
PLACEMARKER: CLASSIFICATIONS AND INDICES



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INDICES

1. INTRODUCTION TO PLACEMARKER INDICES

The Study Area and River surveys that contribute to PlaceMarker assessments record numerous properties that are not particularly informative when viewed individually. Therefore, a number of indices have been developed, each integrating several of the field measurements, to provide summaries of different aspects of the raw field measurements. Values of the indices are calculated by the information system. The current list of indices and how they are calculated is given in Table 1 (River Survey indices) and Table 2 (Study Area Survey indices). While the River Survey indices were originally developed in 2001 and have been used to develop classifications of river properties (see section 2) that have been tested using several hundred surveys, the Study Area indices are newly created, and their utility is at an early stage of testing. As PlaceMarker surveys are undertaken, these river and study area indices can be tested, and new ones can be developed. Indeed, any manipulations of the original data can be added or modified at any time to increase their utility and robustness.

2. RIVER INDICES

The river indices (Table 1) describe different groups of properties of the river and its margins:

- Sediment calibre indices
- Flow type indices
- Bar type
- Bank profile type indices
- Vegetation indices
- Bank protection indices
- Pollution and nuisance plant species indices
- Channel stability indices
- Channel adjustment indices
- Other (mainly cross-cutting indices)

3. STUDY AREA INDICES

The study area indices (Table 2) describe different groups of properties of the study area:

- Land cover indices
- Human accessibility and connectivity indices
- Recreation indices
- Health and safety indices
- Economic and social value indices

Table 1 Indices derived from PlaceMarker River Survey measurements to describe the characteristics of the river and its margins

Short Name	Full Name	Description
SEDIMENT CALIBRE INDICES		
DomSub	Dominant Channel Substrate Type	The channel mineral bed substrate type recorded the most times in the spot checks, indexed from 1 to 9 in order of decreasing particle size (1 = artificial (paved / concrete), 2 = bedrock, 3 = boulder, 4 = cobble, 5 = gravel / pebble, 6 = sand, 7 = silt / mud, 8 = clay). Where two categories have equal frequency, the coarser category (smaller number) is used.
Sedcal	Bed Sediment Calibre Index	<p>Converts the mineral, mobile bed sediment types recorded in the 10 spot checks into an approximate average particle size for the stretch in phi units compatible with the Wentworth scale, where BO, CO, GP, SA, SI, CL are the number of spot checks falling into the Boulder, Cobble, Gravel/Pebble, Sand, Silt/Mud, Clay categories (note AR, BE, PE, NV are not used – if all spot checks fall into these categories, no value will be recorded in the URS database and ‘artificial’ will be displayed on the website):</p> $\text{Sedcal} = \frac{(-8*BO)+(-7*CO)+(-3.5*GP)+(1.5*SA)+(6*SI)+(9*CL)}{(BO+CO+GP+SA+SI+CL)}$
DomBkMat	Dominant Bank Material Type	The bank material type that is recorded the most times in the spot checks, indexed from 1 to 7 in order of increasing erodibility (1 = artificial, 2 = bedrock, 3 = boulder, 4 = cohesive, sticky clay, 5 = cobble, 6 = earth, 7 = gravel / sand). Where two categories have equal frequency, the less erodible category (smaller number) is used.
Bankcal	Bank Sediment Calibre Index	<p>Converts the natural mobile bank sediment types recorded in the 10 spot checks into an approximate average particle size for the stretch in phi units compatible with the Wentworth scale, where BO, CO, GS, EA, CL are the number of spot checks falling into the Boulder, Cobble, Gravel/Sand, Earth, Clay categories (note AR, BE, NV are not used– if all spot checks fall into these categories, no value will be recorded in the URS database and ‘artificial’ will be displayed on the website):</p> $\text{Bankcal} = \frac{(-8*BO)+(-7*CO)+(-1.5*GS)+(1.5*EA)+(9*CL)}{(BO+CO+GS+EA+CL)}$
NumBedSed	Number of Mineral Bed Sediment Calibre Classes	Number of different mineral bed sediment calibres recorded from BE, BO, CO, GP, SA, SI, CL (excludes AR (artificial) and PE (peat) to give a potential maximum value of 7)).

FLOW TYPE INDICES		
DomFlow	Dominant Flow Types	The flow type recorded most frequently in the spot checks, indexed from 0 to 10 approximately according to decreasing flow energy (1 = free fall, 2 = chute flow, 3 = chaotic flow, 4 = broken standing waves, 5 = unbroken standing waves, 6 = rippled, 7 = upwelling, 8 = smooth, 9 = no perceptible flow, 10 = dry channel). Where two categories have equal frequency, the higher energy (smaller number) is used.
NumFlow	Number of Flow Types	The number of different flow (patch) types recorded in the spot-checks (free fall - FF, chute - CH, broken standing waves - BW, unbroken standing waves - UW, chaotic flow - CF, rippled - RP, upwelling - UP, smooth - SM, no perceptible flow - NP, dry - DR).
NumFlowHab	Number of Flow Habitats	Number of different in-channel flow habitat types recorded in cumulative measurements (max 9 - CC, BL, RP, RI, RU, GL, PO, MD, PR)
PropPools	Proportion of Pools	The percentage of channel area (nearest 5%) occupied by pools (PO, cumulative measurements).
PropMarginalWater	Proportion of Marginal Dead Water	The percentage of channel area (nearest 5%) occupied by marginal deadwater (MD, cumulative measurements).
PropGlides	Proportion of Glides	The percentage of channel area (nearest 5%) occupied by glides (GL, cumulative measurements).
PropRiffles	Proportion of Riffles	The percentage of channel area (nearest 5%) occupied by riffles (RI, cumulative measurements).
PropRuns	Proportion of Runs	The percentage of channel area (nearest 5%) occupied by runs (RU, cumulative measurements).
PropPondedReach	Proportion of Ponded Water	The percentage of channel area (nearest 5%) ponded (PR, cumulative measurements).
PropRapid	Proportion of Cascades&Rapids	The percentage of channel area (nearest 5%) ponded (CC, RP, cumulative measurements).
CountHab	Count of in-channel habitats	CountHab is the total number of types of habitat identified in the counted and percentage cumulative measurements. To avoid double counting, the following are excluded from the list of percentage habitat types: riffle, pool, marginal deadwater

