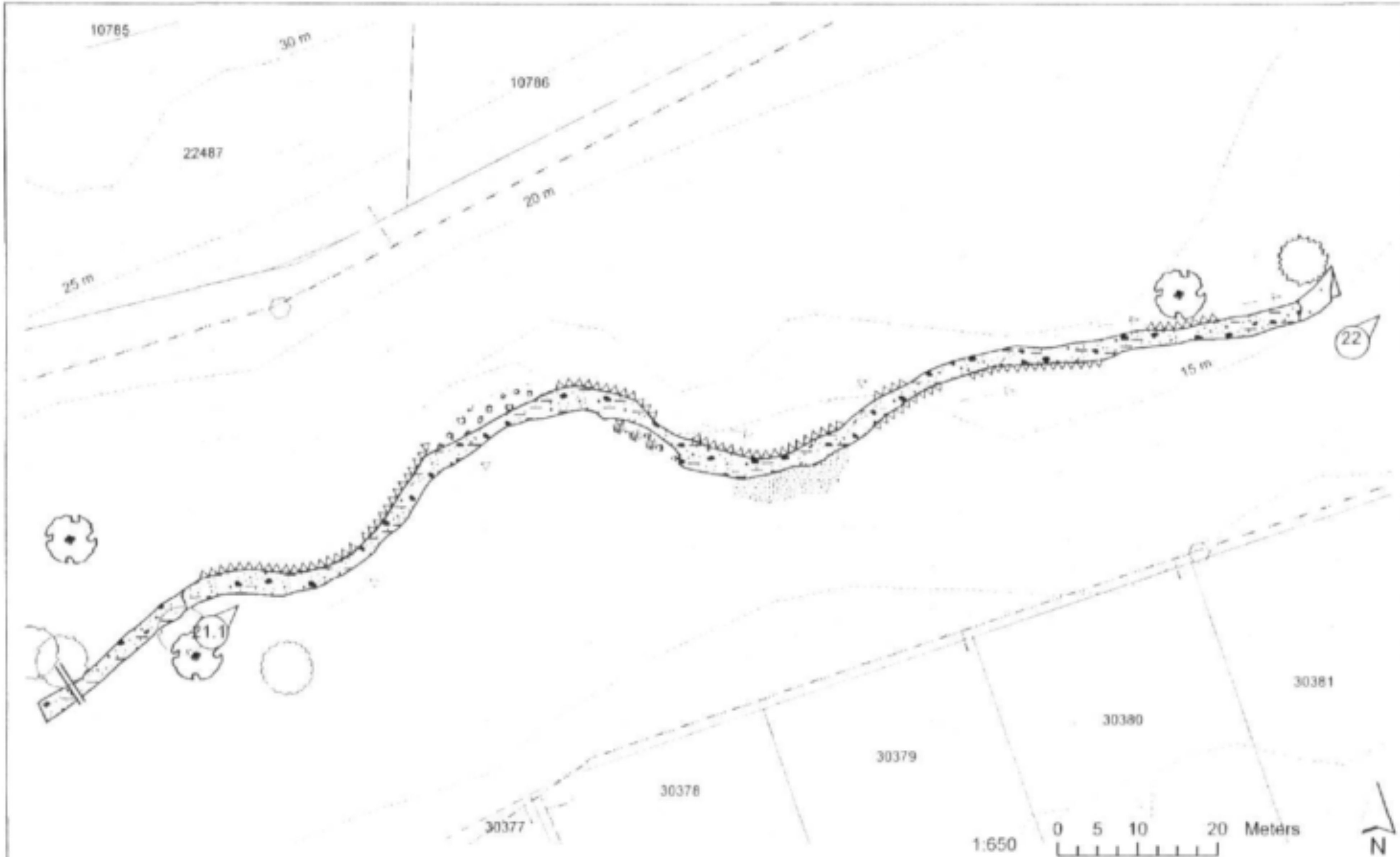


MAP NO 4.20

REACH 20 PRESENT STATE IHLANZA RIVER

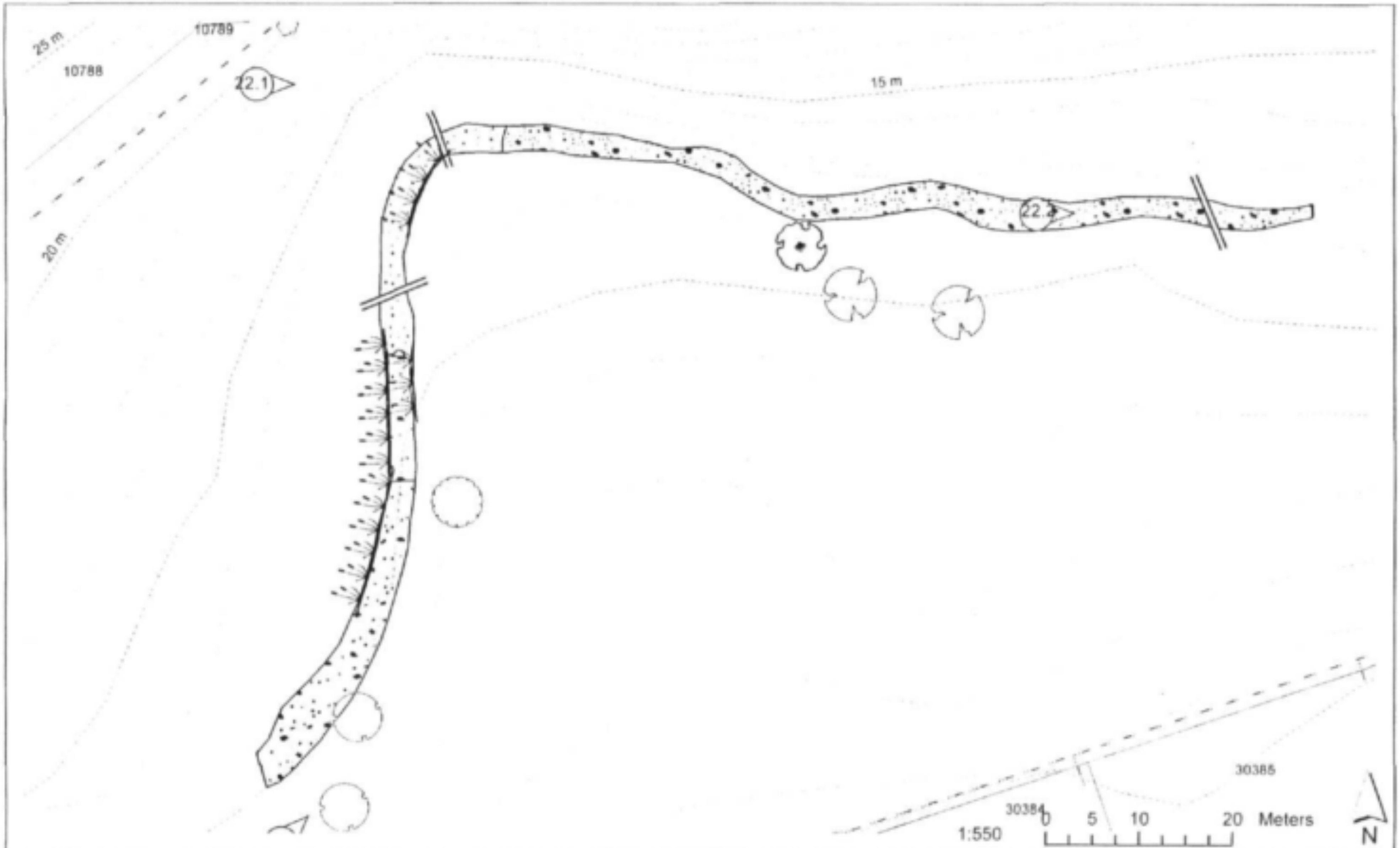
Water Research Commission

Down 2 Earth



MAP NO 4.21

REACH 21
PRESENT STATE
IHLANZA RIVER



Boulder, cobble, sand
Cobble
Cobble, gravel
Cobble, sand
In - channel vegetation
Phragmites / arundo reeds
Tree block
Contour_1m
Contours_5m
Sew_manholes
Sew_pipes

MAP NO 4.22

REACH 22
PRESENT STATE
IHLANZA RIVER

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Aquatic Research Consultancy Media
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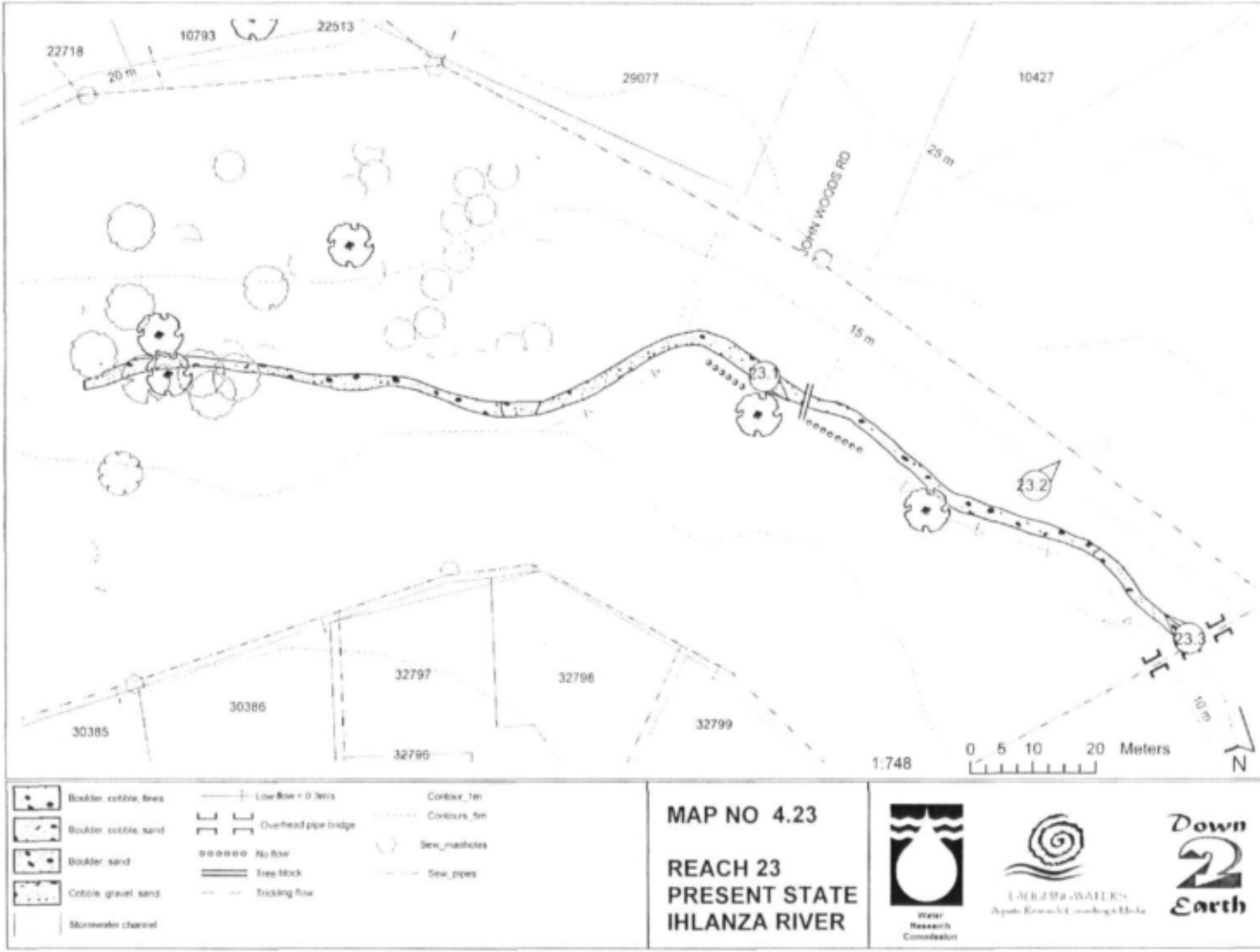
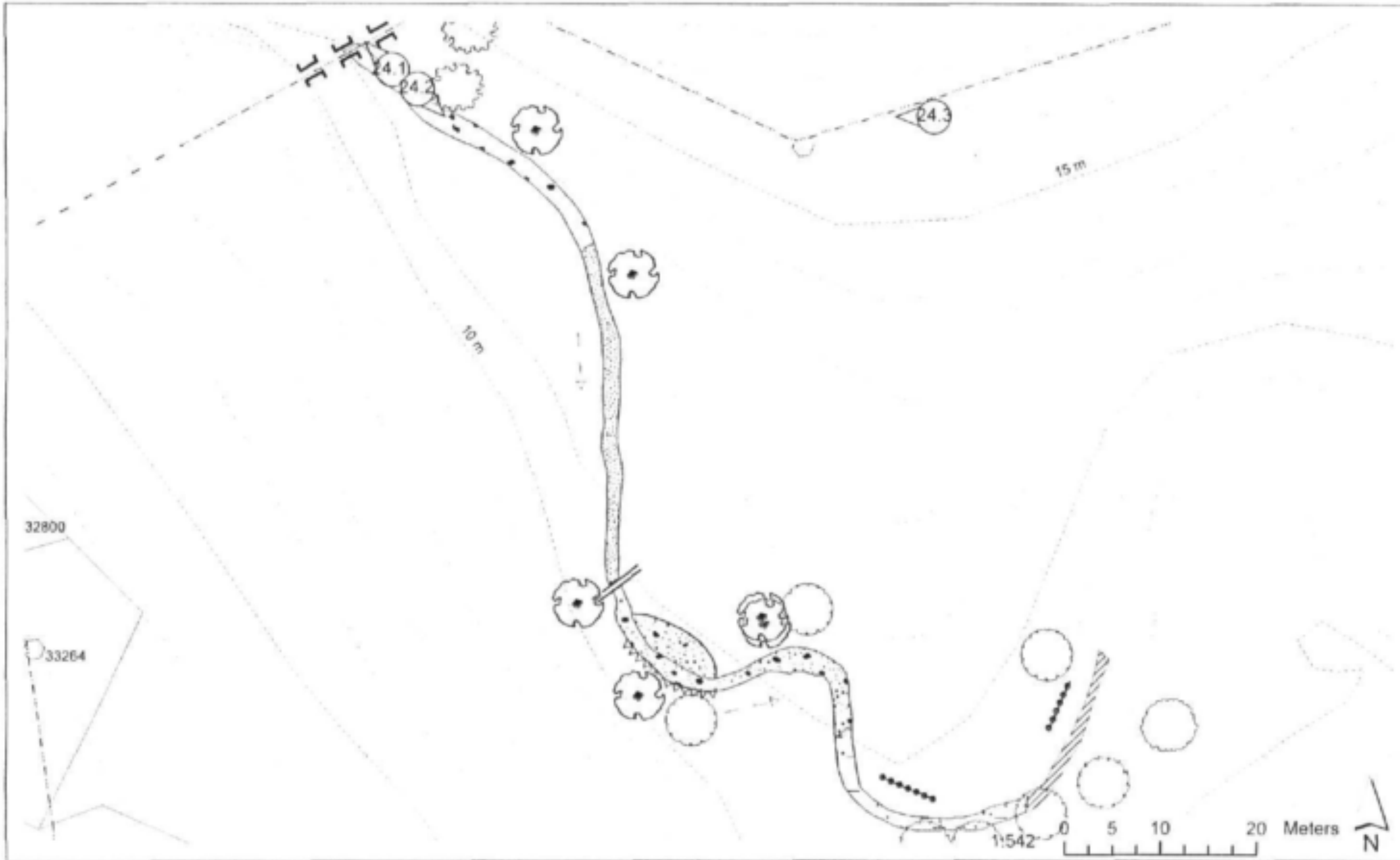


MAP NO 4.23

REACH 23
PRESENT STATE
IHLANZA RIVER



Bar - Cobble, gravel, sand
Bedrock, cobble
Boulder
Boulder, cobble, sand
Boulder, sand
Pool
Sand
Bank destabilization S
Overhead pipe/bridge
Still (Flow < 0.1 m/s)
Tree block
Trickling flow
Contour_1m
Contours_5m
Sew_manholes
Sew_pipes

MAP NO 4.24

REACH 24
PRESENT STATE
IHLANZA RIVER

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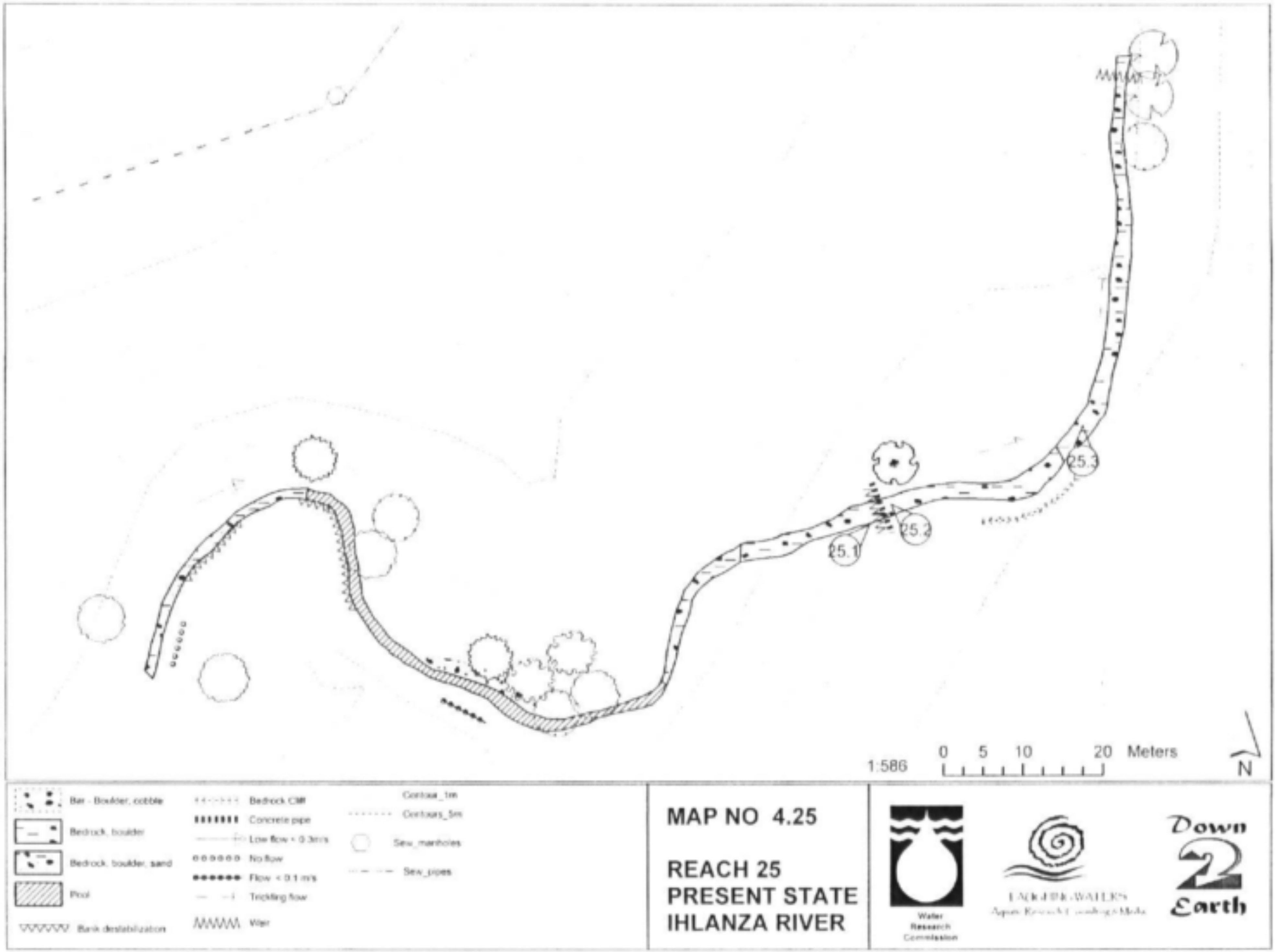

MAP NO 4.25

REACH 25
PRESENT STATE
IHLANZA RIVER

Bar - Sand
Bedrock, boulder
Bedrock, boulder, cobble, fines
Bedrock, boulder, cobble, gravel, sand
Pool
Bedrock Cliff
Flow > 0.3 m/s
No flow
Trickling flow
Contour_1m
Contours_5m

MAP NO 4.26

REACH 26
PRESENT STATE
IHLANZA RIVER

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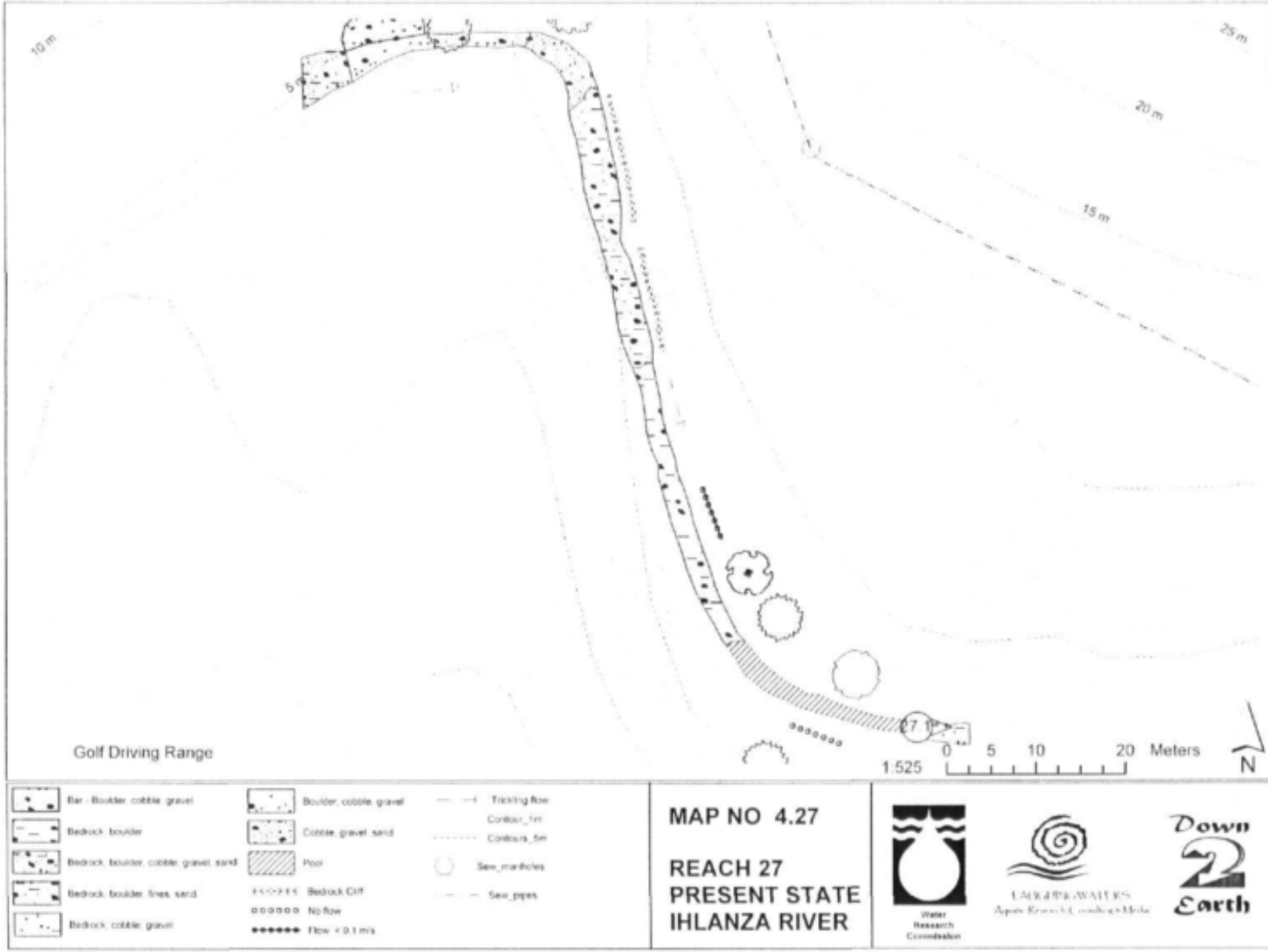
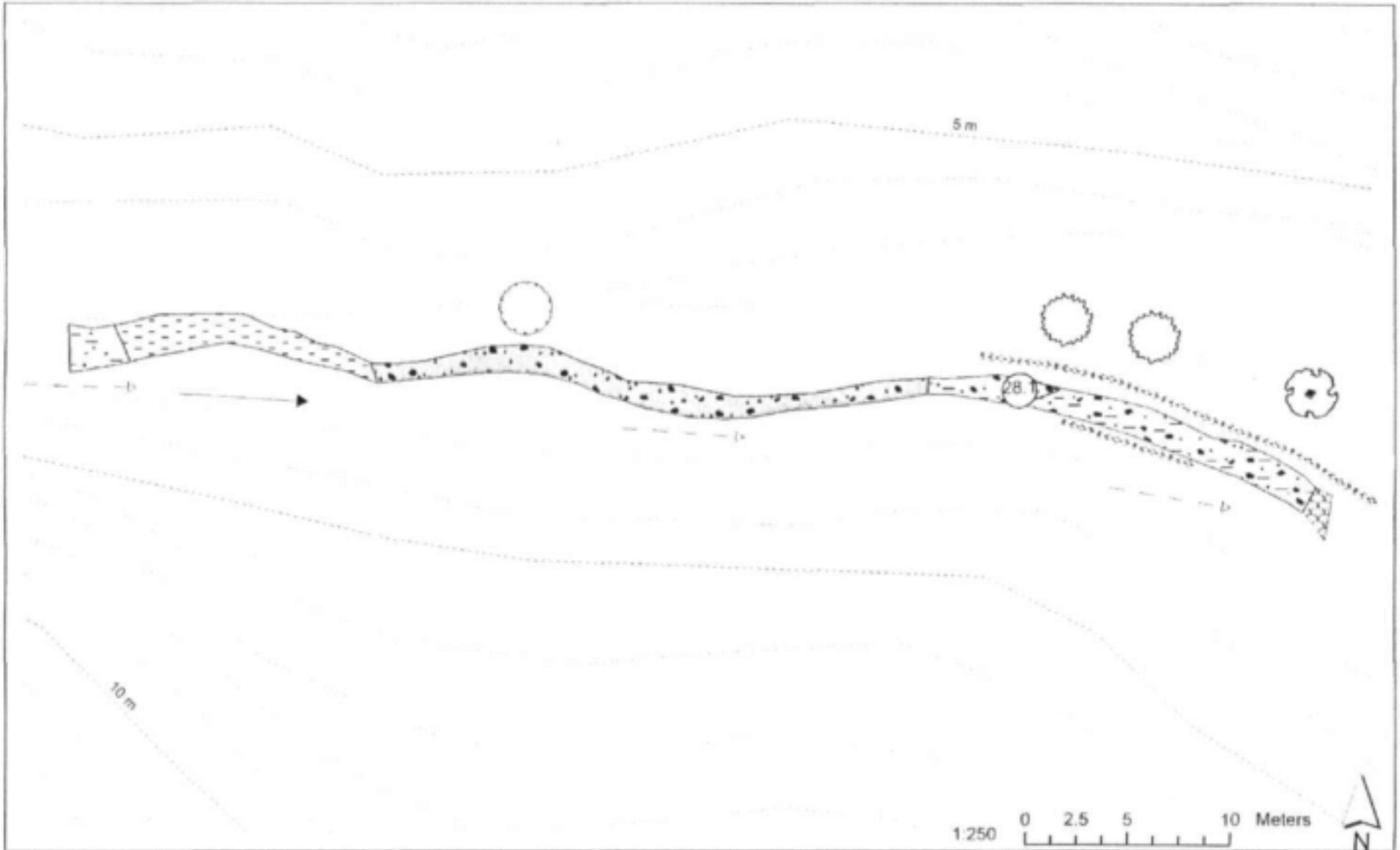


MAP NO 4.27

REACH 27
PRESENT STATE
IHLANZA RIVER



Bedrock

Bedrock, boulder, cobble

Bedrock, cobble, gravel

Boulder, cobble, fine, gravel

Estuary

Bedrock Cliff

Flow > 0.3 m/s

Trickling flow

Contour_1m

Contours_5m

MAP NO 4.28

REACH 28
PRESENT STATE
IHLANZA RIVER

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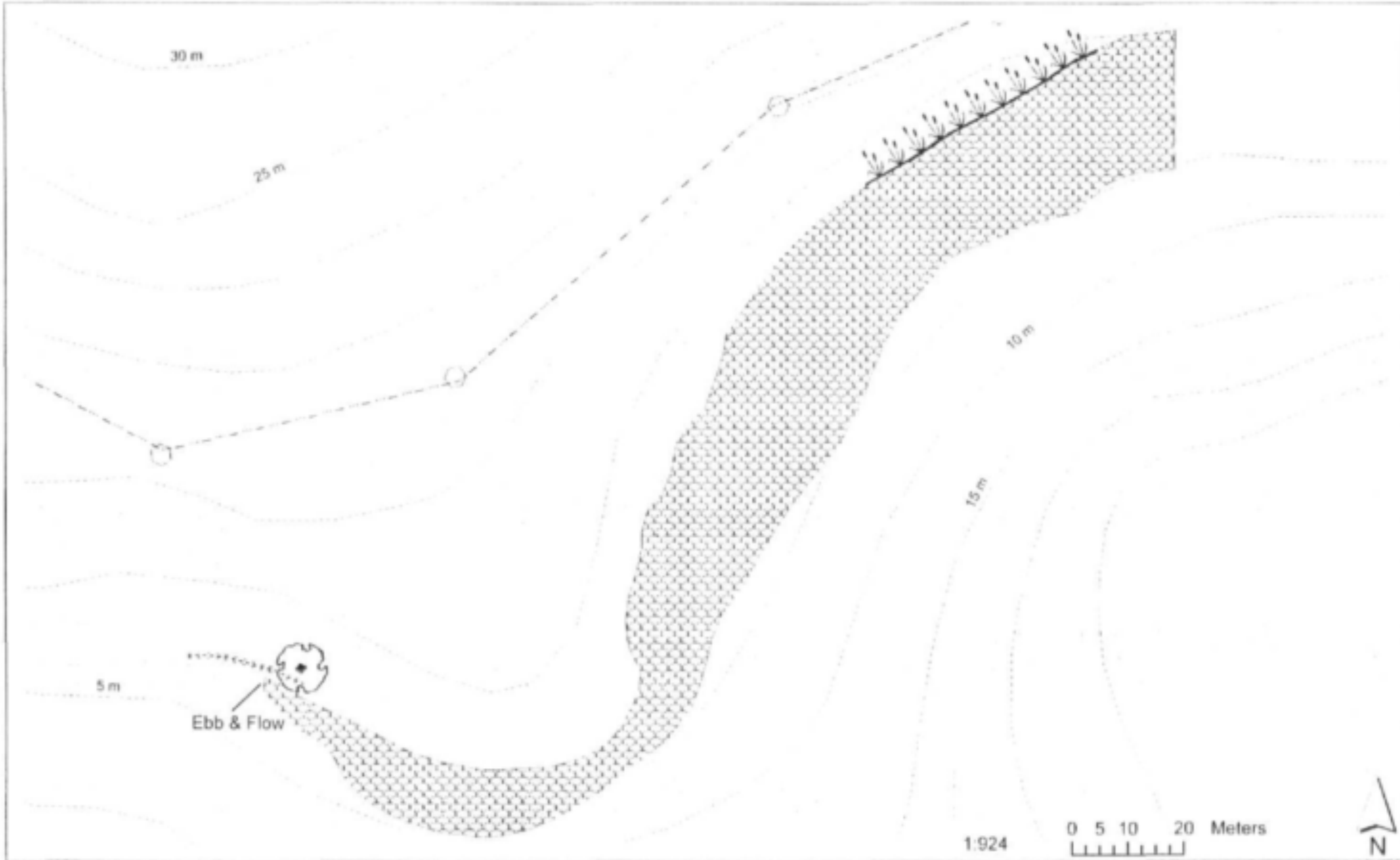

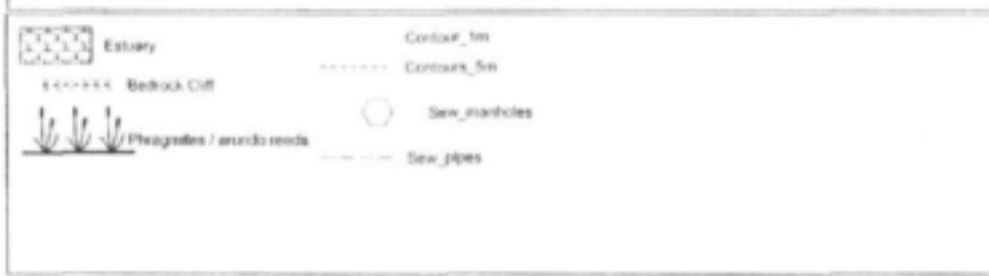

MAP NO 4.29

REACH 29
PRESENT STATE
IHLANZA RIVER

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MAP NO 3.30

REACH 30
PRESENT STATE
IHLANZA RIVER

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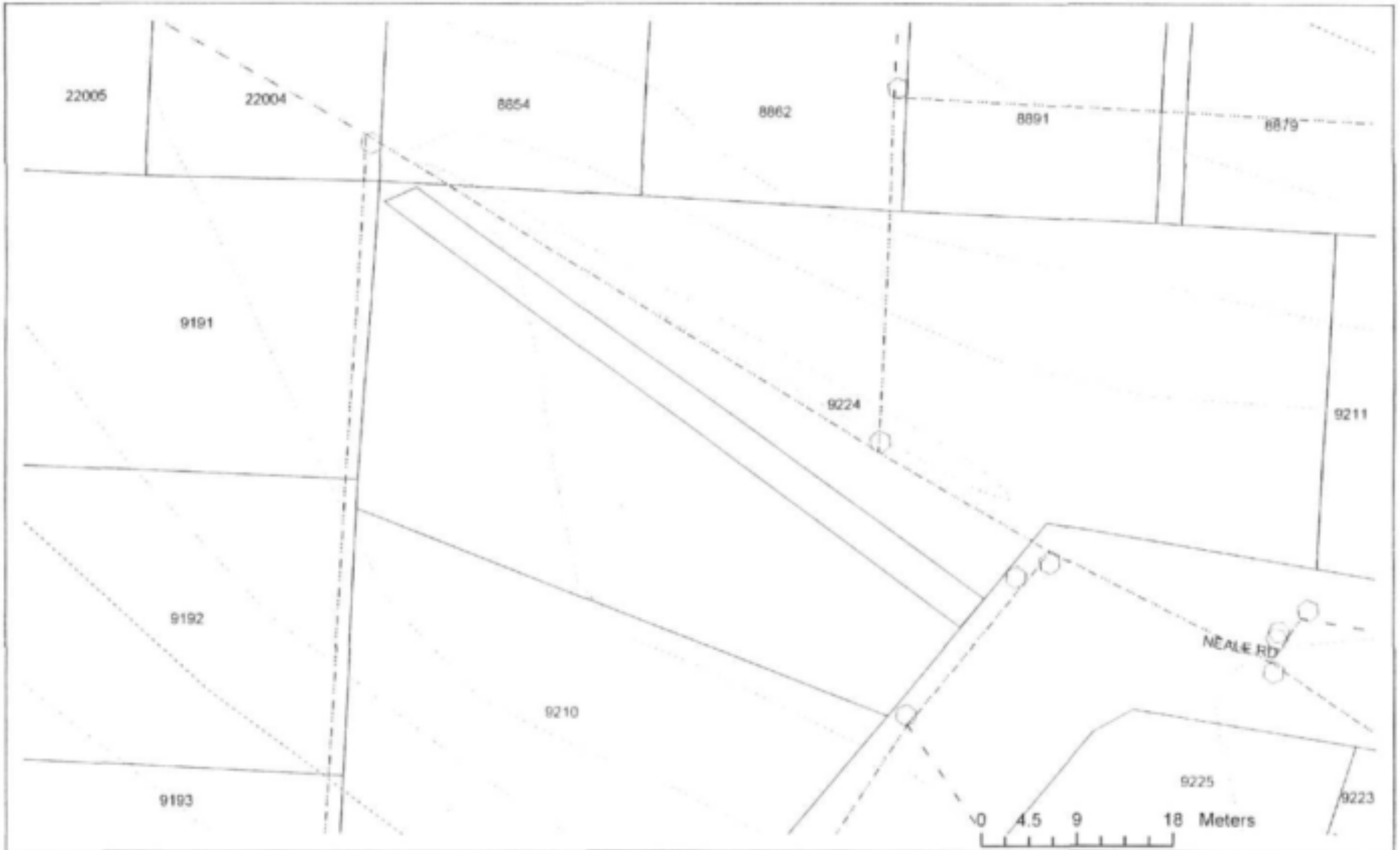
MAPS ILLUSTRATING OBJECTIVES & RECOMMENDED REHABILITATION MEASURES REACHES 1- 30 (Corresponding to maps 5.1 to 5.30)



MAP NO 5.1

REACH 1
OBJECTIVES
IHLANZA RIVER

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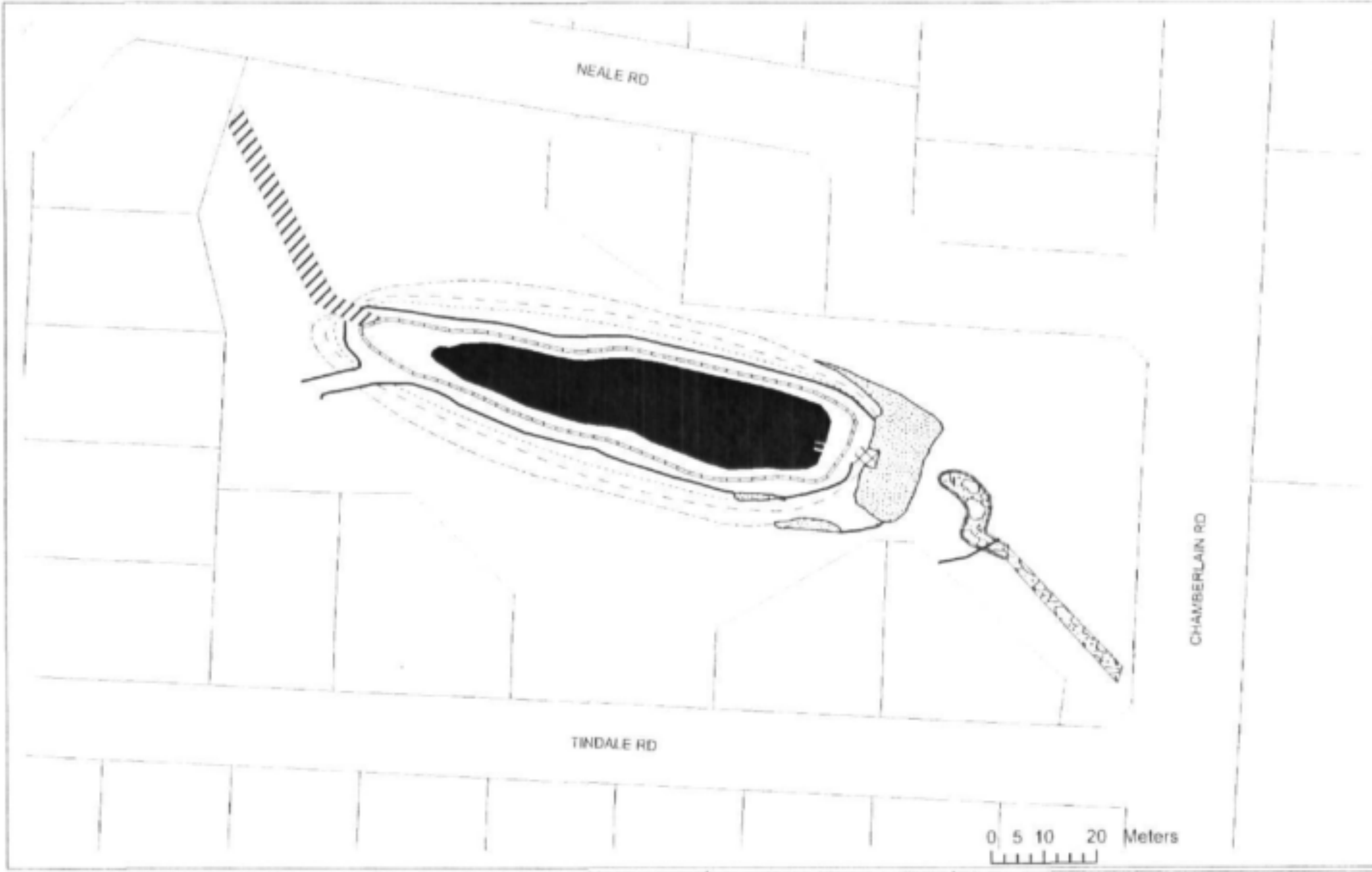
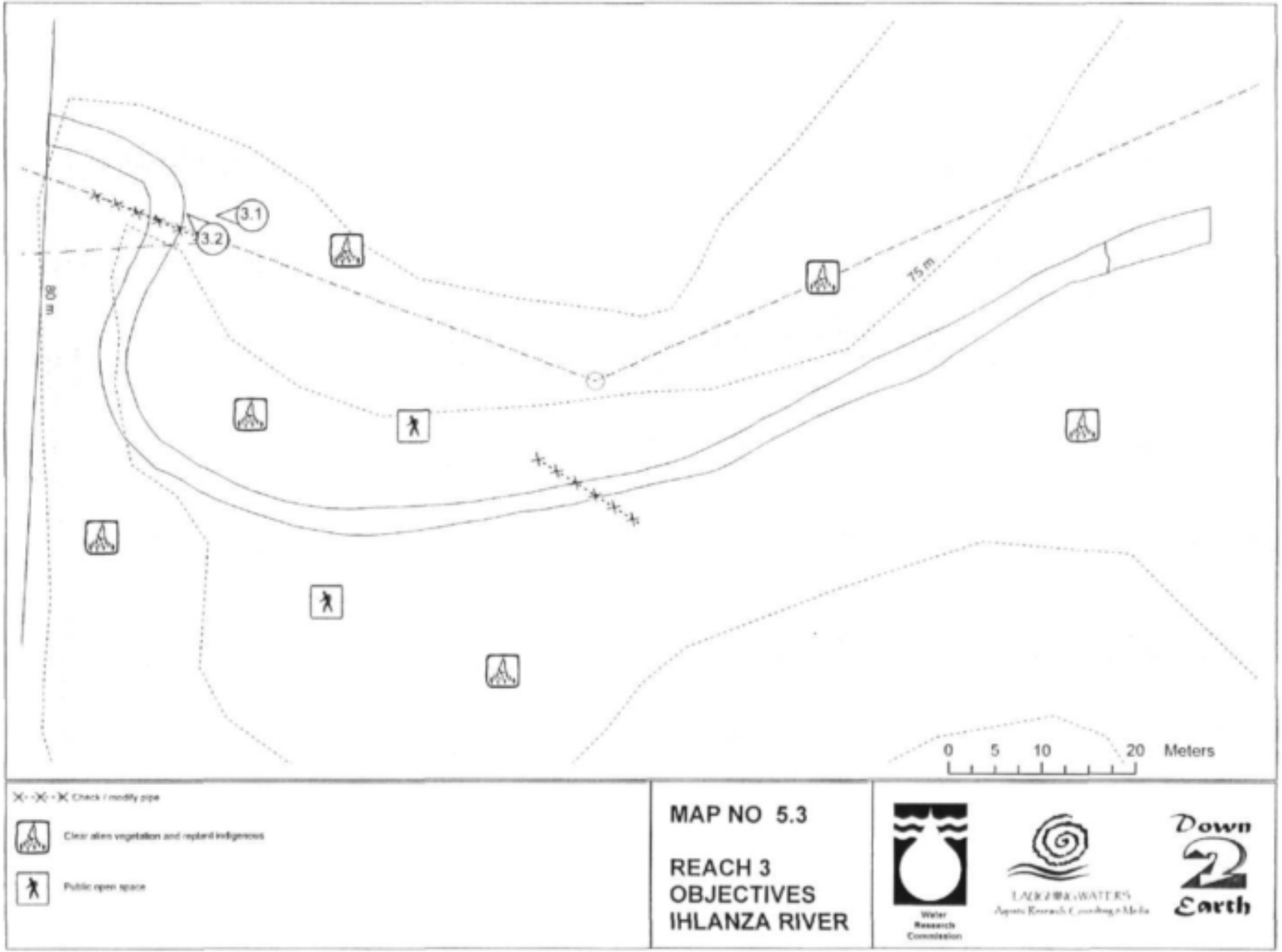


