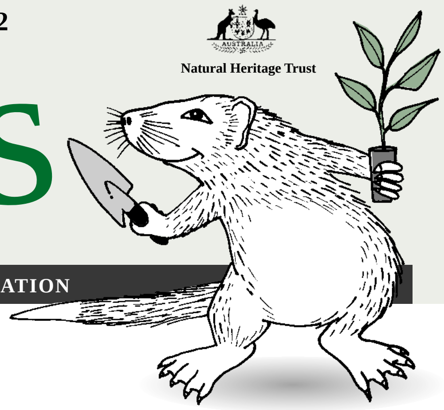
Water and Rivers Commission | WN27 February 2002

Natural Heritage Trust

# Water notes

Water notes for rivers management

ADVISORY NOTES FOR LAND MANAGERS ON RIVER AND WETLAND RESTORATION



# Demonstration sites of waterways restoration in WA

The Water and Rivers Commission, in partnership with other agencies, catchment groups and the community, has established a range of sites demonstrating restoration techniques in urban and rural waterways. The techniques address restoring channel stability, rehabilitating riparian vegetation and enhancing the habitat and ecosystem value of waterways.

This Water Note describes 12 complete and several developing demonstration sites throughout south-west WA.

Site locations range from the Lower Moore River in Guilderton, to Coramup Creek near Esperance. The site descriptions are numbered and correspond to the locations on the map in the centerfold of this Water Note.

The aim of establishing the demonstration sites is to raise community awareness and achieve environmental benefits by promoting adoption of different waterways management techniques. The techniques trialed include installing large woody debris, rebuilding meanders and establishing pool-riffle sequences. Revegetation, fencing and livestock management have also been used to restore and protect the sites. The works are at a variety of scales, from handmade structures on small creeklines, to significant works on major waterways requiring heavy machinery.

## Demonstration sites

### 1. Spencers Brook bed stabilisation using rock riffles

This demonstration site was established in May 1996 on the lower reaches of Spencers Brook near its confluence with the Avon River, ten kilometres upstream of Northam. The natural river processes of the Avon River have been dramatically altered. Large amounts of sediments were exposed through the ripping of the riverbed and removal of debris from the river channel during a River Training Scheme carried out between 1957 and 1973 (Davies *et al*. 1996). The Scheme was instigated to alleviate flooding, but resulted in extensive erosion and sedimentation.

The Spencers Brook site was one of the first trials in Western Australia of the Newbury and Gaboury (1993) technique of using riffles to restore channel stability. A riffle is like a small ‘rapid’ and forms an obstruction during low flow conditions. The stream forms a shallow pool upstream of the riffle and a scour hole or splash pool at the downstream base as flows accelerate over the crest and down the slope of the riffle. The design and benefits of pool-riffle sequences are described in River Restoration Manual Section RR 10 *Stream Stabilisation*.

Spencers Brook was selected as a site for restoration works as it was undergoing severe bed scouring and head-cutting back up the brook, as shown in Figure 1. Near total clearing of the catchment and little supportive vegetation on the banks of the brook resulted in steep banks that were consequently prone to undercutting and collapse. The stream bed had eroded to about one metre lower than its pre-Training Scheme level due to hydrological changes, lowering of the Avon River channel and the lack of supporting vegetation.

*Figure 1. Spencers Brook prior to restoration works. The base of the brook is severely eroded and the headcut is actively advancing upstream.*

A sequence of four riffle structures has been constructed at the site to control the bed level and stabilise the channel slope. Figure 2 shows the first riffle in the sequence, built near the confluence with the Avon River. The riffle structures have been successful in achieving the objective of stabilising the riverbed by reducing the velocity of flows and the down-cutting that high velocities generate. The success of the riffles is evident by sediment trapped upstream in the brook, helping to prevent further sedimentation of the Avon River.

*Figure 2. Riffle structure located 80m upstream of the Spencers Brook confluence with the Avon River in full flow during June 1998. The pool upstream extends for approximately 160m.*

Bank under-cutting and channel widening continued to occur at the site as the stream adjusted to a new flow regime dictated by the greater than natural runoff rates of the highly cleared catchment. If the brook had been left to adapt to the increased runoff without intervention, then the channel would have continued to incise over a length of many kilometres well into the catchment and subsequently widen until reaching a new stable channel alignment. The riffles raise the bed level, which decreases the amount of channel widening that would have otherwise occurred.

A revegetation plan is being implemented at the site. Various planting and direct seeding techniques are being trialed, including scalping, smoked water treatment and altered grazing regimes. The site will continue to be monitored to evaluate the suitability of the pool-riffle stabilisation technique to channel incision problems in the south-west rivers of Western Australia.