BAR TYPE INDICES		
CountVS	Count of Vegetated Side Bars	Total count of vegetated side bars (VS,.cumulative measurements)
CountUS	Count of Unvegetated Side Bars	Total count of unvegetated side bars (SB,.cumulative measurements).
CountSS	Count of Sand / Silt Deposits	Total count of sand and silt deposits (SL,.cumulative measurements).
CountMB	Count of Unvegetated and Vegetated Mid-channel Bar	Total count of unvegetated and vegetated mid-channel bars (MB, VM,.cumulative measurements).
CountPB	Count of Unvegetated and Vegetated Point Bar	Total count of unvegetated and vegetated point bars (PB, VP,.cumulative measurements).
NumBarTypes	Number of Bar Types	The number of different types of in-channel bars and sediment patches recorded in the cumulative measurements (i.e. discrete sand/silt deposits - SL, islands - MI, unvegetated mid channel bar - MB, vegetated mid channel bar - VM, unvegetated point bar - PB, vegetated point bar - VP, unvegetated side bar - SB, vegetated side bar - VS, discrete organic matter deposit - OM).
BANK PROFILE TYPE INDICES		
DomNatBk	Dominant Natural Bank Profile Type	The natural bank profile type recorded most extensively in cumulative measurements, indexed from 1 to 6 according to increasing steepness and decreasing complexity (0 = no natural bank profiles, 1 = natural berm (NBE), 2 = gentle (<45 degrees, NGT), 3 = composite (NCT), 4 = steep (>45 degrees, NST), 5 = vertical with toe (NVT), 6 = vertical / vertical+undercut / undercut (NV, NVU). If two types are equally common record the one with the higher number.
NumNatBk	Number of Natural Bank Profile Types	The number of types of different natural bank profile types recorded in the cumulative measurements (NV, NVU, NVT, NST, NGT, NCT, NBE).

NumNatBkHab	Number of Natural Bank Habitats	Count of presence of eroding cliff (EC), stable cliff (SC) from spot checks plus count of presence of undercut (NVU), vertical with toe (NVT), steep (NST), gentle (NGT), composite (NCT), natural berm (NBE) from cumulative measurements (excludes NV because replaced by EC and SC)
DomArtBk	Dominant Artificial Bank Profile Type	The artificial bank profile type recorded most extensively in cumulative measurements, indexed from 1 to 5 according to increasing level of modification and channel encroachment (0 = none, 1 = poached (APC), 2 = set back embankments (ASE), 3 = artificial two-stage (ATS), 4 = embanked (AEM), 5 = resectioned / reprofiled (ARD). If two types are equally common record the one with the higher number.
NumArtBk	Number of Artificial Bank Profile Types	The number of types of different artificial bank profile types recorded in the cumulative measurements (APC, ASE, ATS, AEM, ARD)
PropNatBk	Proportion Natural Bank Profiles	The percentage (nearest 5%) of the banks occupied by natural bank profiles from the cumulative measurements.
PropNoBk	Proportion No Bank Protection	The percentage (nearest 5%) of banks with no bank protection / reinforcement from the cumulative measurements
PropArtBk	Proportion Artificial Bank Profiles	The percentage (nearest 5%) of the banks occupied by artificial bank profiles from the cumulative measurements.
VEGETATION INDICES		
AveVeg	Average Channel Vegetation Cover	The total percentage cover for all vegetation types (excluding 'none') recorded at each spot check is then averaged over the number of spot checks.
NumVeg	Number of Channel Vegetation Types	The number of different types of channel vegetation (excluding 'none') recorded across all spot-checks.
DomVeg	Dominant Channel Vegetation Type	The channel vegetation type recording the largest total percentage across all spot checks, indexed from 0 to 10 according to increasing approximate flow resistance (0 = none, 1 = liverworts / mosses / lichens, 2 = free-floating, 3 = filamentous algae, 4 = amphibious, 5 = emergent broadleaved herbs, 6 = submerged linear-leaved, 7 = submerged broadleaved, 8 = submerged fine leaved, 9 = floating leaved (rooted), 10 = emergent reeds/sedges/rushes).
CountTreeFeatures	Count of Tree	All of the tree features recorded in the cumulative measurements (channel shading, overhanging

	Features	boughs, exposed bankside roots, underwater tree roots, fallen trees, large woody debris) are scored 0, 1 or 2, according to whether they are absent, present or extensive. The scores are summed to produce the index.
ComplexityFace	Complexity Bank Face Structure	The bank face structure recorded at each spot-check as bare, uniform, simple or complex is scored 0, 1, 2 and 3 respectively and then the scores are summed for both left and right bank faces and divided by the number of spot-checks.
ComplexityTop	Complexity Bank Top Structure	The bank top structure recorded at each spot-check as bare, uniform, simple or complex is scored 0, 1, 2 and 3 respectively and then the scores are summed for both left and right bank faces and divided by the number of spot-checks.
ComplexityTree	Complexity Tree Cover	Tree distribution recorded along each bank in the cumulative measurements is scored (none = 0, isolated/scattered = 1, regularly spaced = 2, occasional clumps = 3, semi-continuous = 4, continuous = 5) and the two bank scores are summed to index the overall complexity of tree cover.
NumVegHab	Number of vegetation habitats	NumVeg plus the number of the following tree-related habitats: from habitat counts - wood debris (WD), wood jam (WJ); from tree features (if P or E): fallen trees, exposed bankside roots, underwater roots
BANK PROTECTION INDICES		
DomBkMatPro	Dominant Bank Material Protection Type	The bank protection material recorded the most times in the spot checks, indexed from 0 to 11 approximately according to increasing erosion resistance (0 = none NO, 1 = washed out WO, 2 = reeds RE, 3 = willow spiling / faggots WS, 3 = biotex / coir BC, 4 = wood piling WP, 5 = rubble (e.g. builders waste BW), 6 = gabions GA, 7 = rip rap RR, 8 = sheet piling SP, 9 = brick / laidstone BR, 10 = concrete and brick CB, 11 = concrete CC). Where two categories have equal frequency, the cumulative measurements are used to determine the dominant bank material protection type. If the two categories are still equal, the category with the most severe impact (i.e. the higher value) is used.
DomBkPro	Dominant Bank Protection Class	The class of bank protection recorded the most times in the spot checks, indexed from 0 to 3 according to increasing rigidity and permanence (0 = no hard bank protection (none, washed out), 1 = biodegradable (reeds; wood piling; willow spiling / faggots; biotex / coir); 2 = open matrix (rip-rap, gabions, builders waste), 3 = Solid (concrete; concrete and brick; brick / laidstone; sheet piling). Where two categories have equal frequency, the cumulative measurements are used to determine the dominant bank protection type. If the two categories are still equal, the category with the most severe impact (i.e. the higher value) is used.
NumBkPro	Number of Bank	The number of different types of bank protection ascertained from the cumulative measurements