Embankment
Riser in embankment
Pond
Inlet
Riprap

MAP NO 4.2

REACH 2 OBJECTIVES IHLANZA RIVER


3.1
3.2
80 m
75 m
0 5 10 20 Meters
Check / modify pipe
Clear alien vegetation and replant indigenous
Public open space
MAP NO 5.3
REACH 3
OBJECTIVES
IHLANZA RIVER
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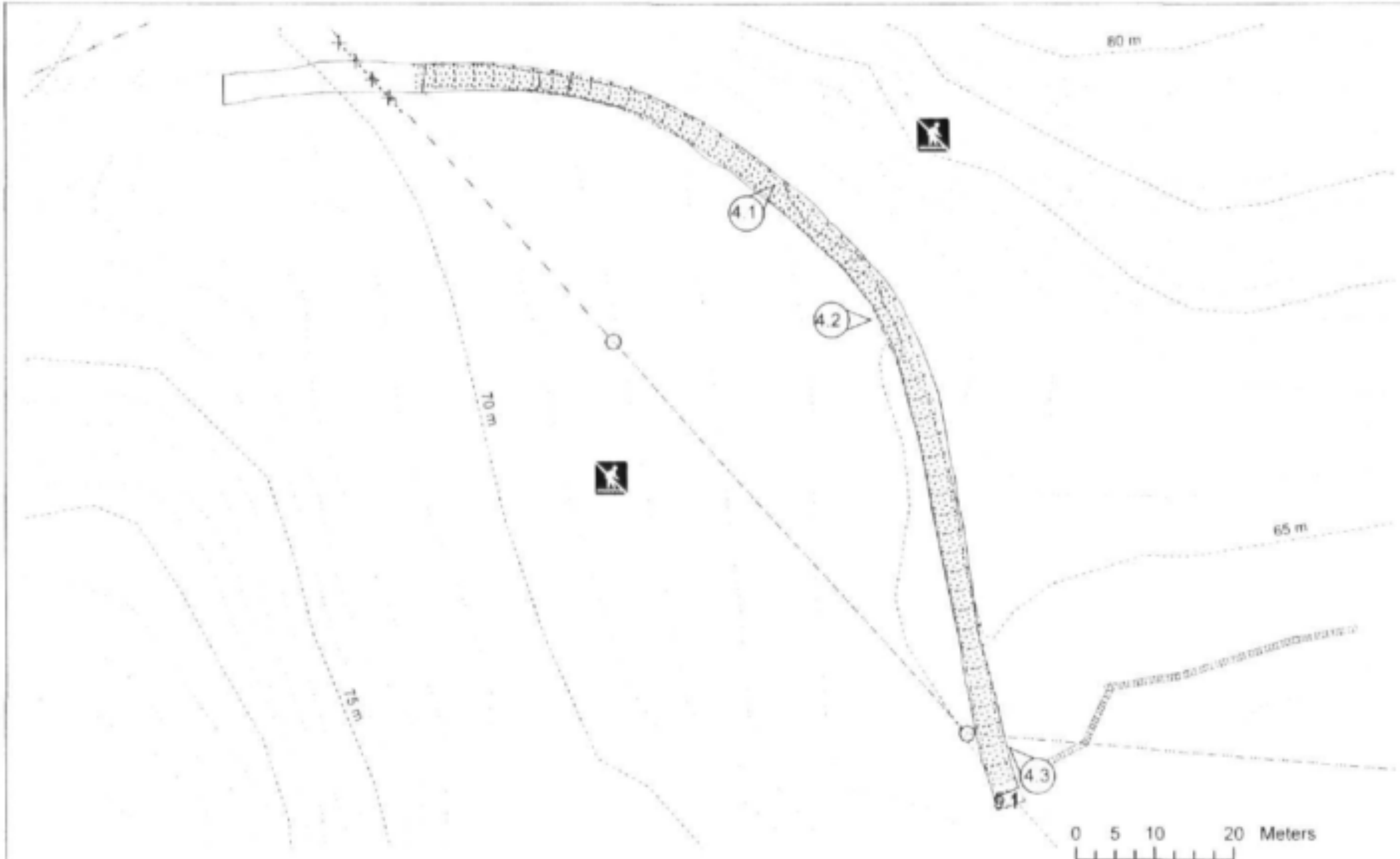


Boardwalk

Check / modify pipe

Riffle run pool

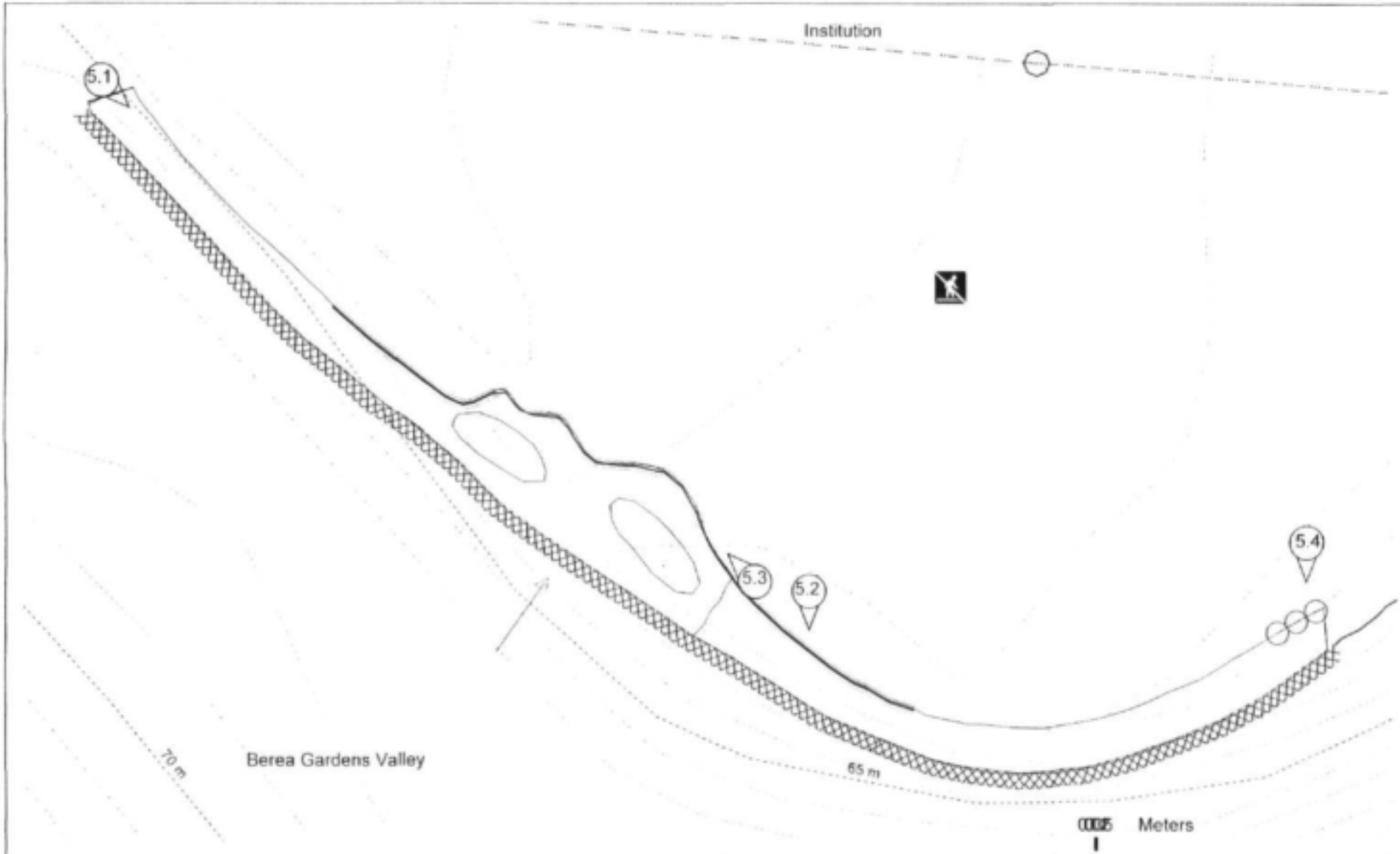
Private open space

MAP NO 5.4

REACH 4 OBJECTIVES IHLANZA RIVER

Water Research Commission

Down 2 Earth



Attend to structure
Boardwalk
Gabion
Stabilize
Terrace
Private open space

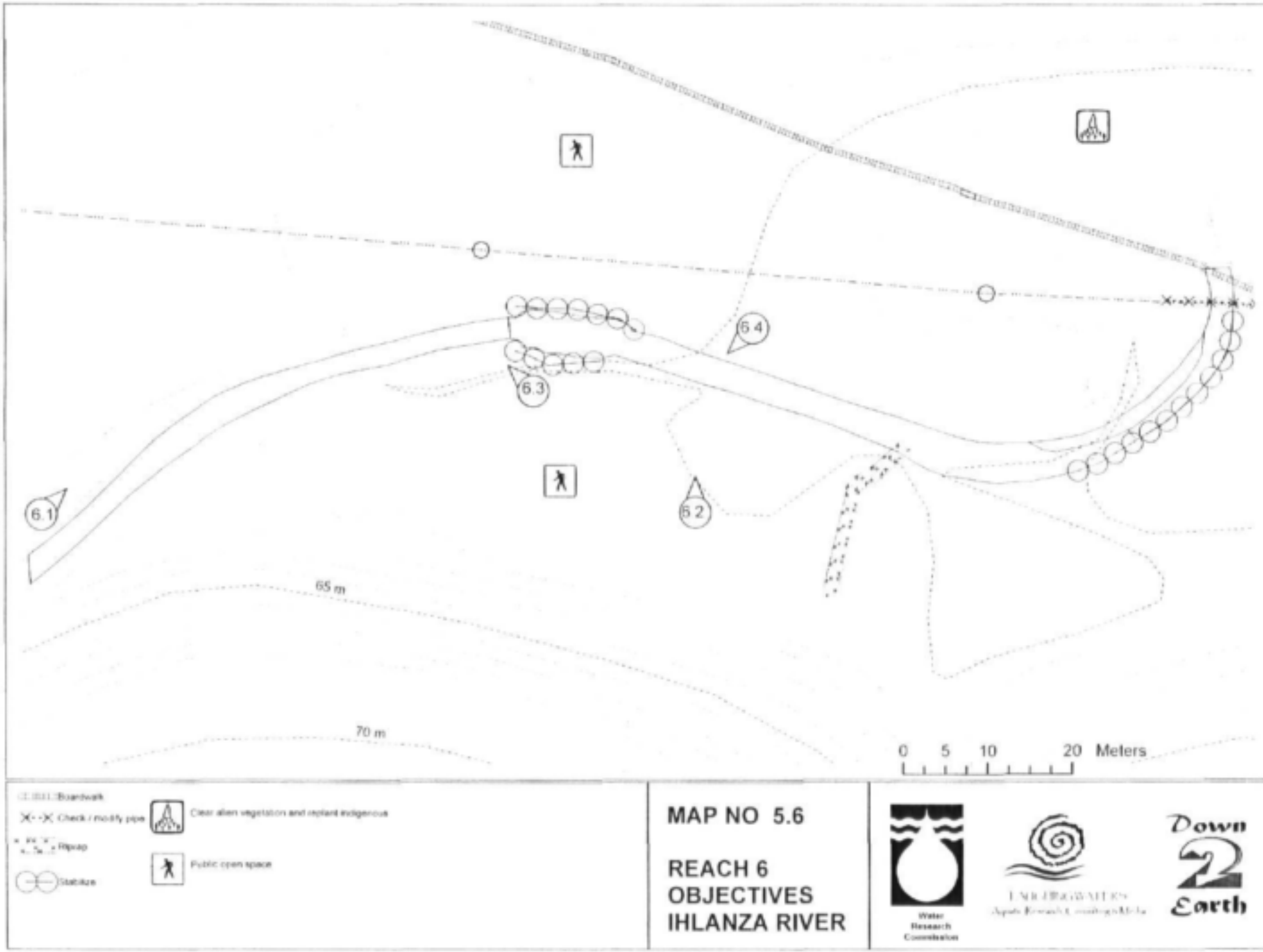
MAP NO 5.5

**REACH 5
OBJECTIVES
IHLANZA RIVER**

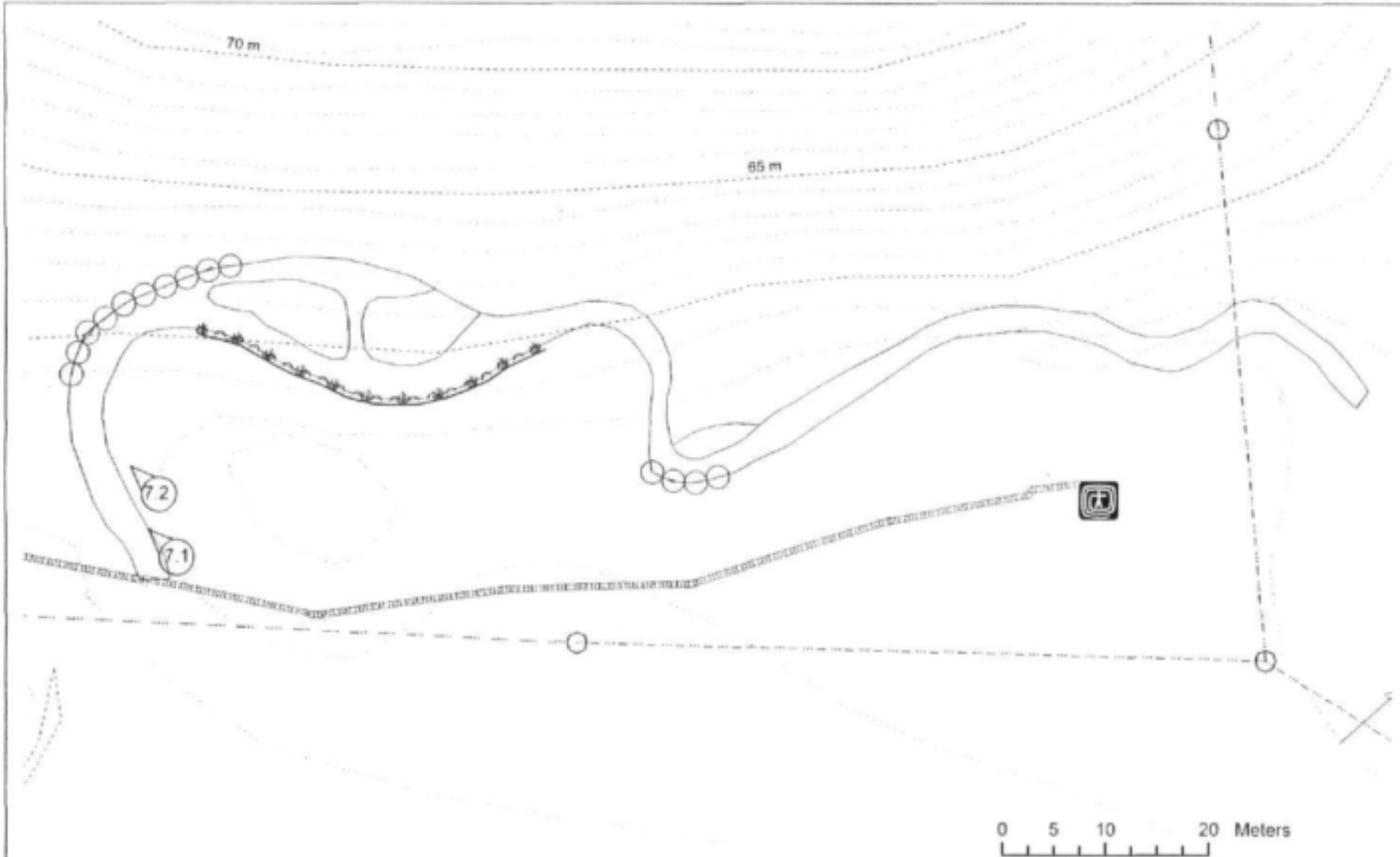
Water Research Commission

LAUGHING WATERS
Aquatic Research Consulting & Media

Down 2 Earth



6.1
6.2
6.3
6.4
65 m
70 m
0 5 10 20 Meters
Boardwalk
Check / modify pipe
Clear alien vegetation and replant indigenous
Riprap
Public open space
Stabilize
MAP NO 5.6
REACH 6
OBJECTIVES
IHLANZA RIVER
Water Research Commission
Down 2 Earth



Attend to structure
Boardwalk
Stabilize
Veg berm
Clear alien vegetation and replant indigenous
Fragrant garden