The cost for the installation and enhancement of the four rock riffles was approximately $10,000 (1996/97 prices). Additional funds were spent on surveying and monitoring the site. In some situations riffle construction is more cost effective when stabilising and rehabilitating waterways than concrete drop structures. Drop structures can cost in the order of ten times more to construct than riffles and do not provide habitat enhancement benefits. The possible economic losses, due to erosion damage to farmland and infrastructure such as roads and bridges, can far exceed the costs associated with stabilising the waterway.

**2. Southernwood Creek rehabilitation**

The project commenced in 1996 as a “Friends of the Canning River” community initiative to transform an urban drain into a living stream. A living stream is a complex ecosystem supporting a wide range of plants and animals. The site is located on Southernwood Creek, Gosnells, near the corner of Anaconda Drive and Shearwater Way. The creek profile was surveyed and analysed and a design developed to stabilise the bed and enhance the habitat value of the creek. The first stage of the project was to build meanders along the straight drain, as shown in Figure 3. A geotextile mat was installed along the creek banks to stabilise the banks and inhibit weed growth.

*Figure 3. Realignment of Southernwood Creek.*

*Figure 4. Rock riffles and matting installed on Southernwood Creek.*

A series of riffles was constructed in the channel using broken cement curbing and stone. The riffles were installed to control erosion by gradually stepping the creek down to the river. The riffles were spaced at short intervals to reduce flow velocity along the artificially steep slope of the creek to its confluence with the Southern River (Figure 4). The site was further enhanced through revegetation, weed control and re-contouring the steep banks to control drainage (Figure 5).

*Figure 5. Southernwood Creek, four years later. The riffles have stabilised the bed and revegetation has stabilised the banks.*

**3. Preston River realignment**

The Commission established several restoration sites as part of the Leschenault Catchment River Restoration and Enhancement Project. The three year project commenced in 1998 with funding from the Natural Heritage Trust. The project has been very successful, with a large amount of community involvement. Restoration initiatives on the Wellesley, Collie, Ferguson, Brunswick and Preston rivers and their tributaries were undertaken. Projects included fencing, revegetation, bank stabilisation and erosion control works.

An example is an erosion control project on the Preston River at Donnybrook. Instream sediment deposition was causing undercutting of the outer meander. The bare, unprotected bank was eroding at a rate of about three metres per year. During April 1998, approximately 80 metres of the river was realigned by removal of the deposited sediment on the inside of the meander. The sediment was placed on the outer bank and the area reshaped to a stable slope. The bank was battered, mulched and revegetated. Rows of trees were planted along the outer bank contours to reduce overland flow and stabilise the channel. Sections were stabilised with stone pitching.

**4. Dandalup River habitat enhancement using large woody debris**

The majority of rivers on the Swan Coastal Plain have been de-snagged to the extent that little large woody debris (LWD) remains in the channels. Additionally, much of the native vegetation that once grew along the riverbanks has been cleared. Consequently, there has been a large increase in the amount of mobile sandy bed habitat such that, during the high flows of winter, the river channels are almost devoid of fauna. The lack of LWD has also reduced the frequency and depth of pools, which are a refuge for aquatic fauna over the long dry summer.

In May 1998, with the assistance of a grant from Land and Water Australia, the Commission established a Large Woody Debris Demonstration Site on the Dandalup River near Pinjarra, 70 kilometres south of Perth. The trial site was built to develop techniques for the replacement of large woody debris in sandy river channels and to monitor the ecological response to the enhancement of in-stream habitat.

More than 70 tree trunks were installed in two reaches selected for the project. The reaches are:

a) A ‘Demonstration Site’ in a highly degraded section of the Dandalup River, two kilometres upstream of its confluence with the Murray River. The reach is 600 metres long and is located immediately upstream of the Paterson Road bridge. The reach is unfenced and subject to both livestock grazing and trampling (Figure 6).

b) A 300 metre long ‘Reference Site’ is located a further six kilometres upstream on the South Dandalup River within Fairbridge Village. This reach has been fenced off in recent years and has good regeneration of riparian vegetation. The village is being developed to demonstrate best management practices for coastal plain farming.

*Figure 6. Dandalup River prior to installation of LWD. The site selected for one of the log riffles was severely degraded and destabilised due to cattle trampling.*

The construction of the Paterson Road site was carried out over two days in May 1998. Forty large tree trunks were installed using a hydraulic excavator. At three locations, logs were placed perpendicular to the flow to form ‘riffles’.

Two logs were used at each site to build a V-shaped riffle across the low flow channel (Figure 7). The remainder of the logs were orientated to provide 'toe protection' to support stream banks either immediately upstream or downstream of the riffles, or on the outside of meander bends to direct flows away from the banks. Sections of the banks were stabilised with jute matting, which was pinned down. The cost for the installation and enhancement of the log riffle structures and toe protection was approximately $10,500 (i.e. about $260 per log placed).