	Protection Types	(excluding washed out and none).																						
PropBio	Proportion Biodegradable Bank Protection	The percentage (nearest 5%) of banks occupied by biodegradable bank protection (planted reeds; biotex / coir, wood piling; faggots / willow spiling – i.e. willow stakes inserted and interwoven to provide a living structure to support the bank) estimated from the cumulative measurements.																						
PropOpenMatrix	Proportion Open Matrix Bank Protection	The percentage (nearest 5%) of banks occupied by open matrix bank protection (rip-rap; gabions; builders waste) estimated from the cumulative measurements.																						
PropSolid	Proportion Solid Bank Protection	The percentage (nearest 5%) of banks occupied by solid bank protection (concrete; concrete and brick; brick / laidstone; sheet piling) estimated from the cumulative measurements.																						
PropImmBk	Proportion Immobile Bank Materials	= (No. of spot-checks with immobile bank materials (concrete, concrete and brick, brick / laid stone, sheet-piling, bedrock) x 100) / No. of spot-checks																						
PropImmSub	Proportion Immobile Substrate	= <u>No. of spot-checks with immobile bed materials (artificial, bedrock, boulder) x 100</u> No. of spot-checks																						
POLLUTION AND NUISANCE PLANT SPECIES INDICES																								
NumPollution	Number of Pollution Indicators	The number of different pollution indicators observed in the cumulative measurements excluding gross pollution (i.e. water odours, sediment odours, oils, surface scum).																						
ExtentLitter	Extent of Trash and Gross Pollution	Assessed using A, P, E records for Gross pollution in the cumulative measurements and the number of records of Trash in the spot check measurements of channel features: Extent Litter = 0 (Negligible); 1 (Low): 2 (Moderate): 3 (High): 4 (Very High) as follows: <table><tr><td></td><td>Trash</td><td>0</td><td>0-2</td><td>2-5</td><td>5+</td></tr><tr><td rowspan="3">GrossPollution</td><td>A</td><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>P</td><td>1</td><td>1</td><td>2</td><td>3</td></tr><tr><td>E</td><td>3</td><td>3</td><td>3</td><td>4</td></tr></table>		Trash	0	0-2	2-5	5+	GrossPollution	A	0	1	2	3	P	1	1	2	3	E	3	3	3	4
	Trash	0	0-2	2-5	5+																			
GrossPollution	A	0	1	2	3																			
	P	1	1	2	3																			
	E	3	3	3	4																			

NumNuisance	Number of Nuisance Plant Species	The number of the seven different nuisance plant species recorded in the cumulative measurements (Himalayan balsam, Japanese knotweed, Giant hogweed, Floating Pennywort, Australian swamp stonecrop, Parrot’s feather, Creeping Water Primrose).																																
ExtentNuisance	Extent of Nuisance Plant Species	The extent of each riparian nuisance species (Himalayan balsam, Japanese knotweed, Giant hogweed, Floating Pennywort, Australian swamp stonecrop, Parrot’s feather, Creeping Water Primrose) from the cumulative measurements is scored (none = 0, single individual = 1, isolated clumps = 2, frequent = 3, extensive = 4), summed across all species present and then divided by the number of nuisance species present to obtain their typical extent.																																
NuisanceInvasion	Severity of Invasion by Nuisance Plant Species	NuisanceInvasion = 1 (Negligible); 2 (Low); 3 (Moderate) 4 (High); 5 (Very High) as follows: <table><tr><td></td><td>ExtentNuisance</td><td>0-1</td><td>1-2</td><td>2-3</td><td>3-4</td><td>4+</td></tr><tr><td rowspan="3">NumNuisance</td><td>0-1</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>1-2</td><td>2</td><td>3</td><td>3</td><td>4</td><td>5</td></tr><tr><td>2+</td><td>3</td><td>4</td><td>4</td><td>5</td><td>5</td></tr></table>								ExtentNuisance	0-1	1-2	2-3	3-4	4+	NumNuisance	0-1	1	2	3	4	5	1-2	2	3	3	4	5	2+	3	4	4	5	5
	ExtentNuisance	0-1	1-2	2-3	3-4	4+																												
NumNuisance	0-1	1	2	3	4	5																												
	1-2	2	3	3	4	5																												
	2+	3	4	4	5	5																												
CountInput	Number of Input Pipes	The total count recorded in the cumulative measurements is converted into a score (0 pipes = 0, 1 = 1, 2 = 2, 3 = 3, 4 = 4, 5 = 5, 6-9 =6, 10-14 = 7, 15-20 = 8, 20-30 = 9, >30 = 10)																																
CountLeach	Number of Leach Points	The total count recorded in the cumulative measurements is converted into a score (0 points/patches = 0, 1 = 1, 2 = 2, 3 = 3, 4 = 4, 5 = 5, 6-9 =6, 10-14 = 7, 15-20 = 8, 20-30 = 9, >30 = 10)																																
CountInput&Leach	Number of Input and Leach Points	= CountInput + CountLeach																																
TotalPollIndicators	Potential River Pollution Intensity	Based upon NumPollution+ExtentLitter+CountInput&Leach: TotalPollIndication is 0 (Negligible: if the sum is ≤ 1), 1 (Low: if the sum is 2-3); 2 (Moderate: if the sum is 4-6); 3 (High: if the sum is 7-9); 4 (Very high: if the sum is > 9)																																

CHANNEL STABILITY INDICES		
HeavyVeg	Heavily Vegetated Banks and Bars	1 if on all spot checks, bank face vegetation is simple or complex and all bars are vegetated. Otherwise 0
NoBkErosion	Negligible bank erosion	1 if 0% is recorded for all of the following natural bank profiles in the cumulative measurements: NV, NVU, NVT. Otherwise 0
ExtMatureTrees	Extensive Mature Trees along Banks	1 if both banks record a continuous or semi-continuous tree distribution in the cumulative measurements. Otherwise 0.
StableChannel	Stable channel	1 if HeavyVeg+NoBkErosion+ExtMatureTrees > 0 (i.e. channel is very stable). Otherwise 0 (some channel dynamics)
CHANNEL ADJUSTMENT INDICES		
Migrating	Evidence for Lateral Migration	Based on the ‘one bank eroding’ record in the cumulative measurements: 0 (if none recorded), 1 (negligible) 2 (local), 3 (extensive); 4 (very extensive).
Widening	Evidence for Channel Widening	Based on the ‘opposite banks eroding’ record in the cumulative measurements: 0 (if none recorded), 1 (negligible) 2 (local), 3 (extensive); 4 (very extensive).
Narrowing	Evidence for Channel Narrowing	Based on the ‘opposite banks depositing’ record in the cumulative measurements: 0 (if none recorded), 1 (negligible) 2 (local), 3 (extensive); 4 (very extensive).
BedIncisionLikelihood	Potential Channel Bed Incision	1 if from the cumulative measurements ((bankfull width) / (smaller of Left and Right bankfull height + water depth)) < 1.5
BedIncision	Evidence for Channel Bed Incision	Sum of A=0, P=1, E=3 for each of the following four cumulative measurements: Bed sediment exposed in bank profile, Trees with exposed roots / collapsing / leaning into channel on both banks, Heavily compacted and armoured bed, Exposure of foundations of structures PLUS for Opposite banks eroding none = 0, negligible/local = 1, extensive/very extensive = 3. Divide the sum by 5.
Aggradation	Evidence for Bed and/or Bank Aggradation	Sum of A=0, P=1, E=3 for each of the following five cumulative measurements: Buried soil within bank profiles, Burial of river bed with finer sediment, Burial of the base of structures, River channel narrow relative to bridge openings, Burial of base of established vegetation. Divide the sum by 5.