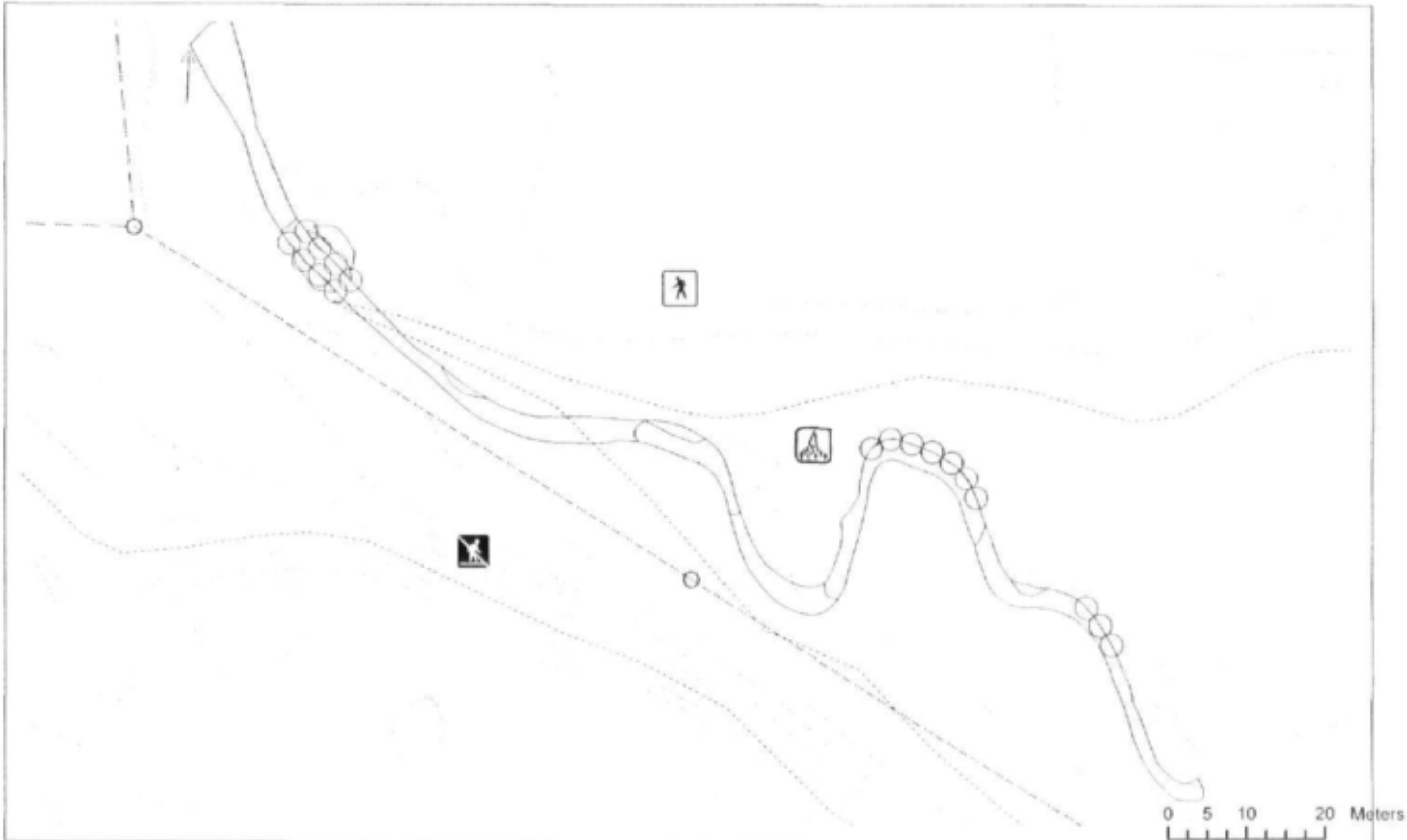
MAP NO 5.7

REACH 7 OBJECTIVES IHLANZA RIVER

Water Research Commission

LAUGHING WATERS Aquatic Research Consulting & Media

Down 2 Earth



Attend to structure

Stabilize

Clear alien vegetation and replant indigenous

Private open space

Public open space

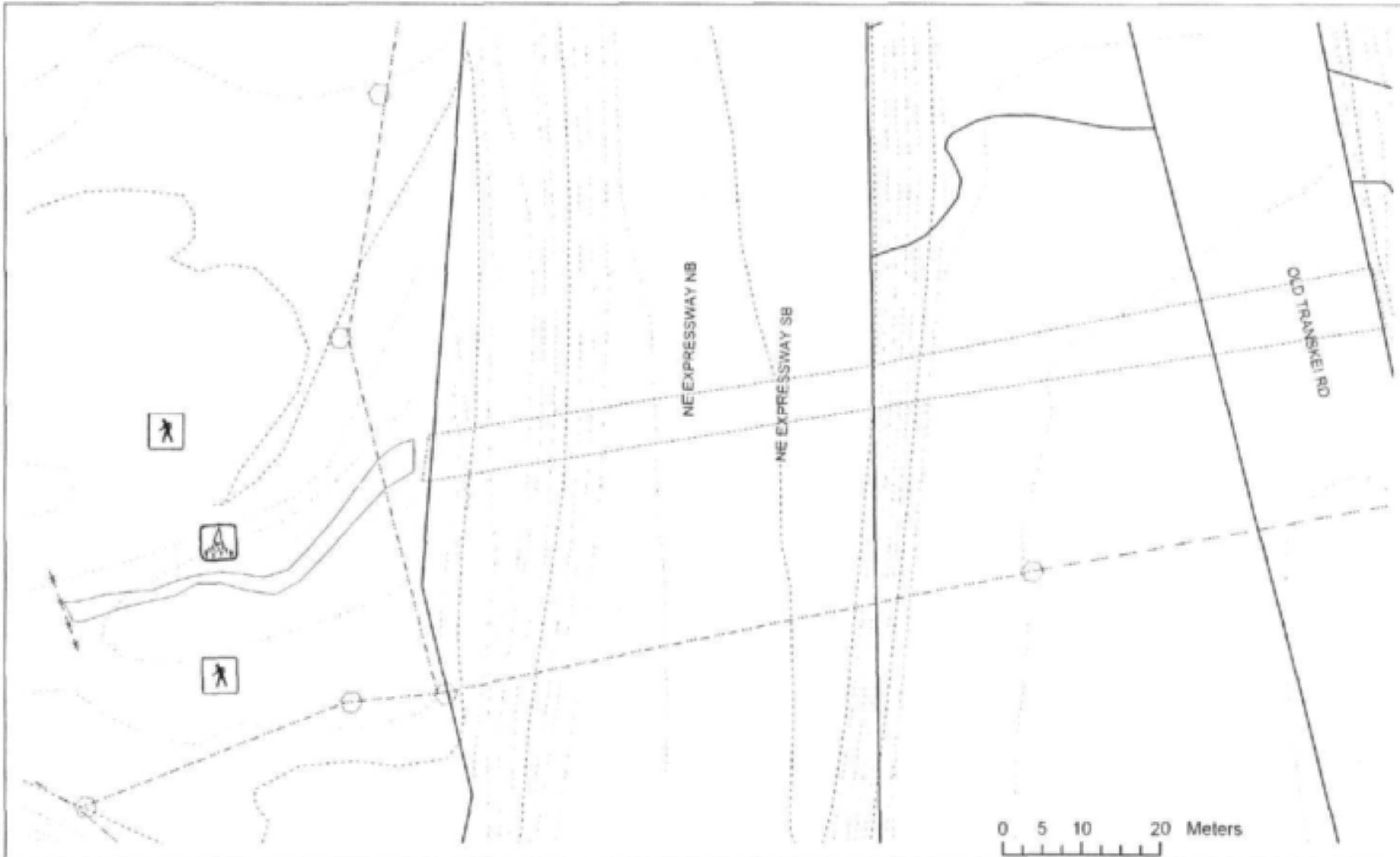
MAP NO 5.8

REACH 8
OBJECTIVES
IHLANZA RIVER

Water Research Commission

LAND & WATERS

Down 2 Earth



Fenceline

Clear alien vegetation and replant indigenous

Public open space

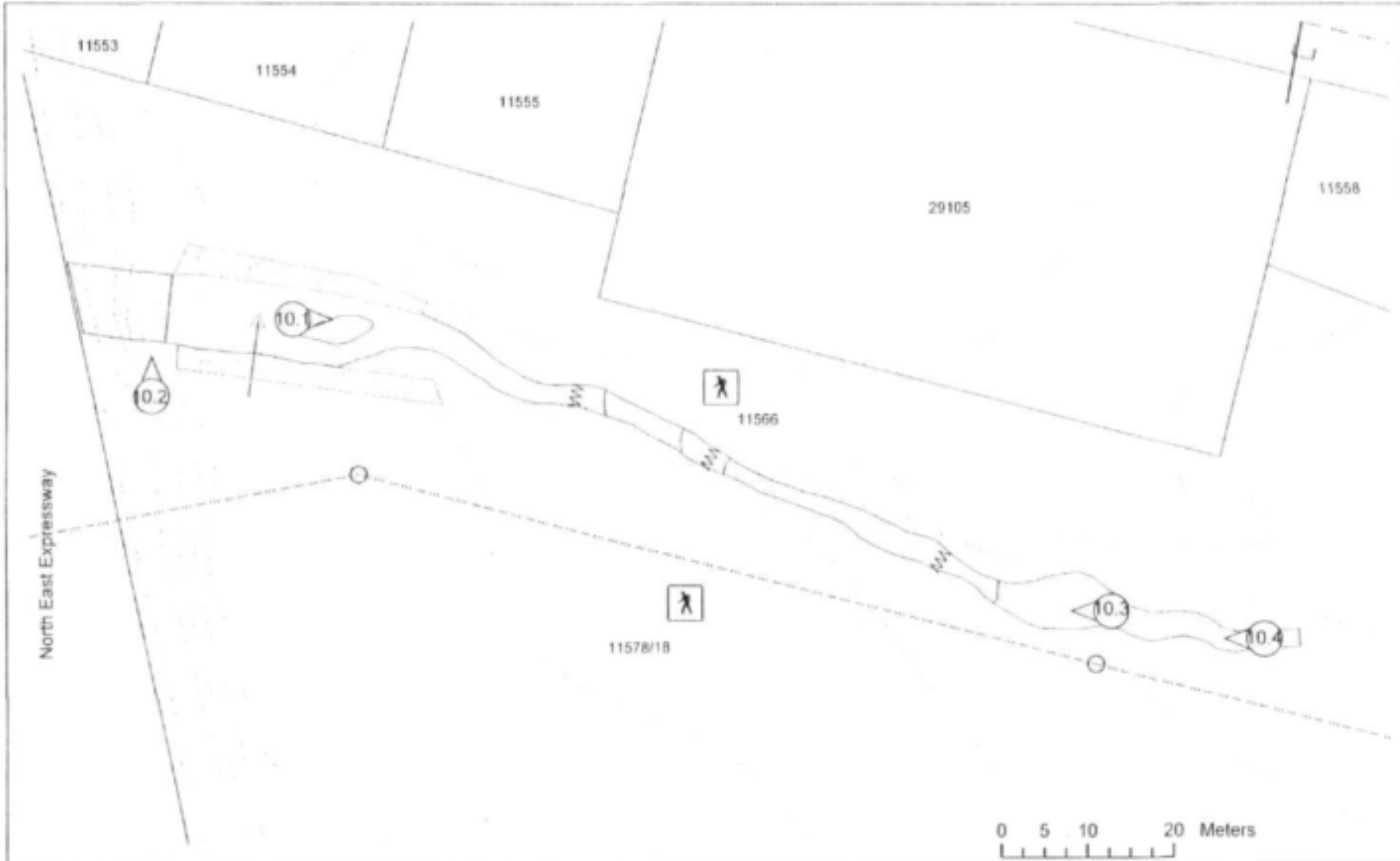
MAP NO 5.9

**REACH 9
OBJECTIVES
IHLANZA RIVER**

Water Research Commission

LAUGHINGWATERS

Down 2 Earth



Attend to structure

Notched weir

Trail

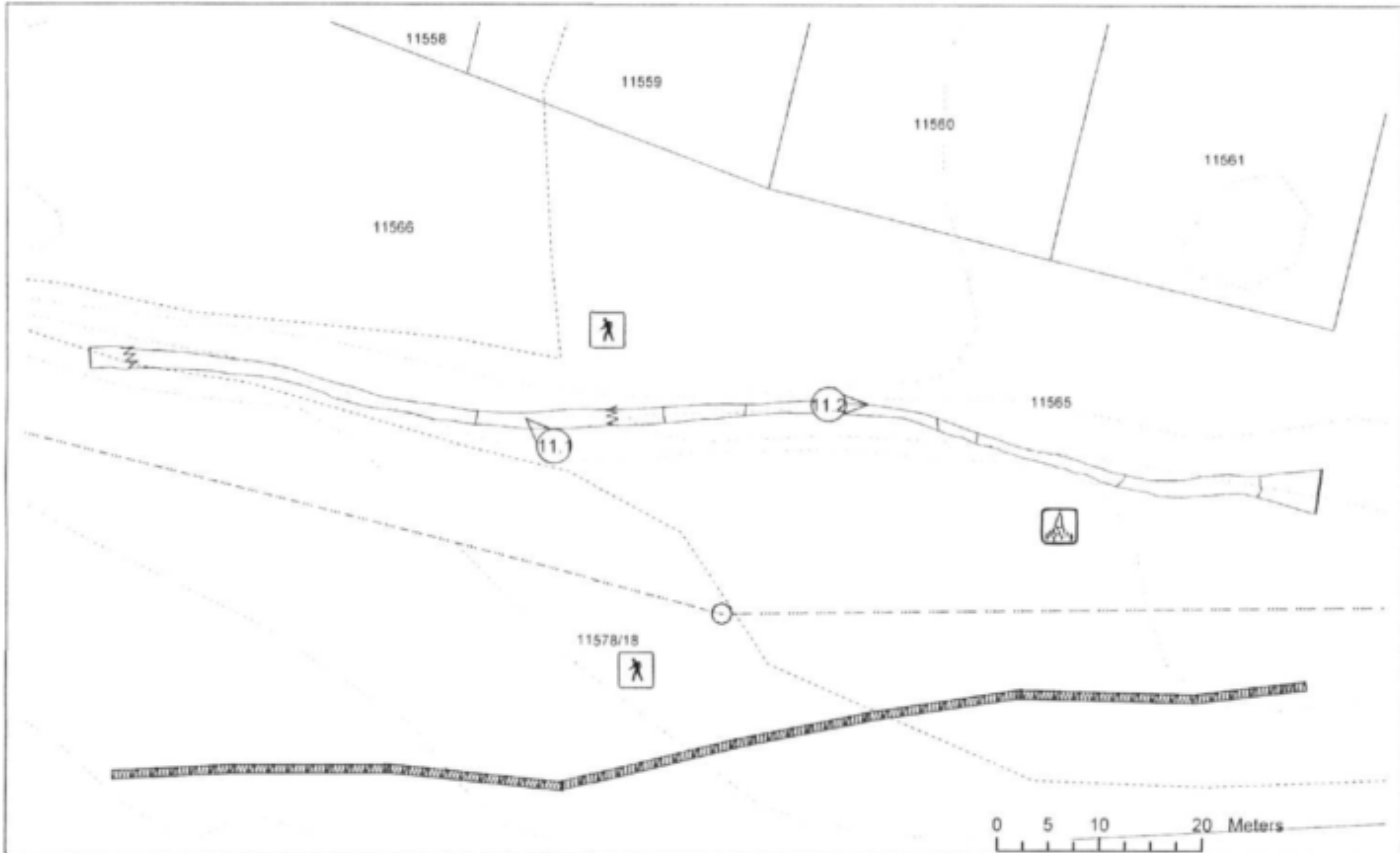
Public open space

MAP NO 5.10

REACH 10 OBJECTIVES IHLANZA RIVER

Water Research Commission

Down 2 Earth



Notched weir

Trail

Clear alien vegetation and replant indigenous

Public open space

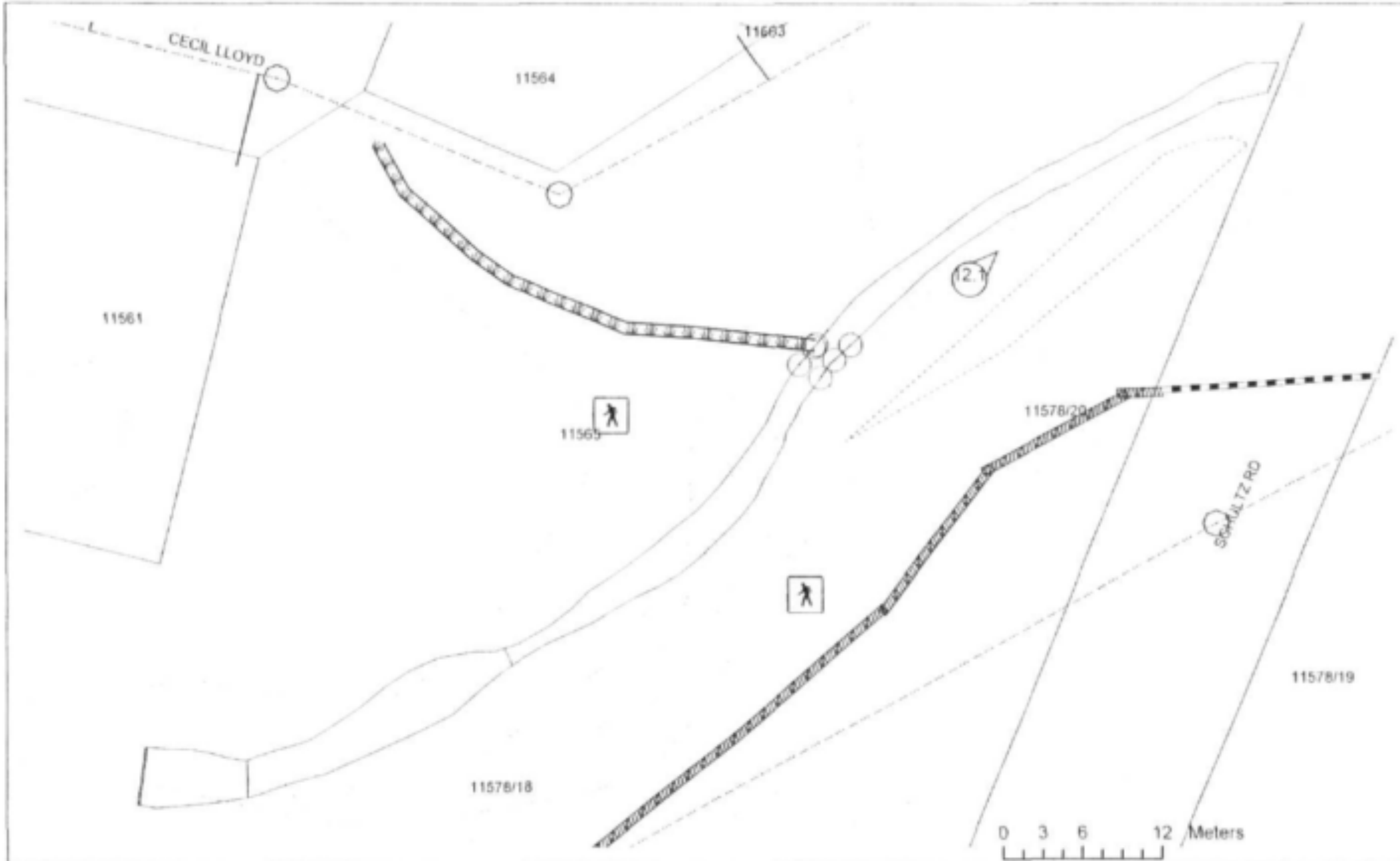
MAP NO 5.11

REACH 11 OBJECTIVES IHLANZA RIVER

Water Research Commission

LAUGHINGWATERS Aquatic Research Consulting & Media

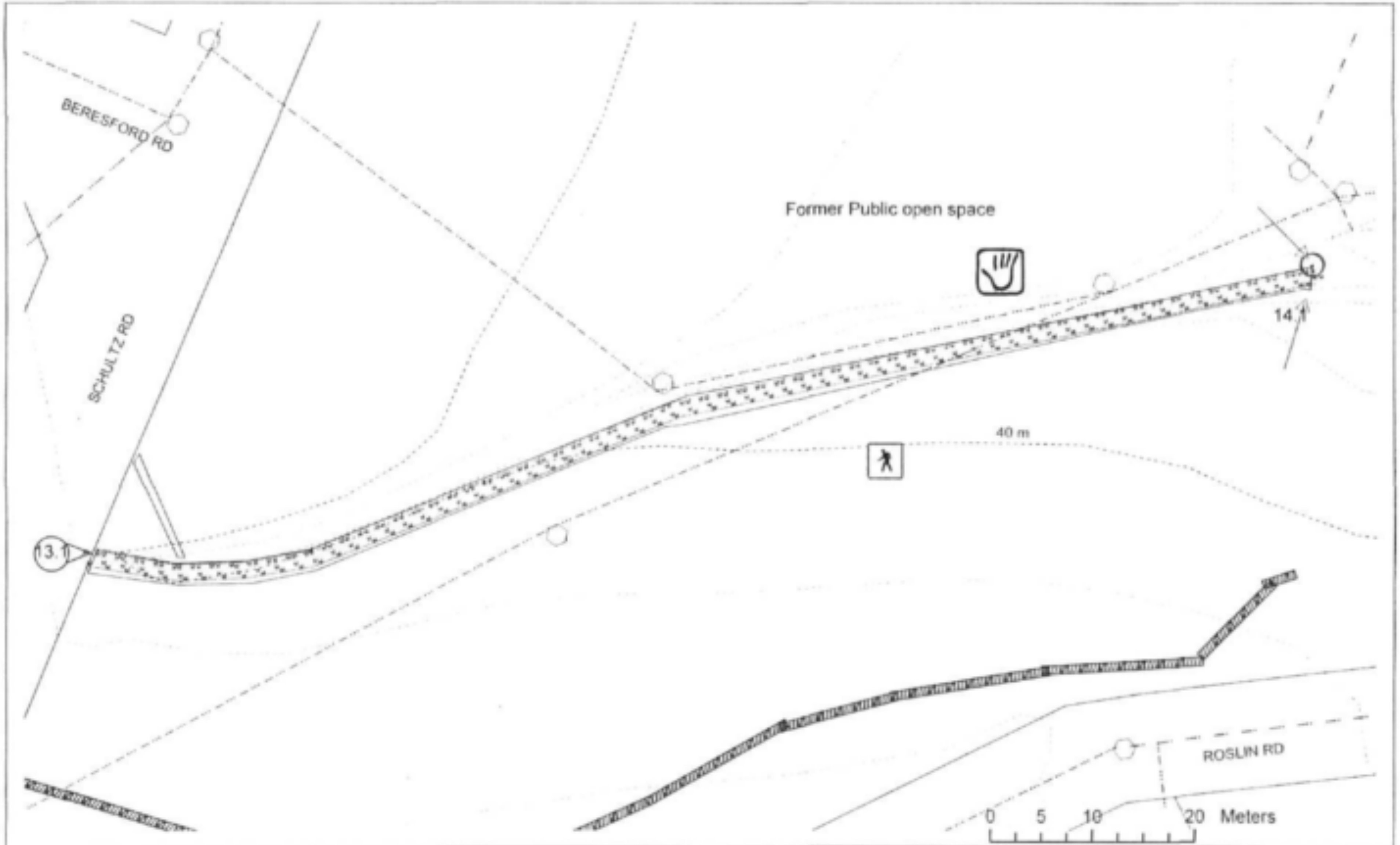
Down 2 Earth



Construct swale
Public open space
Pedestrian crossing
Stabilize
Trail

MAP NO 5.12

REACH 12 OBJECTIVES IHLANZA RIVER



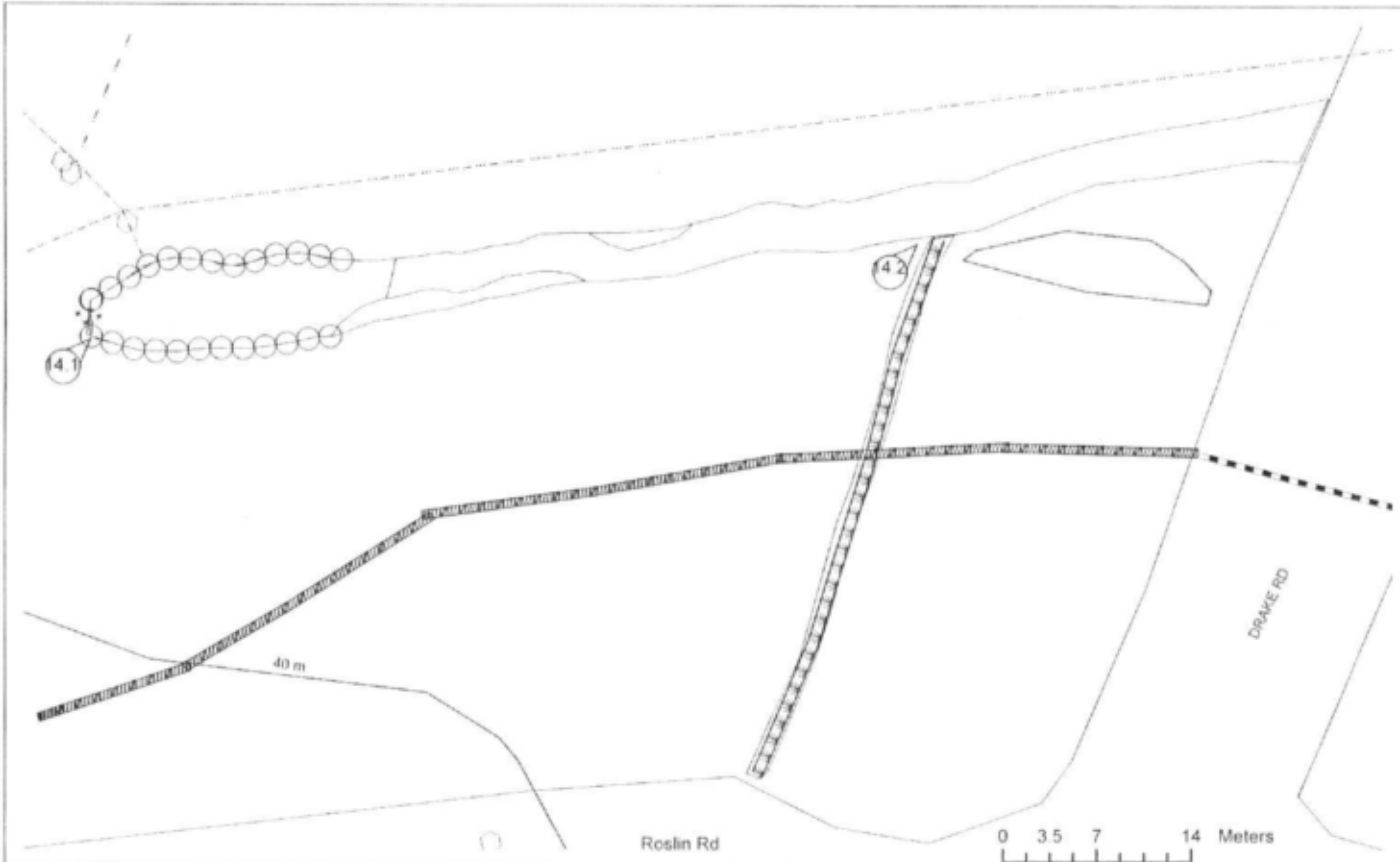
MAP NO 5.13

REACH OBJECTIVES IHLANZA RIVER

Water Research Commission

LAUGHING WATERS

Down 2 Earth



Construct swale

Riprap

Stabilize

Trail

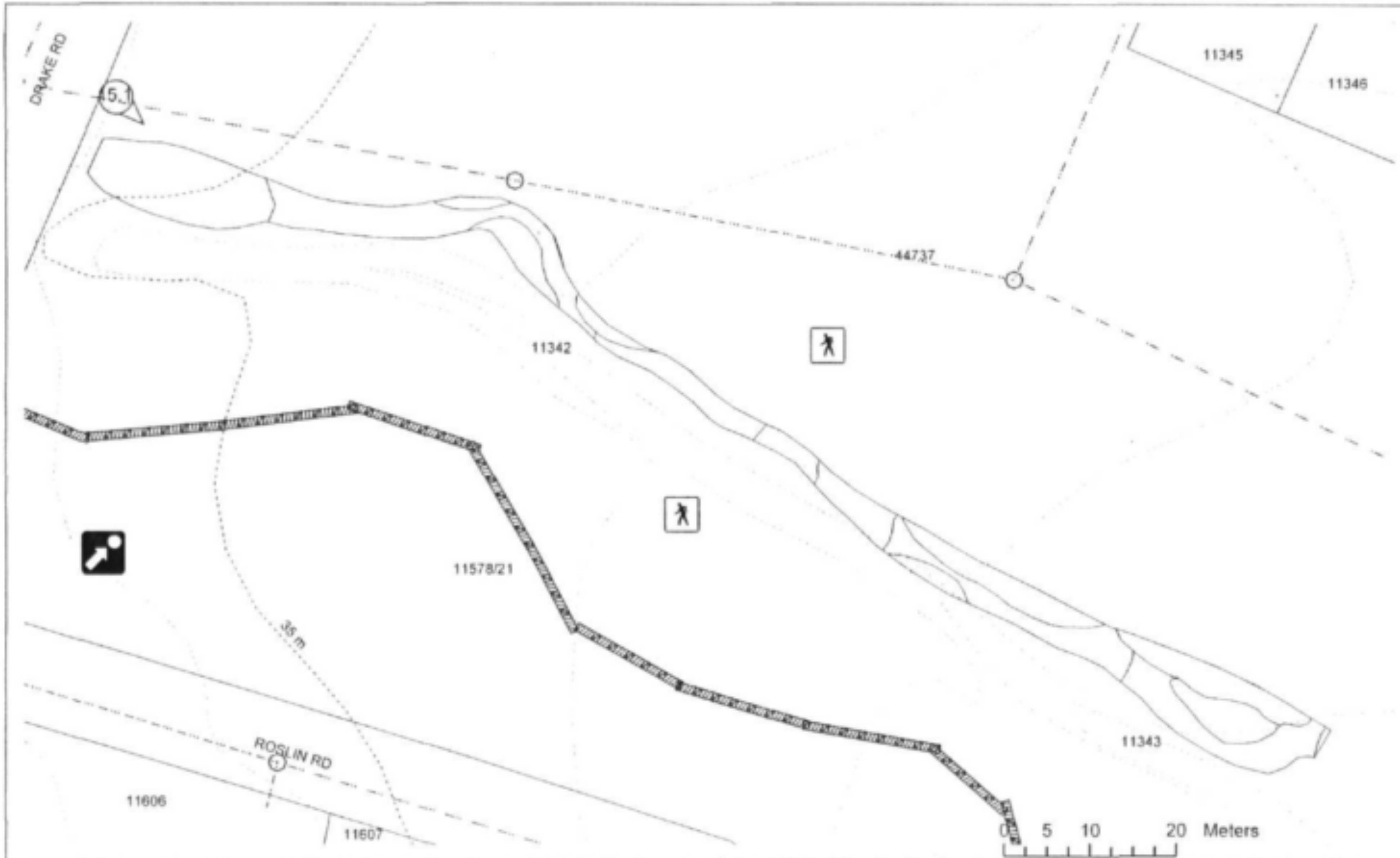
Pedestrian crossing

MAP NO 5.14

REACH 14 OBJECTIVES IHLANZA RIVER

Water Research Commission

Down 2 Earth



Trail

Public open space

Signage

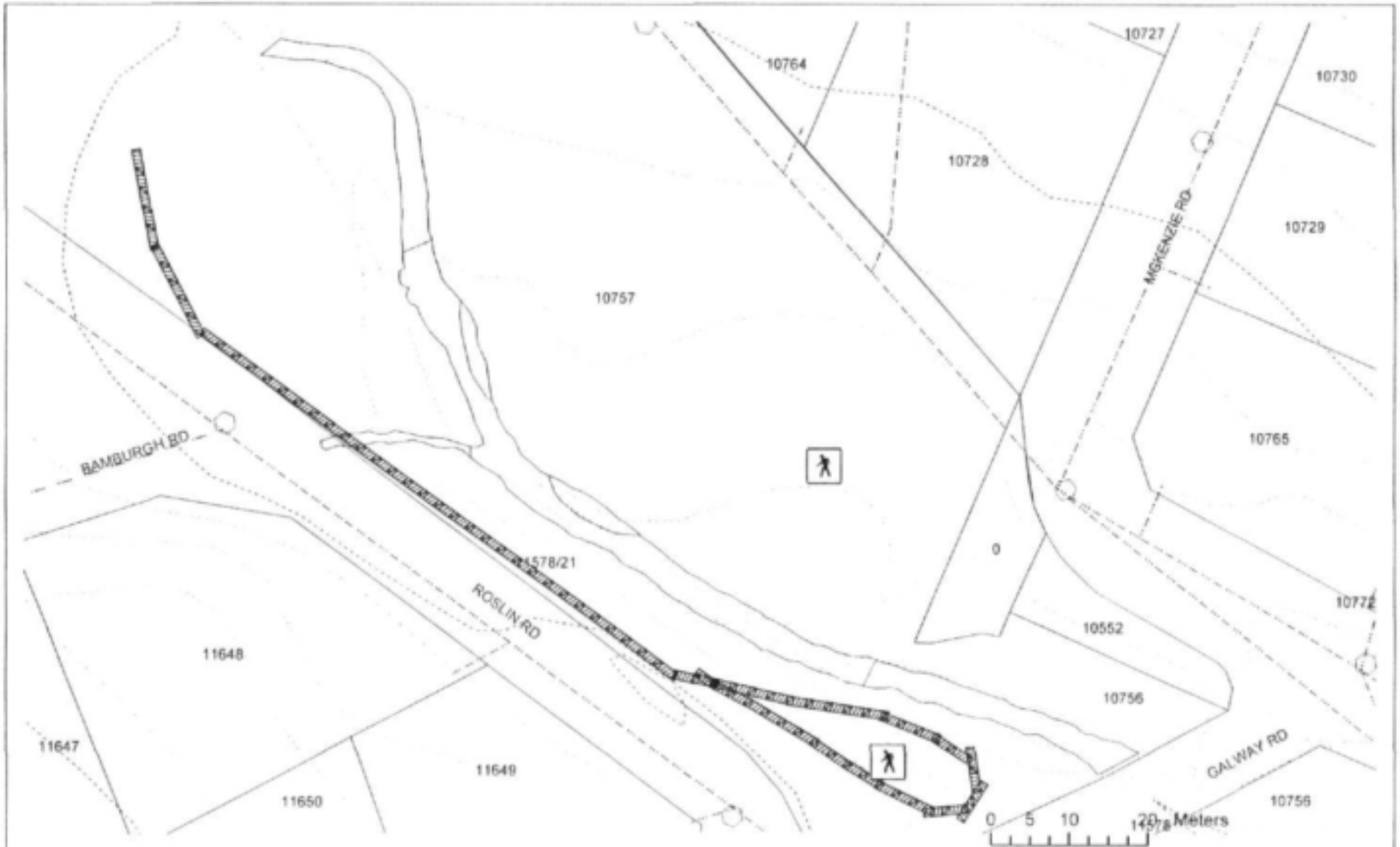
MAP NO 5.15

REACH 15 OBJECTIVES IHLANZA RIVER

Water Research Commission

LAUGHING WATERS

Down 2 Earth



Trail

Public open space

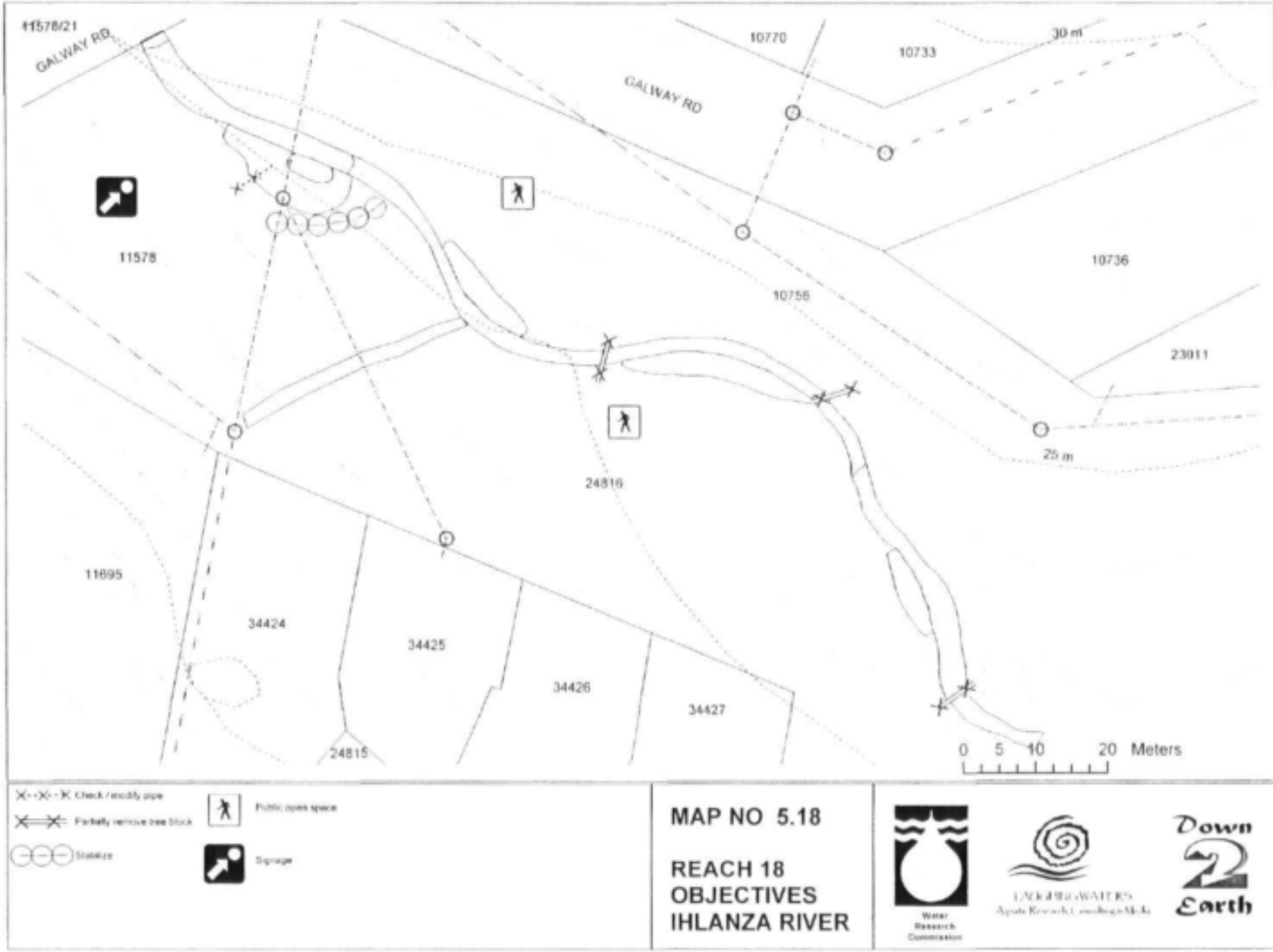
MAP NO 5.17

REACH 17
OBJECTIVES
IHLANZA RIVER

Water Research Commission

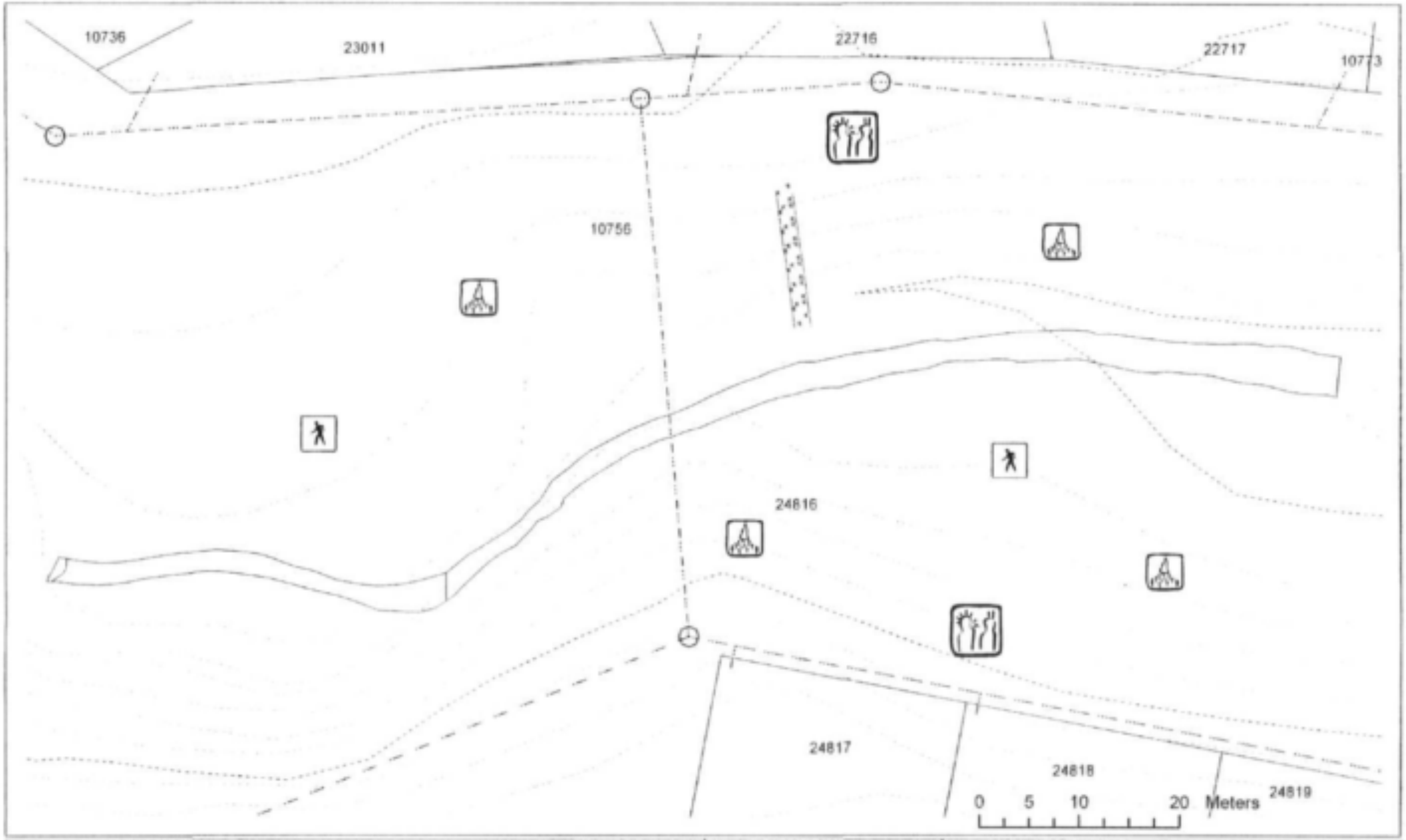
LAUGHING WATERS
Aquatic Research, Consulting & Media

Down 2 Earth



MAP NO 5.18

REACH 18 OBJECTIVES IHLANZA RIVER



Riprap

Clear alien vegetation and replant indigenous

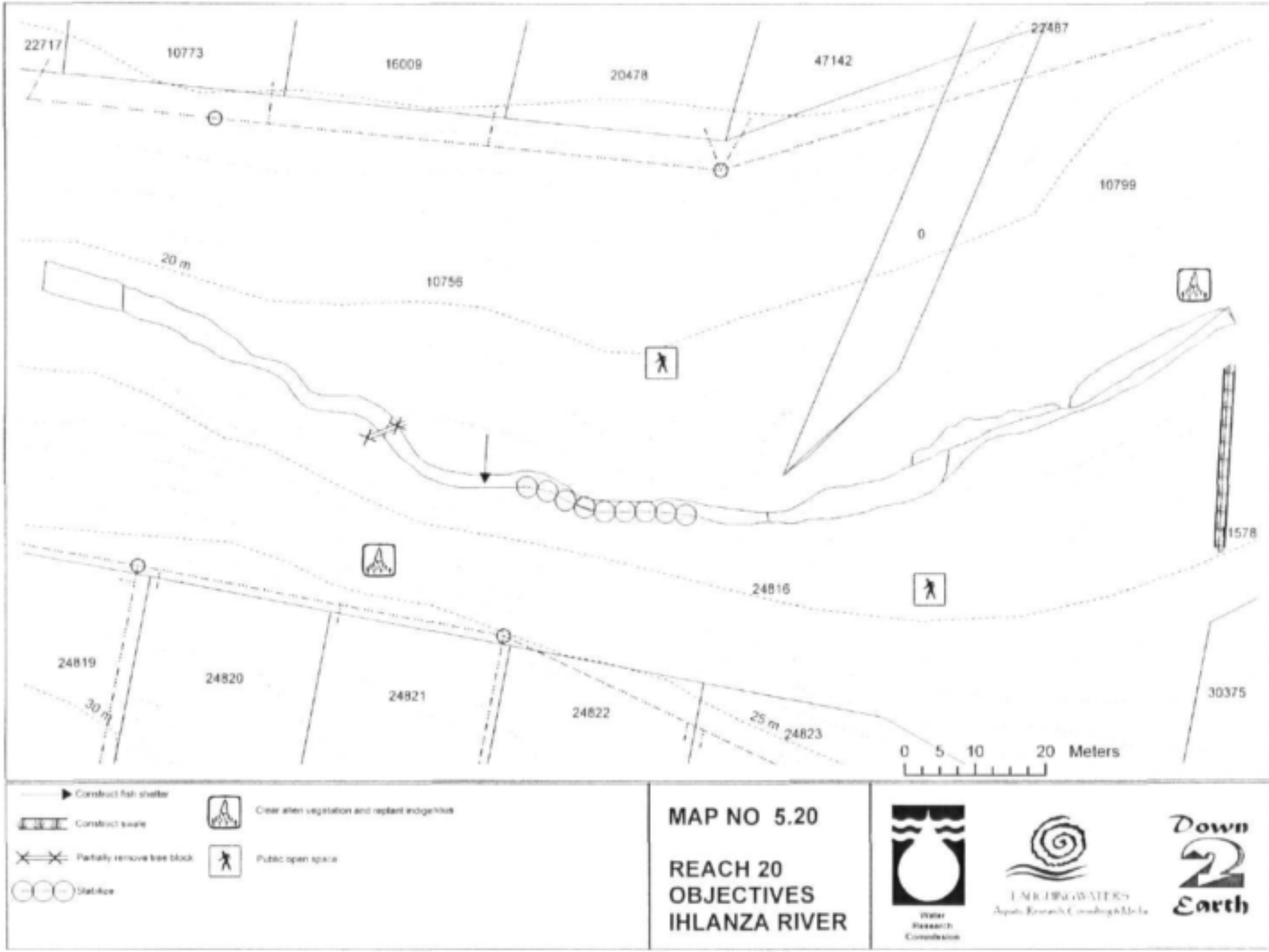
Liaise with community

Public open space

MAP NO 5.19

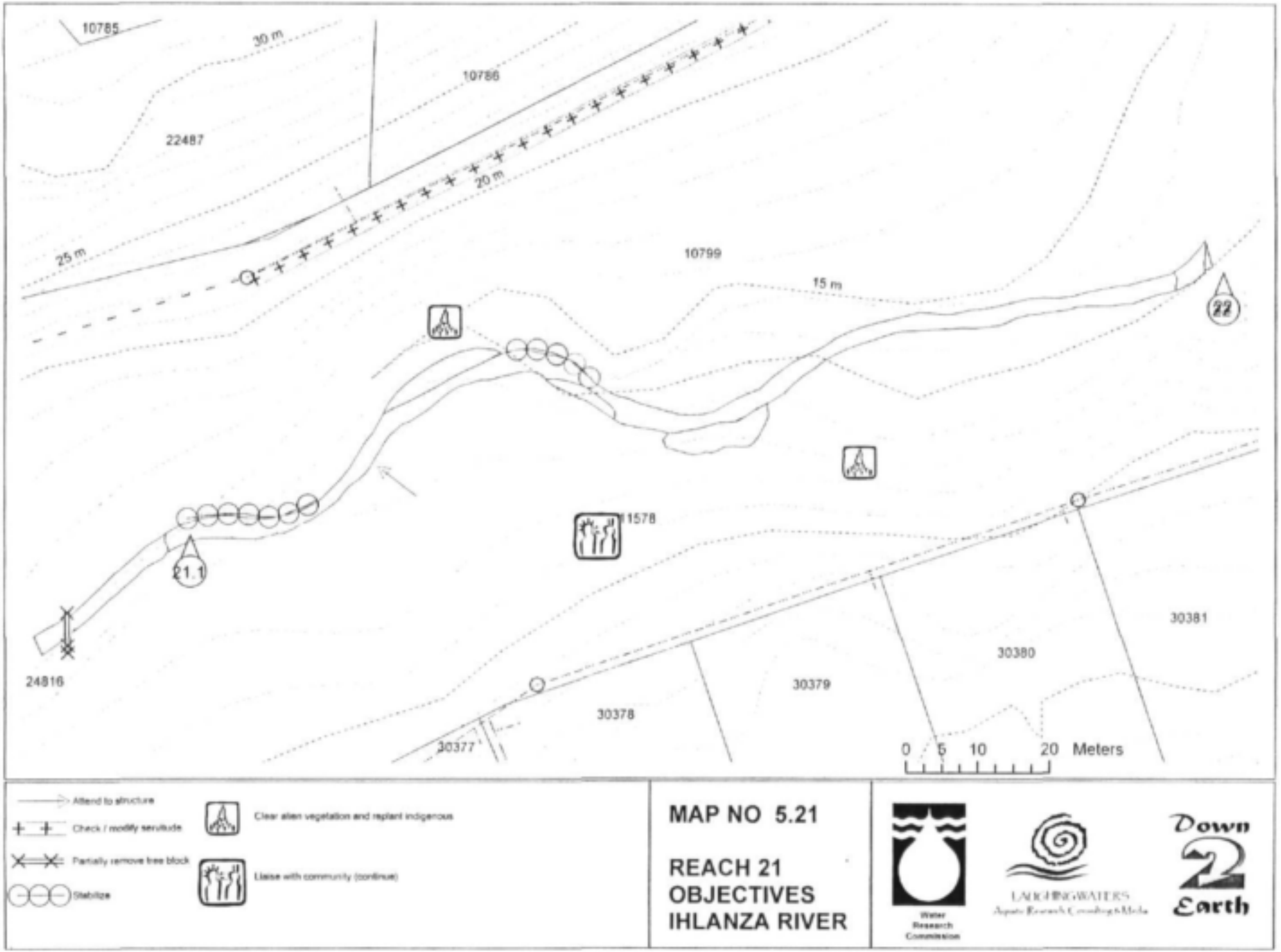
REACH 19 OBJECTIVES IHLANZA RIVER

Water Research Commission



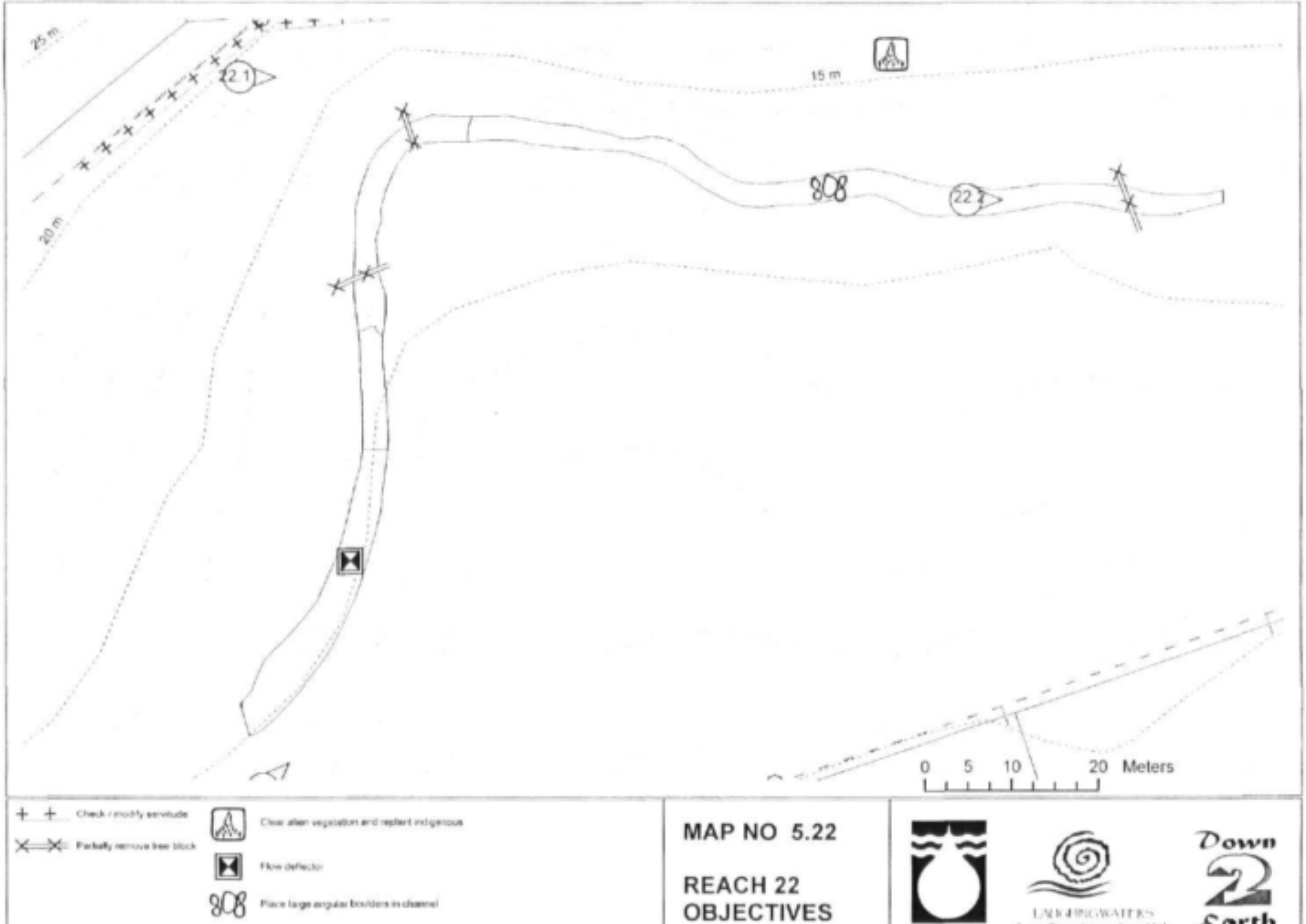
MAP NO 5.20

REACH 20
OBJECTIVES
IHLANZA RIVER



MAP NO 5.21

REACH 21
OBJECTIVES
IHLANZA RIVER

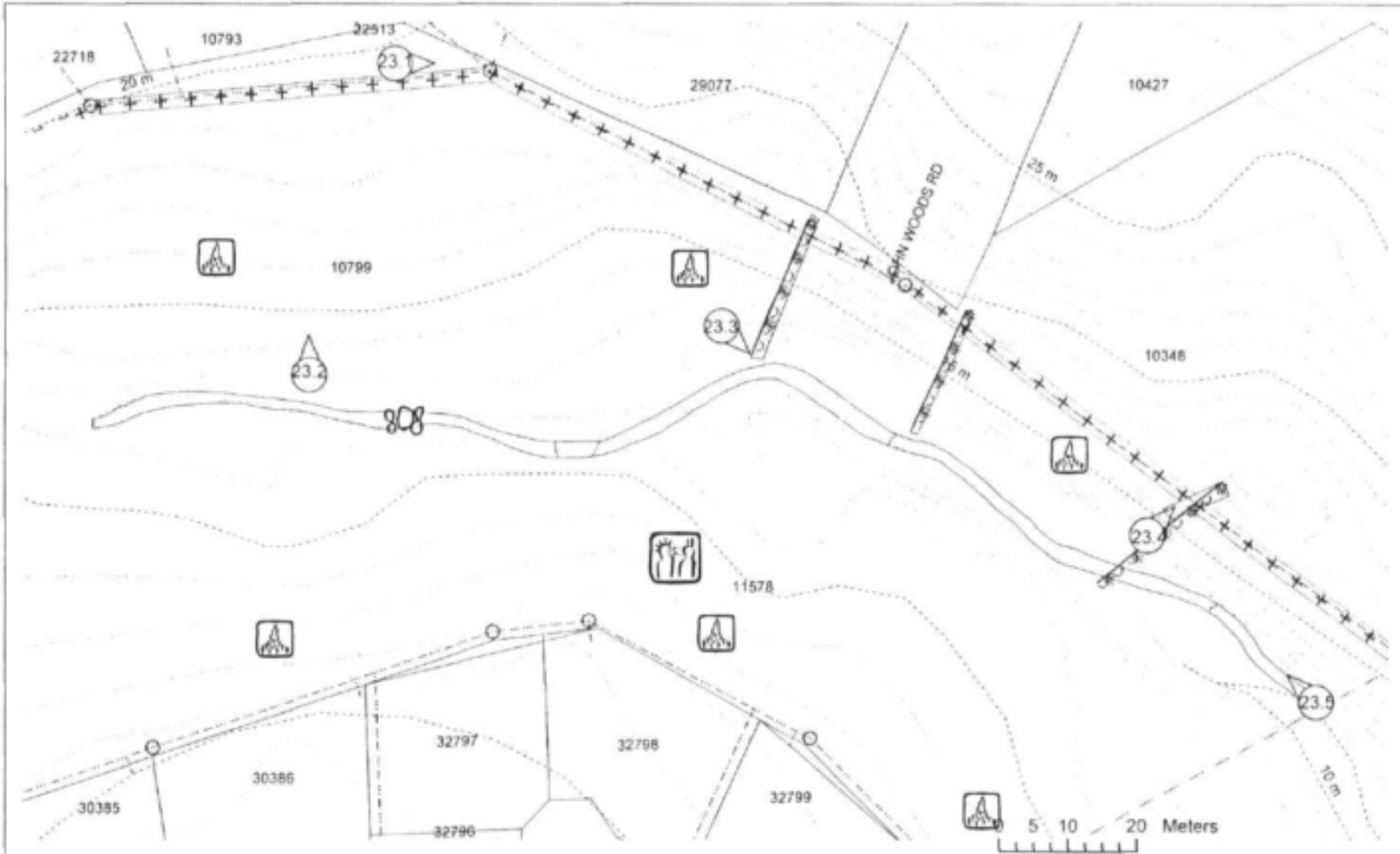


MAP NO 5.22

REACH 22 OBJECTIVES IHLANZA RIVER

Water Research Commission

Down 2 Earth



Check / modify servitude

Veg berm

Clear alien vegetation and replant indigenous

Liaise with community

Place large angular boulders in channel

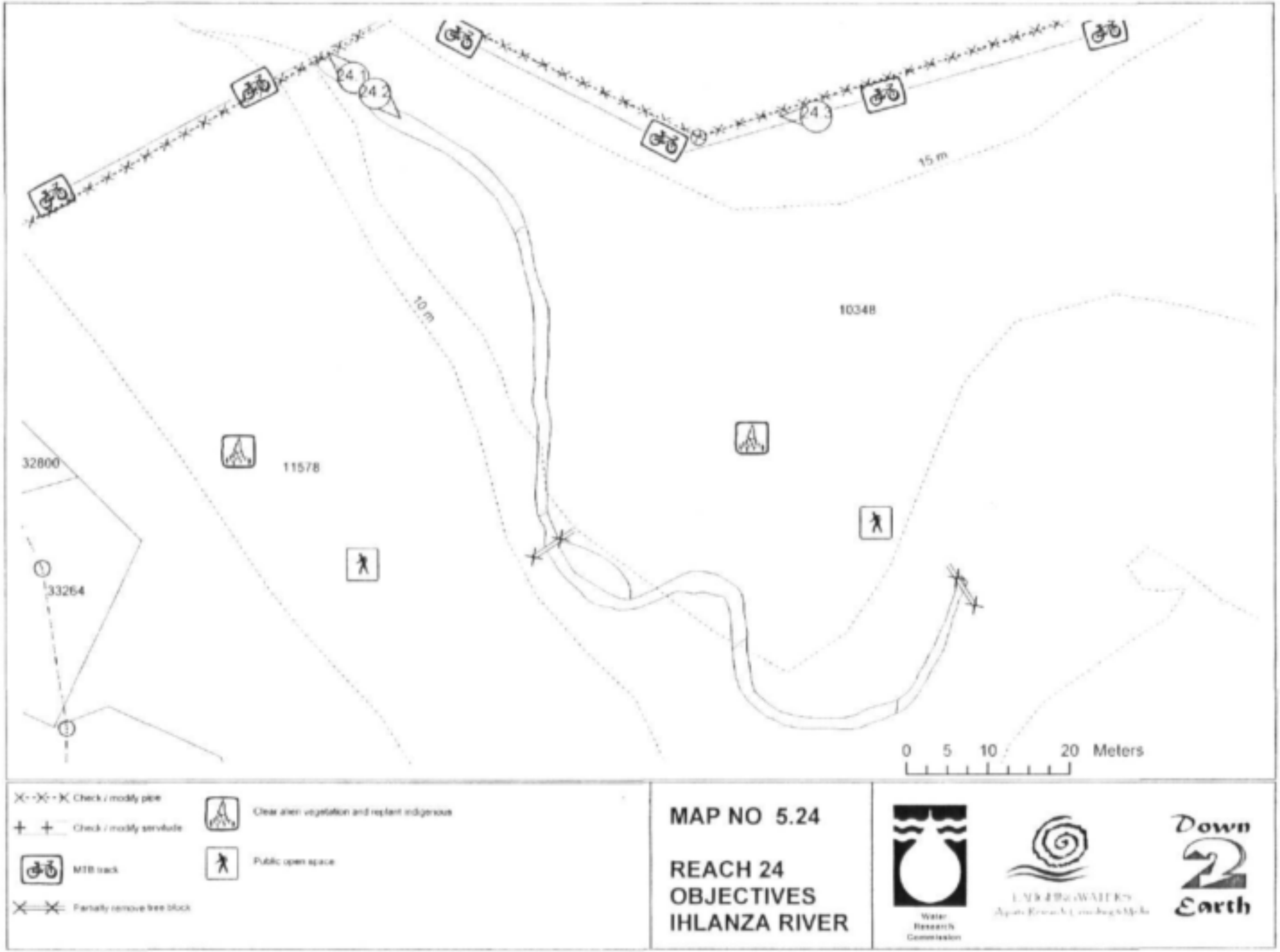
MAP NO 5.23

REACH 23 OBJECTIVES IHLANZA RIVER

Water Research Commission

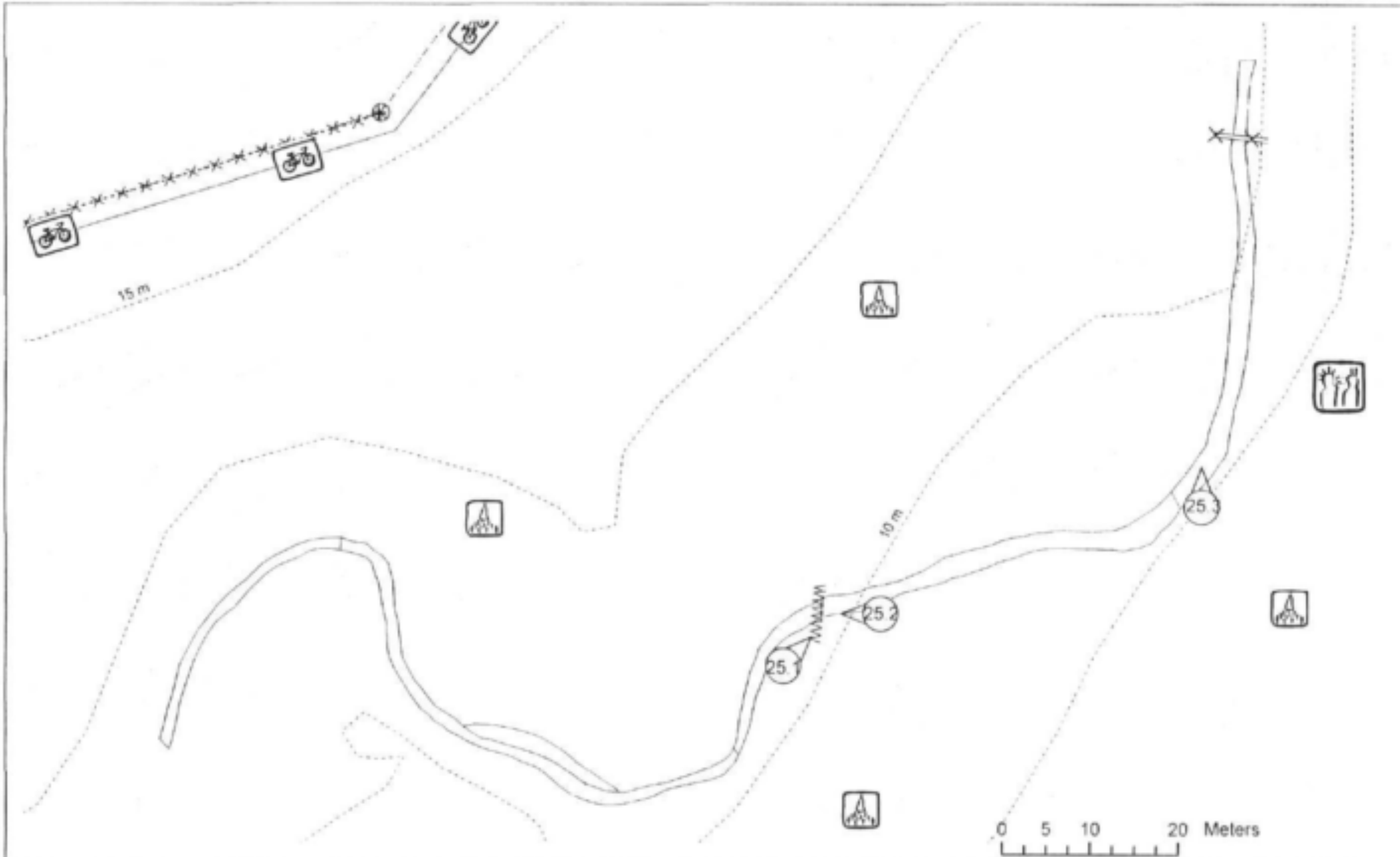
LAUGHING WATERS

Down 2 Earth



MAP NO 5.24

REACH 24
OBJECTIVES
IHLANZA RIVER



Check / modify pipe

MTB track

Notched weir

Partially remove tree block

Clear alien vegetation and replant indigenous

Liaise with community

MAP NO 5.25

REACH 25 OBJECTIVES IHLANZA RIVER

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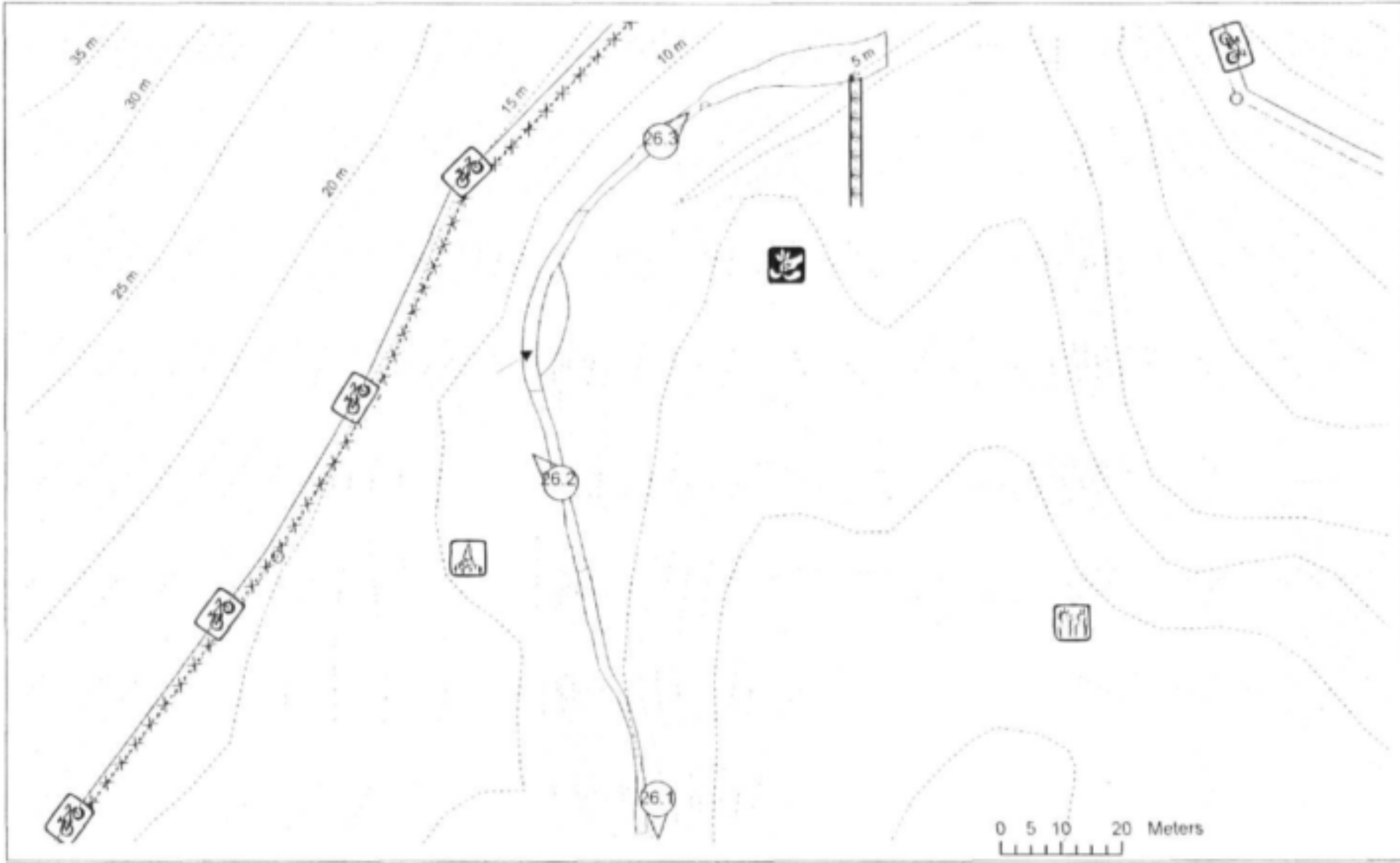
LAUGHING WATERS Aquatic Research, Consulting & Media