*Figure 7. The riffles were constructed with the root balls of the logs buried into the bank to anchor the logs and the tapered ends pointing slightly upstream. A scour pool has formed in the centre of the channel.*

The technique was evaluated and extended to the South Dandalup River project site at Fairbridge in March 1999. As the riparian vegetation is well-established along this reach, access by heavy machinery to position the logs would have caused considerable damage to the banks. In order to minimise disturbance to the riparian zone, the logs were installed manually by twelve Landcare trainees through the Fairbridge "Ecohouse Project" (Figure 8). Thirty logs of somewhat smaller size than those used at Paterson Rd were installed (Figure 9).

The logs were retained by wiring and bracing to pine posts and galvanised fencing droppers jetted or driven into the bed. Sedges and rushes were also transplanted and brushing installed to protect banks from undercutting. Some minor movement of logs occurred during the high flows of the 1999 winter. The movement was due to some of the pine posts being inadequately installed, which was easily rectified. The materials and construction cost of the site was approximately $3,000 (i.e. $100 per log placed). Additional funds were spent on surveying, site supervision, weed control and monitoring. The works were funded by both the Natural Heritage Trust and the Water and Rivers Commission.

*Figure 8. Landcare trainees installing logs on the South Dandalup River.*

*Figure 9. Log riffle and bank protection on the South Dandalup River.*

Fish and macroinvertebrate species diversity and abundance was monitored over several years by the Zoology Department at the University of Western Australia to assess the ecological benefit of instream habitat restoration. An increase in fish biodiversity appears to be the major ecological benefit of LWD installation. The number of fish species recorded increased substantially, from one in 1997 to six in 1999 (Davies and Creagh 2000).

Significantly, more macroinvertebrate species were collected from the demonstration sites compared to the control sites during the summer sampling, however there was little difference between the sites during spring. The loads of LWD were possibly insufficient to create enough diversity of hydraulic habitats during high flows. These initial results may be indicative of the benefits of increased LWD during the long periods of low flow experienced during the summer in the south-west of Western Australia (Davies and Creagh 2000).

**5. Brunswick River, Wellesley Road Bridge, Brunswick Junction**

Natural Heritage Trust funding was used to establish a demonstration site along an 800 metre reach of the Brunswick River. The river reach was degraded through cattle grazing and the lack of vegetation, resulting in an incised and oversized channel, with steep, unstable banks.

The site was surveyed and a design developed to stabilise the channel and commence rehabilitation of the river. Rock riffles were built to stabilise the river bed level. Large logs and boulders were installed along the base of the steep banks to provide toe support (Figure 10). Sediment bars that had built up on the inner bends, constricting the channel and causing erosion of the outer banks, were removed.

Approximately 24 logs ranging in size from three to nine metres long and 0.4 to 0.6 metres in diameter were installed along the outer bends of the river. The logs formed groyne structures to direct flows smoothly around the meander and to the centre of the channel, away from the toe of the bank. The logs were pegged into position by wiring them to metal stakes driven about 1.5 metres into the bed. Near vertical banks were battered to a gentler slope. Seed was scattered on the banks and erosion control matting pinned to secure the bank material. The matting is biodegradable and relies on the establishment of vegetation to provide long term protection.

*Figure 10. Works in progress on the Brunswick River. Large logs and boulders were placed along the base of the eroding bank (foreground) and the face battered and covered with matting (background).*

The preferred management strategy is to exclude livestock from the river channel by providing off-stream livestock watering points. As a condition of approval to fence the restoration site, the landowner on the northern bank requested that livestock access to the river for watering be maintained in the first paddock. A livestock watering and access track was incorporated into the restoration design.

The reach has been fenced and a management agreement signed with the landowners to manage livestock access, protect revegetation works and enhance regeneration. Two thousand seedlings were planted on the foreshore during June 2000. The site will continue to be monitored and enhanced.

**6. Lower Moore River, Lancelin Road Bridge – river pool excavation and channel diversion works**

The aim of the project was to restore and protect a 150 metre reach of severely eroded river bank on the Lower Moore River, Guilderton. The reach is located about 100 metres upstream of the Lancelin road bridge. The erosion was caused by timber blocking the low flow channel and diverting water, creating a new side channel into the unvegetated sandy riverbank (Figure 11). The flow was being diverted from the main river valley down the breakout channel (or avulsion) as it was the most open and shortest route. The bank continued to erode into the adjacent paddock and sand eroded from the steep bank was being transported downstream of the road bridge, filling a deep river pool.