OTHER (MAINLY CROSS-CUTTING) INDICES		
Complexity	Number of river and margin habitats	NumBedSed + NumFlowHab + NumNatBkHab + NumVegHab
DisConnectivity	Extent of disruption of longitudinal continuity by in-channel structures	DisConnectivity is assessed using artificial features recorded in the cumulative measurements in the following equation: $\text{Disconnectivity} = (\text{No. culverts} + \text{No. major weirs / sluices}) * 5 + (\text{No. intermediate weirs / sluices}) * 3 + (\text{No. minor weirs} + \text{No. major deflectors / groynes} + \text{No. major bridges}) * 2 + (\text{No. intermediate bridges} + \text{No. intermediate deflectors / groynes})$ and is then expressed as an integer number
NumSpecialFeatures	Number of Special Features	Count of the number of special features recorded in the cumulative measurements from the following list: side channels, fen, marsh/bog, carr, water meadow, floating mat / reed bed (count 1 if P or E in special features list), bedrock, waterfall, connected backwater, disconnected backwater, wood jam (if count ≥ 1 on Habitat Feature counts).

Table 2 **Indices derived from PlaceMarker Study Area measurements to describe characteristics of the study area**

Short Name	Full Name	Description
LAND COVER INDICES		
CountStudyAreaHabs	Number of 'green' land cover types in the study area	A count of the following 'green' land cover types that are recorded within the study area: Dr (derelict land); Cr (cropland); Pa (pasture); Or (orchard); Al (allotments); Co (coniferous woodland), Dd (deciduous woodland), Ow (open woodland), Sc (scrub), Op (community grassland), Ce (cemetery), He (heathland), La / Rv / Qu (lakes), Tb (streams), Wt (wetland).
HUMAN ACCESSIBILITY AND CONNECTIVITY INDICES		
Accessibility	Accessibility into the Study Area for People	Assign scores of 0, 1, 2 for records of None, One, >One for the following - Bus services: Car parks; Cycle racks; Horses; Wheelchairs and >1km, 200-1000m, <200m for the following – Rail / Underground Station. Add all of these 6 scores up and divide by 6.
Footpaths	Indicates accessibility provided by footpaths	Left Bank, Right Bank, and Through-Area footpaths are assigned scores of 0, 1, 3 for records of A, P, E, respectively. For study area located on only one bank: Footpaths = Left or Right Bank score + Through Area score For study area located on both banks: Footpaths = (0.5 * (Left Bank score + Right Bank score)) + Through Area score
CyclePaths	Indicates accessibility provided by cycle paths	Left Bank, Right Bank, and Through-Area cyclepaths are assigned scores of 0, 1, 3 for records of A, P, E, respectively. For study area located on only one bank: Cyclepaths = Left or Right Bank score + Through Area score For study area located on both banks: Cyclepaths = (0.5 * (Left Bank score + Right Bank score)) + Through Area score
WheelChairAccess	Indicates accessibility available to wheelchairs	Left Bank, Right Bank, and Through-Area wheelchair access are assigned scores of 0, 1, 3 for records of A, P, E, respectively. For study area located on only one bank: Wheelchairs = Left or Right Bank score + Through Area score For study area located on both banks: Wheelchairs = (0.5 * (Left Bank score + Right Bank score)) + Through Area score

RiverVisibility	Visibility of river from study area	Viewing platforms scored 0, 1, 3 for records of none, one, > one, respectively Left Bank and Right bank visibility scored 0, 1, 3 for records of A, P, E, respectively. For study area located on only one bank: RiverVisibility = Left or Right Bank visibility score + Viewing platform score For study area located on both banks: RiverVisibility = (0.5*(Left Bank visibility score + Right Bank visibility score)) + Viewing platform score
UrbanVisibility	Visibility of urban-industrial-transport from study area	Left Bank and Right bank urban visibility scored 3, 1, 0 for records of A, P, E, respectively. For study area located on only one bank: UrbanVisibility = 2*(Left or Right Bank urban visibility score) For study area located on both banks: UrbanVisibility = Left Bank urban visibility score + Right Bank urban visibility score
VisualConnectivity	Quality of Visual Connectivity	(RiverVisibility+UrbanVisibility)/2
HumanConnectivity	Aggregate study area connectivity	(Accessibility + Footpaths + Cyclepaths + Wheelchairs + Visual Connectivity)/5
RECREATION INDICES		
RecreationOpportunities	Range of recreational facilities types available	Count of the following that are present within the study area core: Se, Cp, Do, Pc, Sf, Te, Ru, Sp, Gy, Sw, Bo, Fi, Wi, Np, Na
RecreationCondition	Average Condition of recreational facilities	Average condition score (used and cared for (score = 1); intensive use and needing attention (2); moderate use and needing attention (3); misused or vandalised (4); not used (5)) of the following that are present within the study area core: Se, Cp, Do, Pc, Sf, Te, Ru, Sp, Gy, Sw, Bo, Fi, Wi, Np, Na
Wilderness	Presence and condition of 'wildlife areas' areas	Score 0 if not record as present and condition score (1-5) if present.