Down 2 Earth



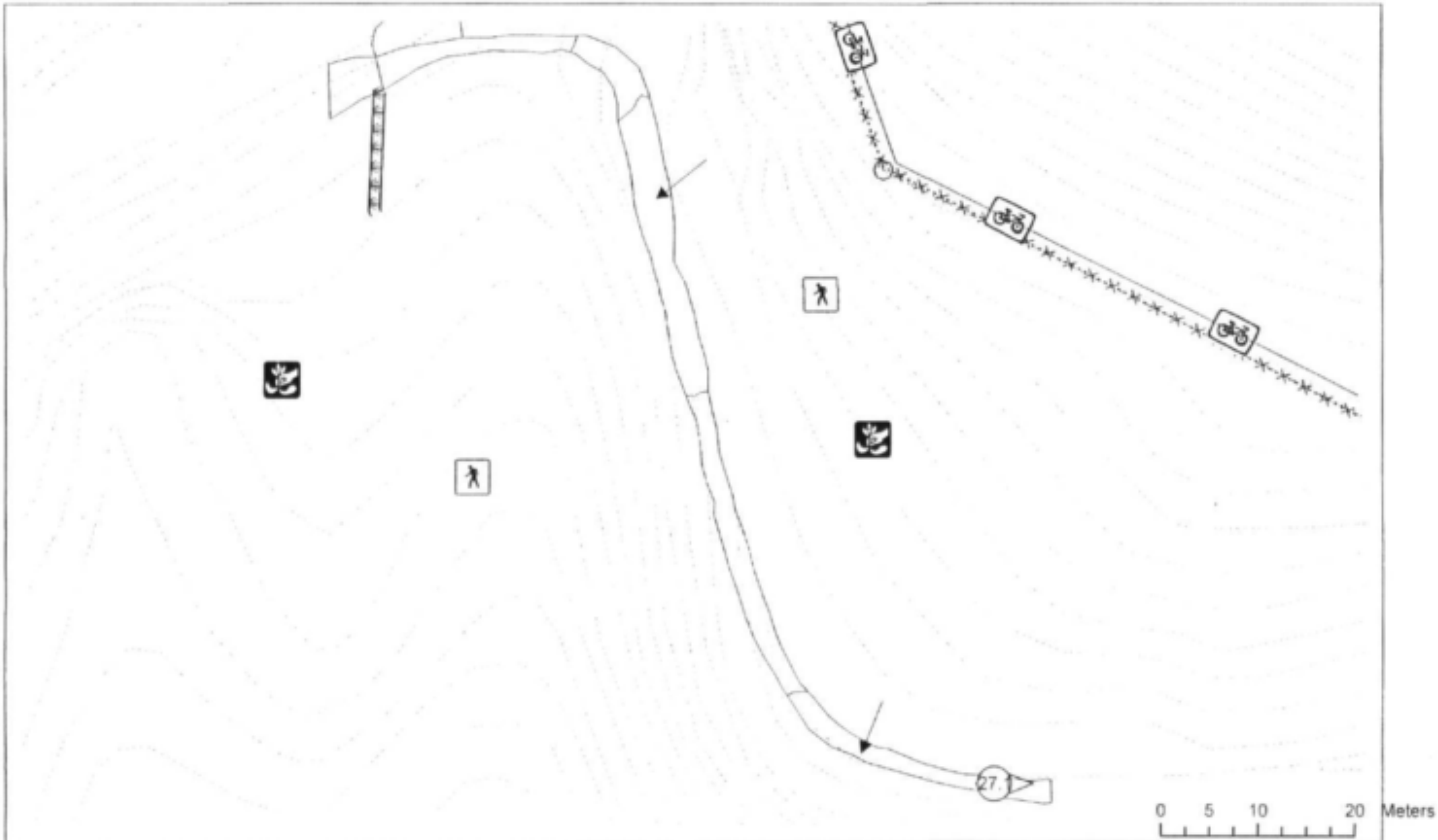
Check / modify pipe
Construct fish shelter
Construct swale
MTB track
Clear alien vegetation and replant indigenous
Liaise with community
Protect indigenous forest

MAP NO 5.26

REACH 26 OBJECTIVES IHLANZA RIVER

Water Research Commission

Down 2 Earth



Check / modify pipe
Construct fish shelter
Construct swale
MTB track
Liaise with community
Protect indigenous forest
Public open space

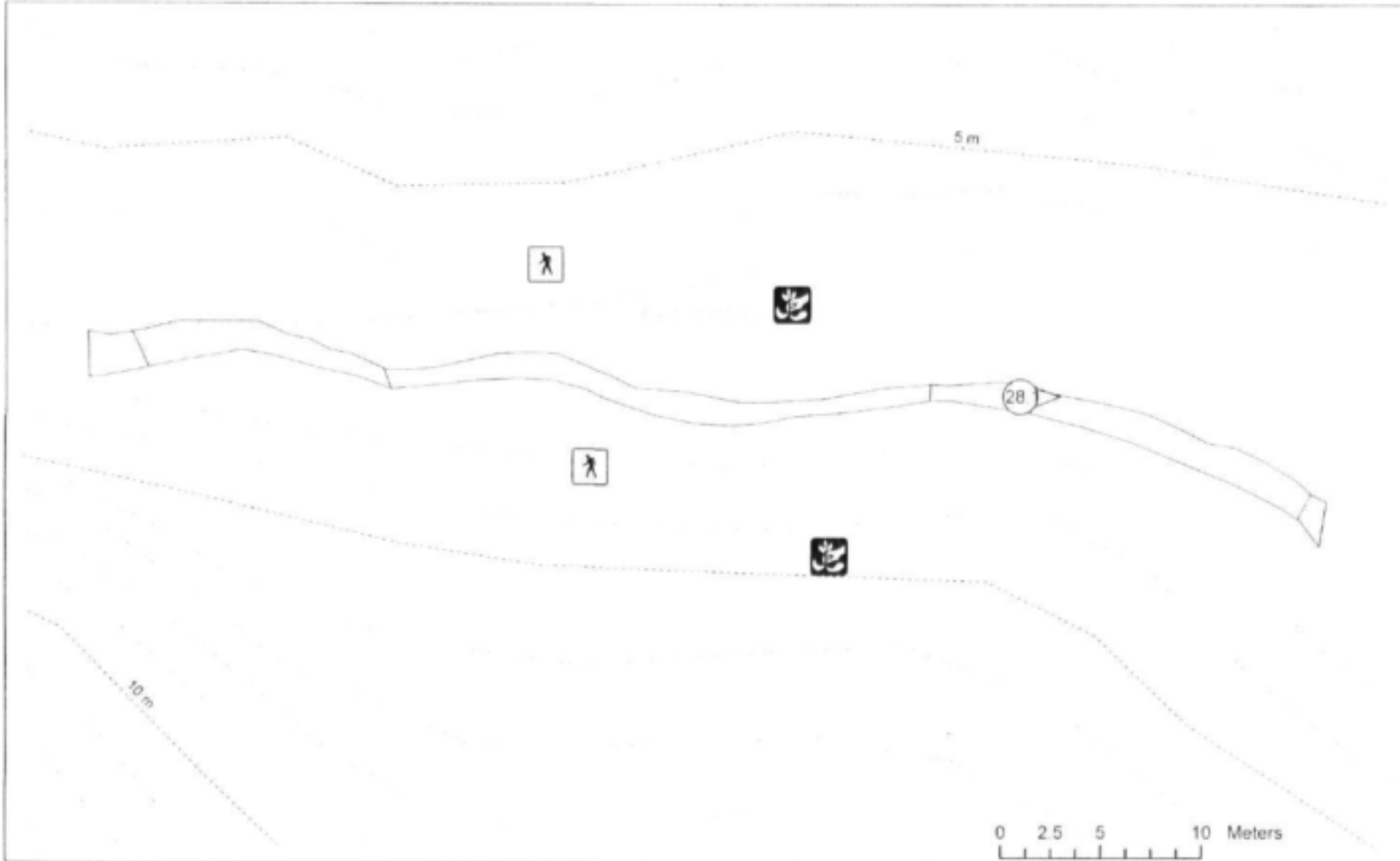
MAP NO 5.27

**REACH 27
OBJECTIVES
IHLANZA RIVER**

Water
Research
Commission

LAUGHINGWATERS
Aquatic Research, Consulting & Media

Down 2 Earth



Protect indigenous forest

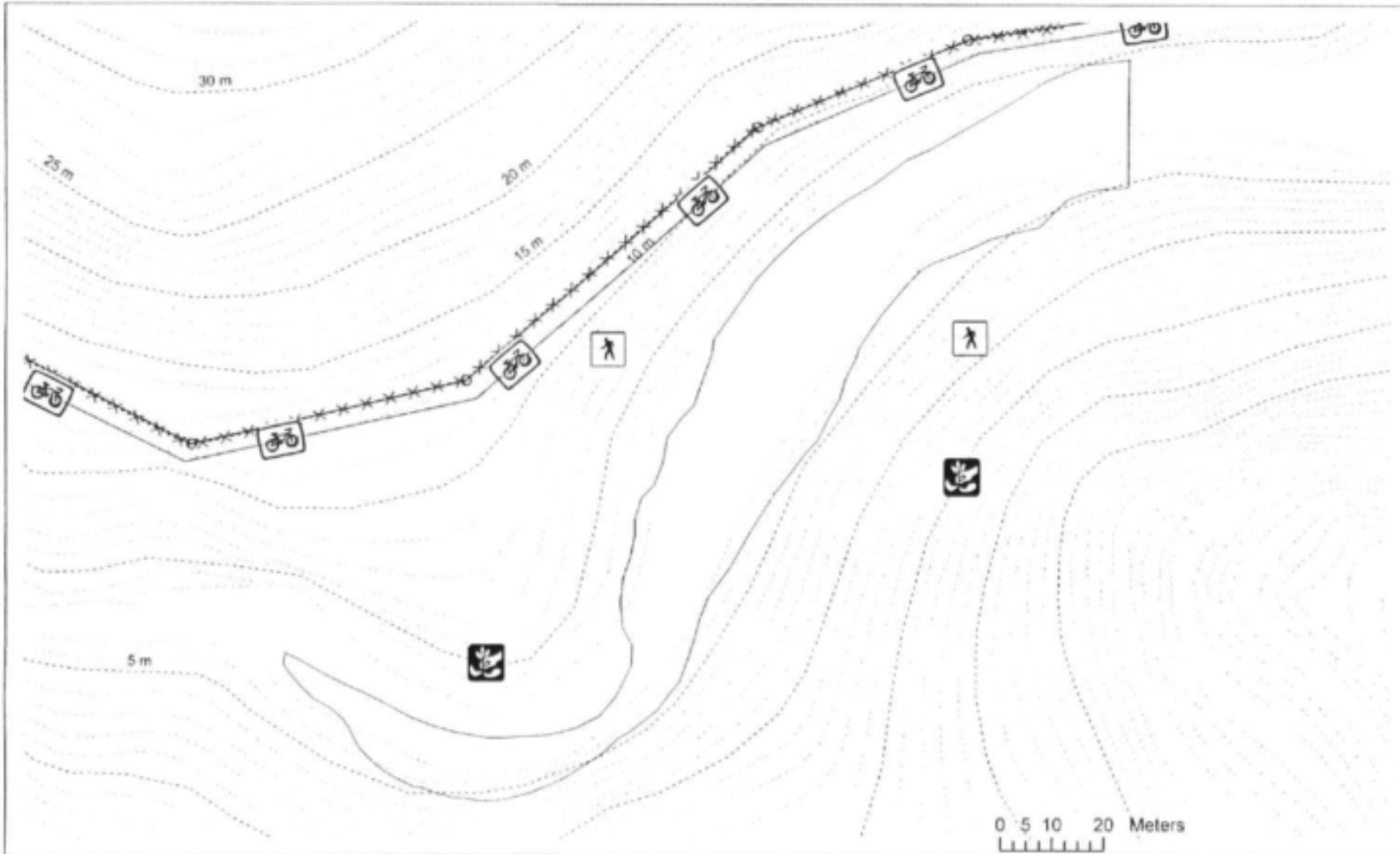
Public open space

MAP NO 5.28

REACH 28
OBJECTIVES
IHLANZA RIVER

Water Research Commission

Down 2 Earth



Protect indigenous forest

Public open space

Check / modify pipe

MTB track

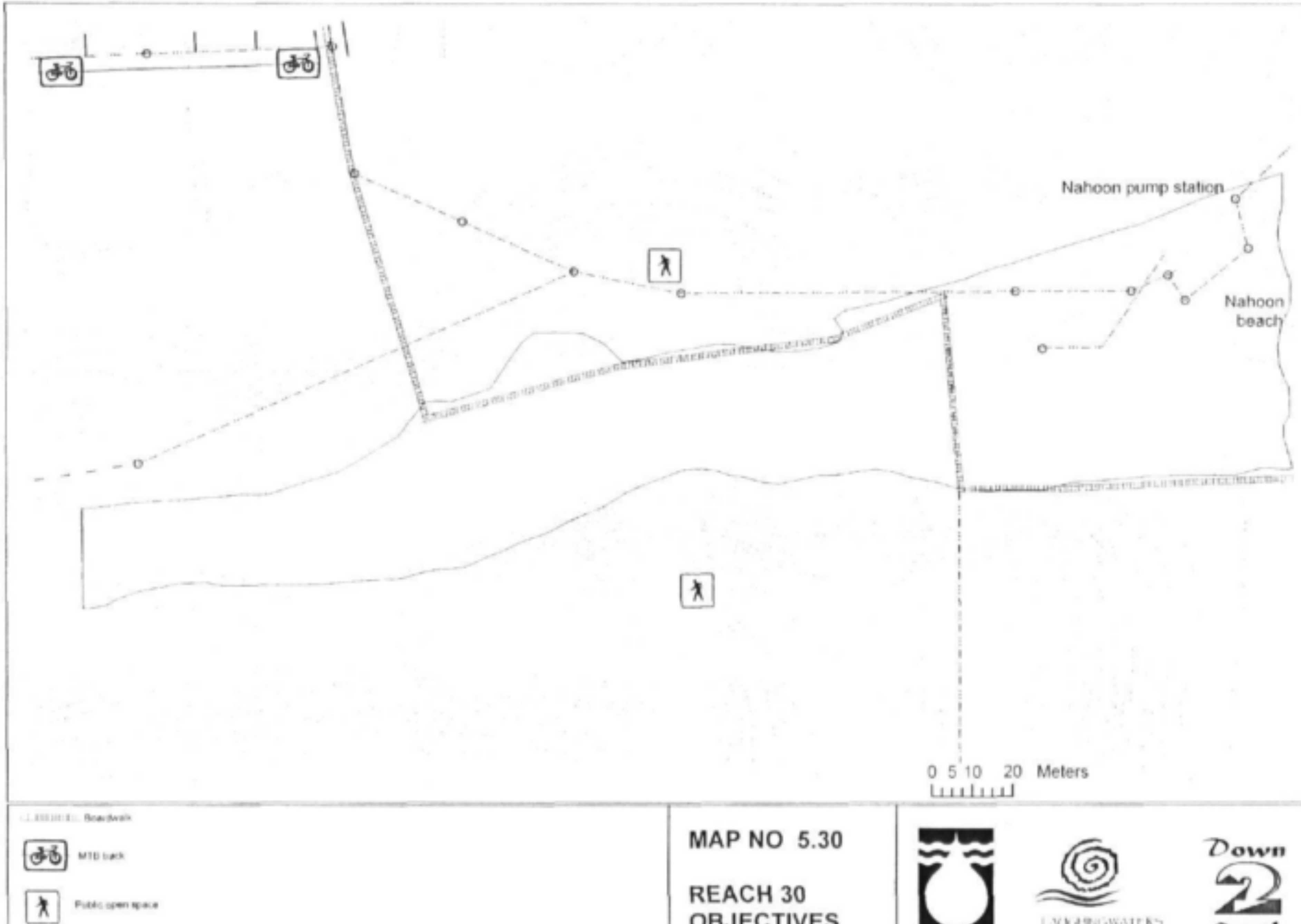
MAP NO 5.29

REACH 29 OBJECTIVES IHLANZA RIVER

Water Research Commission

LAUGHING WATERS

Down 2 Earth



MAP NO 5.30

REACH 30
OBJECTIVES
IHLANZA RIVER

Water Research Commission

APPENDIX 1

SUMMARY OF THE 12-STEP AUSTRALIAN STREAM REHABILITATION METHOD

A SUMMARY OF THE 12-STEP AUSTRALIAN STREAM REHABILITATION METHOD

Frame 1. A generic 12-step rehabilitation process (*after Rutherfurd et al. 2000)*

WHAT NEEDS DOING?	
Step 1	Develop a vision and goal
Step 2	Share the vision and goal
Step 3	Describe the stream condition
Step 4	Identify the assets and problems
NARROWING IT DOWN	
Step 5	Set priorities
Step 6	Develop strategies
Step 7	Set measurable objectives
Step 8	Check the feasibility
DOING IT	
Step 9	Design the details
Step 10	Plan the evaluation
Step 11	Schedule and supervise the works
Step 12	Assess, evaluate and maintain the project

Only Steps 1 – 9 are relevant to this project and are summarised here.

Step 1. Develop a Vision and a Goal

This step can be confusing purely because of the breadth of interpretation of the terms 'vision' and 'goal'. It should be noted that the approach recommended in this step is a slight modification of that proposed by Rutherfurd et al. (2000a). It is rather that of Larsen (1996) and Gippel (1999), who follow Kern's (1992) *'Leitbild'* concept. This involves firstly developing the 'vision' for a river. This is formulated on the basis of:

- a description of the pre-impact, natural state of the river (as described in Step 5 of the 12-step process);
- an assessment of irreversible changes to abiotic and biotic factors; and
- a consideration of certain aspects of cultural ecology.

The synthesis of these efforts serves as the vision, 'guiding image' or 'model image' for the rehabilitation. This vision, in the sense Kern (1992) describes it, is not the desired outcome, but the *optimal* solution, and serves only as a reference point from which to set realistic goals, objectives and targets. Thus, the vision is developed as the ideal but, most likely, unattainable condition for the stream.

The 'goal' is set relative to this vision or guiding image, and is the foundation of the project. It is an overall, broad statement of what is to be achieved once the rehabilitation work is finished. It describes the underlying motivation that will sustain the period of effort required to rehabilitate the river. A goal should have clear end-points, and should be inspiring. The latter is what draws involvement from communities and others. Rutherfurd et al. (2000a) present an amusing comparison of two goals from individual projects. The goal for the restoration of the Don River in Toronto, Canada was: *'The Don that we envision for the future is a revitalised river, flowing with life-sustaining water, through regenerated natural habitats and human communities. In its upper reaches the sparkling brooks and deep forest pools will flash with fish. Downstream in the older urbanised area of the city, the Don will ripple gently under shade trees, meander across its grassy plain, and merge into wetlands alive with waterfowl'*. The authors comment that this inspired, if romantic goal, is to some extent measurable and achievable, even if only from an aesthetic perspective. It is compared with one such as this: *'After the project, the creek will be environmentally improved and attractive'*. This sort of goal is both uninspiring and impossible to measure.

The goal must clarify what the stakeholders want to achieve in the overall project. One may have also goals for different sections of the river, or for features of the river (e.g. the estuary). In a later step, the goal will have achievable objectives and measurable targets attached to it.

Step 2. Share the vision and goal

This step is a reminder that rehabilitation is one of many competing demands on a stream. The idea is to identify all of the interests in the stream catchment at this early stage, to avoid the situation that at an advanced stage of the project, efforts could be disrupted by the actions of a powerful group or developer. This step not only gets people involved but also gives the rehabilitation process some measure of protection.

The four sequential tasks are:

Sharing the goal: Task 1

Identification of individuals with interests in the stream (this will include land-owners, water users, authorities, water supply agencies, etc.)

Sharing the goal: Task 2

Identification of individuals who support and oppose the rehabilitation goals. Identification of relevant legislation and local regulations.

Sharing the goal: Task 3

Identification of individuals with the power to help or hinder the attainment of the goal.

Sharing the goal: Task 4

Decision as to how to increase support for the goal.

A database of these individuals should be kept.

Step 3. Describe the stream condition

This is the generic equivalent of Steps 3 and 4 '*Set Reference Conditions*' and '*Assess Resource Status*' in the SA Resource Directed Measures process (Section 5.3.5), and Step 8 '*Assessment*', in the SA Catchment Management Process (Section 5.6). This is discussed in Chapter 7.

This step is the equivalent of a preliminary assessment. The output of this is a statement of the present state of the river, how it has changed since settlement in the area, and how much it differs from the desired 'goal' state.

The level of detail required for this stage depends on the information available, the size of the project, and the cost of getting the information wrong. The work involved is time-consuming and requires input from both the community and specialists.

The information gathered is best compiled in report form, together with a series of annotated maps. This synthesis of information will form the basis for future decision making and planning. It serves as the baseline for the project.

The sequential tasks in this step are:

Assessment: Task 1

Divide the stream into segments and reaches.

This is the process of dividing the river length into manageable units on the basis of physical and biological criteria. This allows one to consider the catchment-scale effects on each unit – e.g. considering the inputs to or impacts on a stream longitudinally (from the upstream or downstream directions) and laterally (from riparian zone and beyond).

River segments are logical divisions of the river based on broad-scale parameters such as slope or catchment characteristics; sections along which there is no significant change in the imposed flow or sediment load (Wadeson and Rowntree 1994). In rehabilitation work, these are typically measured at the scale of kilometres.

River reaches are the basic stream rehabilitation units. These are typically measured at the scale of hundreds of metres, but can be up to several kilometres for the purposes of this work (Rutherfurd et al. 2000a). A reach is typically a length of stream (channel and riparian zone) within which the constraints on channel form are uniform, resulting in a characteristic geomorphic assemblage (Brierley 1999, Wadeson and Rowntree 1994). The reach can also be defined on the basis of definable flow and sediment regimes, bed material, characteristic instream biota, riparian vegetation, etc. Reaches may also be defined on the basis of point changes e.g. tributary junctions, point source outfalls, dams, etc., if these are important to the management objectives.

The catchment context of this reach-based approach can be accommodated by considering effects on the reach from: upstream sources, lateral sources (the riparian zone), and downstream (headward erosion, barriers to fish passage).

The rationale for the reach divisions should be recorded on a map. Sources of inputs to and outputs from a stream reach should be identified on the map to provide a catchment context for the reach.

Assessment: Task 2

Construct a template of what the stream should look like (ideally in its pre-impact state).

Rutherfurd et al. (2000) describe the construction of a template as a formalisation of the idea a stream manager, for example, has developed of what the stream *should* look like. The formalisation procedure is empirical and relies on the gathering of information and the checking of assumptions. Where, for example, one may have assumed that riffle-pool sequences would be the appropriate hydraulic habitat to reinstate in a river reach, investigations may reveal that naturally, only pools were present. The template is the equivalent of the reference state.

This step is the equivalent to the construction of a picture of 'natural' condition described by Larsen (1996) and Gippel (1999) and presented in Step 1. The template is referred to by Larsen and Gippel as the 'model image' or 'guiding image', and is not regarded as an endpoint, but rather, as the vision towards which to work, as it is unlikely in the majority of cases that this natural state will be achievable.

The template will be based on historical information (including aerial and topographical maps); investigation of remnant features remaining (with caution in scaling-up to stream size); reaches still in good condition; empirical approaches (e.g. comparison with data on other streams); and generic models on streams in good condition. Anecdote is another source of this information, although caution must be applied and 'stories' verified.

It may be possible to devise a sequence of images of the river associated with different periods on the basis of historical information (e.g. aerial photographs, remnant features remaining in the field, similar reaches still in good condition). Wherever possible, for these images, information on the following attributes should be collected:

- diversity and populations of animals and plants present;
- riparian vegetation structure, diversity, natural regeneration;
- flow regime: flow duration and magnitude, any regulation or water diversion;
- longitudinal connection along the river: artificial barriers to movement;
- lateral connections along the floodplain, and alterations to this (including levees, changes to flow regime, blocked flood channels);
- water quality;
- channel structural complexity and stability.

Kondolf and Larson (1995) recommend that historical changes in channel form (and the independent geomorphological variables of runoff and sediment load from the catchment) should be documented from a variety of sources, including historical maps, boundary lines, aerial photography, bridge and pipeline surveys, gauging records, field evidence and archival sources. Historical riparian vegetation can also be documented from early survey records and aerial photographs. These authors recommend that historical analysis should cover an area large enough to capture all events potentially influencing the project reach.

Collection of historic information will allow some estimation of the historic *rate and direction* of change in the system, and will clarify the extent to which change has occurred. Gippel (pers. comm.) reports instances in which the perception of 'extensive change to the system', for example the claim of excessive channel widening downstream of regulatory structures, has been proved erroneous or an exaggeration, as a result of thorough historical channel analysis. Much of the information search involves identifying and contacting the numerous, often 'hidden' or forgotten sources of information. Distributional records of fauna, previous studies on the river system, engineering drawings for infrastructure etc. may be decades old, and persistence is required in the process of seeking this information and constructing the model image.

Assessment: Task 3

Describe the present condition of the stream

This task is the generic equivalent of Step 4a of the South African Resource Directed Measures methodology (*Determine the 'Present Ecological Status' (PES) of the resource unit*, see Section 5.3.5). It requires the help of a team of river specialists. There are a number of methods available to assist with preliminary assessment of current river condition in Australia (Frame 4.2), however none of these should be assumed (in themselves) to provide sufficient information to develop a report on present state. Where possible, further expert surveys should be undertaken.

During this step, information on the current state of the seven river attributes mentioned in Task 2 should be collected during specialist surveys. Information on species with high conservation importance or rarity status is required.

Assessment: Task 4

Produce a variety of annotated maps

The large quantity of data collected to this point in the various surveys is now synthesised and edited to produce a clear account of the important facts.

The explanatory text should be accompanied by a variety of annotated maps, for example:

- a planform map of the entire section of river to be rehabilitated, showing divisions into segments and reaches, with notes justifying these divisions;
- a similar planform map, annotated with information on 'natural state' and 'present state', relevant cross sections etc.;
- larger scale maps on key features within the individual reaches to be rehabilitated.

Step 4. Identify the assets and problems

The stream in its present condition is now compared to the 'template' (of the original condition) produced in Step 3, and an assessment is made to enable further planning.

Assets and Problems: Task 1

Identify environmental assets.

Wherever there is accordance between the present state and the template, that ecological or physical component of the river is termed an 'asset' (this referring to an environmental asset). Processes or planned developments that threaten assets must be identified. The trajectory of the asset should also be evaluated to establish whether the stream is moving away from or in the direction of its natural state (degrading or recovering) or stable. The rarity of the assets must also be identified to allocate relative value. This is necessary for the setting of priorities.

Assets and problems: Task 2

Identify present problems.

'Problems' are those processes or activities which are threatening or impacting on present assets. This is the equivalent to identifying the causes of current degradation of assets. An investigation into land-use in the catchment can assist in this process. The practitioner's or specialist's knowledge and experience should be drawn upon in finding clues to causes. Present distribution of organisms may also be of assistance. Four errors are possible in identification of cause: mistaking a natural attribute for a problem, failing to recognise that a 'problem' may be part of a natural recovery process, identifying issues which may be typically be considered problems but are not actually threatening to the fauna and flora of the stream, and identifying the wrong problem. The literature on rehabilitation abounds with examples of these sorts of errors.

Assets and problems: Task 3

Determine the trajectory of the assets and problems.

This is a complex step, and an understanding of natural recovery processes in streams is necessary to accurately determine whether a stream is in a state of recovery (moving towards a dynamic equilibrium), maintaining state, or deteriorating. The decision as to where the system lies along the recovery trajectory is important as it will inform decisions regarding what interventions are required to arrest deterioriation, protect assets, or speed recovery of assets, and will assist in identification of areas in which no action is necessary at all. Questions which need investigation include: How the asset has changed or been anthropogenically altered over time, whether the problem is likely to change in the future (i.e. what the typical ecosystem response to this problem is over time), and how assets would respond to problems which are stable.

Assets and Problems: Task 4

Map the assets and problems.

Summaries of assets and problems may be superimposed on the maps already produced.

Step 5: Setting Priorities

In its simplest state, prioritisation is a series of questions: what to protect, what issues to address first, on what basis, how to rank problems and relevant actions relative to the prevailing conditions, constraints, and resources (environmental, labour, finance, time).

Rutherfurd et al. (2000a) present a useful background to prioritisation philosophy and concepts. These authors describe the currency of stream rehabilitation, that basic measure for deciding priorities, as '***the amount of sustainable natural biodiversity that can be gained per dollar, or per unit effort, usually in the shortest time, and optimally for the greatest length of stream***'. This represents a simplification of a complex thought process. Priorities are thus based on achieving optimal and appropriate levels of biodiversity.

It would thus be considered more effective to save whole reaches of a river than to rescue individual species or communities and leave the reaches to be destroyed. While the currency of biodiversity does not ostensibly take the *composition* of the biodiversity into account, the notion of giving priority to more sensitive and/or less common communities is still upheld in the Manual, as it is in other rehabilitation work (e.g. Goals Project 1999). Ideally, one would optimise by maintaining and conserving source areas of fauna and flora with both high diversity and high conservation value.

The procedure for setting priorities is intended to be a dynamic, adaptive one. Once the general framework of priorities has been set, the details may change according to needs and outcomes.

The practical guidelines to achievable, ongoing prioritisation in stream rehabilitation presented by Rutherfurd et al. (2000a) are briefly described here, and the sequential tasks in prioritisation are included under 'Rehabilitation Process' (Section 4.6).

The principles for prioritisation are:

Save reaches that support valuable organisms or communities (rare or endangered) before less valuable reaches which support common organisms and communities.

Protect streams that are in the best general condition before attempting to improve those in poor condition.

Where possible, arrest degradation rather than waiting for the system to stabilise and then attempting to accelerate recovery.

Improve the condition of damaged reaches, beginning with those that are easy to attend to.

Where there are still reaches needing protection or improvement, attend to these before fixing badly degraded reaches.

Identify the critical or 'fatal' problems and limiting factors. The obvious problems, such as bank erosion, may be less serious than the 'hidden' problems such as polluted stormwater runoff.

Ideally, prioritisation for stream rehabilitation should proceed from the local to regional to the national scale. In practice, this means eventually comparing the condition of whole catchments rather than just reaches, a complex undertaking. However, the six principles presented above work equally for catchments.

The argument for prioritising 'best condition' reaches for protection is that it is difficult to artificially recreate a functioning physical and biological system, and attempts at doing so are also usually prohibitively expensive. One has to take the longer-term view of getting maximum return for investment over a period of decades.

The monetary costs of not protecting reaches already in good condition, which are often the upper reaches, are:

the cost of later possibly having to recreate these reaches;

the additional cost of rehabilitating lower reaches due to the absence of a productive seed source;

the opportunity cost of later having to spend money on rehabilitating the upper reach, that could have been spent elsewhere.

Rutherfurd et al. (2000a) provide a hypothetical example of all three of these costs being incurred in a project as a result of favouring rehabilitation actions in degraded downstream reaches of a river and neglecting to protect or conserve the intact, ecologically sound upper reaches. The argument is that for a small extra short-term cost this upper section could be protected, thus eliminating the longer-term threats and costs associated with potential degradation of this reach.

The four criteria guiding the prioritisation and ranking of reaches in this methodology are distilled from the six principles described:

Rarity (rare reaches have higher priority than common ones);

Condition (reaches in good condition are easier to fix than those in bad condition);

Trajectory of change (Deteriorating reaches should be stabilised before action is taken on reaches which are improving without any intervention);

Ease (attend to those reaches which are easy to fix, before those that are difficult).

Reaches are assigned into one or more of nine categories in order to determine priorities for rehabilitation. These are presented in Table 4.5, and it is obvious that criteria for each of these categories would have to be developed to assist the process. Clearly, also, some reaches may fall into more than one category. This eventuality is dealt with in Step 5 of the rehabilitation process presented later in this chapter.

Once one has prioritised reaches, then the problems within the reach must be prioritised. Rutherfurd et al. (2000a) recommend that the hierarchy of problems must be identified, from fatal problems that exclude particular species from the reach, to limiting problems which stress the species in question, to nuisance problems which have minor effects on the population. Eventually all these problems should be addressed, but to speed up the process of improvement, the problems should be tackled in that order. The eventual aim of rehabilitation is to move all reaches into Category 0.

Setting Priorities: Task 1

Assign reaches to one of the nine categories presented in Table 3.1, Section 4.5. (This report)

Reaches are assigned to one of the nine categories on the basis of rarity, general condition, trajectory, and ease. With the information already acquired this should be possible.

Setting Priorities: Task 2

Rank reaches that are in the same category.

Where more than one reach falls into a single category, they are ranked on the same basis as above (rarity, condition, trajectory, and ease).

Setting Priorities: Task 3

Query and check the reach priority rankings.

Here, reasons other than ecological value are brought into consideration in the prioritisation process. Rankings may be changed on the basis of the importance of a particular reach in terms of its place in the life of a community, its proximity to other urban features, or the fact that it supports an animal with great public appeal (e.g. the Platypus, in Australia). This is where the 'science' of rehabilitation meets the 'society' of rehabilitation. It is obviously important that costs of rehabilitation are taken into account in adjusting priorities and rankings. In the case of an upstream reach being rehabilitated, it is considered best to work from upstream to downstream in rehabilitation implementation (Larsen 1996). This may be another reason for adjusting priorities. It is also necessary to consider the areas through or into which a river is flowing, as a possible further reason for raising the priority of a section of river for improvement.

Setting Priorities: Task 4

Setting problem priorities.

Prioritising which problems to address first may be complex. Causes of degradation need to be set into a hierarchy, from **fatal** problems (which are extreme and may exclude fauna or flora from a reach) to **limiting** problems (considered stressors to the expected species distribution) to **nuisance** problems (which have a minor effect on the biotic community). The interactions between different degradation factors may mean that improvement in one area causes an improvement in another.

Setting Priorities: Task 5

Check for other limiting problems.

Rutherfurd et al. (2000a) define a limiting problem as one that most severely affects an asset. If this problem persists, the aspect/s of the stream targeted by the rehabilitation is/are unlikely to recover, even if other problems are remediated.

It is necessary to identify linkages between problems. This may either be in a hierarchical fashion, such that one problem is fatal and the next limiting, or a direct relationship, such that one problem results from another. Understanding these linkages is important to ensure that problems are not solved in the wrong order.

Setting Priorities: Task 6

Exceptions to the problem priorities: Optimising the costs.

There may be reasons to prioritise problems that are not considered fatal or limiting. In the long run this may also result in good value for money.

Where large reaches are damaged: Where the costs are equivalent, it can be more beneficial to fix a longer reach of stream than to attend to smaller scale, site-specific works.
Long-term perspective: Where rehabilitative actions are likely to take several years to take effect, such as the reinstatement of riparian vegetation (10 years in drier regions), it may be wise to initiate the recovery process sooner rather than later.
Community support: Once again a higher priority may be accorded to reaches in circumstances where the influence would be good on the community, or would improve the visibility of the stream area..

Setting Priorities: Task 7

Check if some reaches should have more than one rank.

The majority of reaches are likely to have multiple problems, and may have a number of assets to protect. In these cases, the recommended course of action is to protect the assets in this reach and then to move on to protect assets in other reaches before attending to degradation in the first reach. This first reach can be re-classified in terms of its priority, by comparing it with all other reaches, assuming that the quality reaches have been protected. The same reach may thus initially be a Category 1 (Regional Conservation Value) and, following remedial actions, be allocated to Category 4 (Expand Good Reaches).

Step 6: Strategies to protect assets and improve the stream

In this step, general strategies are identified for:

- the protection of environmental assets and/or the prevention of degradation;
- the improvement of environmental assets;
- fixing present problems.

These could involve changing stream processes by changing inputs to the stream. The strategies developed here will be transformed into objectives in the following step. It is recommended that as much effort is put into developing strategies to *protect* the stream as into attending to degradation of assets.

Strategies for changing human behaviours are also important and include providing education and motivation to prevent individuals from causing loss to biodiversity or degradation in streams; legislation and regulation (e.g. permitting certain actions), education about what to plant in the riparian zone, and how to reduce urban impacts on streams.

At the end of this step the following should have been completed: the ranking of reaches in order of priorities, with identification of major assets and potential assets in each reach; the identification of potential problems for each asset; and a list of strategies for reducing the impacts of these problems, and for enhancing or improving river protection. The continuation of this process is the setting of attainable objectives.

Step 7: Setting specific, measurable objectives

A common lesson from rehabilitation exercises around the world is that insufficient attention has been paid to the setting of objectives and the subsequent evaluation of whether or not these have been met. Without these two steps, rehabilitation projects proceed in an ad-hoc fashion towards uncertain outcomes, and, amongst other things, this approach does not justify the money spent.

Objectives are considered the specific aims of the project, and are seen as steps along the route to achieving the holistic 'goal' of stream rehabilitation as discussed in Steps 1and 2. It may take a long time to develop these goals, and the basis for them may vary from project to project. In the Baylands Ecosystem Project in San Fransisco Bay, for example, project participants were to develop habitat goals only after assembling and analysing many kinds of data about the Baylands, and worked together for almost two years before they began making recommendations for habitat improvement goals (Goals Project 1999). When they did, they acknowledged that, although it had been required that the goals be based on best available science, *'the goals were not developed through experimental testing of scientific hypotheses – the data were too thin for this approach. Rather, the goals were developed using the best available data, reasonable inference based on these data, and the collective best professional judgement of the regional community of environmental scientists and managers'* (Goals Project 1999).

The process of setting objectives allows the practitioner/s to determine what they would consider a successful outcome of the rehabilitation. The process also forces the scope and scale to be defined for the project: what proportion of the reach will be treated, whether the present problems are to be fixed or simply reduced in severity, what are the acceptable timescales for response, etc. It becomes clear during this process which objectives are not compatible. Evaluation of project effectiveness can only be carried out if prior to the implementation being undertaken, measurable objectives attached to time periods were set (Kondolf 1995).

Setting Objectives: Task 1

Defining the extent of change desired.

It is important to state what a rehabilitation project is aiming to achieve. This will either take the form of absolute statements regarding improvement (e.g. 'sewage will no longer be discharged into the river') or may be expressed in terms of a range of acceptable outcomes, where one end of the range represents the best possible outcome, and the other end the smallest useful improvement (e.g. 'sewage discharges into the river will be reduced by a minimum of 20% and a maximum of 75% within five years'). Objectives may be also be stated in terms of maintenance. For example, when protecting an existing asset, the objective would be 'that the condition does not deteriorate'.

Setting Objectives: Task 2

Defining the spatial scope of the objective.

The spatial scope of the project is dependent on the problem being treated, the cost of the treatment, and the length of river requiring treatment in order to get a response.

Setting Objectives: Task 3

Setting the time frame.

Sufficient time must be allocated for the stream to respond to the rehabilitation actions. However, the timeframe that is set needs to be short enough to maintain the interest of those involved in the project. The manual suggests that one means of achieving this is to couch the objectives in terms of two time frames – one for the completion of the rehabilitation treatment (**output**), which is a short term objective, and another for the evaluation of the treatment (**outcomes**), which is a longer term objective, in the order of a number of years.

Setting Objectives: Task 4

Determining the type of objective.

Objectives may be framed in terms of output, as in Task 3, as long as there is some confidence that the desired outcome will follow. It is preferable to include objectives for both output and outcome.

Five general types of objective are recommended:

Output/outcome	**Type of objective**
Output	Execution of the project and treatment/s
Output	Survival of the project and treatment/s
Outcome	Aesthetics of the stream
Outcome	Physical condition of the stream
Outcome	Improvement or maintenance of ecological function and processes

Step 8: Checking the feasibility of objectives

Feasibility: Task 1

Is it affordable?

The costs of getting a stream rehabilitation project mobilised are often overlooked, while attention is focussed on the cost of implementation of management actions.

Planning Costs: In order to get the information and assistance required in the early phases of the project, specialists are required during the planning phase. Consultancy fees in Australia were estimated at AUS\$500-\$1500 per day in 1999 (Rutherfurd et al. 2000a).