EDUCATION INDICES		
InterpretationBoards	Presence and condition of interpretation boards	Presence is recorded as A, P, E; Quality of information and Condition of boards are both recorded as good, moderate, poor Score 3 for E / good; 2 for P or moderate and 1 for A or poor. $\text{InformationBoards} = 2 * (\text{presence score} \times \text{quality score} \times \text{condition score}) / 9$
FormalEducation	Presence and condition of formal education facilities	Presence is recorded as A, P, E; Condition of facilities is recorded as good, moderate, poor Score 3 for E / good; 2 for P or moderate and 1 for A or poor. $\text{FormalEducation} = 2 * (\text{presence score} \times \text{condition score}) / 3$
Education	Aggregate educational value of study area	$(\text{InformationBoards} + \text{FormalEducation}) / 2$
HEALTH AND SAFETY INDICES		
Hygiene	Presence of Toilet and Drinking Water facilities	Toilets <u>with</u> hand washing facilities and Drinking water taps / fountains are both recorded as none, one, > one (score 0, 1, 3 for these, respectively). $\text{Hygiene} = (\text{score for toilets with hand washing facilities} + \text{score for drinking water taps / fountains})$
Litter	Presence of litter across the study area	Score 0, 1, 3 for A, P, E, respectively, for each of large litter (e.g. shopping trolleys, fly tipping), small litter (paper, cans, plastic bottles), dog waste $\text{Litter} = 2 * (\text{sum of scores for large litter, small litter, dog waste}) / 3$
LitterDisposal	Presence of litter disposal facilities across the study area	Score 0, 1, 3 for A, P, E, respectively, for each of litter bins, dog waste bins $\text{Litter} = \text{sum of scores for litter bins, dog waste bins}$
PersonalSafety	Facilities and Indicators of Personal Safety	Score 0, 1, 3 for A, P, E of the following: Visibility and lighting along main footpaths; emergency contact numbers, emergency float aids. Score 3, 1, 0 for A, P, E for social issues $\text{Personal Safety} = (\text{sum of the above 4 scores}) / 2$

ECONOMIC AND SOCIAL VALUE INDICES		
Economic&SocialValue	Potential economic and social value of the study area	<p>Four properties are recorded none, some, many and should be scored 0, 1, 3, respectively): Do adjacent properties face onto the river, Have properties been designed to enjoy the river views, Do properties benefit from vegetation screening, Evidence of public involvement. One property (are there businesses that depend on the study area) is recorded none, one, >one, for which assign scores 0, 1, 3, respectively.</p> <p>Economic&SocialValue = (sum of the above 5 scores)/2.</p>

CLASSIFICATIONS

4. INTRODUCTION

Currently there are eight classifications that are derived for individual river stretches from river survey measurements and indices:

Classifications of river stretch **Complexity**, **Stability**, channel **Condition**, and longitudinal **Connectivity** combine to support high level assessment of habitat and biodiversity in the study area. PLEASE NOTE THAT THESE ARE NEW CLASSIFICATIONS THAT WILL NEED TO BE REVIEWED ONCE A SUFFICIENT SET OF OBSERVATIONS IS AVAILABLE.

The **Stretch Habitat Quality Index (SHQI)** also supports high-level assessment of habitat and biodiversity in the study area and its value is derived from three component classifications of the **Materials**, **Physical Habitat** and **Vegetation** characteristics of individual river stretches

5. CLASSIFICATION OF STRETCH COMPLEXITY, STABILITY, CONDITION, AND CONNECTIVITY

Table 3 describes how classifications of stretch Complexity, Stability, channel Condition, and longitudinal Connectivity are applied to some of the indices listed in Table 1, and how the classes can be interpreted.

Table 3 Classification of Complexity, Stability, Condition, and Connectivity

Short Name	Full Name	Description
ComplexityClass	Classes reflect the number of river and margin habitats present	1 (High) if Complexity = > 10; 2 (Above average) if Complexity = 9 - 10; 3 (Average) if Complexity = 6 – 8; 4 (Low) if Complexity = 4-5; 5 (Very Low) if Complexity < 4
StabilityClass	Evidence for Geomorphic Stability / Dynamics	1 (very stable) if StableChannel = 1, otherwise 0 (probably some dynamics) For channels where StableChannel = 0 2 (Slightly Dynamic) if all of Migrating, Widening, Narrowing, BedIncision, Aggradation have a score < 2 3 (Dynamic) if all of Migrating, Widening, Narrowing, BedIncision, Aggradation have a score of <4 4 (Highly Dynamic) if any of Migrating, Widening, Narrowing, BedIncision, Aggradation have a score of 4
ChannelCondition Class	Condition of Channel in relation to Pollution Potential and Nuisance Species Invasion	1 (Good: IF TotalPollIndicators = 0 AND NuisanceInvasion = 0); 2 (Average: IF TotalPollIndicators = 1 AND/OR NuisanceInvasion = 1); 3 (Poor: IF TotalPollIndicators = 2 AND/OR NuisanceInvasion = 2); 4 (Very Poor: IF TotalPollIndicators = 3 or 4 OR NuisanceInvasion = 3 or 4); 5 (Extremely Poor: IF TotalPollIndicators = 3 or 4 AND NuisanceInvasion = 3 or 4)
ConnectivityClass	Classifies strength of longitudinal Connectivity	1 (very high if DisConnectivity = 0); 2 (high if Disconnectivity = 1 or 2); 3 (moderately impeded if Disconnectivity = 3-4); 4 (poor if Disconnectivity = 5-9); 5 (extremely poor if Disconnectivity > 9)

6. CLASSIFICATION OF MATERIALS, PHYSICAL HABITAT, VEGETATION

6.1 Statistical derivation of the classifications

The three classifications were guided through a cluster analysis of three groups of river survey indices describing the ‘Materials’, ‘Habitat’ and ‘Vegetation’ properties of surveyed stretches. Prior to analysis, all of the indices were reduced to a similar numerical range by dividing percentage indices by 10. The cluster analysis was based on Euclidean distance as the distance measure and Ward’s method as the clustering algorithm. Once each cluster analysis was complete, the number of clusters that best described distinct groupings or classes of stretches was identified using the cluster dendrogram and focussing on agglomerations to between 3 to 10 clusters. The validity and meaning of the clusters were explored by:

- (i) applying non-parametric (Kruskal Wallis) analysis of variance (ANOVA) to identify which of the individual river survey indices provided a statistically significant ($P < 0.05$) discrimination between the clusters;
- (ii) inspecting box and whisker plots for each of the indices to further identify which clusters were discriminated by each attribute and the strength of the discrimination;
- (iii) identifying whether the clusters were comprised of stretches with any distinct engineering types (i.e. combinations of cross profile, planform and level of reinforcement), which might suggest a causal impact of engineering on cluster characteristics;
- (iv) considering whether the clusters made scientific sense.

6.2 Classifications

Following the identification of clusters or classes of stretches according to their ‘Materials’, ‘Physical Habitat’ and ‘Vegetation’ properties, a simple decision tree was devised for each that allowed newly-surveyed stretches to be allocated to a class according to a small set of the original river indices. The identified classes are named and described in Tables 4, 5 and 6 and the three decision trees are displayed in Figures 1 to 3.

Table 4 Descriptions of the characteristics of stretches attributed to different Materials classes

Group Name: abbreviation	Description of discriminating (Materials) indices
SNC (semi-natural coarse)	Low proportions of bank protection. Coarser substrates (Sedcal) and bank materials (average Bankcal).
SNM (semi-natural mixed)	Low proportions of bank protection, with mixed substrates (Sedcal) and bank materials (Bankcal).
SNF (semi-natural fine)	Low proportions of bank protection. Finer substrates (Sedcal) and bank materials (Bankcal).
LE (lightly engineered)	Moderate proportions of bank protection or high proportions of biodegradable protection (reeds; wood piling; willow spiling / faggots; biotex / coir) (DomBkPro).
EN (engineered)	High proportions of open matrix bank protection (rip-rap, gabions, builders waste) (DomBkPro), often with moderate proportions of solid bank protection. Low proportions of immobile substrate.
HE (heavily engineered)	High proportions of solid bank protection (concrete, laid stone etc.) (DomBkPro) but low proportions of immobile substrate (i.e. bed reinforcement).
VHE (very heavily engineered)	High proportions of immobile substrate (ca. 100%) (PropImmSub) usually with extensive solid bank protection (concrete, laid stone etc.).

Table 5 Descriptions of the characteristics of stretches attributed to different Physical Habitat classes.

Group Name: abbreviation	Description of discriminating (Physical Habitat) indices
SNAct (semi-natural active)	Very high proportions of natural bank profiles (PropNatBk) and >7 different habitat types (CountHab) indicating both deposition and erosion.
SNMAct (semi-natural moderately active)	Very high proportions of natural bank profiles (PropNatBk). 5-7 different habitat types (CountHab) indicating less deposition and erosion activity than SNAct.
SNSt (semi-natural stable)	Very high proportions of natural bank profiles (PropNatBk). <5 different habitat types (CountHab) indicating a relatively stable channel.
Adj (adjusting)	Only a moderate proportion of natural bank profiles (PropNatBk) but ≥ 5 different habitat types (CountHab) indicating some deposition and erosion activity indicative of a relatively active channel environment
St (stable)	Only a moderate proportion of natural bank profiles (PropNatBk) and < 5 different habitat types (CountHab) indicating some deposition and erosion activity suggests a relatively stable channel environment
UAdj (uniform adjusting)	Low proportions of natural bank profiles (PropNatBk < 10%) but more than one bar type (NumBarTypes) indicates some channel adjustment within a modified channel.
USt (uniform stable)	Low proportions of natural bank profiles (PropNatBk < 10%) but one or zero bar types (NumBarTypes) indicates a modified stable channel.

Table 6 Descriptions of the characteristics of stretches attributed to different vegetation classes.

Group Name: abbreviation	Description of discriminating (Vegetation) indices
HTconn (high bank tree cover that is well connected to the channel)	High bank tree cover (semi-continuous to continuous) (ComplexityTree) with high (>7) tree features (CountTreeFeatures) indicating strong connection with channel.
HTV (high bank tree cover and vegetated channel)	High bank tree cover (semi-continuous to continuous) (ComplexityTree) with some (3-7) tree features (CountTreeFeatures) indicating some connection with channel and some ($\geq 10\%$) channel vegetation cover (AveVeg).
HTLV (high bank tree cover, low channel vegetation cover)	High bank tree cover (semi-continuous to continuous) (ComplexityTree) with some (3-7) tree features (CountTreeFeatures) indicating some connection with channel. Low (<10%) channel vegetation cover (AveVeg).
HTdisconn (high bank tree cover disconnected from the channel)	High bank tree cover (semi-continuous to continuous) (ComplexityTree) with very few (<7) tree features (CountTreeFeatures) indicating strong disconnection of trees with the channel.
MTVdiv (moderate bank tree cover, diverse channel vegetation)	Moderate bank tree cover (ComplexityTree) with a moderate to high cover ($\geq 10\%$) (AveVeg) of diverse (>5 morphotypes) (CountVeg) channel vegetation.
MTV (moderate bank tree cover, vegetated channel)	Moderate bank tree cover (ComplexityTree) with a moderate to high cover ($\geq 10\%$) (AveVeg) of channel vegetation comprised of few morphotypes (≤ 5) (CountVeg).
MTLV (moderate bank tree cover, low channel vegetation cover)	Moderate bank tree cover (ComplexityTree) and low cover (<10%) (AveVeg) of channel vegetation.
LTVdiv (low bank tree cover, diverse channel vegetation)	Low bank tree cover (ComplexityTree) with a moderate to high cover ($\geq 10\%$) (AveVeg) of diverse (>5 morphotypes) (CountVeg) channel vegetation.
LTV (moderate bank tree cover, vegetated channel)	Low bank tree cover (ComplexityTree) with a moderate to high cover ($\geq 10\%$) (AveVeg) of channel vegetation comprised of a few morphotypes (≤ 5) (CountVeg).
LTLV (moderate bank tree cover, low channel vegetation cover)	Low bank tree cover (ComplexityTree) and low cover (<10%) (AveVeg) of channel vegetation.

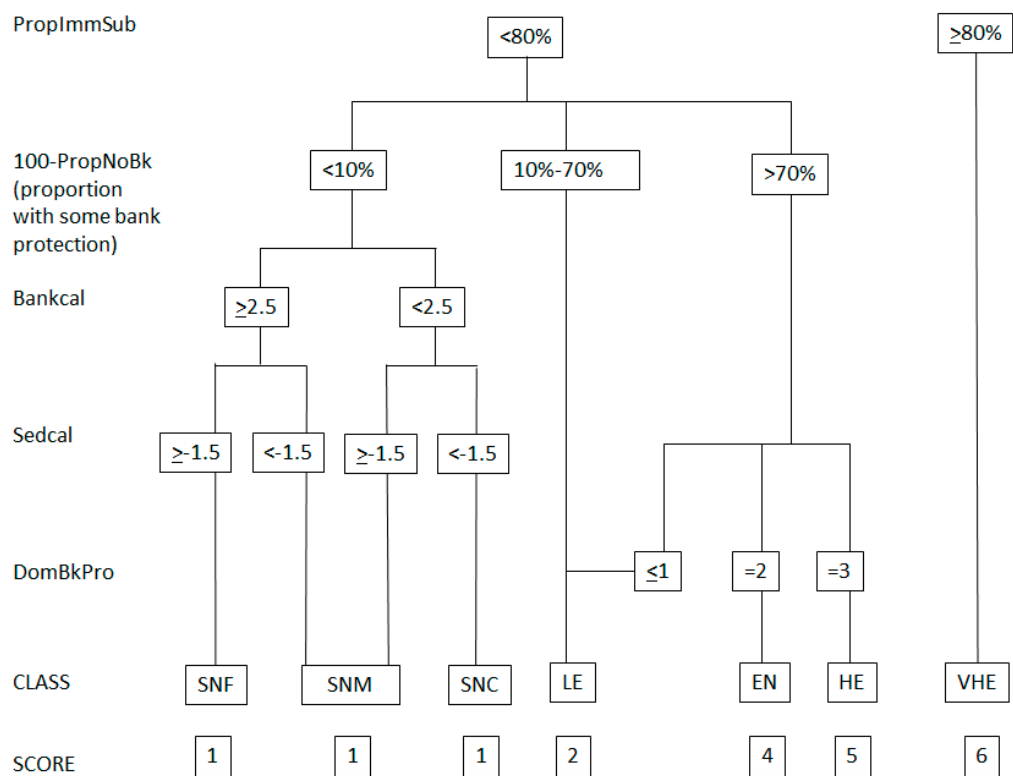


Figure 1: Flow chart for allocating river stretches to the relevant materials class