Information Costs: The cost of items which are required in the early phases of the project, e.g. aerial photographs.

Establishment Costs: This includes the cost of getting the project established. If land purchases are required, or heavy machinery is to be used on site, the establishment costs could account for a large percentage of the total budget.

Compensation to other stream users: It may be possible (in Australia) to fence out and revegetate stream frontage if compensation is paid for channel watering-points for stock.

Post-project costs:
Maintenance: all construction work (particularly if bio-engineering approaches have been followed) needs to be maintained.
Evaluation: A detailed evaluation programme can cost more than the project itself. This includes costs of monitoring and measurement.

Other costs: These include vandalism and the unexpected consequences of the project

Feasibility: Task 2

Is it legal? What are the legislative and administrative constraints?

At the outset, it is necessary to be aware of the multiplicity of laws and regulations controlling what can and cannot be done in and around rivers. It is worth spending some time investigating and compiling a database or report of the relevant controls, particularly in the metropolitan context, where several authorities or service providers may have intersecting jurisdictions (e.g. roads, planning, stormwater control).

Feasibility: Task 3

Is it worth doing? (Do negative effects outweigh positive ones?)

This step provides assurance that the positive effects of the project will outweigh the negative ones. To maintain public support, outcomes need to be (in the balance) positive, and non-threatening. If the outcome of environmental 'enhancement' measures is unintentionally negative, such as flooding or erosion, public support for stream rehabilitation will dwindle. It is worth placing some assurance on the positive outcomes of the project, and calculating the chance (and extent) of possible 'negative' effects, and then checking the balance between the two. The latter may not be negative in an environmental sense, but rather in terms of public perception (e.g. the return of frequent small floods). Education focussed on the compromise between environmental needs and human needs would also assist in sustaining public support.

Key questions are listed as:

- whether the intended treatments would cause erosion or deposition;
- whether actions may influence flood height or duration;
- whether the option would affect the performance of hydraulic structures (for example, the installation of a fish ladder could compromise the performance of a weir); if so in what way, and how does one compensate for this;
- whether the option would affect the current practices of riparian landholders;
- whether and in what way/s the option affects the recreational uses of the stream;
- whether the option will affect other uses of the stream (e.g. water use, use as a drain or sewer) and how to compensate for this.

Rutherfurd et al. (2000a) provide numerous examples of stream rehabilitation plans doing more harm than good to the ecosystems in question.

Feasibility: Task 4

How much confidence do you have that it will work?

This issue relates also to balancing costs, risks and outcomes in rehabilitation. The more the project is going to cost, the greater the confidence required in the outcome (i.e. the lower the risk). Risk assessment procedures can be used here.

Feasibility: Task 5

Weigh up the feasibility.

The issues already covered in this step should have determined the cost-effectiveness, cost-benefit relationship, and any legal constraints on the project, as well as the affordability of attaining objectives. If feasibility is still a questioned on the basis of any of the aforementioned, Rutherfurd et al. (2000a) provide three options:

Compromise: this will involve modification of objectives to tailor the project (where appropriate) to legal requirements, costs, and community requirements.
Do a trial run: where outcomes are uncertain, it may be possible to run a low-cost pilot trial of the treatments planned, both to estimate effects and to harness further public interest and support.
Recognise absolute ('terminal') unfeasibility: There may be scenarios where the potential negative effects outweigh benefits, or where legal constraints disallow the key rehabilitation actions. In certain instances it must be recognised that halting the project at this point is necessary.

Step 9: Detailed project design

This step is concerned with the detailed design of the structures to be built or actions to be taken. Basic principles related to changing the physical character of the stream are presented.

Longevity of the Strategy

Sound rehabilitation measures should still be effective in the stream decades after implementation. However, initially dramatic improvements may pale over time. A number of possible reasons, and guidelines to prevent this, follow:

The design should enhance natural recovery. Case studies have shown the benefit of assisting the recovery of the stream, rather than attempting to recreate a 'natural' stream environment, which is considered the equivalent of '*cajoling the stream into a desirable, equilibrium form*' (Rutherfurd et al. 2000a).

Rehabilitation effects should outlast structures: Where structural work is required in the river, the rehabilitation measures accompanying these should outlast the structures which have a finite lifespan. Bio-engineering approaches should be used for structures, where possible. Where a structure can be combined with natural measures to ensure the sustainability of the effect (e.g. planting trees on the sediment bar which forms downstream of a groyne to preserve channel alignment even once the groyne structure has gone).

Treat reaches and not points: The reach should be treated as a whole, rather than a few isolated points within the reach.

External factors may jeopardise structures: This concerns problems that continue after rehabilitation, such as ongoing coarse sediment loading, which can cover in-channel structures within a short space of time.

The Inclusion of Vegetation

The majority of rehabilitation works should include some form of revegetation. Vegetation can assist in stabilising channel beds and banks, protecting streamsides, providing shading and providing valuable habitat.

The Threats to the Project

Cost of failure: The cost of designing and building a structure should be approximately proportional to the consequences of its failure. Where failure of a structure is likely to have severe costs or consequences, professional design and construction advice is advised.
Major nearby assets: Note should be taken of any nearby assets which could be affected in the event of a failed rehabilitation attempt.

Value of biological communities being protected: How will the project help rare, sensitive, or endangered communities, and what are the costs of failing to achieve this.

Potential causes of failure: It is important in the planning stages to consider the worst possible scenarios for failure, and to assess the likelihood and acceptability of each scenario. These should be investigated upstream and downstream of planned treatments. Examples of upstream causes could be sand slugs burying the work, high debris loads which may get caught in a structure, increasing the hydraulic load and resulting in failure during flooding. Other structures in the stream and their functioning or impeded function may provide clues as to potential causes of failure. Threats of vandalism and theft of imposed structures should be considered.

The threat of floods or droughts: It is important that managers accept this risk at the outset. The flood size/s the instream works are designed and expected to survive should also be specified. Loss of the structure in a flood larger than this then does not constitute failure. Long periods of low flow or drought can also lead to failure of particular rehabilitation measures (e.g. through loss of vegetation).

The unexpected at high flows: Instream structures must withstand the force of water, at least of the design flood specified. Unexpected changes may occur to the structure, for example, a permeable structure which traps flood debris may become impermeable.

The Right Tools

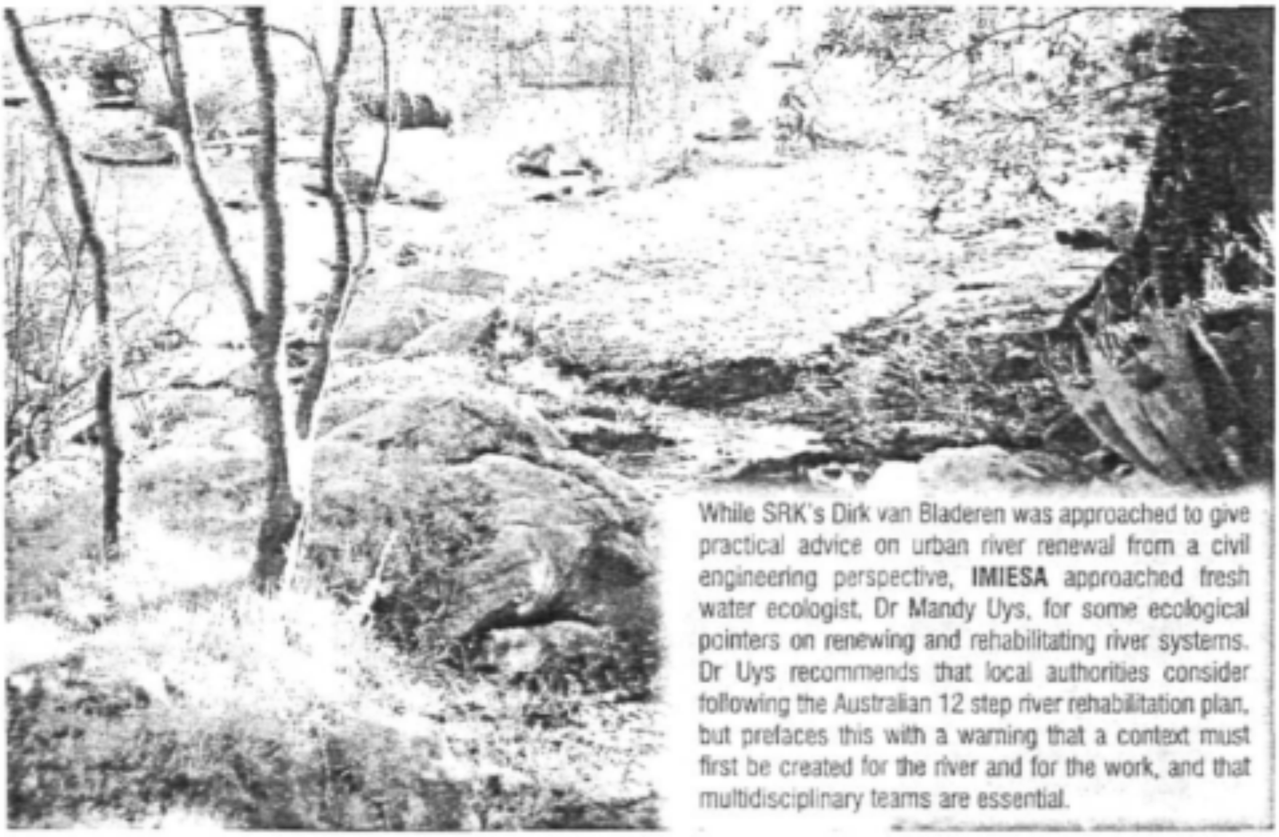
Repeated use of the same design: The example is cited of a single type of structure being installed repeatedly through a stream system, and all failing for similar reasons. The recommended approach is to tailor the structures to the streams, and where possible to use a variety of structures.

The right tool for the stream in question: Structural approaches that have worked in one stream may not work in another. Before adopting a technique which has been successful elsewhere, one should query whether the stream differs, in terms of: fauna, vegetation, sediment load, bed and bank material type, erosive potential of streambanks, stream power and size, history of disturbance and river management, or hydrology.

Check the approach: Small pilot trials may allow the relative merits of different approaches to be assessed.

APPENDIX 2

VARIOUS NEWS REPORTS ABOUT THE PROJECT



While SRK's Dirk van Bladeren was approached to give practical advice on urban river renewal from a civil engineering perspective, **IMIESA** approached fresh water ecologist, Dr Mandy Uys, for some ecological pointers on renewing and rehabilitating river systems. Dr Uys recommends that local authorities consider following the Australian 12 step river rehabilitation plan, but prefaces this with a warning that a context must first be created for the river and for the work, and that multidisciplinary teams are essential.

THE DISCIPLINE OF RIVER REHABILITATION

By Dr Mandy Uys of Laughing Waters, Aquatic Research, Consultancy and Media

Although river rehabilitation is a fairly new field in South Africa, we can learn a great deal from the experiences of other countries that have been practising this science for several decades. Techniques and approaches developed in areas with similar climatic conditions to ours (e.g. California, Australia) can be transferred and adapted to South African river conditions, thus saving us enormous developmental costs and time. Though we do not as yet have practical guidelines for rehabilitation of our urban or non-urban rivers, this is considered an urgent requirement, and moves are afoot to develop these with the help of international expertise and methodologies.

While efforts to manage rivers for human needs and safety, to manage rivers at a catchment level, to set environmental flows and improve water quality could all be viewed as helping to *improve* rivers, none of these are in themselves considered 'rehabilitation' unless they are included in a full rehabilitation planning, implementation and evaluation process, as shown below. For river rehabilitation to be taking place, it must be organised, practiced and viewed as a discipline in its own right, and needs particular approaches, methods and skills.

In South Africa, many types of river and asset maintenance or improvement, including flood control, bank stabilisation and stormwater management operations, are being (somewhat incorrectly) termed 'river rehabilitation' or 'river restoration'. Internationally, the term 'restoration' implies the return of a river to its natural, pre-impact state. This may be a noble aspiration, but is seldom achievable. Rehabilitation, on the other hand, focuses on achievable objectives and also aims for ecological and physical improvement and protection, with the aim of the system eventually resembling its pre-impact state. Where the river is seriously degraded, 'remediation' aims to improve the ecological condition and functioning of the river, but not to return it to something resembling its original condition. In urban rivers, the useful approaches to follow are rehabilitation or remediation.

In South Africa, river rehabilitation is now gaining research and funding attention and momentum. However, we have a lot to learn, and a great deal of talking and learning needs to be done at the engineering-ecology-economics interface! A strong link between these disciplines will be the greatest strength of a rehabilitation field in a country where water demand and sanitation will always take priority over ecological requirements and aesthetics.

Which brings us to the bottom line. Rehabilitation is an expensive business, and costs are quoted in the order of millions (of any currency!) per kilometre of river. South Africa will need to develop pragmatic, low-cost solutions in this field. To be cost-effective over the long-term, rehabilitation requires extensive planning and should not be undertaken without consultation with appropriately trained specialists. This is because successful rehabilitation relies on a sound understanding of river systems and of their 'recovery' processes. Before one can begin to plan, one must establish whether a river system is *recovering* from a natural or human-induced event or change, whether it is *degrading* due to the change, or whether it has *stabilised* following the change. This is a difficult task even for experienced geomorphologists, ecologists, and other specialists. Where a river is seen to be recovering, rehabilitation actions are planned to assist and possibly hasten that recovery. Where the system is degrading, the aim is to stop the degradation and to initiate recovery. Where the system is considered stable, possibly no action may be necessary, and money spent in this instance will probably be wasted.

PROCEED WITH CAUTION

The 12-step Australian river rehabilitation process (and explanatory notes) shown below is greatly simplified for the purpose of this article! The steps are not necessarily linear — many may be ongoing at the same time, and some will take several months (and lots of money!) to complete. The planning stages of the project are extensive and time-consuming, but years of international experience have proved these are critical to the (measurable) success of the rehabilitation.

The process is a practical rather than a specialist technical one, and is generic to river systems in general, and thus transferable to SA rivers. Stakeholder consultation should be initiated at the beginning of the process and incorporated throughout.

WHAT NEEDS DOING?

Step 1	Develop a vision and goal
Step 2	Share the vision and goal
Step 3	Describe the stream condition
Step 4	Identify the assets and problems

NARROWING IT DOWN

Step 5	Set priorities
Step 6	Develop strategies
Step 7	Set measurable objectives
Step 8	Check the feasibility

DOING IT

Step 9	Design the details
Step 10	Plan the evaluation
Step 11	Schedule and supervise the works
Step 12	Assess, evaluate and maintain the project

From: Rutherfurd I D, Jerie K and Marsh N (2000), *A Rehabilitation Manual for Australian Streams* Volume 1. A joint publication by the Cooperative Research Centre for Catchment Hydrology and Land and Water Resources Research and Development Corporation (now Land and Water Australia). Accessible at www.rivers.gov.au

NOTES ON EACH STEP

1. The vision is the *optimal* (and probably unattainable) solution, and serves as a reference point or guiding image from which to set realistic goals, objectives and targets. The 'goal' is set relative to this vision and is the foundation of the project. It is an overall, broad statement of what is to be achieved once the rehabilitation work is finished. It must also clarify what the stakeholders want to achieve. In a later step, the goal will have achievable objectives and measurable targets attached to it.
2. The idea is to identify all of the interests in the stream catchment at this early stage, to avoid the situation that at an advanced stage of the project, efforts could be disrupted by the actions of a powerful group or developer. A database of interested or affected parties should be developed and maintained.
3. Here, specialist input (ecologists, geomorphologists, hydrologists etc.) is required. First, the river is divided up into logistically and ecologically workable segments and/or reaches. A historic picture (or template) of what each segment or reach looked like under natural or as-close-as-possible conditions is then developed using historic and anecdotal information (aerial photographs, maps, historic accounts etc). Information on the following is included: diversity and populations of animals and plants present; riparian vegetation structure, diversity and natural regeneration; flow regime; any regulation or water diversions; longitudinal connection of water along the river; artificial barriers to movement; connections to the floodplain and alterations to this (including levees, changes to flow regime, blocked flood channels etc); water quality; channel structural complexity and stability. Collection of historic information will allow some estimation of the historic *rate and direction* of change in the system, and will clarify the extent to which change has occurred. The next task in this step is to describe the present condition of the river or section, assisted by a team of river specialists, who are trained in relevant methods. Again, information on all the attributes mentioned above should be collected for this step. The data collected to this point in the various surveys are now synthesised and edited, and various maps are produced (ideally including some in GIS format) which include an account of the important facts. Typically one requires at least a planform map of the section of river to be rehabilitated, showing divisions into segments and reaches and annotated with information on "natural state" and "present state" of key components, and larger scale maps showing key features in the individual reaches to be rehabilitated.
4. Wherever the historic picture and the present state picture of an aspect of the river section are the same, that component of the river is termed an 'asset' (i.e. an environmental asset). Any processes or planned developments that threaten assets must be identified. The rarity of the assets must also be identified to allocate relative value. This is useful in the setting of priorities. 'Problems' are those processes or activities that are threatening or impacting on present assets. An investigation into land-use in the catchment can assist in this process. Specialist and local knowledge and experience should be drawn on in finding clues to causes.
5. There are various methods of prioritising or ranking the reaches in terms of which should receive attention first, and to what extent they should be rehabilitated. Prioritising which problems to address first is a complex process receiving research attention internationally. Many criteria must be considered and ranked, which makes this a multidimensional analysis. Rankings may be changed on the basis of the importance of a particular reach in terms of its place in the life of a community, its proximity to other urban features, or the fact that it is a site with public or cultural significance. Costs of rehabilitation are further considerations in the priority setting process. The linkages between different problems need to be identified, either in a hierarchical fashion, such that one problem is fatal and the next is merely a limiting factor; or a direct relationship, such that one problem directly results from another. Understanding these linkages is important to ensure that problems are not solved in the

wrong order. Prioritising would include the following types of considerations:

Where large reaches are damaged, and the costs are equivalent, it may be more beneficial to fix a longer reach of stream than to attend to smaller scale, site-specific works; Where rehabilitative actions are likely to take several years to take effect, such as the reinstatement of riparian vegetation (10 years in drier regions), it may be wise to initiate the recovery process sooner rather than later; Where river improvement would be a good influence on the community, or would improve the visibility of the stream area, a higher priority may be assigned.

6. In this step, strategies are identified for the protection of environmental assets and/or the prevention of further degradation; the improvement of known environmental assets; and fixing present problems. The strategies developed here will be turned into objectives in the following step. As much effort should be put into developing strategies to *protect* the stream as into attending to degradation of assets. Strategies for changing human behaviours are also important and include providing education and motivation to individuals and groups.

   By the end of this step, one should have: river reaches ranked in order of priorities, with identification of major assets and potential assets in each reach; the identification of potential problems for each asset; and a list of strategies for reducing the impacts of these problems, and for enhancing or improving river protection.

7. The process of setting objectives allows the practitioner/s to determine what they would consider a successful outcome of the rehabilitation. The process also forces the scope and scale to be defined for the project: what proportion of the reach will be treated, whether the present problems are to be fixed or simply reduced in severity, what are the acceptable timescales for response, etc. It becomes clear during this process which objectives are not compatible. Evaluation of project effectiveness can only be carried out if, before implementation stage, measurable objectives attached to time periods were set.

8. Here a suite of questions such as the following complex questions need to be looked at critically: Is it affordable? (Budget for planning, information acquisition, any compensation, implementation, post project evaluation). Is it legal? What are the legislative and administrative constraints? Is it worth doing (or do negative effects outweigh positive ones)? How much confidence do you have that it will work? The feasibility must be assessed in terms of these sorts of questions.

9. Unbelievably, only does one begin with detailed planning for rehabilitation! This step may again be a lengthy one and requires multidisciplinary input, particularly from engineers and landscape architects, concerning the detailed design of the structures to be built or actions to be taken in each of the sections to be rehabilitated. Ecologists and geomorphologists will need to check the appropriateness of designs in terms of the overall objectives for the river. The output of this stage would be the design report and drawings.

10. Post-project evaluation is essential if river rehabilitation is to advance as a field, and this is planned and budgeted for at this stage of the proceedings. Again it is a fairly complex subject and will require the assistance of individuals trained in evaluation and monitoring. Valuation ensures that both practitioners and the public are informed whether or not objectives of a project have been met.

11. This step involves the scheduling and implementation of the solutions and strategies involved in the rehabilitation approach. Scheduling must allow for a logical 'flow' and timing of work in each area, with some tasks being carried out simultaneously. Implementation should proceed from upstream to downstream and must take seasonality of various river components (flow, biota, etc) into account. Costing and budgeting of the implementation phase must account for all of the costs, including specialist input, travel, planning, equipment, and implementation of actions.

12. This is the longest step at which an assessment is made of whether or not a project was a success, and if not, why. This should ideally last for a number of years, as that is the time period over which outcomes will become evident. This critical step includes reporting experiences and transferring learning both to other projects and to the field of rehabilitation as a whole.

Dr Mandy Uys is currently involved in a consultative process for a Water Research Commission project. The project aims to produce a new programme for the rehabilitation of rivers in South Africa.

If you are interested in participating in the consultative process, Dr Uys can be reached at:
laughingh20@icon.co.za

EARLY WARNING SYSTEM FOR ALGAL BLOOMS

Groundbreaking Australian research has developed a DNA-based method for rapid detection of toxic blue-green algae in fresh water, providing managers with an early warning system for potential algal blooms.

Serious health effects including damage to vital organs and nerve function can result from consumption of water contaminated with toxic blue green algae. Kim Fergusson from the Co-operative Research Centre (CRC) for Water Quality and Treatment has developed DNA 'fingerprints' for detecting toxic blue green algae in Australia's waterways.

Speaking at ENVIRO 2002/IWA Third World Water Congress, PhD student Kim Fergusson was awarded the Young Water Scientist of the Year for her research, an annual award for leading research within water-orientated CRCs.

"The method uses DNA probes to work out whether toxic algae are present in water, and it can do this in one day rather than the week it currently takes," she said. "Our method also lets water managers know if a water sample contains toxins or not.

"This eliminates any unnecessary and costly further testing of water that contains non-toxic algae."

Ms Fergusson's test has attracted international commercial interest, and researchers are currently looking to develop a field-testing kit that can be simply used by remote communities.

Neglected little rive

By Amalie Niland

Man must share blame for recent flood chaos

THERE is a river that runs through Vincent that every now and again gives a spectacular display reminding residents that it still exists despite being grossly abused and neglected.

One of these events resulted in damages amounting to millions after record rains flooded Vincent Park Shopping Centre and caused major damage to properties.

A major concern was not only the structural damage, but also the nasty by-products that inevitably got caught up in its wake. Human waste is released into the Ihlanza River whenever there is high rainfall.

The river follows a long and windy route through many suburbs before reaching its final destination – one of the most popular surfing beaches in the country, Nahoon beach.

The stream first becomes visible as a concrete storm-water canal alongside Neale Road in Vincent.

It runs under Chamberlain Road, between Hudson Park School and the Berea Gardens complexes and is then routed underneath the NE Expressway.

From there it runs through the suburbs of Vincent, Berea, Stirling and Nahoon, and then opens onto Nahoon Beach.

Dr Mandy Uys

River ecologist Mandy Uys of Laughing Waters (Aquatic Research, Consultancy and Media) heads a pilot project on the Ihlanza River that is based on the Australian river rehabilitation method.

"The Ihlanza River is by all standards a small river in a small catchment and is often overlooked by people."

Her hope is to try to recover some of its ecological function.

Over the years individual developers have contributed to many changes to the natural flow of this river.

"In its short length, the Ihlanza River has been exposed to almost every urban impact possible.

"Like so many urban rivers, it has been built over, built in, canalised, contained, diverted, had levees built or land reclaimed on its banks, had its natural bank vegetation removed and replaced, its in-stream habitat changed, removed or replaced, its natural flow completely altered and its natural water quality seriously affected." With the development of urban areas came the increase of hardened surfaces such as pavements, parking lots, roads and paved surfaces.

Vincent Park Shopping Centre bore the brunt of the floods because it lies directly in the path of the river and at a low point. "The storm-water drainage system has been designed to accommodate about 80 per cent hardened surfaces," said Dr Uys.

All the water that would normally infiltrate to the upper catchment groundwater, and be gradually released into the river, is now running overland or being drained into a storm-water system, and discharged into the river channel lower down in the catchment.

Adding to the problem is that the river channel has been built over and the river has been confined to underground tunnels.

"This is incomprehensible to a river scientist. It is asking for trouble to bury and contain a river," Dr Uys said.

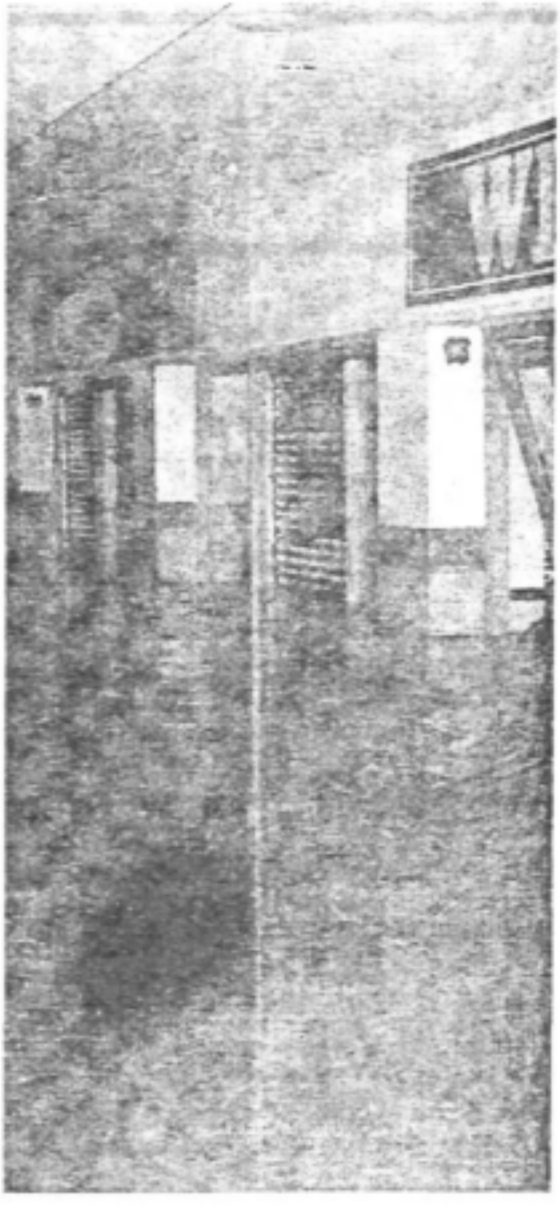
The upper section of the Ihlanza River, upstream of the NE Expressway, is particularly vulnerable to sewage spills during heavy rains.

Because the river is the lowest point in the catchment area, the main sewerage pipe – which is gravity fed – is routed alongside the river and storm-water drainage system in this area. "Manholes pop open when the sewerage pipe is carrying more waste water than it was designed for, or as in this case was filled up with storm water illegally discharged into the sewer."

"This is not strictly a municipality problem or engineering flaw, although the municipalities always get the rap for it," she said. She said the problem was more likely the fault of individual developers, builders and property owners who fed the runoff from their roofs and other storm-water runoffs into the sewerage system.

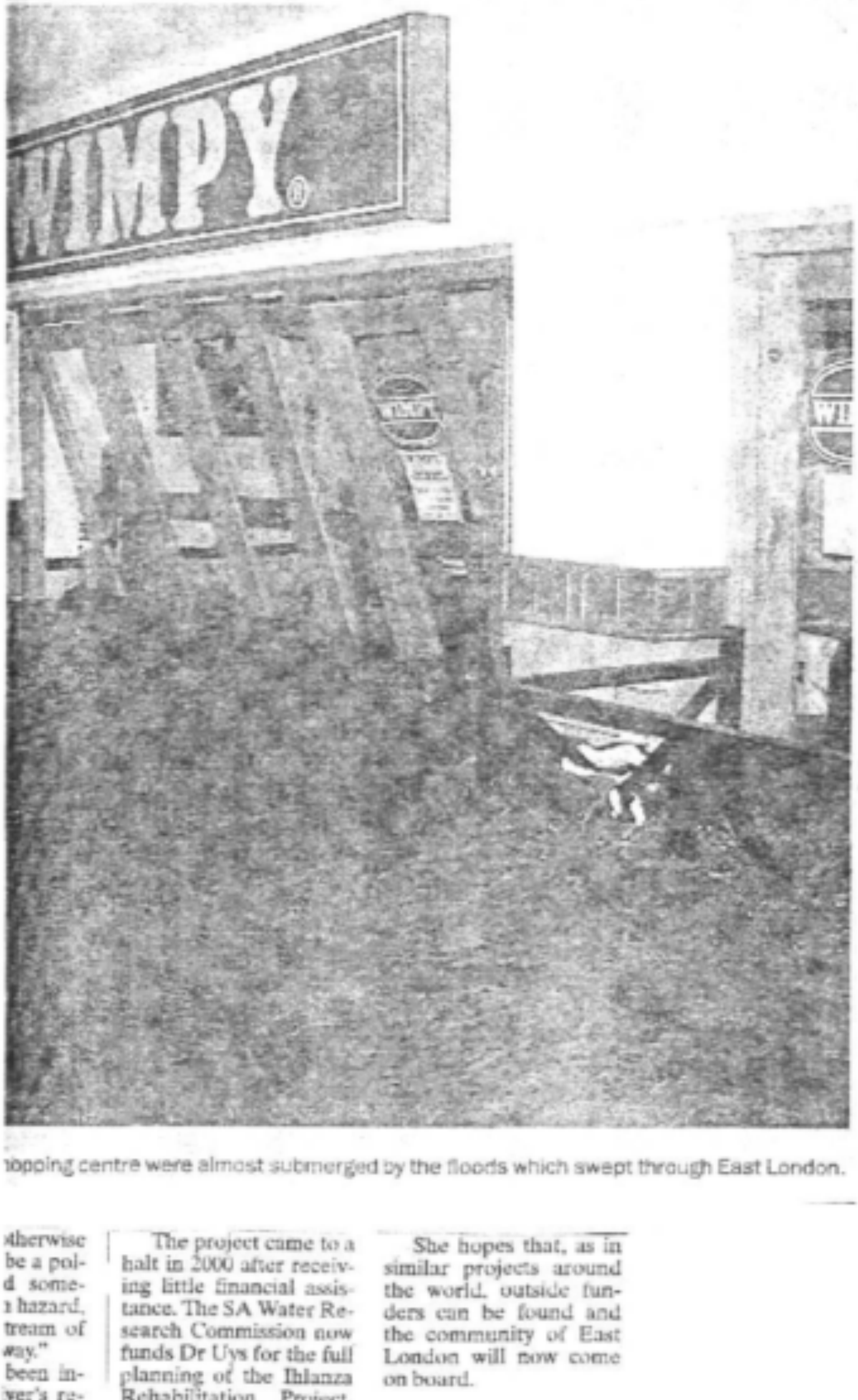
The problem should be addressed through public awareness and co-operation and innovative design, "otherwise this will always be a polluted river and something of a health hazard particularly upstream o the NE Expressway."

Dr Uys has been involved in the river's rehabilitation since 1998 when the Ihlanza River Watch Committee triec to improve the river.



INUNDATED . . . Shops in the Vincent Park shopping

er's revenge



hopping centre were almost submerged by the floods which swept through East London.

otherwise be a pol- d some- a hazard, tream of way."

been in- ver's re- ce 1998, za River tee tried iver.

The project came to a halt in 2000 after receiving little financial assistance. The SA Water Research Commission now funds Dr Uys for the full planning of the Ihlanza Rehabilitation Project, but the implementation of the plan, which is the most costly, has not yet been funded.

She hopes that, as in similar projects around the world, outside funders can be found and the community of East London will now come on board.

Flooding forces Vincent Park drain alterations

By Amalie Niland

OLD Mutual Properties are again stepping up requirements to prevent flooding of the Vincent Park Shopping Centre during heavy rains. The decision was taken after over 400mm of rainfall resulted in the flooding of the entire lower section of the centre.

The cause of all the problems is that the Ihlanza River runs down an underground pipe beneath the shopping centre.

Old Mutual Properties have already upgraded the stormwater drains on two occasions in 1990 and in 1997 and again after the March 2001 flooding.

"The municipality built a huge stormwater drain on the Surrey Road side of the property as well as additional catchment areas, and enlarged other catchment pits," said Vincent Park Centre spokesman Mandy Bellamy

Old Mutual Properties will meet the city council on the same issues again this week and is drafting proposals from consulting engineers.

Plans include widening of some drains, installing more catchment pits and increasing the height of the road in certain areas to reduce the inflow of water. The renovations are expected to be completed by October.

"Conditions in the area have changed since Old Mutual Properties' first analysis of rainfall and water flow. We have commissioned a consulting engineer to do a hydrological survey of the area. "One of the changes includes the fact that due to development, grassland was replaced by hardened surfaces.

All aboard

with Nick Pike

I WAS A turdy rat in 1978. At Nahoon Beach we all used to hang out on turdy block and we were all frightened of Da Boys.

At the beach where the Inhlanza (turdy) River spews out its miserable contents just to the right of the river mouth, there remains the remnant of a retaining wall enclosing some sand choked grass and a large concrete block. This block in its day was a manhole cover of some sort for the sewage pumping system. This was the proud turdy rat domain (what were we thinking?).

Anyway it was a really big thing to be a turdy rat. You didn't just step up to the block and say "Hi Guys" and you were one of the crew. No way Jose.

Your right of passage meant that you had to be flung off the wall by the senior turdy rats into the turdy river and then your status was earned! STOKED. You were in.

I am ashamed to admit that I sneaked onto the block without paying the price — perhaps Brad Manthe will throw me in posthumously if I ask him nicely.

The real dudes of the beach though were Da Boys. They were not so much Da Boys as Da Manna!

Near where the new pump station now resides are some toilets. Next to the toilets is a gnarly old tree. This tree was the access route to climb onto the roof of an old kiosk. Da Boys used to climb onto the roof and tan and hang out like the real lions of the beach that they were.

We respected them. They were the heavies. You know the *Lion King* movie where the hyenas say "Mufasa!" and then they all go, "Oooooh, it sounds frightening just to say it!"

Well that's how we turdy rats felt about da boys.

If the surf was cooking and the day was sunny then all was good. Da Boys surfed with the rats (as long as the rats had permission to be on the same peak) and the rats surfed with the wannabe rats.

It was a peaceful coexistence. But if the surf went flat and Da Boys got bored. Mayhem.

Nothing so fearful as a turdy raid. They only ever caught me once. I was painted white with PVA. It was only a shade lighter than my terror.

It was wonderful. It was magnificent. You should have been there. Those days the beach vibe was massive. Its all gone now. It's so different.

They say it takes a village to raise a child. I think it takes a beach.

To Steve Warren and Raz. Thanks okes it was great. You painted my right of passage. Lighties of today, you really missed it, and I am not talking about the surf yesterday.

See you in the water. Turdy rats rule okay?

This years Border Champions are:

- *Open: Roydon Bryant, U20 Devon Malthys, U18 Jonathan Bratton, U16 Keegan Nel, Girls: U20 Natasha Bastini, U18 Cindy Calbert, U16 Roxanne Hodge.*
- *Masters: Andre Malherbie*
- *Grand Masters: David Malherbie*
- *Super Veterans: Andy Austin*
- *Boys: U14 Clinton Granett, U12 Aaron Reilly.*
- *Surfer of the year: Brad Bricknel*
- *Junior Surfer of the year: Roxanne Hodge.*
- *Bruce Corby most radical move trophy: Paul Proctor*
- *Most improved junior: Lungani Memani*
- *Most improved Senior: Steven Venter*

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Intense study on Vincent Park's river

TO BE STUDIED . . . The Ihlanza River

By Amalie Niland

THE rather topical Ihlanza River, which was mainly responsible for flooding Vincent Park Shopping Centre, will be studied by a group of specialist scientists starting this weekend until next Thursday as part of a Water Research Commission project.

Ecologist Dr Mandy Uys said the whole length of the river would be studied including the source at Western Avenue, through the suburbs of Vincent, Berea, Stirling and Nahoon down to the mouth at Nahoon Beach in order to plan the rehabilitation of the river according to international methods.

Dr Uys, of Laughing Waters, a local consultancy, secured the funding for the project from WRC and will work closely with other scientists, the Buffalo City Municipality and the greater East London community.

The public will also be included in the planning process once the results have been made available. However, she said, funds were still needed for the implementation of the rehabilitation plan.

Dr Uys hoped that in line with the trends of the rest of the world there would be gradual public and private buy-in once the plan has been formalised.

"Business, schools, churches and the public are encouraged to participate by contributing information, time, labour, expertise, materials or funds in the upgrading of the river," she said.

Despite the river's being extremely degraded in many sections – particularly the lower end – it has the potential to recover.

"With a little help and a lot of energy, the Ihlanza team hopes to soon declare it un-politically correct to call the Ihlanza River the Tordy!" Dr Uys exclaimed.

The specialists who will be involved in the study include Dr Anton Bok (fish specialist), Dr Drew Birkhead (river hydraulics), Gregg Brett (fish specialist), Debbie Reynhard (vegetation specialist and horticulturist) and Dr Roy Wadeson (a geomorphologist).

Dr Mandy Uys

RIVER DANCE: Mandy Uys and Debbie Rynhardt performing environmental studies along the Ihlanza River in Nahoon yesterday. Uys warned that children should not play in the water as it is not safe.
Picture by ALAN EASON

Ihlanza to be cleaned up

EAST LONDON — The little Ihlanza River, which recently helped flood Vincent Park Centre, has been studied by a group of specialist scientists for the past week.

"They concluded that parts of the river can be restored to A-class condition," said Mandy Uys of Laughing Waters, a local consultancy.

"Other parts can be brought up to B or C, but there is a lot of work to be done."

The river runs from its source at Western Avenue, through the suburbs of Vincent, Berea, Stirling and Nahoon, to the mouth at Nahoon Beach.

The study was part of a Water Research Commission (WRC) project to plan the rehabilitation of the river following international methods.

Uys received funding from WRC to undertake the planning.

"I am consulting specialist scientists, the municipality and the greater East London community," Uys said.

"Once the scientific results are available the public will be included in the planning process."

But there are no funds yet to implement a rehabilitation plan.

Uys hopes there will be gradual public and private buy-in, as has happened in other parts of the world.

"We hope businesses, schools, churches and the public in the area will contribute information, labour, expertise, materials or funds to upgrading the river."

Although many sections are very degraded by every kind of urban impact, the river has the potential to recover.

"With a little help and a lot of energy, the Ihlanza team hopes to soon declare it un-politically correct to call the Ihlanza River the Turdy!" says Uys.

Interested parties can contact Mandy Uys at Laughing Waters 082 336 9838 — DDC

DAILY DISPATCH
SAT. NOV 16 Pg 4

A river runs through it

Gardening with Debbie Reynhardt

I RECENTLY had the opportunity to join a team making a close study of one of East London's local rivers, the Ihlanza, and I realises again the importance of looking beyond the garden walls, at the bigger picture.

Our rivers make the Eastern Cape arguably one of the most scenic places to live in South Africa and they beautify and give breath to our cities. Many urban residences border on streams and rivers and inextricably affect them, and in turn are affected by them: the very same rivers that flow into the sea past our beaches where residents and visitors alike love to relax.

As gardeners our aim is to beautify our homes, but by doing so responsibly we can also contribute to the conservation of our greater surroundings. Apart from the obvious pollution to rivers with solid litter discarded by unconscious litterbugs, urban rivers are also affected by the way home owners regulate drainage on their properties.

A common problem is the unlawful channelling of storm water drainage into the sewer system. When a number of households are doing this, the sewer system becomes overloaded with the extra volume of fluid which it was not designed to handle, and spills over.

Where sewer lines run alongside rivers the water becomes contaminated and fish, frogs, insects and other organisms maintaining the ecosystem are destroyed, turning the river from an asset into a health hazard.

By law, landowners are required to accept water from neighbouring properties adjacent or above them and then in turn have to channel this water downwards onto the next property or into the street.

Where the volume of the run off is increased significantly or drastic changes to ground level are made, suitable measures to deal with water flow should be made. One way of dealing with damp areas in the garden is to plant a bog garden with plants such as arum lilies, tree ferns and sedge grasses.

The plants act as a sponge and slow the flow of water during periods of high rainfall. Solid walls at the lowest point of the property create a dam effect during flash floods, which increases damage on the property below if the wall breaks. Damage can be minimised by converting these to more permeable structures.

The excessive use of dangerous chemicals such as pesticides and herbicides should be avoided so as not to contaminate groundwater which can then subsequently leach into our streams. Swimming pool backwash may also become a hazard when the chlorine laden water is discharged directly into running streams by home owners living adjacent to them.

The streams and rivers that have such an influence on our lives are likewise affected by all our actions.

It is said that water is one of the strongest forces in nature, but it is also one of the most vulnerable and susceptible to abuse.

Win a book on flower arranging

TODAY we're giving away a copy of Jenny Raworth's *Creating Flower Displays*, a beautifully presented expert guide for both novices and experienced flower arrangers. Published by New Holland Publishers, this useful book features clear, step-by-step instructions for a variety of projects, including table and festive displays, each with glossy photographs illustrating every step. There are more than 20 easy ideas for displays using artifical and fresh fruit, foliage and flowers.

To stand a chance of winning, send your contact details to *Flower Display Competition*, Daily Dispatch Features Department, Box 131, East London, 5200, to reach us before Friday.

An Interview with a South African River-Restorer

South Africa's rivers and streams are under stress. Dams, diversions, pollution, invasive exotic species, land clearing and wetlands drainage are just a few of the problems afflicting the nation's 19 major river systems. The government is struggling to balance human needs with ecological requirements, but with rivers already over-stretched and an estimated increase in water demand of over 50% in the next 30 years, it's an uphill battle. The semi-arid country is one of 25 African nations expected to be classified as water-scarce or water-stressed by 2025. South Africa's water stress is even spreading to its neighbors: dams in Swaziland and Lesotho divert rivers for use in South Africa's bigger economy, but both of these countries are expected to join the water-stressed ranks by 2025 as well. At the front lines are people like Mandy Uys, who is working to restore rivers. Uys grew up near the polluted Braamfontein Spruit – a tributary of the Crocodile River north of Johannesburg. Her background in freshwater ecology and years of experience in river-health monitoring led her to the practice of sustainable river restoration.

WRR: ***Generally speaking, what is the state of South Africa's rivers?***

MU: Rivers in this country are in moderate to poor health – although some are better than others. According to the National State of the Environment Report, every major river in South Africa has been regulated for water supply. This is a tough problem, especially since in many catchments the need for water exceeds supply. South Africa has taken various steps to categorize the state of its rivers, which is a good first step. There is a national program on river health funded by the Department of Water Affairs and Forestry (DWAF), which monitors the environmental state of rivers. There is also DWAF's classification system which describes the current state of the nation's rivers. Most of our rivers are impacted to varying degrees, as a result of imposed hydrological changes (damming, inter-basin transfers, etc.), clearing of riparian zones, water pollution, exotic plant invasions, urbanization, and poor catchment management.

WRR: ***What are some of the positive things you see on the horizon for the nation's waterways, and some of the negatives?***

MU: There are many positives on the horizon. Perhaps the key one is that the 1998 National Water Act requires that before any river water is allocated by the department for abstraction or use, an "Ecological and Human Reserve" must be determined for that system. The Ecological Reserve is the quantity and quality of water (and its distribution in time) required to maintain and protect the aquatic ecosystem and enable sustainable development of the relevant water resources. The Human Reserve is the quantity and quality of water required to satisfy basic needs of people in the catchment. But of the 50-60 reserves that have been determined for various parts of rivers, none have yet been implemented. Implementation will probably come on the larger systems first. Also, virtually no reserve-related environmental flow monitoring has been set in place. As with all policy, no matter how good it is, it's powerless until it can be enacted.

The negative side of things, in my view, is that we are way behind much of the rest of the world in our river rehabilitation strategy. While wetland rehabilitation has accumulated a decade of experience here and is now receiving considerable attention and funding from both private and government sources, there is as yet no coordinated research and development program for the practice of river rehabilitation in South Africa. The initiatives to improve waterways are generally undertaken on an ad-hoc basis, with no standardization or guidelines to assist planning, implementation or evaluation of success. The majority of the river "rehabilitation" projects undertaken are biased toward engineering requirements rather than ecological outcomes. Public awareness needs to be built, guidelines produced, and legislative frameworks set in place to establish river rehabilitation as a recognized practice in this country.

WRR: ***Describe the South African government's plan to rehabilitate the nation's rivers and streams.***

MU: The determination of the reserve for each of the country's major rivers is considered a major step toward re-establishing the health of our rivers, but flow and water quality issues are only part of a rehabilitation effort. To my knowledge, DWAF has no formal plan as yet to rehabilitate the nation's rivers and streams. Although rehabilitation is embedded in the National Water Act, the National Environmental Management Act and other legislation, there is as yet no legislative framework in place to provide for the definition and effective delivery of policy.

The parastatal research and funding agency, Water Research Commission (WRC), has announced its intention to launch a research programme for river rehabilitation in 2004. Although it is too early to speculate, I have always envisaged that the ideal program would be strongly linked to the DWAF reserve determination process, to local authority initiatives, the national River Health Programme, Working for Water (a program to clear alien vegetation, which can suck up much more groundwater than native vegetation), and wetland rehabilitation initiatives, amongst others. But this is work in progress, and there is still much to do!

WRR: ***What are some of the most effective solutions for fixing South Africa's greatest problems with its rivers and streams?***

MU: We have many problems, and the effective solutions are not all at our fingertips as yet. From a human health point of view, water quality is a huge problem. It has been reported that at least 650 South Africans die of diarrhea every day. In rural areas, the drinking of contaminated river water has in the past few years resulted in many deaths

Mandy Uys relaxing in Cape Town's hills.

due to cholera. This is only one of a number of water-borne diseases. Possible solutions in this case include increased funding and input into health care and health education in rural areas; and ongoing efforts to provide clean piped water and adequate sanitation to these areas.

From a river point of view, the considerable damage caused to river catchments by invasive alien vegetation encroachment is being addressed at a major scale by the Working for Water programme, managed by DWAF. This program has been effective in meeting the needs of a vast number of unemployed individuals who have been trained and paid to remove alien vegetation from their local catchments. Over the past five or so years, a large number of catchments have been cleared of invasive vegetation. The aims are alien control, the return of closer-to-natural flow in these catchments, and the reestablishment of indigenous riparian vegetation. A subsidiary of this program, Working for Wetlands, is focussed on wetland delineation, rehabilitation and management. These programs are highly effective solutions to both social and environmental problems, combining resource management and protection with capacity building and poverty alleviation.

The nation's urban rivers are possibly the area in which there is the greatest need for solutions in terms of water quality and physical rehabilitation. At present, storm water and flood-control management are still considered the major urban issues, and these are commonly solved by engineering applications. The bio-engineering approaches – using natural materials to remedy structural or hydrological problems in rivers, rather than resorting to concrete – that are being tried in the US, UK, Australia and elsewhere have not yet been adopted to any significant extent here. Catchment-scale planning, management and rehabilitation guidelines for urban rivers would be one solution which could be applied at a local authority level.

WRR: Describe the restoration project you are working on for the Ihlanza River.

MU: The Ihlanza River runs through the suburbs of East London, on the east coast. This little river, in its length of only 6km, has been exposed to every urban impact possible, including a shopping center being built over its channel! It has severe water quality problems and therefore health implications, as the river flows into a famous surfing beach. Having been involved with this system for a few years with a local committee, we already had a vision for the river, but needed the scientific work to be done to determine what was possible in terms of rehabilitation. In November 2002, a team of eight specialists did a week of fieldwork at the river to determine its present condition in terms of geomorphology, water quality and quantity, riparian vegetation, fish and invertebrates, and estuarine aspects. We will define likely pre-impact (natural) condition, a present condition, and a future attainable condition for each of the parameters. A series of objectives will provide the detail as to what is required in order to address the current problems.

WRR: In your work to restore this river, you have said: "The best gift we could give this city would be the skills to bring their rivers back to life." What kinds of skills do you envision citizens learning that will enable them to become actively involved in river restoration? How important is citizen involvement in maintaining the health of rivers?

MU: I'd say it is largely a matter of citizens becoming aware. Firstly the public needs to be equipped with some basics: that the river is a system which functions at the scale of the catchment rather than just the channel, and that rehabilitation takes decades rather than years. Also, how the river works, both at a physical level (flow, water chemistry, geomorphology) and at the biological level (fish, plants, invertebrates). Once there is some understanding of these fundamentals, basic skills would include the ability to identify alien and indigenous vegetation, and the signs that indicate that physical catchment problems exist – for example that channel incision may indicate excessively high urban flows; bank instability may relate to the clearing of the indigenous riparian zone, gullying or cattle trampling; sedimentation in an otherwise bedrock channel can signify upstream erosion; excessive algal growth indicates eutrophication; alien invaders are a sign of disturbance; discoloration may indicate water quality deterioration. They also need to understand their role in these impacts: for example, the effect that leading one's storm water drain into the sewage system can have on sewerage pipe capacity (and why sewage systems can spill into rivers).

Then there are the simple guidelines which inform the public "what now." What the principles of rehabilitation are; what aspects of the degraded system should be looked at first; what questions to ask and

continued on page 11

Interview continued from page 9

who to ask them of; who controls what (authorities and jurisdictions); how to find out what the river looked like historically; who to contact to provide expert advice; the concepts of historic, present and attainable future conditions and who is trained to provide this input; etc. These are the sorts of skills which empower communities to begin their own river rehabilitation projects. Once there is understanding of what is wrong and how difficult it is to fix it, I also think that public lobbying of local authorities and politicians would increase, which would be an enormous help.

WRR: If cost and politics were no issue, what would river restoration work be able to accomplish, using what tools?

MU: In urban areas, rehabilitation or restoration would, over time, have an enormous effect both on the landscape and those living in it. Returning aesthetically pleasing, clean, healthy aquatic ecosystems to urban areas, for example, would not only restore balance and energy to the natural ecology, food web and microclimate, but would also afford humans the chance to re-establish a relationship with the complex family of nature. Even if rivers were not restored to their natural state, but something resembling it, the psychological effect of having a once damaged, dangerous river "returned" in good functional order as a safe green corridor to a town or region would be significant.

The Hawaiian word for water is *wai*, which represents abundance and wealth. *Wai* is a life-force, rather than a commodity. Perhaps the effort and cost that it takes us to return rivers to something resembling their natural state will put us non-indigenous cultures in mind that nature is way beyond an amenity, and that water is far greater than a resource. I would like to think that restoration could eventually accomplish that sort of shift in human ideas.

As to the tools – well, obviously one needs appropriate policy, expertise, skilled individuals with experience in the field of river science and management, and an understanding of the principles of river and storm water engineering. But without enthusiasm, friendliness and dogged commitment, even the most skilled professional will fail to achieve long-term results. That is why community projects, informed by specialists, are such a great way to tackle restoration. My own experience is that successful rehabilitation requires an unstoppably positive person driving the project almost full-time.

WRR: What is your wish for South Africa's rivers for the new year?

MU: Firstly, closer-to-natural flow regimes! That is, for dammed rivers, implementation of environmental flow releases, where possible, and careful management of abstraction rates and flow reduction activities downstream. Appropriate flows at the right times of the year would bring many kilometres of river and estuaries back to life and balance. For urban streams, closer-to-natural flow regimes would require a decrease in the amount of paved surfaces (i.e., an increase in permeability), a willingness to try progressive storm water management approaches and flood control measures, and the adoption of bio-engineering approaches.

Secondly, increased water demand management and awareness thereof. Vast quantities of water are wasted by industry, wealthy homeowners, farmers – and leaky pipes! A strong media campaign to create awareness of the scarcity and value of our water resources would certainly help, as would implementation of sliding tariffs. There was a case a while back in Hermanus where the need for a water-supply dam was circumvented purely through imposed demand management. This is the sort of case-study which needs to be used to challenge other municipalities to do likewise. ■

The Ihlanza River

The Ihlanza River trickles through the 'burbs of East London, from Vincent through Berea, Stirling and Nahoon collecting little but pollution, until it spills into the sea at our world-famous surfing spot, Nahoon Beach. It often spits horrendously contaminated water into the surf zone where our young surfers catch their ritual daily waves.

Ask people about it, and they will acknowledge it as "oh, that drainage ditch..." or "that servitude". Now these constitute serious insults to a river. If the Ihlanza could speak, it would have some filthy language of its own about the earthlings who have caused it such shame. Here are three stories about local people who are working to fix the river and — as importantly — to fix our attitude about all the rivers that flow through the 'burbs.

Ihlanza River cleanup

By Aubrey Pepler, Grade 7 Selborne Teacher

I FELT the need for the Selborne boys to become pro-active in the community, and we decided to take on the cleaning of part of the Ihlanza River as part of our Outcomes Based Education (OBE) curriculum.

After a number of meetings with Ward Councillor Mrs Ann Rens and Buffalo City Municipality Director of Social and Ecological Services, Mr Willie Moritz, we set a date for the cleanup.

The idea was to clear pollution from one or more sections of the river and to capture the data regarding the type of pollution we extracted from the river onto data recording sheets.

This would be transferred to computer-based spreadsheets by the pupils themselves, and graphs would be created from this data.

The boys worked extremely hard and it was a fantastic exercise — it opened their eyes to how this river area had been abused by people.

By Pupils Rhuben Jacobs and Johan Janse van Rensburg

ALL THE Selborne Grade 7's were excited and full of energy, dressed in old clothing and wearing rubber gloves, ready for their river clean-up.

This was definitely not something you saw every day.

This was a wonderful experience as everybody took part in the clean up and learnt how important it is to conserve our beautiful planet.

It was a sunny Friday morning on May 16. All the boys were sent to clean up the Ihlanza River in Nahoon.

Many of the boys' moms helped with transport to and from the river. We were not just cleaning the river, but recording the amount of refuse collected in the river.

The refuse was recorded into many different categories such as plastics, rubber, glass and metal.

After all the refuse had been recorded, they were sent to Dr Mandy Uys who has been studying the river in depth for a long time. She has added our information to her studies.

This will hopefully prove to be helpful in the future conservation of the river.

As we arrived at the river near Galway and Roslin Roads, we met up with Christo Hunt, the Coastal Conservation Officer from the Aquarium.

Christo was our link from the municipality for this exercise. He made sure that we were all wearing gloves and gumboots before we got into the river.

He divided the boys into two main groups.

One group started at the most southern end of the river section (Galway Road) and the other group started at the most northern end of the section (Drake Road).

Aubrey Pepler, our teacher and the organiser of the river cleanup, said that we would work our way towards the middle of the section, picking up all the refuse on the way until the two groups met.

The boys collected the articles found in the river, and brought it to a central point where the data capturers logged the information onto specially prepared sheets.

It was absolutely amazing to see what sort of refuse had been found in the river and along the banks that day.

From small things (like metal pieces and cardboard boxes) to more rare items like a large broken oven and old tankies.

It was hard work for everyone. We had a few snack breaks inbetween, but we actually didn't want to stop cleaning the river.

One of the main problems that we found all over the banks of the Ihlanza River was the number of plastic bags. Plastic bags clearly stood out as a problem on the records, as this category dwarfed the other refuse categories.

Once the data had been captured, it was placed into black bags and taken away by Christo. The information we got was to be used to make graphs using spreadsheets on the computer.

We are sure that everyone who participated in the clean-up learnt something new and realised how important it is to conserve the natural environment.

And of course, everyone had a lot of fun cleaning the Ihlanza River.

RIVER RESCUERS: Selborne boys decided to take on the cleaning a section of the Ihlanza River as part of their Outcomes Based Education (OBE) curriculum.

Changing the filth back to the Ihlanza

By Mandy Uys

THIS little river, in its length of less than 6km, has been exposed to every urban impact possible.

Its channel has been widened and concrete-lined in several sections (for flood protection); the original channel has been moved; it runs under roads and bridges; its banks have been cleared; pollution and sewage are commonplace in it; and, worst of all, it has been built over by a shopping centre in Vincent.

Having been involved with this system for a few years with a local committee, we already had a vision for the improvement of the river, but needed some scientific work to be done to plan for its rehabilitation. In this sort of planning, one needs to take the whole river into account, not just a few short sections.

The project we have been busy with for a year now is funded by the Water Research Commission of SA, an organisation which backs most of the major water research in the country.

The aim of the work is test part of the 12-step Australian stream rehabilitation method, and in so doing, to come up with a plan for the rehabilitation of the most degraded sections of Ihlanza. The project funding covers for the rehabilitation-planning exercise only, and we hope to get further funding from local sources for the actual rehabilitation.

In November 2002, a team of eight scientists did a week of fieldwork at the river to work out the "present state" of the river, how badly different sections were degraded, and what it would take to improve them. We looked at geomorphology, bank vegetation, fish and invertebrates (river bugs), and the estuary.

The river was divided up into five different land-use zones, ten river segments and thirty river reaches to make it easier to study it for the project.

The information we gathered, and the planning for rehabilitation will be done using computerised maps, one per River Reach. For each Reach, we need to work out what the river looked like before humans settled, what it looks like now (and why), and what it possibly could look like in the future if we spent enough time and money fixing it and get the right type of experts involved.

We then come up with goals or objectives for each River Reach, and these will be shown on the maps. At the end of the project, we will produce a report showing the results of this exercise.

So far, the river in its present state is not looking great. But it has potential if we clean it up and make some changes over time. The lack of fish, and the tough bugs living in the river can be blamed on poor water quality and rather-too-regular leaky sewers. But we're working on that!

Much of the vegetation along the upper river has been cleared and replaced by grass and exotic trees and plants, but in lower sections of the river, a group of residents are gathering to plant indigenous river forest. This is an inspiring initiative.

Closer to the estuary, the forest and river are still in a fairly good condition and need to be protected. It would be a fine thing if, by the end of our project, more local East Londoners and the Municipality were on board with this initiative to transform the scruffy stream back to the clean Ihlanza.

The Hawaiian word for water is wai, which means abundance and wealth. When Hawaiians talk about wai they refer to a life-force, rather than a commodity.

Perhaps the effort and cost it takes to return rivers to something close to their natural state will remind us all that nature is more than an amenity, and that water is more important than a resource.

I would like to think that our mutual involvement in the rehabilitation of damaged rivers could gradually lead to that sort of change in human thinking.

• Dr Mandy Uys runs a consultancy called Laughing Waters and is involved in aquatic research. She is based in Gonubie, in East London.

APPENDIX 3

WATER QUALITY INFORMATION

Table 1: Target Water Quality Ranges: Guidelines as listed in DWAF (1996a and b)		
Variable	Recreational Use (DWAF, 1996a)	Aquatic Ecosystems (DWAF, 1996b)
pH	6.5 – 8.5	Values should not be allowed to vary from background pH values by whichever is the more conservative of: more than 0.5 of a pH unit or greater than 5%
EC (mS/m)	-	-
$TS^{180\,C}$	-	-
$DS^{180\,C}$	-	-
$SS^{105\,C}$	-	Background TSS should be < 100 mg/ℓ, and increase in TSS concentrations should be limited to < 10% of background levels
NH_3 as N	-	≤ 7 µg N/ℓ
PV (4-h) as O_2	-	-
o-PO_4 as P	-	< 5 µg/ℓ is considered sufficiently low to reduce the likelihood of algal and other plant growth
Al	-	≤ 10 µg/ℓ
Cd	-	≤ 0.40 µg/ℓ (depending on water hardness*)
Co	-	-
Cu	-	≤ 1.4 µg/ℓ (depending on water hardness)
Cr (Total)	-	Cr (VI): ≤ 7 µg/ℓ Cr (III): ≤ 12 µg/ℓ
Fe	-	Fe should not vary by more than 10% from background concentration
Pb	-	≤ 1.2 µg/ℓ (depending on water hardness)
Mn	-	180 µg/ℓ
Ni	-	-
V	-	-
Zn	-	≤ 2 µg/ℓ
Het. Plate Count Count / ml	-	-
Total Coliforms MPN / 100ml	0 –30	-
E.coli I MPN / 100ml	0 – 130	-

Table 2. Results of a single water quality sampling exercise for 8 points along the Ihlanza River, October 2003.

Sample	pH	EC (mS/m)	$TS^{180°C}$	$DS^{180°C}$	$SS^{180°C}$	NH_3 as N	PV (4-h) as O_2	o-PO_4 as P	Al	Cd	Co	Cu	Cr (Total)	Fe	Pb	Mn	Ni	V	Zn	Het. Plate Count Count / ml	Total Coliforms MPN / 100ml	E.coli I MPN / 100ml
	pH units	mS/m	mg/l	mg/l	mg/l	mg/l	Permanganate Value per hour as 02 = measure of oxidisable organic material in H20 - COD	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	Count/ml	Most probable number /100ml	
Reach 2	6.6	103.6	746	575	171	6.31	60.8	1.96	0.86	0.02	0.06	0.04	0.91	1.42	0.13	0.08	0.29	0.44	0.22	4000001	110001	110000
Reach 3	7.0	114.2	447	395	52	3.67	68.8	0.83	0.46	0.00	0.03	0.01	0.46	0.12	0.13	0.14	0.35	0.90	0.05	210000	110001	110000
Reach 6	7.2	91.1	709	696	14	2.68	72.8	0.62	0.70	0.02	0.05	0.04	1.71	1.04	0.33	0.38	0.39	1.45	0.01	120000	110001	4300
Reach 11	7.7	101.8	632	601	31	0.40	69.6	0.83	0.38	0.01	0.05	0.02	1.02	0.29	0.09	0.16	0.31	0.67	0.03	50000	4300	4300
Reach 14	7.8	92.4	738	681	57	0.22	73.6	0.62	1.54	0.01	0.03	0.00	1.48	0.00	0.16	0.09	0.35	0.95	0.01	940000	7500	2000
Reach 16	7.9	73.2	871	828	43	0.11	72.0	0.62	0.56	0.01	0.05	0.00	1.33	0.00	0.12	0.09	0.35	0.89	0.03	2000000	24000	24000
Reach 21	7.8	63.2	605	559	46	0.15	84.0	0.62	0.68	0.01	0.04	0.00	1.60	0.00	0.12	0.11	0.38	1.12	0.01	340000	24000	24000
Reach 26	7.7	64.6	544	513	31	0.11	74.4	0.62	0.62	0.00	0.05	0.01	1.08	0.32	0.09	0.06	0.33	0.61	0.04	180000	2300	920

Note that the position of all Water Quality sampling points is indicated on the Present State Maps in Chapter 4

SUMMARY REPORT : WATER QUALITY MONITORING

IHLANZA STREAM AT CHAMBERLAIN ROAD

From : 01 Jan 2003
To : 03 Jun 2003

	n	Max	Min	Median	Mean
pH	29	8.9	7.3	7.9	7.9
Conductivity (mS/m)	29	233.0	32.7	125.1	121.0
Ammonia Nitrogen as N	29	8.51	0.04	0.36	1.37
Permanganate Value (4-h) as O_2	29	45.2	2.0	6.7	9.5
Orthophosphate as P	27	9.7	0.5	1.8	2.7
Dissolved Oxygen (% Sat.)	25	92.00	0.0	67.0	62.9
Aluminium as Al	1	0.35	0.4	0.4	0.4
Cadmium as Cd	1	0.00	0.0	0.0	0.0
Cobalt as Co	1	0.00	0.0	0.0	0.0
Copper as Cu	1	0.00	0.0	0.0	0.0
Chromium (total) as Cr	1	0.05	0.1	0.1	0.1
Iron as Fe	1	0.16	0.2	0.2	0.2
Lead as Pb	1	0.00	0.0	0.0	0.0
Manganese as Mn	1	0.13	0.1	0.1	0.0
Nickel as Ni	1	0.00	0.0	0.0	0.1
Vanadium as Va	1	0.00	0.0	0.0	0.0
Zinc as Zn	1	0.00	0.0	0.0	0.0
Heterotrophic plate count (count/ml)	29	4000001	600	40001	
Total coliforms (MPN/100ml)	29	1100001	9200	110000	
E.coli I (MPN/100ml)	29	1100000	23	11001	

SUMMARY REPORT : WATER QUALITY MONITORING
IHLANZA STREAM AT GALWAY ROAD

From : 01 Jan 2003
To : 03 Jun 2003

	n	Max	Min	Median	Mean
pH	27	8.2	7.1	7.9	7.9
Conductivity (mS/m)	27	164.5	25.3	120.4	116.9
Ammonia Nitrogen as N	27	6.28	0.00	0.15	0.42
Permanganate Value (4-h) as O_2	27	7.6	0.6	3.8	3.8
Orthophosphate as P	27	3.0	0.3	1.1	1.2
Aluminium as Al	1	0.24	0.24	0.24	0.24
Cadmium as Cd	1	0.00	0.00	0.00	0.00
Cobalt as Co	1	0.00	0.00	0.00	0.00
Copper as Cu	1	0.04	0.04	0.04	0.04
Chromium (total) as Cr	1	0.04	0.04	0.04	0.04
Iron as Fe	1	0.31	0.31	0.31	0.31
Lead as Pb	1	0.00	0.00	0.00	0.00
Manganese as Mn	1	0.07	0.07	0.07	0.07
Nickel as Ni	1	0.00	0.00	0.00	0.00
Vanadium as Va	1	0.00	0.00	0.00	0.00
Zinc as Zn	1	0.00	0.00	0.00	0.00
Heterotrophic plate count (count/ml)	26	40001	400	3400	
Total coliforms (MPN/100ml)	26	11001	430	11001	
E.coli I (MPN/100ml)	26	11001	36	4600	

Note: Bacteriological results in excess of a figure are denoted by 01 for statistical purposes.

APPENDIX 4

PHOTOGRAPHS OF THE RIVER IN VARIOUS REACHES

Plate 1.1
The river first daylights into this canalised section. There is a manhole halfway along the canal. Flow direction shown.

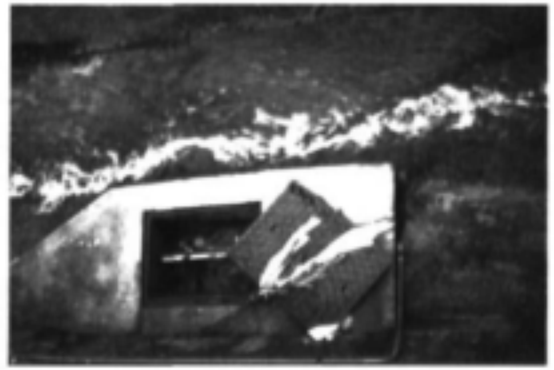


Plate 1.2
Open sewerage manhole in the concrete canal (see vertical arrow in Plate 1.3)

Plate 2.1
Steep canalised section of the river downstream of Neale Road. Direction of flow shown.

Plate 2.2
Canalised section of the river, downstream of Neale Road. Direction of flow shown

Plate 3.1
Sewage pipe bridge across upper section of the channel in Reach 3, immediately downstream of Chamberlain Rd bridge.

Plate 3.2 Extensive dumping on the left bank of the river immediately downstream of Chamberlain Road. Note the steep left bank (reclaimed). The manhole at bottom left is the same as that shown in Plate 3.1. Position of channel and flow direction shown by arrow.

Plate 4.1 Steep exposed left bank in mid-Reach 4.

Plate 4.2 Mid Reach 4. Thin arrow shows direction of flow. Wide arrow shows the flow path over-bank during 2002 floods

Plate 4.3 Reach 4 as viewed from the bridge downstream

Plate 5.1 Channel at top of Reach 5

Plate 5.2 Gabion-stabilised right bank in mid-Reach 5

Plate 5.3 Looking upstream mid-Reach, note undercut banks on right of picture (arrow)

Plate 5.4. Lower end of the reach, showing the vegetated gabion stabilisation on the right bank of the river. Channel and flow direction shown with an arrow.

Plate 6.1 U-shaped earth channel in Reach 6.

Plate 6.2 Panoramic view of Reaches 6 and 7 from the left bank, showing a bankfull flow following the August 2002 floods. Note the sedimentation on the right bank.

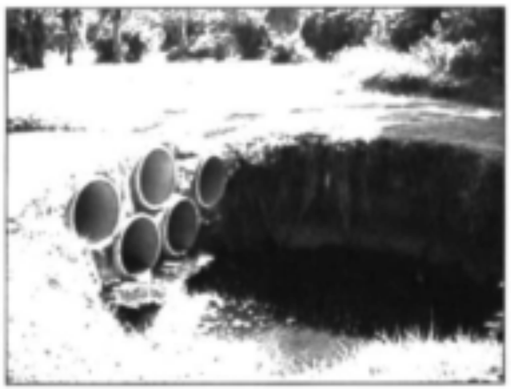


Plate 6.3 Bridge with culverts over mid-Reach 6. Note the bank scour downstream of the bridge.

Plate 6.4 Stormwater input point into Reach 6 from right bank

Plate 7.1 Reach 7 immediately downstream of concrete-encased cross channel sewage pipes

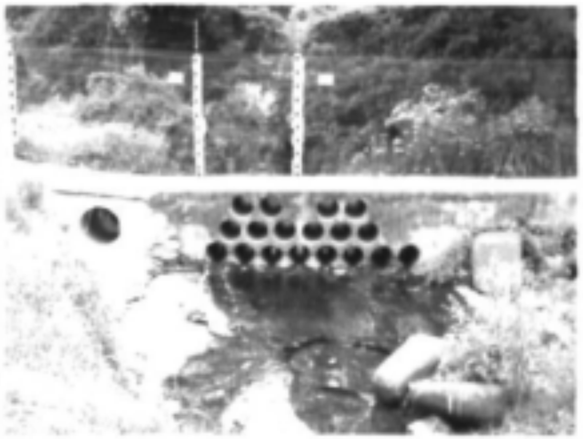


Plate 7.2 Top and middle of Reach 7. Note the steeply eroded right bank on the outer bend. Note the indigenous riparian vegetation on the banks lower in the section

Plate 8.1 Culvert bridge at the upper end of Reach 8

Plate 8.2 The river in Reach 8 (looking downstream)

Plate 8.3 Note channel incision in the middle sections of Reach 8

Plate 9.1 A view of the environs of Reach 9 (looking downstream from the road). This reach is relatively inaccessible.

Plate 10.1 Stilling well at top of Reach 10, receiving flows from the box culvert which runs beneath North East Expressway and Old Transkei Road

Plate 10.2 Blockage in the stilling well

Plate 10.3 Greg Brett (left) and Anton Bok (right) electrofishing a pool in lower Reach 10. Note the channel incision, the exposed, vertical state of both banks, and the disconnection of channel and floodplain.

Plate 10.4. Part of the specialist study team stand on the right bank at the lower end of Reach 10. Note the state of the right bank (left side of photo) and the water level relative to the floodplain level. L-R: Greg Brett, Lesley McGwynne, Anton Bok, Emile Plumstead, Debbie Reynhart.

		
Plate 11.1 Lower Reach 11, soon after August 2002 floods.	Plate 11.2 Bedrock section, looking downstream. Note incised banks	Plate 12.1 Looking downstream. Note channel incision.
		
Plate 13.1 Concrete canal in Reach 13.	Plate 14.1. Pool created by scour immediately downstream of the canal. Picture taken soon after 2002 floods, when large quantities of soapy water were discharged down the river after cleaning out Vincent Park Centre	Plate 14.2 Selborne Grade 7 Pupils having collected litter from the Ihlanza channel in Reaches 14-17

Plate 15.1 Top of Reach 15, downstream of Schulz Road bridge, showing the floodplain on the left bank cleared for development (this has been in a similar state for several years).

Plate 17.1. Selborne Grade 7 pupils categorizing waste collected from the river in this and upstream reaches.

Plate 17.2. Bedrock sill across the river in Reach 17

Plate 17.3 Galway Road bridge. Note angle of bridge relative to channel.

Plate 18.1. Galway Road bridge at top of Reach 18 (looking upstream). This bridge had to be stabilised following the 2002 floods.

Plate 18.2. Reach 18, downstream of Galway Road bridge. Note the reed encroachment and the sewage pipebridge across the channel.

Plate 18.3 Close-up of slow, constant leak in sewage pipebridge, where raw sewage trickles into the river.

Plate 19.1. Bedrock cliffs and boulder section in lower reach

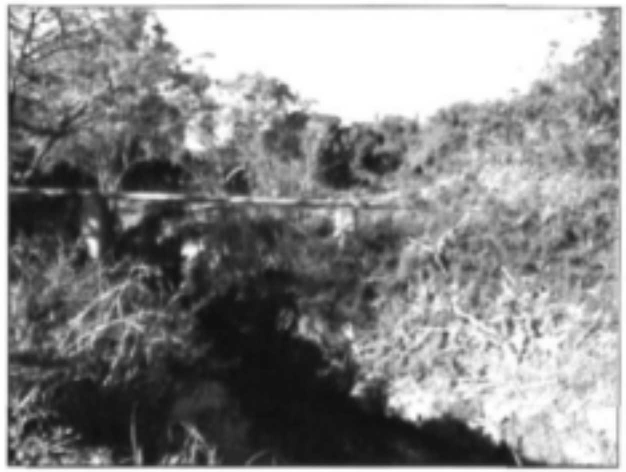


Plate 19.2 Overhead sewage pipe bridge near lower end of Reach 19

Plate 21.1 ðp of Reach 21. Banks invaded wi th aliens and sedimentation relatively extensive.

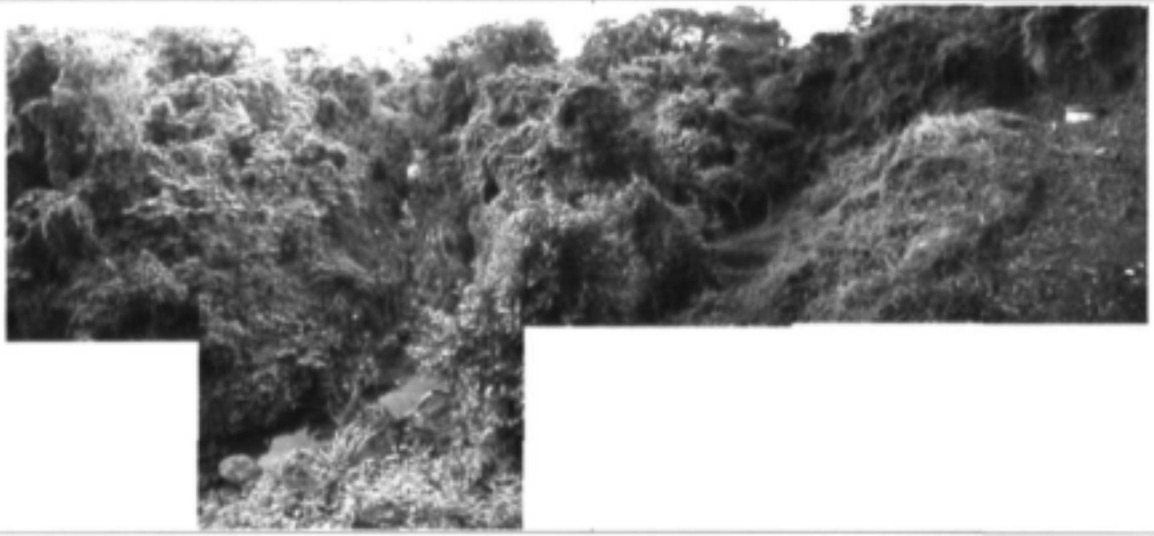


Plate 21.2 Lower end of the reach showing the extensive invasion by alien vegetation

Plate 22. Reach 22 looking downstream from top of the left bank. Note extensive alien creepers and clearing on left bank.

Plate 22.2 Note sedimentation on left side of channel

Reach23. 1 Major tree block in the channel

Plate 23.2. Lower end of the reach, looking upstream

Plate 23.3 (Locality not exact). Showing erosion and alien encroachment around sewerage pipeline at top of left bank

Plate 24.1 Upstream of the pipebridge over the channel

Plate 25.1 Looking upstream towards weir

Plate 26.1 Boulder bed section. Note the canopy cover in this reach.

Plate 27.1 Bedrock section

Plate 27.2 Lower reaches, open canopy section

Plate 28.1 Illustrating the bedrock cliffs in the lower reach

Plate 29.1 Looking upstream towards the ebb and flow in Reach 29

Plate 29.2 Looking downstream from the area of ebb and flow in Reach 29. Note the intactness of the riparian vegetation

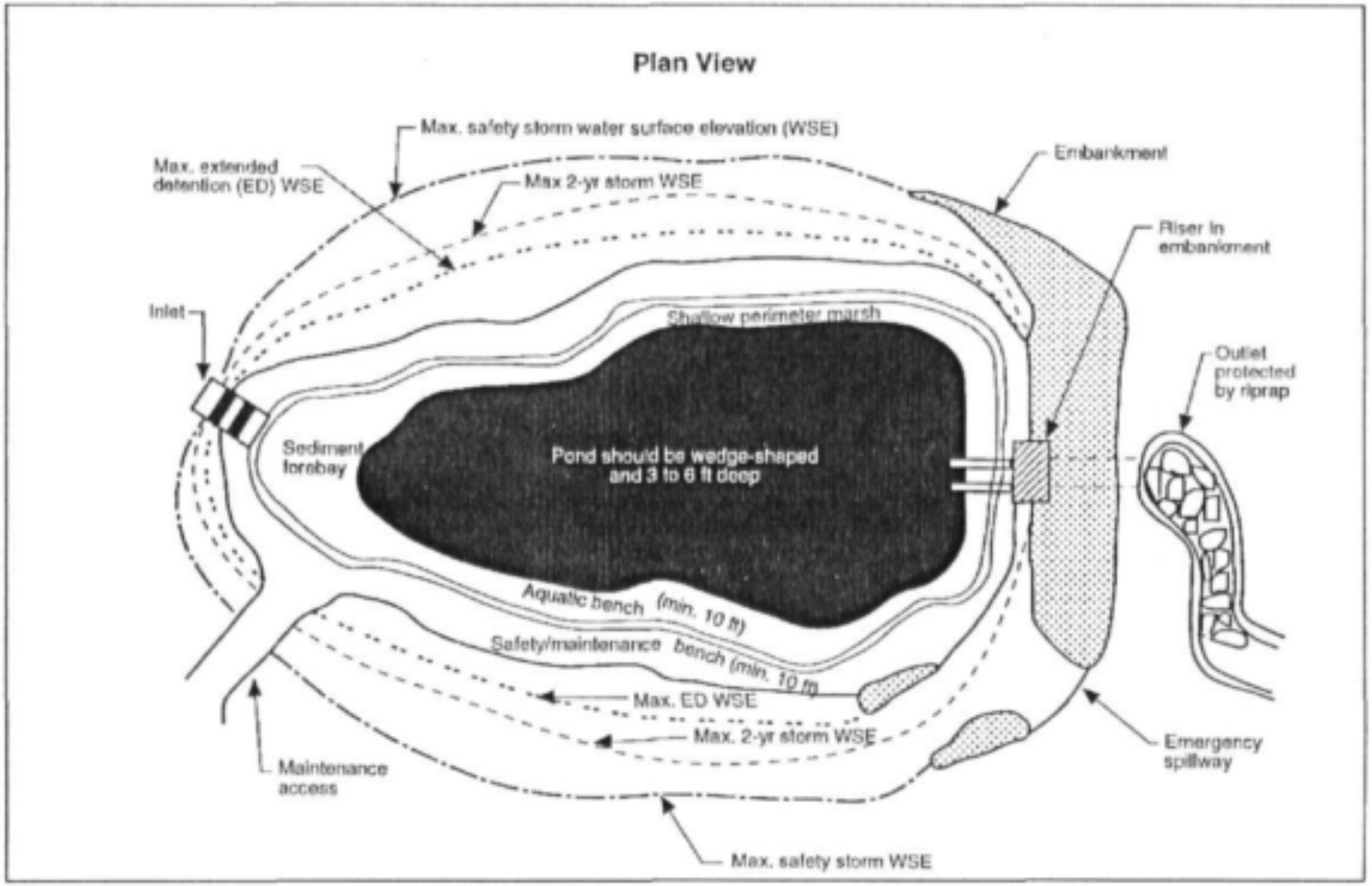
Reach 29.3 Further downstream the estuary widens and deepens towards the mouth.

Plate 30.1 The mouth of the Ihlanza looking from the left bank. Note the concrete bollards used to stabilise the dune (one large section of stabilisation is washed out).
Plate 30.2. The sewage pipe bridge across the estuary in Reach 20. This pipe continues up over the dune system visible in Plate 30.1 and leads to Hood Point Sewerage Treatment Works.

Plate 30.3 The Ihlanza River runs into the sea on the world famous surfing beach, Nahoon. Young learner surfers typically surf near the point at which this river enters the sea.

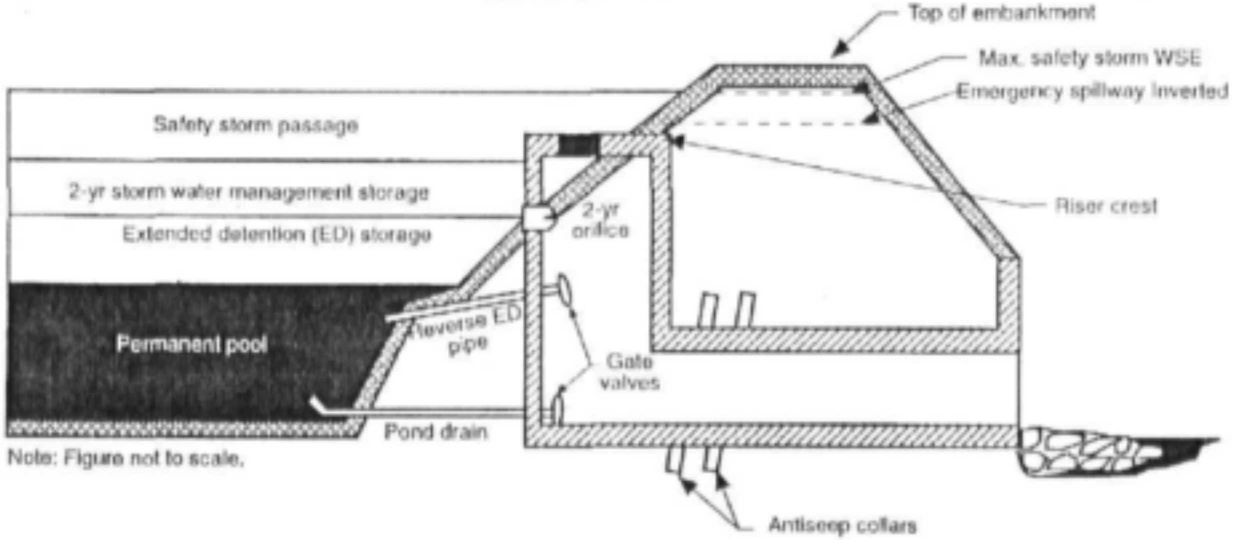
APPENDIX 5

CONCEPTUAL DESIGNS FOR REHABILITATION MEASURES



Design 1. Stormwater detention system similar to that recommended for construction in Reach 2. Note that the major adjustment to this design would be the enabling of continuous flow through the system, such that ponding would only occur under extremely high flow conditions or flood. Design from: EPA Handbook for Urban Runoff Pollution Prevention and Control Planning. EPA/625/R-93/004.

Cross Section



Note: Figure not to scale.

Design 1. Cross sectional representation of detention system similar to that recommended for construction in Reach 2. Design from Design from: EPA Handbook for Urban Runoff Pollution Prevention and Control Planning. EPA/625/R-93/004. Note that the major adjustments to this plan, as recommended by Koekemoer (pers.comm.), would involve ensuring a constant flow through the structure, ensuring that base flows were released to the downstream sections of the river. It is likely that a bidem-lined "leaky pipe" may be used as a mechanism to prevent excessive sedimentation in the flow-through water.

Notes on rehabilitation of vegetation on the Ihlanza river:

Species list for the detention pond area at Reach 2:

Tree species are to be planted around the perimeter to screen the pond from the road. A combination of large and small, pioneer and climax species are to be used:

Syzigium cordatum (Waterberry)
Grewia occidentalis (Crossberry)
Diospyros whyteana (Bladder nut)
Cunonia capensis (Red Alder)
Celtis africana (White stinkwood)
Halleria lucida (Tree fuschia)
Podocarpus falcatus (Common Yellowwood)
Ficus sur (Cape fig)
Pittosporum viridiflorum (Cheesewood)
Trema orientalis (Pigeonwood)
Schotia latifolia (Boer boon)

The edges of the detention pond could be planted progressively from the inner limit closest to the base flow channel to the outer edge with pockets of the following plants respectively; Mariscus congestus, Cyperus textiles, Zantedescia aethiopica and Setaria megaphylla, as well as Stenotaphrum secundatum (which also be used as a groundcover between the trees and for access paths for maintenance staff)

Suggested trees species for the replanting of areas in Reach 3 where alien vegetation is to be removed.