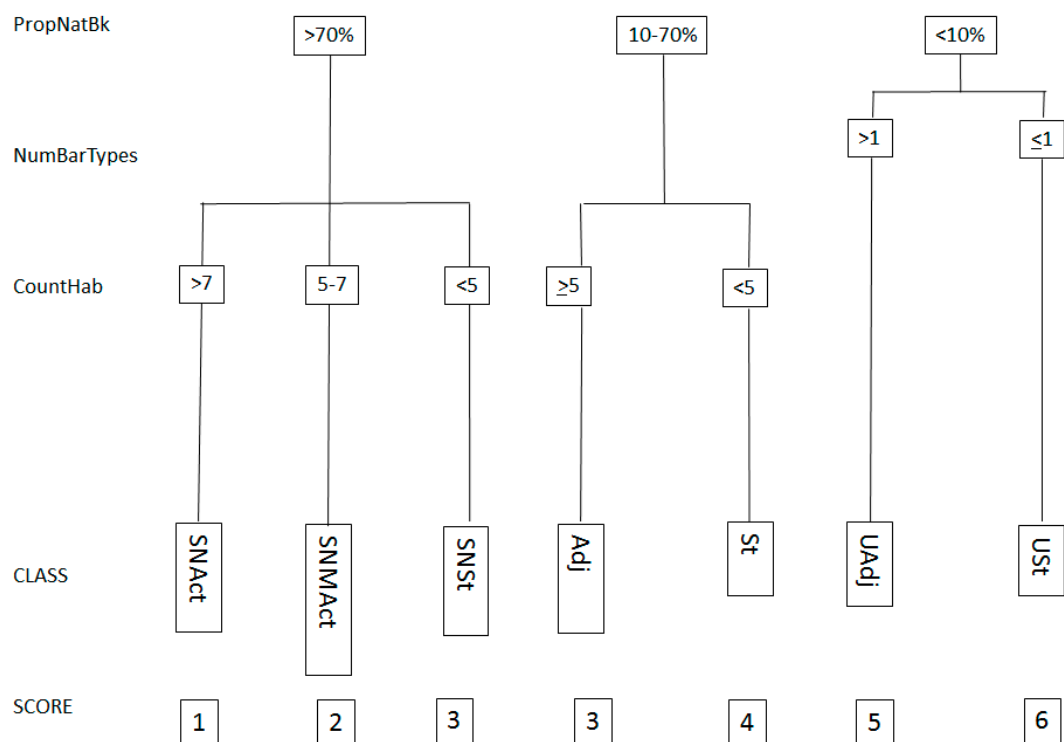


Figure 2: Flow chart for allocating river stretches to the relevant Physical Habitat Class

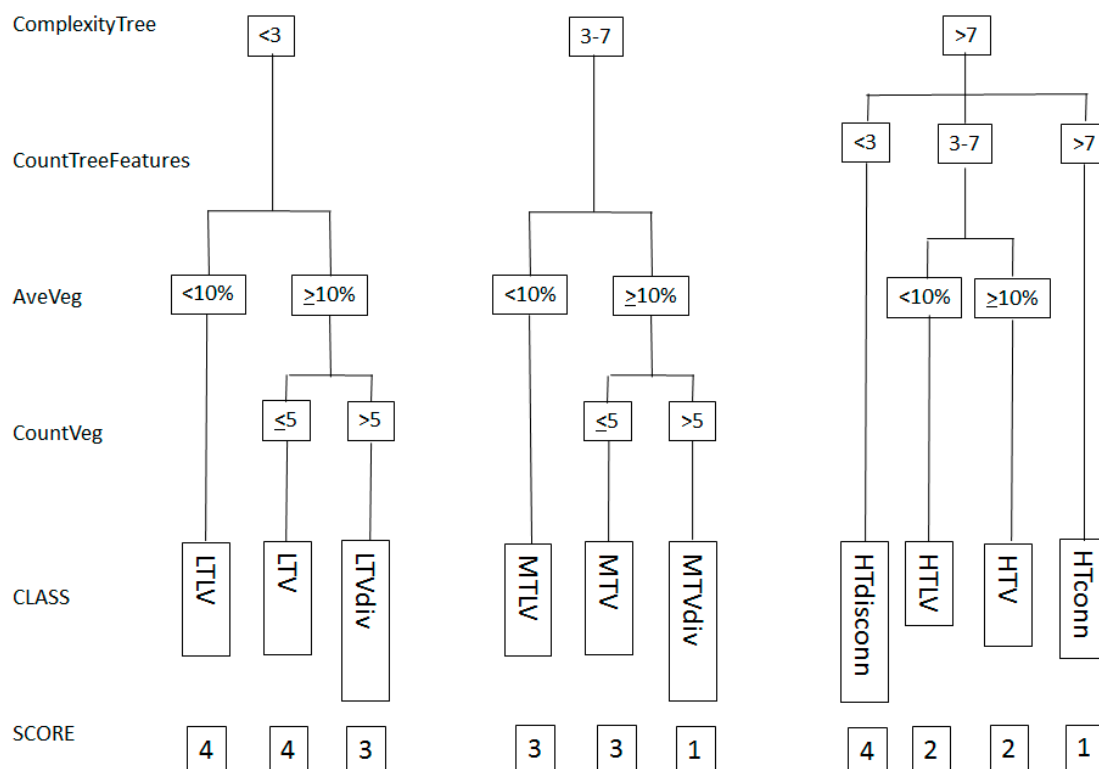


Figure 3 Flow chart for allocating river stretches to the relevant vegetation class.

7 COMBINING CLASSIFICATIONS TO PRODUCE A STRETCH HABITAT QUALITY INDEX (SHQI)

7.1 How the classifications were combined to derive the SHQI

In order to combine the three different classifications to produce a single index of the overall quality of a stretch, scores were assigned to each class /cluster within the Materials, Physical Habitat and Vegetation classifications (Figures 1, 2, 3, Table 7). These three scores are then added together to define an overall Stretch Habitat Quality Index (SHQI), which ranges from 3 to 16 with the smallest scores representing the highest quality stretches.