Podocarpus falcatus (Common Yellowwood)
Harphephyllum caffrum (Wild Plum)
Halleria lucida (Tree fuschia)
Calodendrum capense (Cape chestnut)
Grewia occidentalis (Crossberry)
Hippobromus pauciflorus (Basterperdepis)
Celtis africana (White stinkwood)
Pittosporum viridiflorum (Cheesewood)

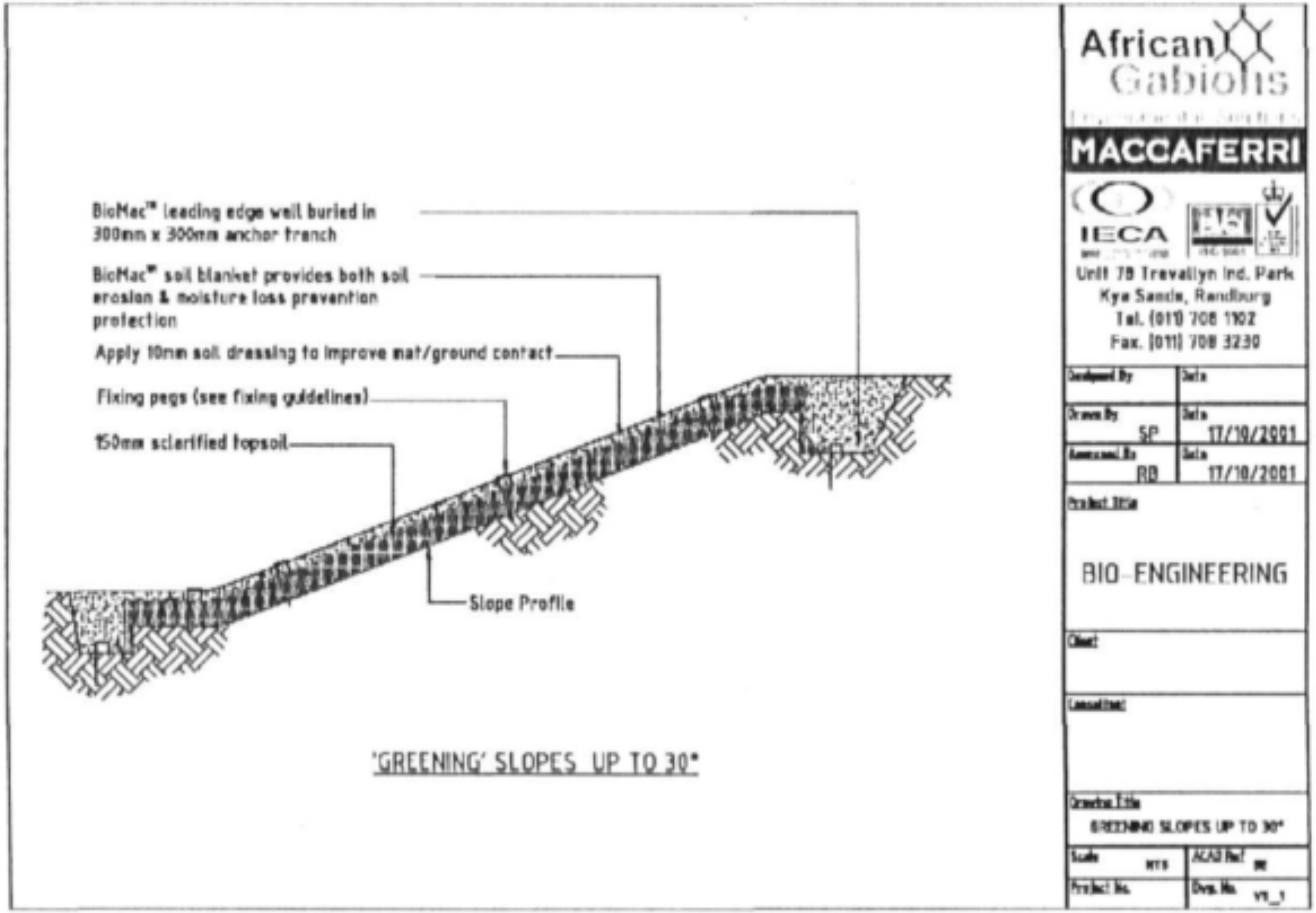
Suggested woody species for restoration of the canopy on the right bank of section 4:

Calodendron capensis (Cape chestnut)
Podocarpus falcatus (Common yellowwood)
Celtis africana (White Stinkwood)
Commiphora harveyii (Red stemmed corkwood)
Apodytes dimidiata (White pear)
Cordia caffra (Septee)
Rothmania globosa (September bells)
Dovyalis zeyherii (Wild apricot)

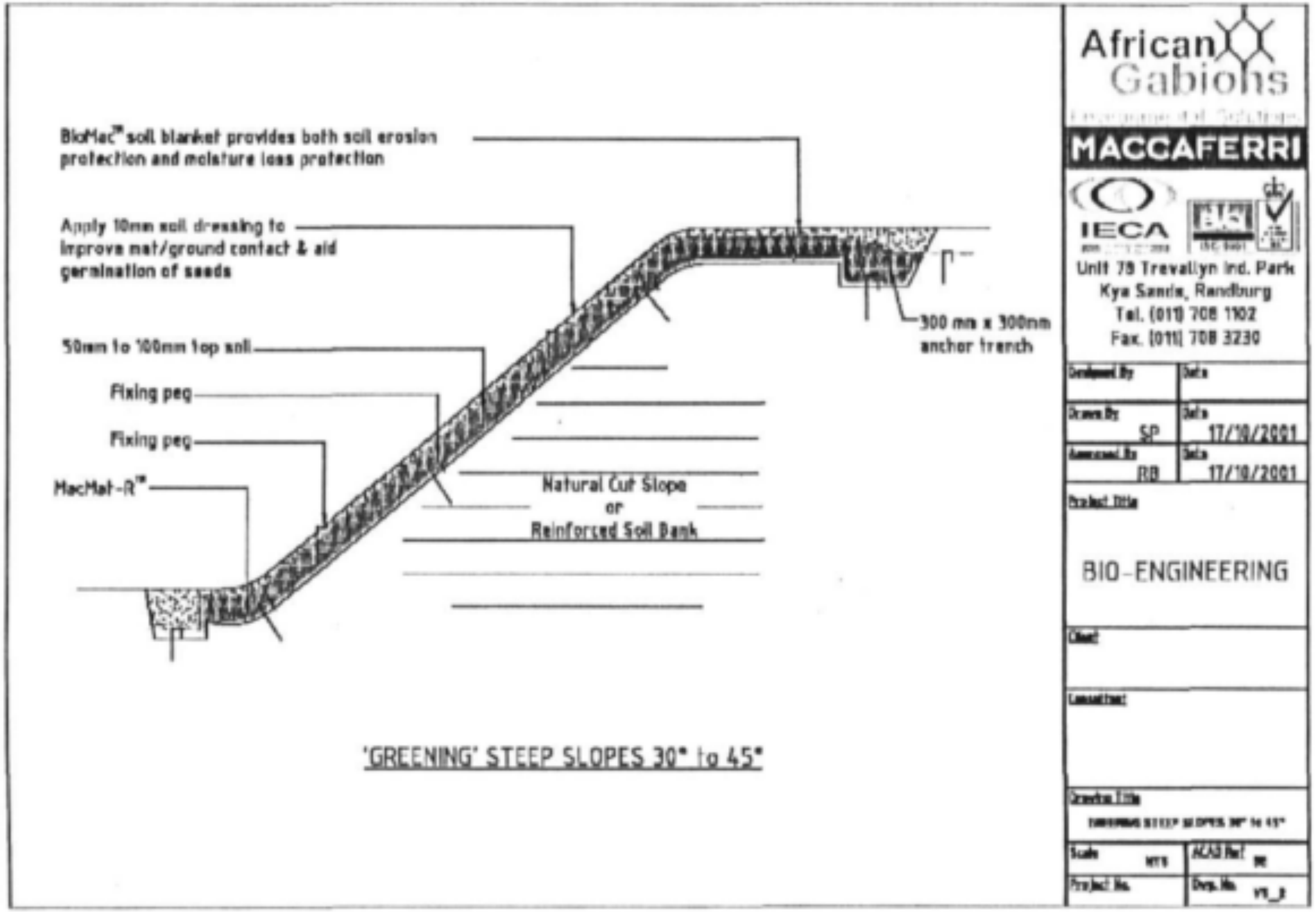
Suggested plants for rehabilitation of the slopes immediately below the bridge at the beginning of Reach 5:

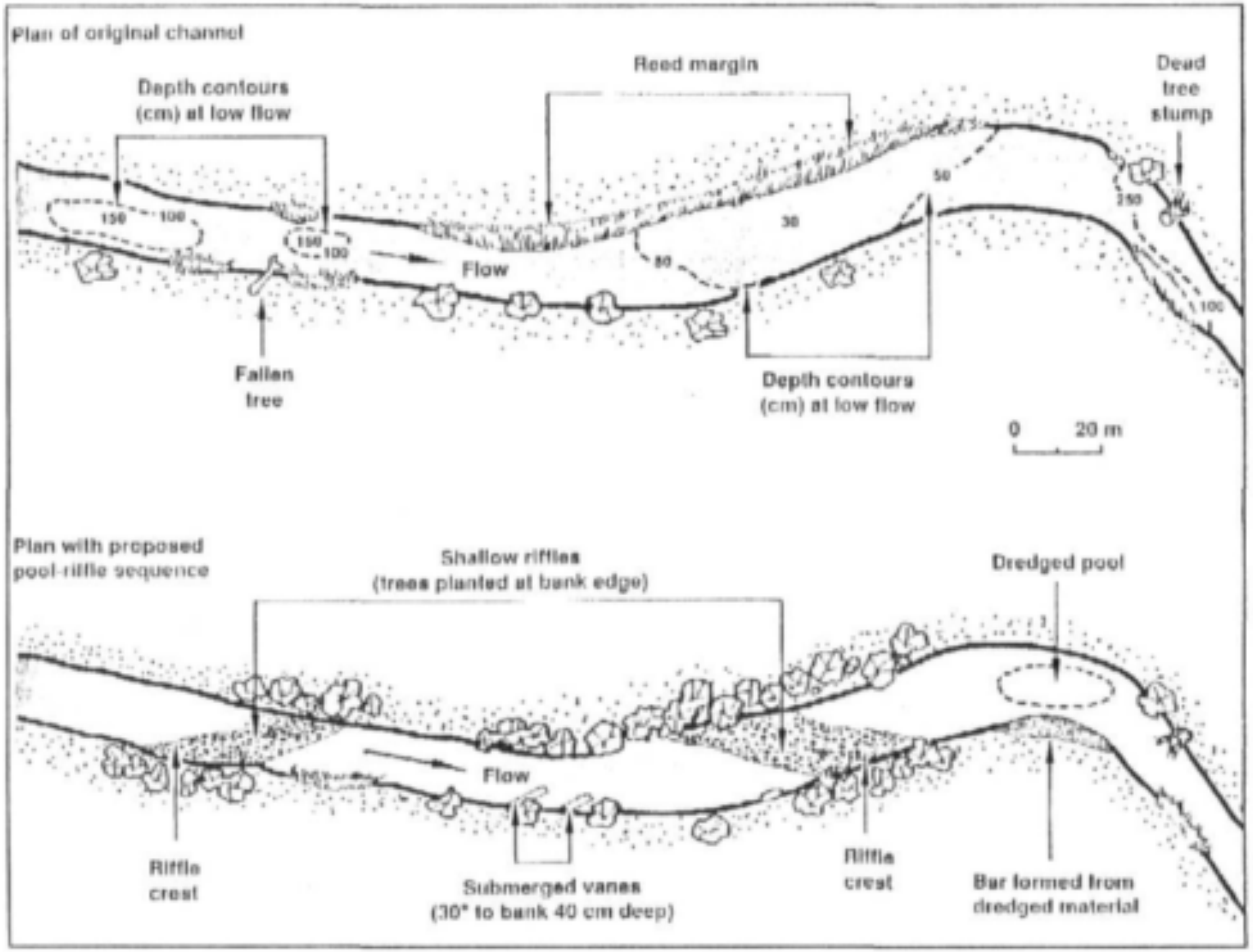
- Stenotaphrum secundatum (Buffalo grass) on revetted slope of right bank, interspersed with pockets of Dietes grandiflora.
- Plant sedges and rushes or perennial bog plants at the toe of the left bank such as Mariscus congestus, Juncus krausii and Kniphofia sp. to give continuity with the planting higher up on this bank.

DESIGN 2a. Stabilisation and greening of slopes up to 30 degrees.

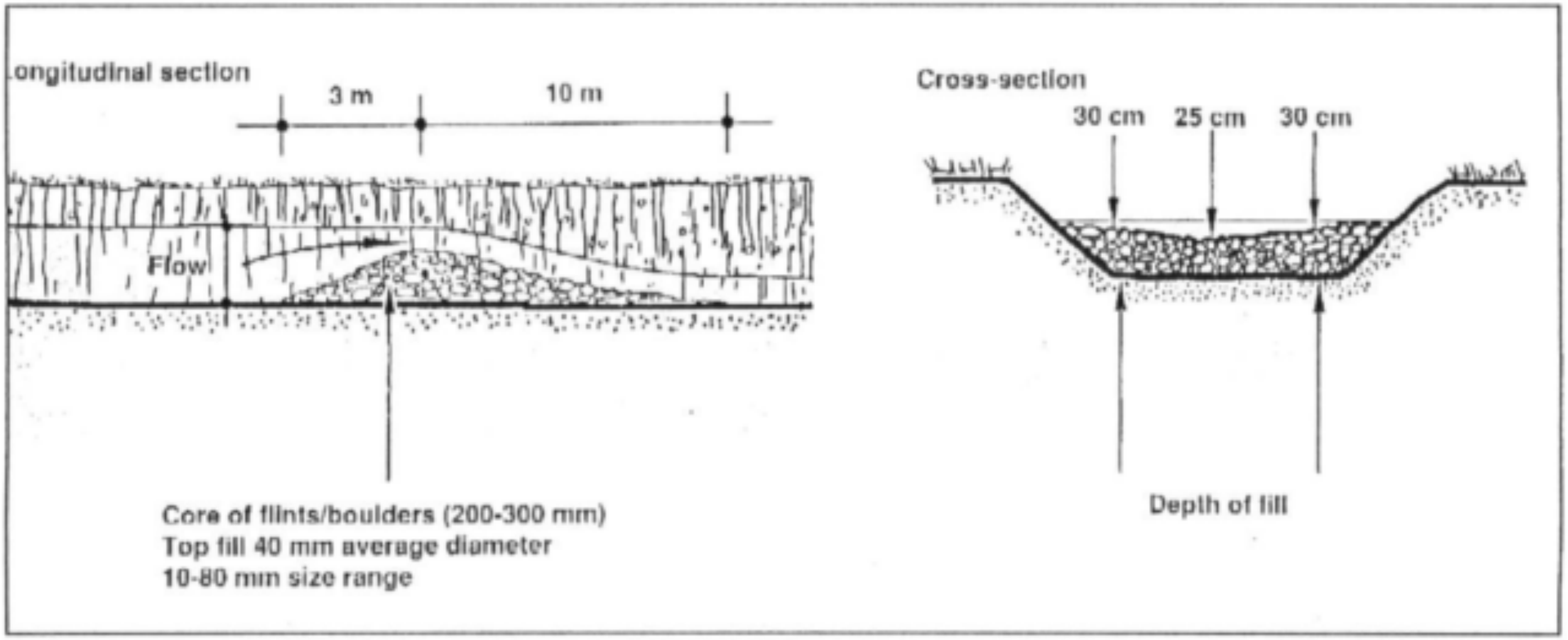


DESIGN 2b. Stabilisation and greening of steep slopes 30 to 45 degrees.



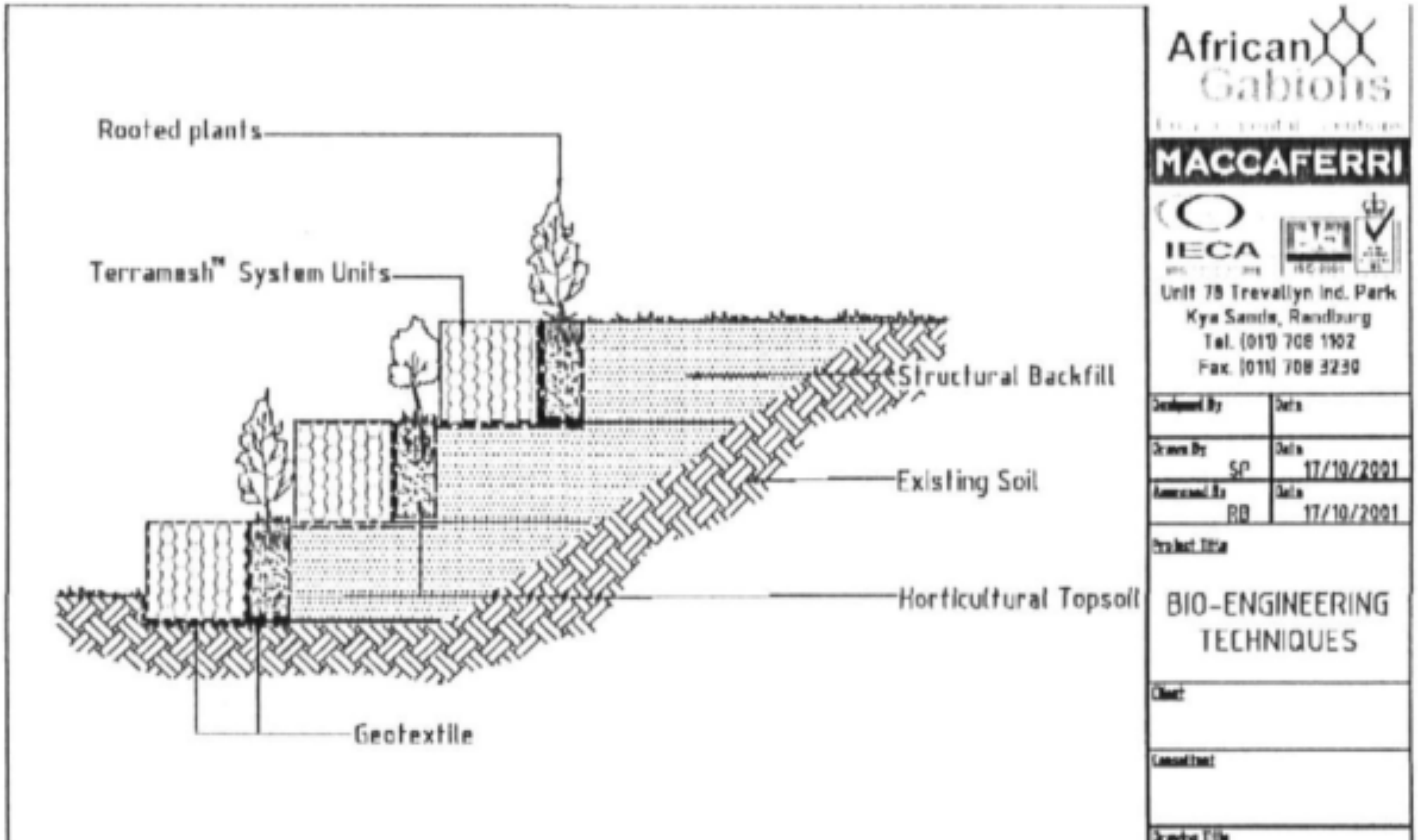


Design 3. Planview of construction of rapids from large stones, and covered with gravel slightly coarser than the local bed material. See notes in text regarding stabilisation of riffle areas. Design from Cowx and Welcomme 1998.



Design 3. Longitudinal and cross sectional views of construction of rapids from large stones, and covered with gravel slightly coarser than the local bed material. See notes in text regarding stabilisation of riffle areas. Design from Cowx and Welcomme 1998.

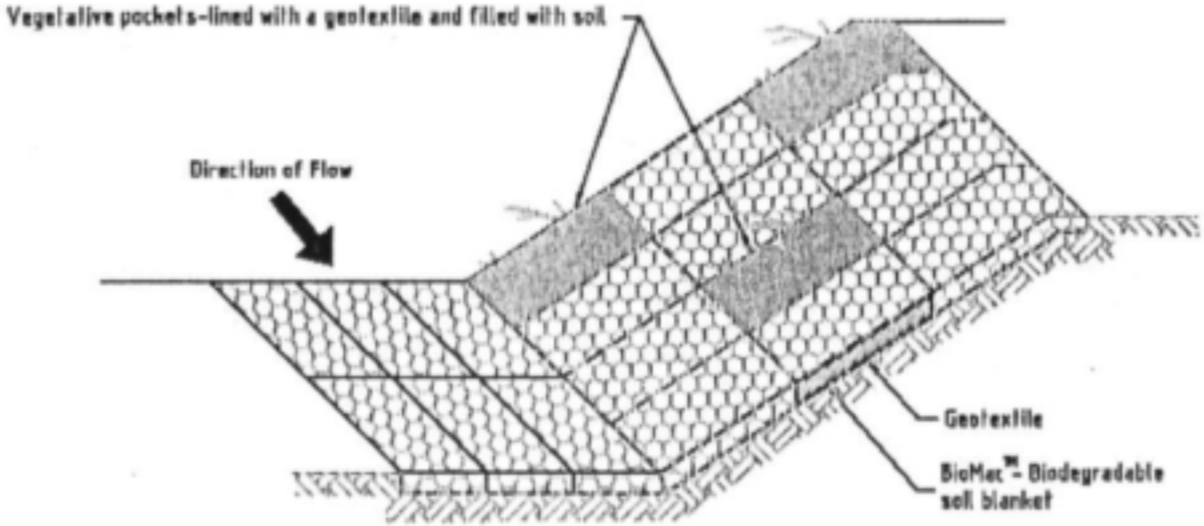
DESIGN 4a: Various options for bank stabilisation with planting.



VEGETATED TERRAMESH SYSTEM STRUCTURE

DESIGN 4b: Various options for bank stabilisation with planting.

NOTE:
All materials manufactured are in accordance with SABS 675 and SABS 1580 and construction methods used are in accordance with SABS 1200DK and African Gabions Specifications.



RENO MATTRESS LINING WITH VEGETATIVE POCKETS

African Gabions
Environmental Solutions
MACCAFERRI
IECA

Unit 7B Trevallyn Ind. Park
Kya Sands, Randburg
Tel. (011) 708 1102
Fax.(011) 708 3230

Designed By SP	Date 12/12/2001
Drawn By SP	Date 12/12/2001
Approved By MP	Date 12/12/2001

Project Title

BIO-ENGINEERING TECHNIQUES

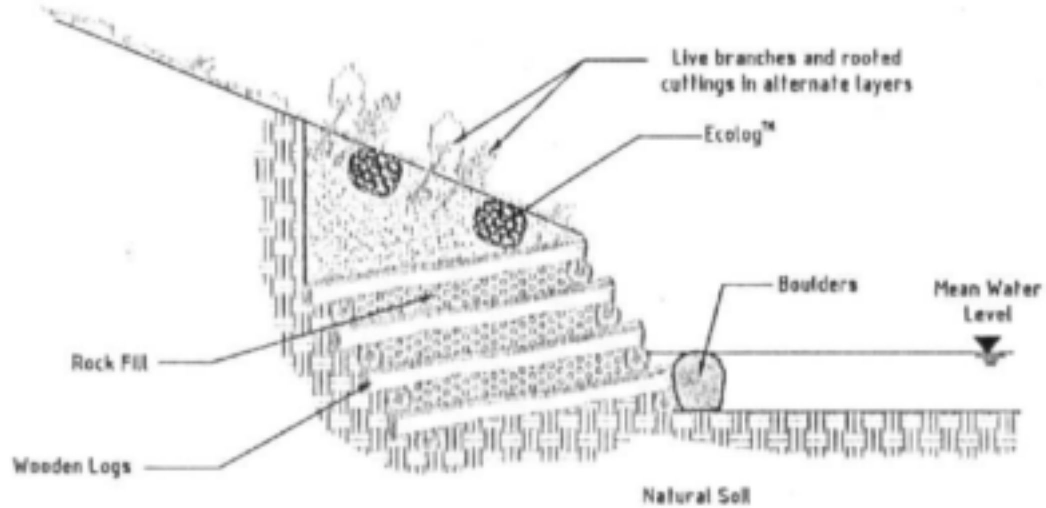
Client:

Consultant:

Drawing Title
Reno Mattress - Vegetated pocket

Scale NTS	ACAD Ref BHC
Project No.	Dwg. No. B2_1

DESIGN 4c: Various options for bank stabilisation with planting.

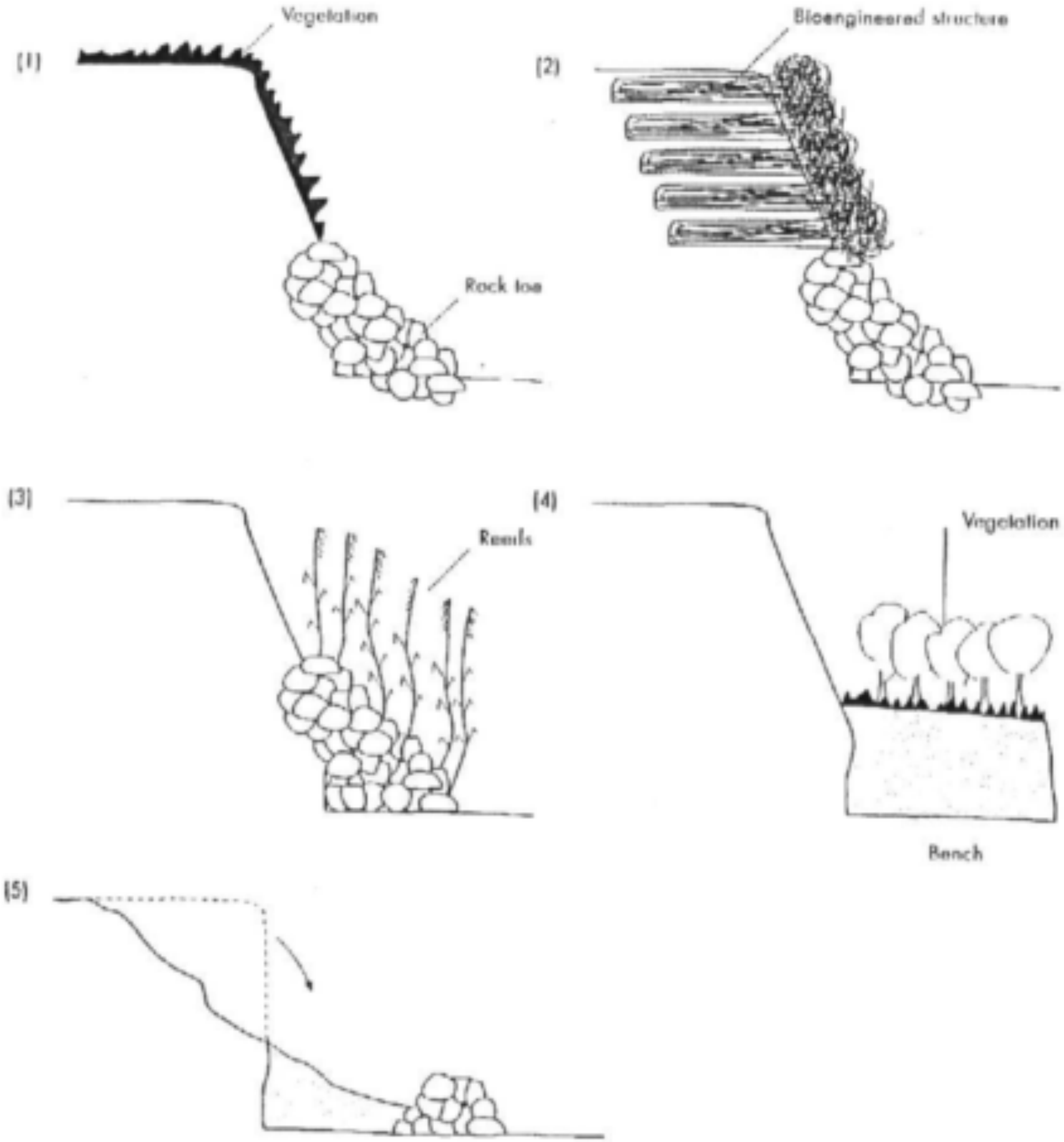


CROSS - SECTION OF GREENED TIMBER CRIB WALLS

African Gabions
MACCAFERRI
IECA
Unit 78 Trevallyn Ind. Park
Kya Sands, Randburg
Tel. (011) 708 1102
Fax (011) 708 3230

Designed By SP	Date 12/12/2001
Drawn By SP	Date 12/12/2001
Approved By MP	Date 12/12/2001
Project Title BIO-ENGINEERING TECHNIQUES	
Client	
Consultant	
Drawing Title Greened Timber Crib Walls	
Scale NTS	ACAD Ref
Project No.	Dwg. No.

DESIGN 5. Options for stabilisation of localised bank scour or erosion .

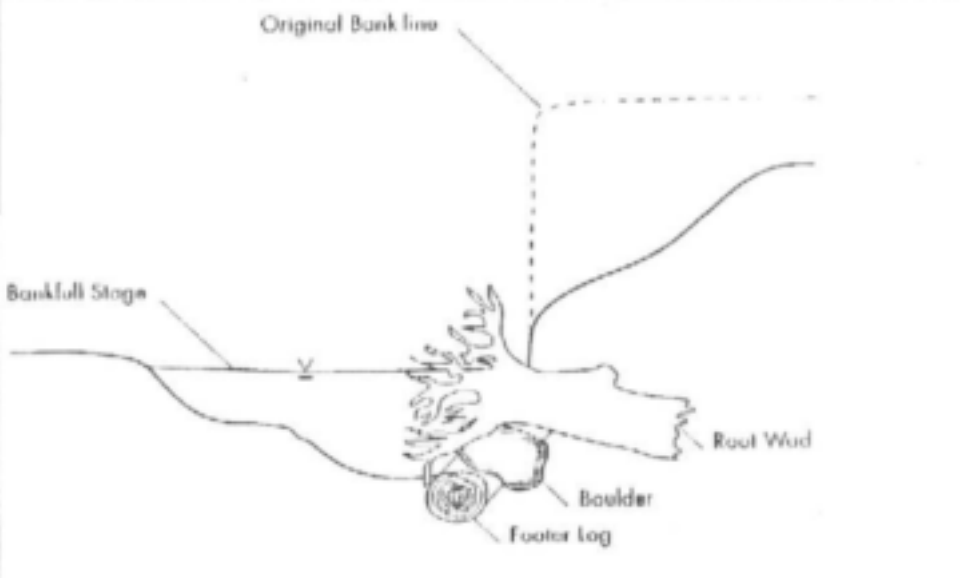


Methods for bank protection, incorporating vegetation.

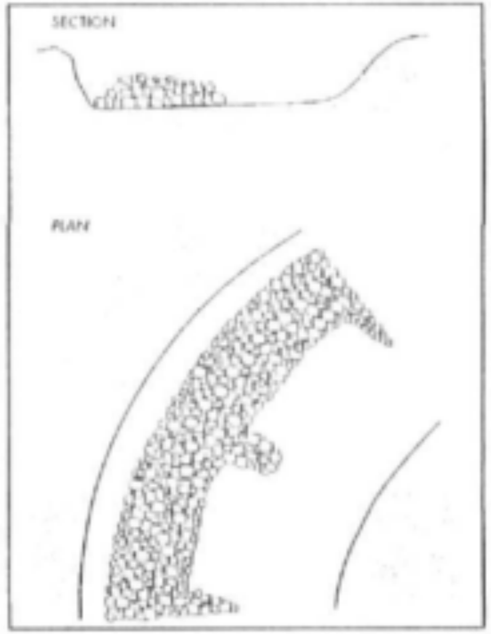
(1) Rocking the toe of the bank and revegetating the bank above the toe
(2) Rocking the tow and stablising the bank face with a bio-engineered geo-grid.
(3) Incorporate reeds directly into the rock toe.
(4) Build a trench at the toe f the bank and revegetate.
(5) Build a peaked stone toe along the bank and allow the bank to batter and revegetate behind.

From Rutherfurd et al. (2000).

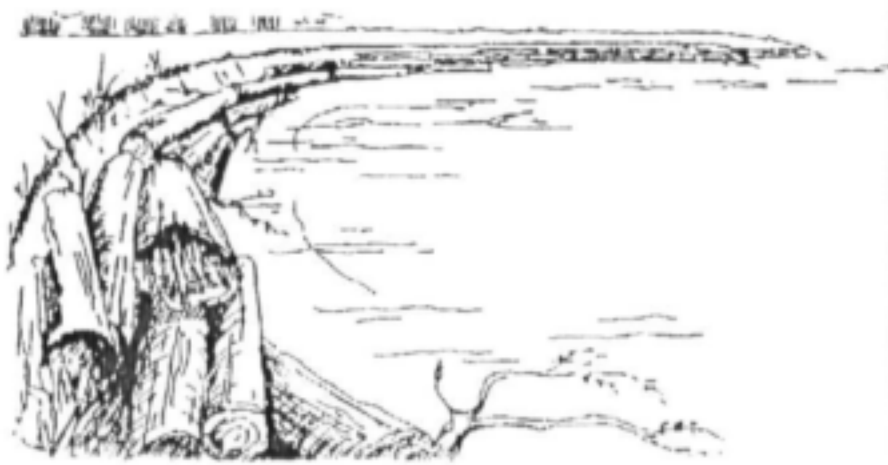
DESIGN 6. Stabilisation of bends.



(Above) The use of local material such as tree root wads for bank protection. Reproduced in Rutherfurd et al. 2000, with permission from Wildland Hydrology.

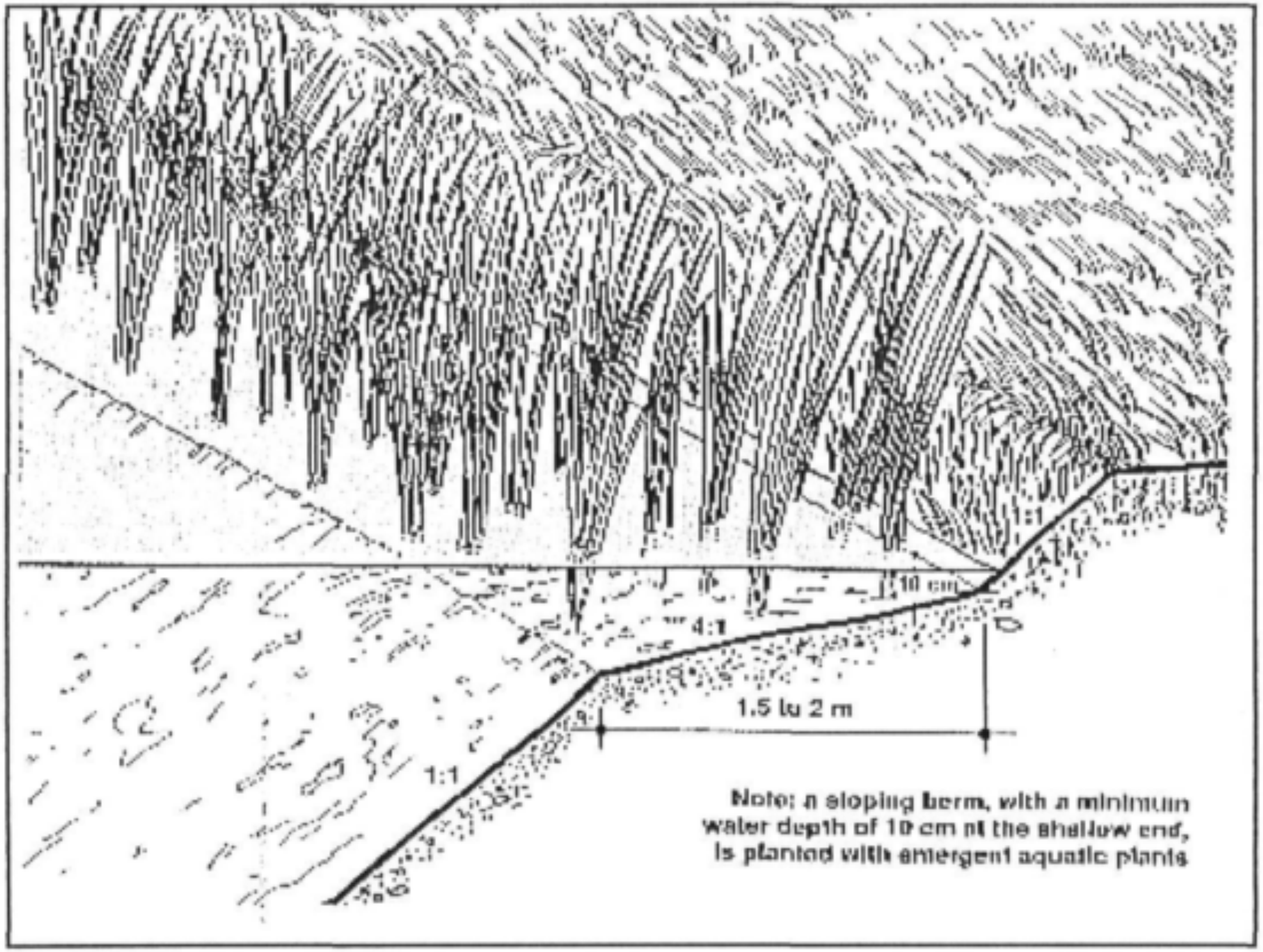


Longitudinal bank toe protection strengthened by 'spur dykes'. Reproduced in Rutherfurd et al. 2000, with permission from the American Water Resources Association



(Left) The use of brushing for bank protection. Reproduced in Rutherfurd et al. 2000

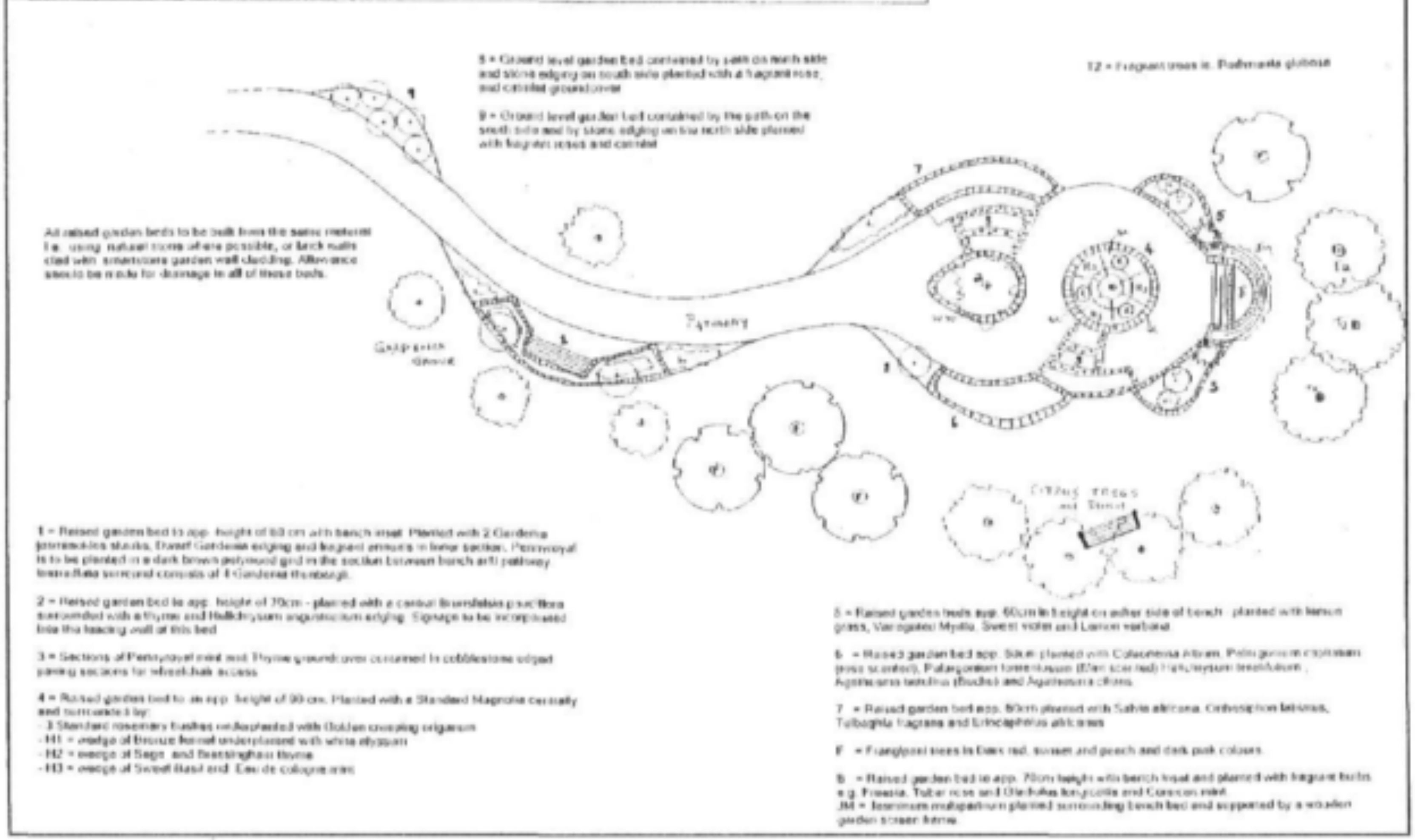
DESIGN 7. Vegetation Berms.



From: Rehabilitation of Rivers for Fish. Cowx & Welcomme (Eds) 1998

DESIGN 8a. Recreational Features: Fragrance Gardens.

PLANTING PLAN – PROPOSED FRAGRANT GARDEN, SEGMENT 4 IHLANZA RIVER
SCALE APP.: 1:100 (A3)
DATE: OCTOBER 2003
DRAWN BY: D. REYNHARDT – DOWN TO EARTH DESIGN



DESIGN 8b. RECREATIONAL FEATURES – Environmentally friendly skateboard park.

CONCEPT PLAN – PROPOSED SKATEBOARD PARK – SEGMENT 5 IHLANZA RIVER

DATE: OCTOBER 2003
DRAWN BY: D.REYNHARDT – DOWN TO EARTH

Spectator bays, and launches areas as well as ½ pipe and ¼ pipe sections are to be contained on the outer edges by galvanised 40mm round tube safety railings.