The scores assigned to the materials classes reflect the change from semi-natural (score = 1) to very heavily engineered stretches (score = 6). The semi-natural coarse (SNC), mixed (SNM) and fine (SNF) classes essentially reflect the different alluvial sediments bounding the river channel and are, therefore, assigned the same score of 1. The remaining classes are assigned increasing scores as the extent and rigidity of bank

reinforcement increases (LE – EN – HE), with the highest score allocated to channels with extensive bed reinforcement (VHE)

Scores assigned to the physical habitat classes reflect the degree to which the channel bank profiles are ‘natural’ (PropNatBk) and the degree to which the channel is displaying different physical habitat features indicative of erosion and deposition of sediment (i.e. geomorphic activity). The semi-natural active (SNAct), moderately active (SNMAct) and stable (SNSt) classes are assigned scores of 1, 2 and 3, respectively, reflecting the fact that they possess largely ‘natural’ bank profiles and show high, moderate to low levels of geomorphic activity (habitat complexity and turnover). The adjusting (Adj) and stable (St) classes both have a moderate presence of ‘natural’ bank profiles but Adj stretches display more physical habitat features indicative of erosion and deposition of sediment than St stretches, so are assigned the same score as SNSt (i.e. 3) whereas St is assigned a score of 4. The two remaining classes (UAdj and USt) both have largely artificial bank profiles, contributing to their high scores (5 and 6). UAdj scores 5 because it displays a greater number of physical habitat features indicative of erosion and deposition of sediment than USt.

Scores assigned to the vegetation classes reflect the extent of bank tree cover and channel vegetation, with the level of connectivity of the trees with the channel and the diversity of the channel vegetation indicating higher quality riparian and in-channel vegetation. Thus HTconn and MTVdiv are allocated a score of 1 because of the presence of at least moderate tree cover accompanied by either high tree connectivity (CountTreeFeatures) or high channel vegetation morphotype diversity (CountVeg). A score of 2 is allocated to channels with a high tree cover that shows moderate connection to the channel, whether the channel has a low (HTLV) or moderately high (HTMV) channel vegetation cover. A score of 3 is allocated to channels with a moderate bank tree cover and either a moderate but not diverse (MTV) or low (MTLV) channel vegetation cover. The same score of 3 is allocated to channels with a low bank tree cover but a diverse in-channel vegetation cover. Finally a score of 4 is allocated to channels with a high bank tree cover that is disconnected from the channel (HTdisconn – often found associated with old, heavily engineered channels), or a low bank tree cover with a largely unvegetated channel (LTLV) or a moderate to high channel vegetation cover of low diversity.

7.2 Management implications of the SQHI classes

The SHQI can be interpreted in relation to typical Materials, Habitat, Vegetation and engineering characteristics (Table 8) as a simple basis for understanding how the potential condition of a stretch may be defined, and how the stretch might respond to likely scenarios for rehabilitation. Table 8 defines 6 categories of river stretch, assigns the overall SQHI values associated with each category and describes the type of management that might be considered to rehabilitate a stretch falling in each category and thus improve its SHQI to achieve a lower value.

Table 7 Scoring system for defining the quality and potential of river stretches and the three scores that accumulate to form a Stretch habitat Quality Index (SHQI).

MATERIALS		PHYSICAL HABITAT		VEGETATION	
Class	Score	Class	Score	Class	Score
SNF (semi-natural fine)	1	SNAct (semi-natural active)	1	HTconn (high bank tree cover-connected to channel)	1
SNC (semi-natural coarse)	1	SNMAct (semi-natural moderately active)	2	MTVdiv (medium bank tree cover; diverse channel vegetation)	1
SNM (semi-natural mixed)	1	SNSt (semi-natural stable)	3	HTV (high bank tree cover; vegetated channel)	2
LE (lightly engineered)	2	Adj (Adjusting)	3	HTLV (high bank tree cover; low channel vegetation cover).	2
EN (engineered)	4	St (stable)	4	MTV (medium bank tree cover; vegetated channel)	3
HE (heavily engineered)	5	UAdj (uniform adjusting)	5	MTLV (medium bank tree cover; low channel vegetation cover)	3
VHE (very heavily engineered)	6	USt (uniform stable)	6	LTVdiv (low bank tree cover; diverse channel vegetation)	3
				HTdisconn (high bank tree cover but disconnected from channel)	4
				LTV (low bank tree cover; vegetated channel)	4
				LTLV (low bank tree cover, low channel vegetation cover)	4

Table 8 SQHI values ranges, associations with Materials, Physical Habitat, and Vegetation classes, and management recommendations associated with categories of SHQI values.

SHQI CATEGORY	SHQI VALUES	MANAGEMENT RECOMMENDATIONS
Very Good	3-4	Predominantly semi-natural stretches or those that are recovering strongly from past interventions. Stretches have well developed riparian vegetation, tree cover and in some cases diverse channel vegetation. The recommendation is to leave these stretches free of management and to protect them from development.
Good	5-6	Semi-natural, recovering and a few uniform channels displaying some activity, with good vegetation complexity and tree cover. The recommendation is to remove any remaining reinforcement to allow the channel to recover more freely. These stretches should also be protected from further development.
Average	7-9	Stretches with varying levels of engineering, but displaying some level of either recovery or activity, with reduced riparian vegetation complexity. The recommendation is, where possible, to reduce the levels of immobile substrates and bank materials and increase sinuosity. Tree cover and bank top and face vegetation should be managed to provide increased variety and complexity. These channels show moderate to high levels of activity and should be targeted for rehabilitation where opportunities arise.
Below Average	10-11	Stretches with varying levels of modification but showing high levels of activity, combined with low bank vegetation complexity and often channels are choked with macrophytes. These channels show moderate to high levels of activity and should be targeted for rehabilitation where opportunities arise. The recommendation is to reduce or alter the level and/or type of reinforcement and increase channel sinuosity where possible. Where macrophytes cover is excessive, increased tree cover through planting or channel narrowing to increase shear stresses are possible management options.
Poor	12-14	Moderate to heavily engineered channels with low to moderate levels of activity, low complexity of bank vegetation and often algal dominated channels. The recommendation is to assess the water quality for improvement of in-channel vegetation diversity and undertake a detailed assessment of the level of rehabilitation required to improve the physical condition of the channel. Where possible, a reduction of reinforcement level and/or type and an increase in sinuosity of the channel is desirable.
Very Poor	15-16	Heavily engineered, often algal-dominated, stable channels with little vegetation complexity. Significant improvements to water quality should be initiated, followed by a detailed assessment of rehabilitation needs. Aesthetic rehabilitation may be the best option in the short term. Wherever possible this should be followed by some reduction in the level of reinforcement and an increase in channel sinuosity.