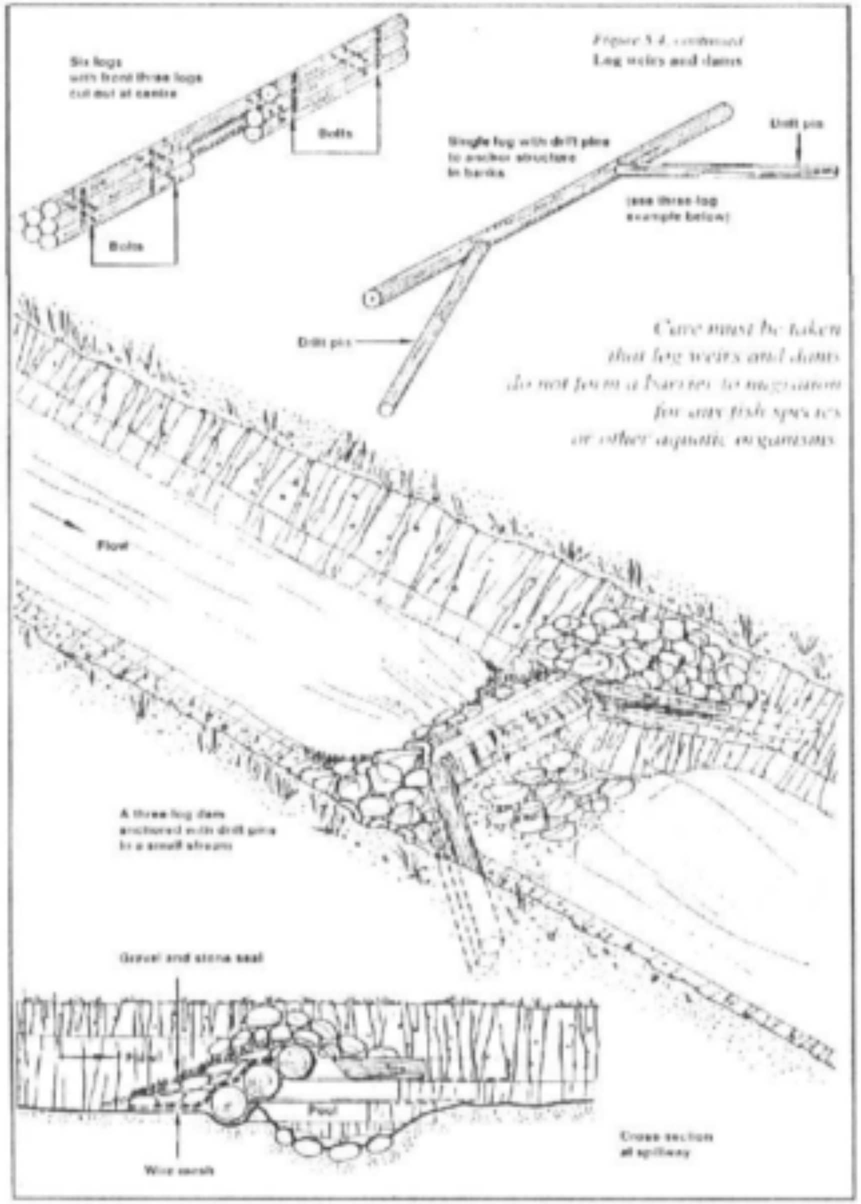
Grindrails are to be constructed of stainless steel round 50mm round tubing with the rail ends turned down for safety. The addition of screw posts will allow for easy height adjustments to the rail

Tree species closest to the skate area perimeter are to consist of indigenous evergreen species that shed a minimum of foliage and flowers relative to other tree species. The planting density is to be greatest near the North-east expressway so as to act as a noise buffer. It is to be lowest on the East side of the skate park to allow uninterrupted views over the ihlanza river riparian area.

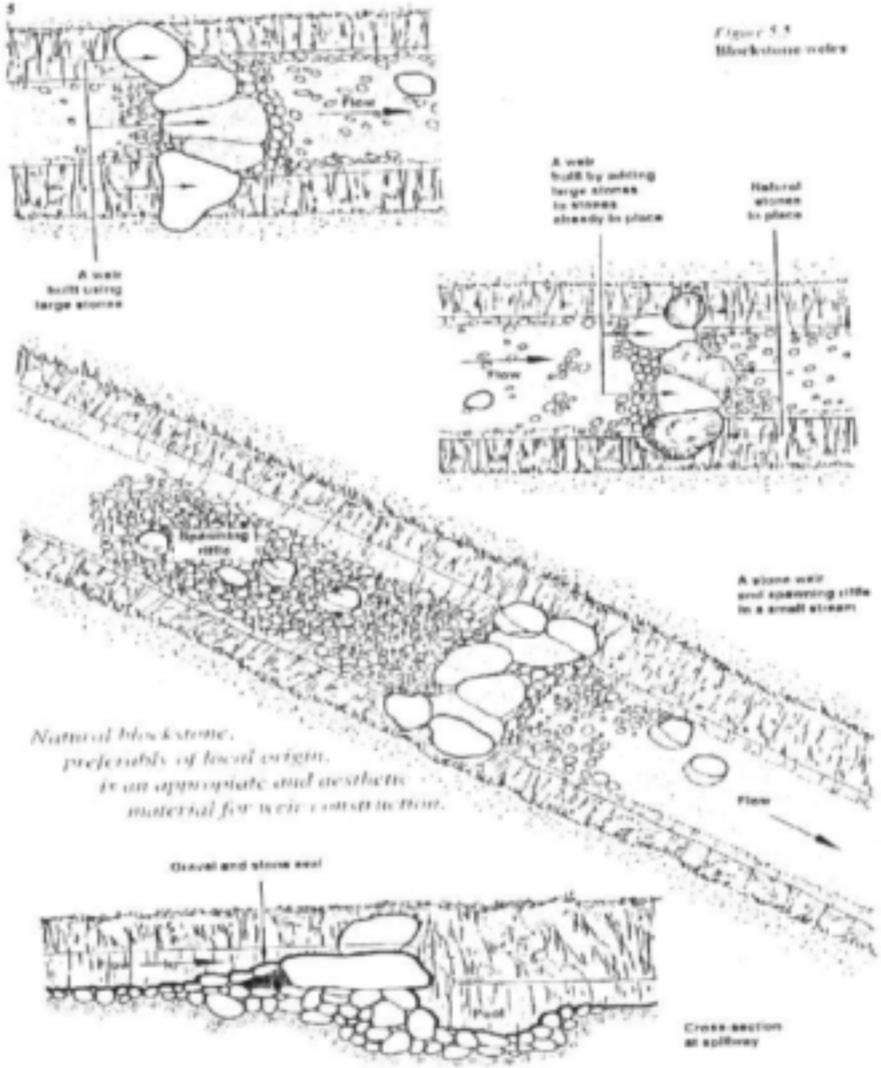
Skate area areas are to be constructed out of concrete with surfacing controlled by sandblasting and trowelling. For the purposes of aesthetics, the surface should preferably be pigmented to a design that is congruent with the theme of the park which should draw attention to river health or urban conservation issues.

Signage, lighting, litter bins and other street furniture should be compatible with the theme of the park as specified by the construction design.

DESIGN 9a: Various options for low, cross-channel weirs (Log)

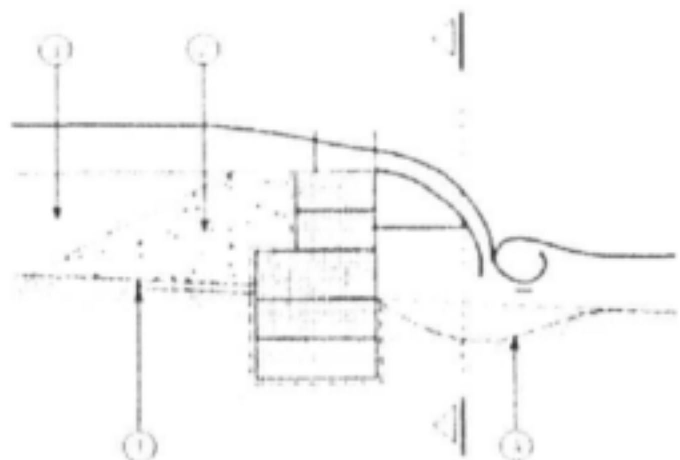


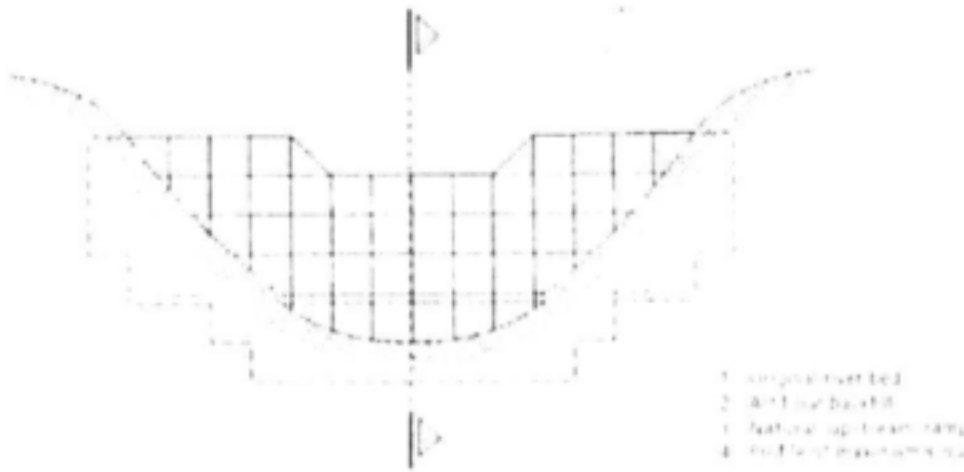
DESIGN 9b: Various options for low, cross-channel weirs (Stone) .



DESIGN 9c: Various options for low, cross-channel weirs (Vertcical Gabion Weir)

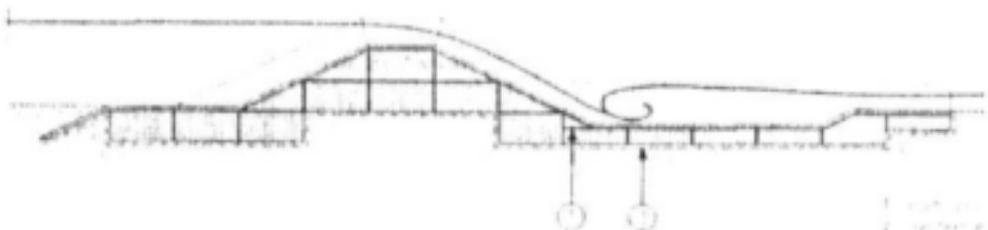
The vertical weir is the simplest type, often used for small weirs in a system to control a reach of a stream. An example of a vertical, notched gabion weir is shown. It is recommended that a fish ramp be built on the downstream face of this weir, as shown in the bottom right illustration. **From *River Training Works – Problems and Solutions – Weirs (African Gabions/ Maccaferri.Environmental Solutions Kit).***

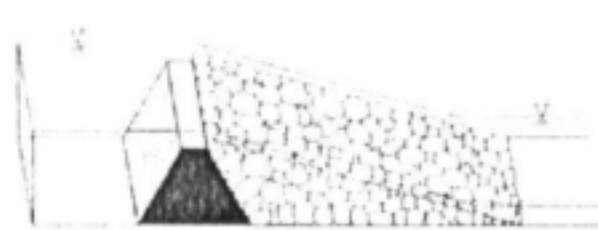




Low sloped Weirs (below, in cross-section) across the channel are an additional option. As the downstream face of this weir is sloped, it may be angled in such a way as to enable fish passage, as shown in the illustration at right. From *River Training Works – Problems and Solutions – Weirs (African Gabions/ Maccaferri.Environmental Solutions Kit).*

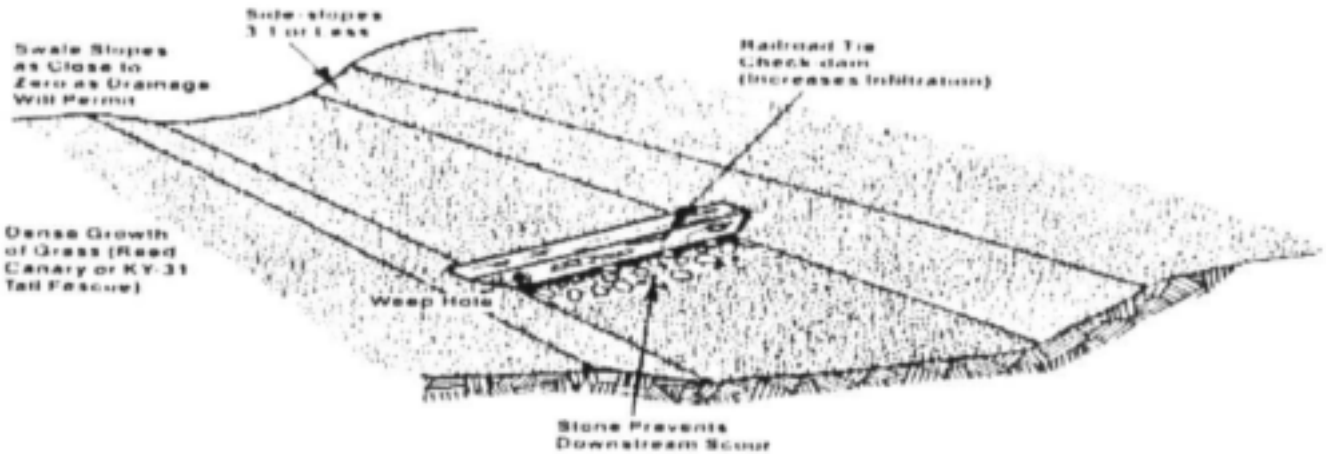
For the construction of the fish ramp (right), the weir crest is submerged either by building the rock-ramp at the height of the weir (full-width rock ramp), or by lowering the weir at the rock ramp to concentrate flow and subsequently increase the depth of flow over the weir lip at the fishway. From *Rutherfurd et al. 2000*





Notch in the weir crest

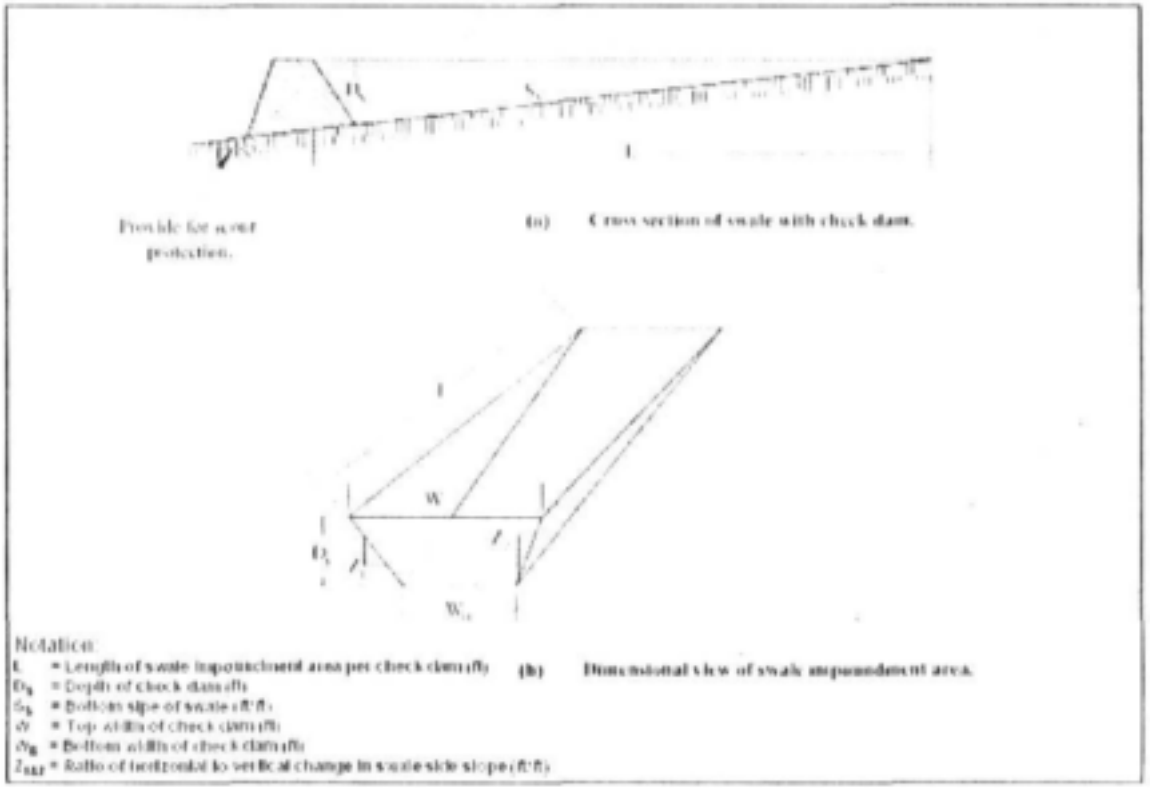
Schematic Design of an Enhanced Grass Swale



Description
Conventional grassed swales are gently sloped, vegetated conveyance ditches in which pollutants are removed from stormwater by filtration through grass and infiltration into the soil. Enhanced grass swales (see figure above), or biofilters, use check dams and wide depressions
to increase runoff storage and promote greater settling of pollutants.

Effectiveness
Swales have achieved mixed success in removing particulate pollutants, such as suspended solids and trace metals, and are generally unable to remove soluble metals and nutrients except through infiltration. As noted in Design of Stormwater Filtering Systems (Claytor Dec. 1996)
removal rates are dependent on factors including the residence time of water in the swale.

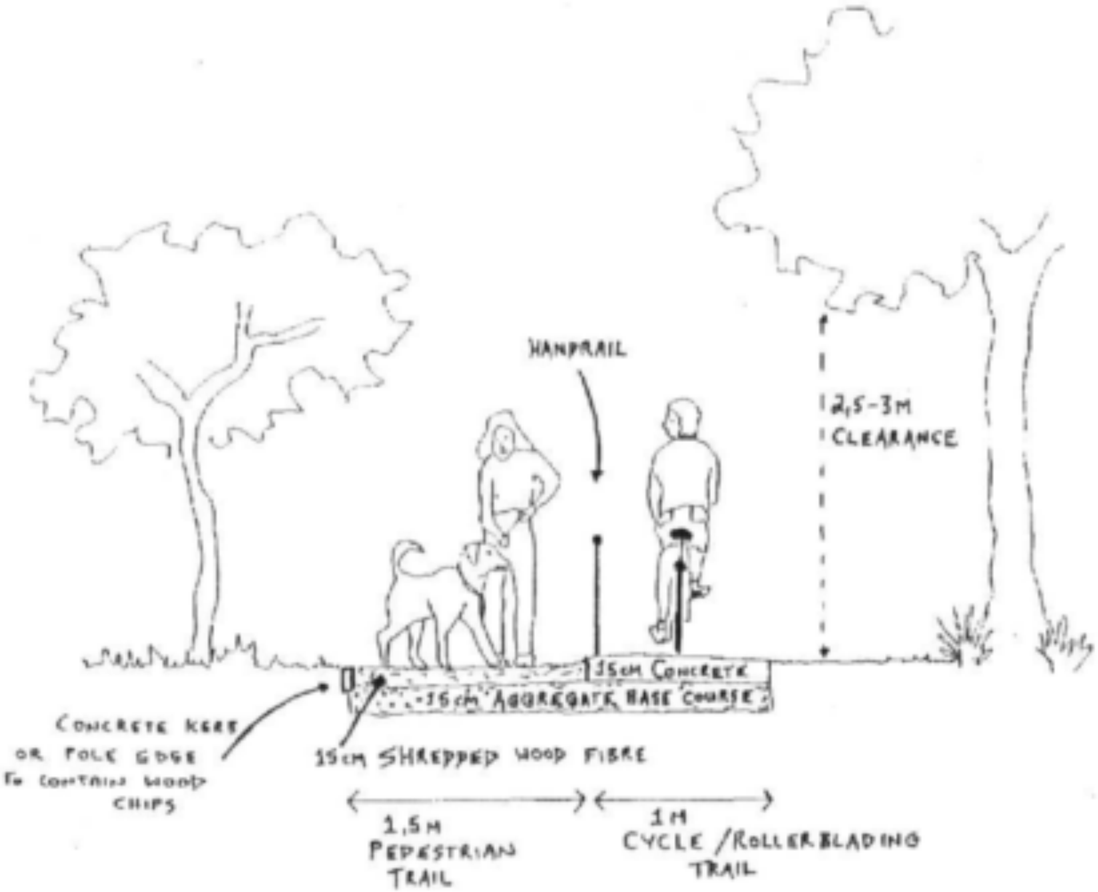
Opportunities for Use
Swales are best used in combination with other treatment BMPs. Their attractiveness is that they can be easily integrated into landscaping plans and can even replace curb and gutter in single-family residential subdivisions and highway medians (they are less expensive to install than curb and gutter or underground piping). The suitability of a grassed swale at a site will depend on the area, slope, and imperviousness of the contributing watershed as well as the dimensions and slope of the swale system.
From:



From: *EPA 1999. Stormwater Technology Fact Sheet: Vegetated Swales. Report No. 832-F-99-006. US EPA Office of Washington.*

DESIGN 11: Dual Tread Pathway (Walking and Cycling) .

DUAL TREAD, MULTI USE PATHWAY – CROSS SECTION DIAGRAM - SEGMENT 5.6.7 IHLANZA RIVER



Shredded wood fibre – is favoured because it provides a soft surface and blends with the natural environment. Replacement and/or topping up will be a maintenance requirement.

Concrete - is the recommended surface for cycling and rollerblading, due to its \ load capacity and resistance to erosion if properly installed. It also has the lowest maintenance requirements. It should be lightly textured to prevent excessive slipperiness when wet.

Handrails – should be constructed from Polywood or galvanised 40mm round tubing where possible.

DESIGN 12: The placement of rip rap in a channel .

Riprap is defined as a permanent, erosion-resistant ground cover of large, loose, angular stone with a geotextile or granular underlining. It is used to protect culvert inlets and outlets, stabilise stream banks, stabilise stream or drainage channels, and protect slopes and other areas subject to erosion from stormwater, where vegetative or geotextile measures are not adequate or appropriate. This practice significantly reduces erosion and sediment movement.

Riprap may be used in many different locations and ways, for example, along a stream or within a drainage channel, as shown in the above photograph, as a stable lining resistant to erosion. Riprap applications for channel or slope stabilisation should be designed by a professional familiar with the design of stormwater conveyance structures.

From: http://www.state.tn.us/environment/wpc/sed_ero_controlhandbook/rr.pdf

LAYOUT PLAN – PROPOSED TRIM TRAIL – SEGMENT 6 , IHLANZA RIVER

DATE: OCTOBER 2003

DRAWN BY: D. REYNHARDT – DOWN TO EARTH

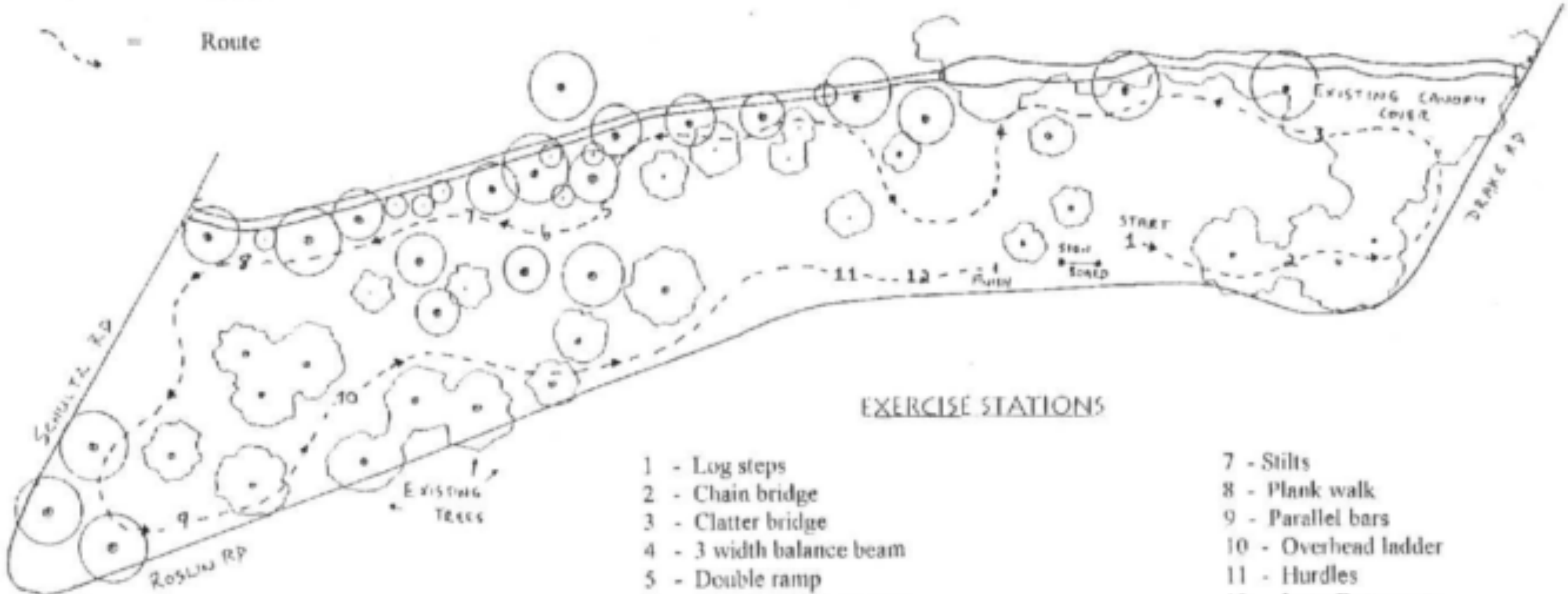
= Existing tree canopies

= Trees to be planted

1, 2 ... = Exercise stations

= Route

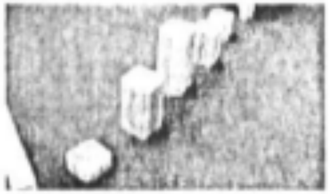
Obstacles are to be constructed out of Polywood timber where possible or wood harvested from Alien invasive trees. Any metal used in construction should be galvanised or stainless steel. Litter bins, lighting, signage and other street furniture match those used elsewhere in reaches 10 – 17.



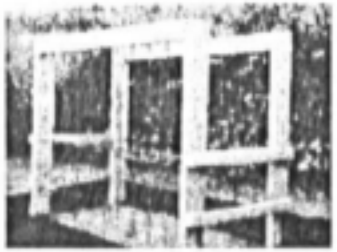
EXERCISE STATIONS

1 - Log steps
2 - Chain bridge
3 - Clatter bridge
4 - 3 width balance beam
5 - Double ramp
6 - Exercise /chin up bars
7 - Stilts
8 - Plank walk
9 - Parallel bars
10 - Overhead ladder
11 - Hurdles
12 - Leap Frog posts

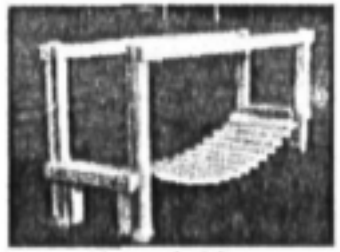
DESIGN 13 Cont. Trim Trail: Perspective view of obstacles for exercise stations



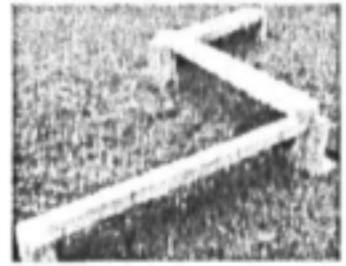
Log steps
(varying heights)



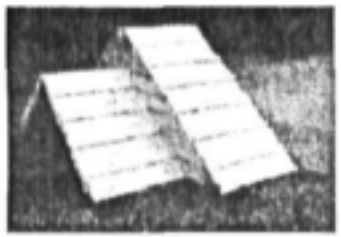
Chain bridge
(3m long)



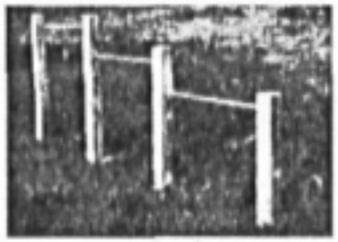
Clatter bridge
(app. 2,5m long, 90cm wide)



3 Width balance beam
(30cm, 20cm & 10cm widths)
respectively. 40cm high)

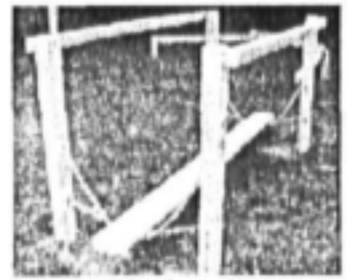


Double Ramps
(app. 90cm wide & between 90cm – 2,5m high)

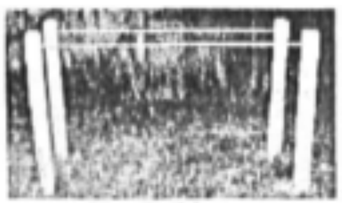


Exercise bars
(total length app. 3m differing heights)

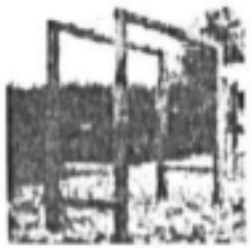
Stilts
(height app. 50cm)



Plank walk
(app. 2,5m long, elevated 40cm)

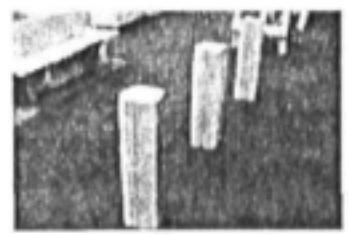


Parallel bars
(app. 2m long, 75cm wide)



Overhead ladder
(height app. 2m, width app. 75cm. length 3m)

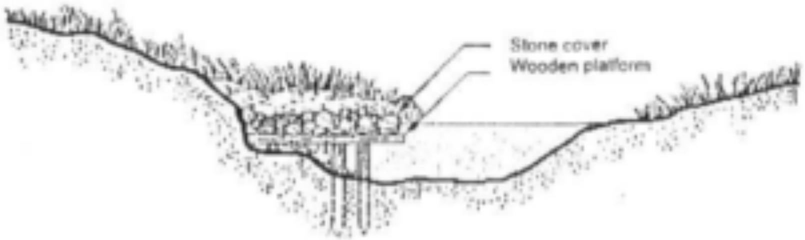
Hurdles
(Different heights for over) and under, 2m wide)



Leap Frog posts
(3 sets of 3 at different heights)

DESIGN 14: Various options for the construction of fish shelters .

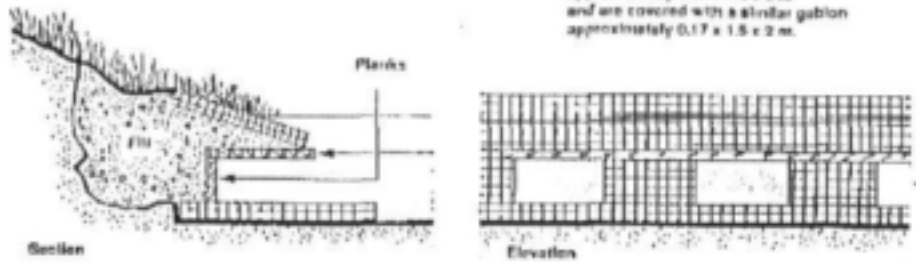
A. Shelter built using a wooden platform with stone and earth cover



Section

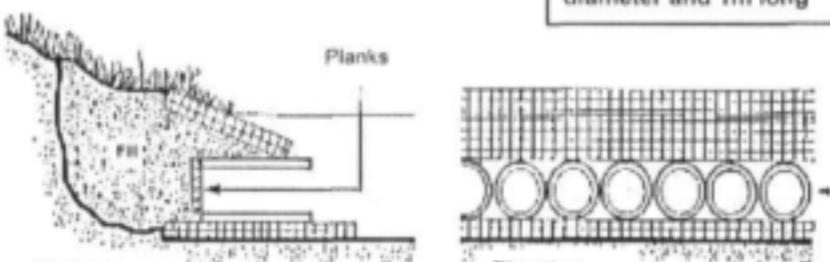
Shelter built using planks and gabions – River Roding, UK

Note: Both fish shelters shown below are constructed on a gabion mattress approximately 0.17 x 1.8 x 2 m and are covered with a similar gabion approximately 0.17 x 1.5 x 2 m.



C. Shelter built using concrete pipes, planks and gabions – River Roding, UK

Shelter pipe, 0.5m in diameter and 1m long

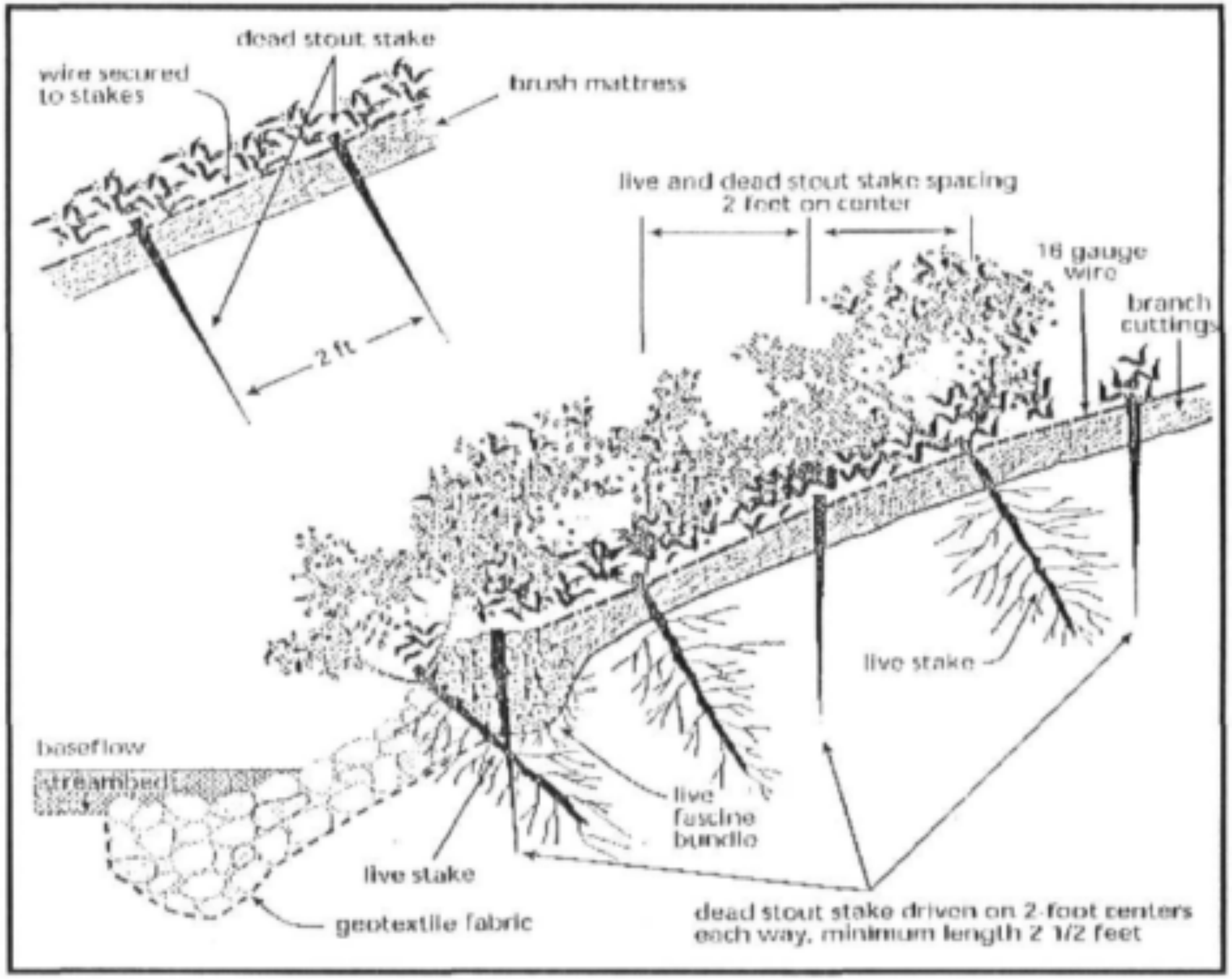


Section

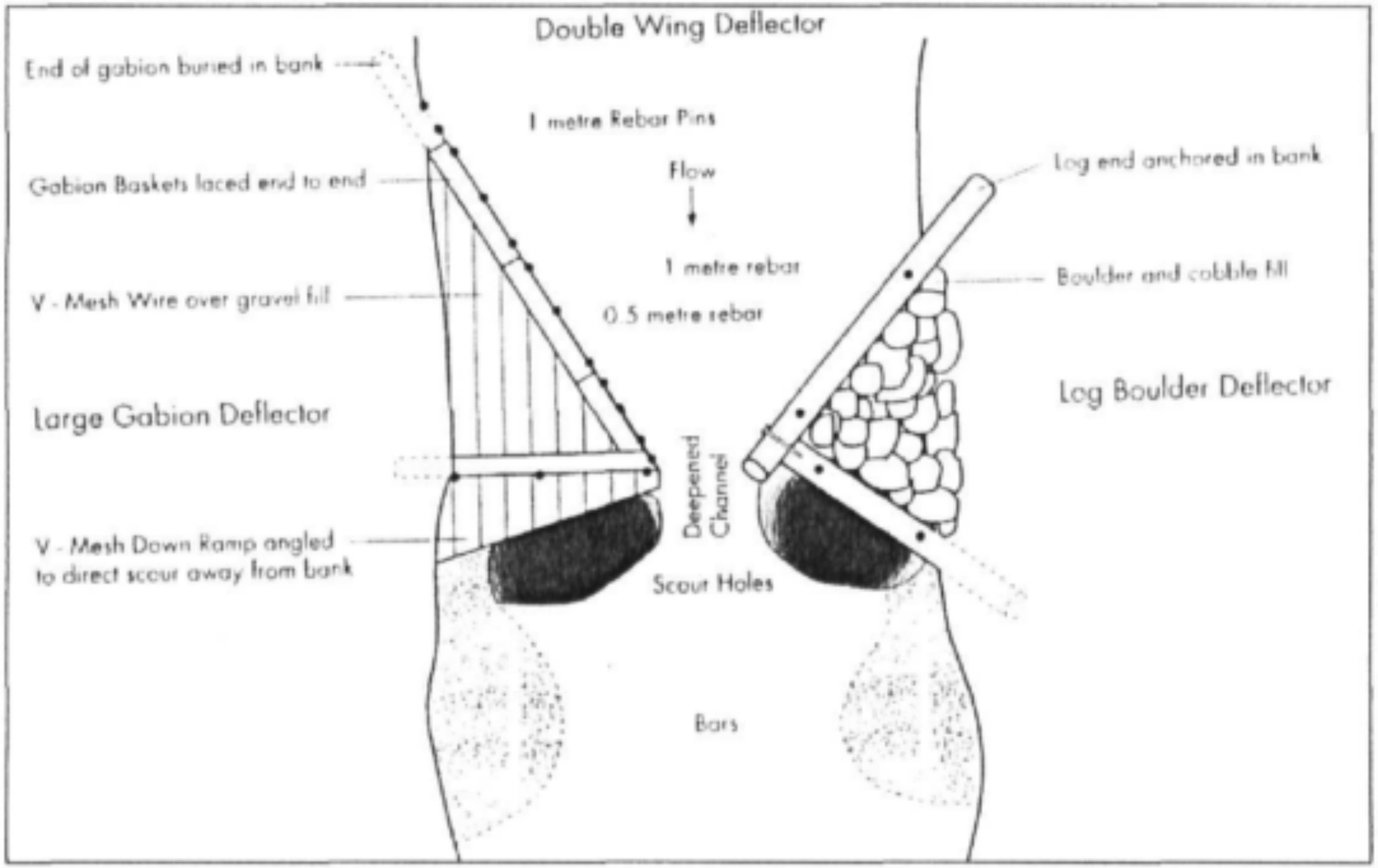
Elevation

Fish shelters created by artificial undertcut banks, using wooden platforms and stones, planks and concrete pipes, or planks and gabions. ***From: Rehabilitation of Rivers for Fish. Cowx and Welcomme (Eds) 1998.***

DESIGN 15: Brush mattress bank stabilisation technique.

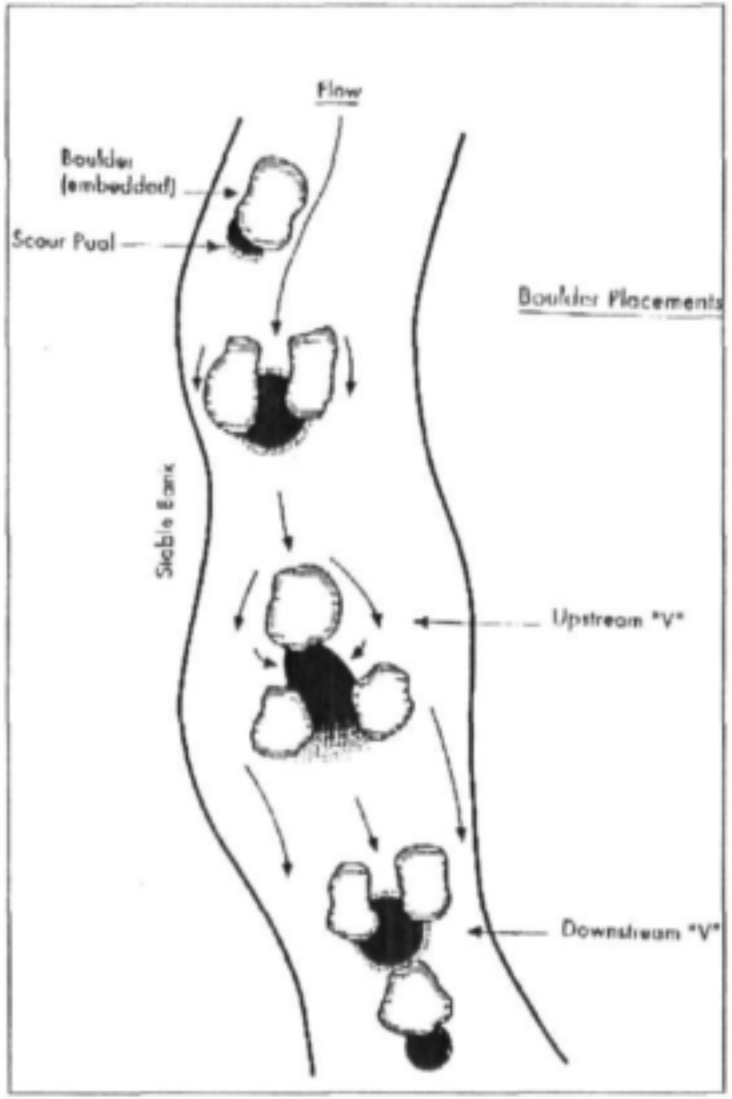


Details of the brushmattress technique. Cuttings, pole plantings and live stakes taken from species that sprout readily (in SA, *Salix mucronata*, the Cape Willow, may be an appropriate choice) are fairly resistant to erosion and can be used low on the bank. These also provide moderation of flow velocities if planted at high densities. From: FIRSWG Stream Restoration Manual (2000).



This is only one of many examples of means of deflecting flow, both to protect banks and to increase physical and hydraulic habitat diversity. Example of a double-wing deflector construction. Reproduced in Rutherfurd et al. 2000, with permission from Butterworth Publishing. It is likely that in the Ihlanza a more simple deflector, on only one bank would be required.

DESIGN 17: Angular boulders in the channel.



Angular boulders placed in different alignments in the channel to increase hydraulic diversity.
From Rutherfurd et al. (2000).

Other related WRC reports available:

River rehabilitation: Literature review, case studies and emerging principles.

King JM; Scheepers ACT; Fisher RC; Reinecke MK; Smith LB

Decades of poor catchment management, over-abstraction of water, use of rivers as waste disposal systems, destruction of riparian buffer strips and river beds have contributed to the toll of badly degraded rivers. The costs of poorly functioning rivers are largely externalised in any development activities, and so unknown. At present, there is not a developed science to deal with this in South Africa. There are no guidelines for, or even general principles, guiding such rehabilitation. The aim of this project is to pilot river rehabilitation in the Western Cape and to develop generic guidelines for rehabilitation, while at the same time building capacity for the science in 2 students

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