*Figure 11. Side channel carved out of the sandy riverbank during the March 1999 flood.*

This situation had been ongoing for over a decade and illustrates the need for action as soon as a problem arises. In this instance, action was only taken after a substantial part of the farmer's paddock had been lost. The purpose of the work was to direct flows back down the pre-existing low flow channels, and prevent further degradation of the river bank and the associated impacts on the river ecosystem.

The area was surveyed and a design developed to block the preferred offshoot channel and re-open the abandoned original main channel. The vegetation, sediment bars and timber debris constricting the main river were selectively cut back or removed to allow free flowing water down the channel. Some large debris was reoriented against the banks and placed to protect large trees on each side of the channel where major scouring had exposed root systems. Two channels were excavated along the west and central channels of the main river. The riverbed was skimmed to remove loose river sand that had accumulated along the channel. Care was taken not to lower the bed below its original level.

The sand from the excavation was used to fill the breakout channel. The vertical banks were graded to a stable slope of 1:6 and the channel avulsion filled with sediment. Sediment was excavated from the river pool and returned to its original location in the break-out channel. The entrance and exit of the avulsion were hardened with limestone riprap laid over filter cloth (Figure 12). The surface of the filled area was covered with a clay mix stabiliser and sections of the steep bank at the downstream end of the rehabilitated reach were covered with biodegradable matting to stabilise the area. These earthworks were carried out in March 2000 and the area was revegetated with native species prior to winter.

The earthworks and selective channel clearing cost $4,950 (2000 prices) and additional funds were spent on surveying. Approximately 1,800 cubic metres of sand was required to fill the channel. The project was funded by the Moore River – Guilderton Community Association through the Natural Heritage Trust with support from the Shire of Gingin and technical assistance from the Water and Rivers Commission.

*Figure 12. The channel was filled and battered in July 2000. Rock was placed to protect the entrance to the break-out channel.*

**7. Yallingup Brook, Yallingup**

The demonstration reach of Yallingup Brook is located behind Caves House, Yallingup, approximately 700 metres upstream of where the brook discharges into the Indian Ocean. The area has high public visibility, being located alongside the tourist Ghost Trail. The amenity of the area was limited due to water-logging, heavy weed growth and littering.

This section of the brook was severely degraded and little more than a weed dominated drain. The channel was incised and the banks undercut and collapsing. The walkway bridge at the upstream end of the reach was also contributing to erosion as the bridge culverts were too small to convey high flows, resulting in water jetting through the pipes and overflowing the bridge. Bed incision and erosion around the walkway were evident.

An Action Plan for Yallingup Brook, with a catchment area of about six square kilometres, was prepared in 1999 by the Geographe Catchment Council (GeoCatch) in partnership with the Yallingup LCDC. Rehabilitation of the demonstration section of the brook was implemented as part of the Action Plan. Weed control, especially of giant reed, castor oil bush and arum lily, and revegetation with sedges and rushes was undertaken. Earthworks to stabilise the headcut, recontour the banks and 'meander' the channel were also carried out. Limestone rock was installed in the channel to control erosion by reducing the flow velocity and drowning the headcut.

**8. Vasse River, Busselton**

As part of the Lower Vasse River Cleanup Program, GeoCatch undertook a major foreshore revegetation initiative along the Vasse River in Busselton. The reach is located between the Causeway and Strelly Street Bridge. The existing reach was a straightened watercourse with near vertical banks and a grassed foreshore extending to the water's edge.

Earthworks were undertaken in April and May 2001 to scalp back lawns and reshape the banks, remove exotic deciduous trees and create three terraces and a new island. The banks were protected with husk-matting to above high water level and the foreshore mulched above this level. Approximately 850 metres of foreshore area was revegetated with about 20,000 seedlings of 30 different species.

The project aimed to restore the riparian zone, improve water quality and enhance the river habitat, as well as improve the aesthetics of the area for the Busselton community. It is also hoped that lower water temperatures and light penetration resulting from increased shading and tannin staining will help address the problem of persistent blue-green algal blooms during summer and autumn. The restoration plan was developed and implemented by GeoCatch, the Shire of Busselton and the Water and Rivers Commission with extensive community input, and was supported by Natural Heritage Trust funding.

Further similar restoration activities are planned for 2002 and will include the area downstream between the Causeway and the Butter Factory.

**9. Capel River bank stabilisation**

The demonstration reach is located on the Capel River, near the railway overpass in Capel. A tight bend in the river was severely eroding and threatening existing large trees on the bank. In March 2000, large logs were placed by an excavator around the erosion zone to stabilise the bank (Figure 13). The logs were held in place by driving three metre pine posts into the riverbed and wiring the logs to the posts.

The area is now stabilised with matting and has been revegetated. The work was undertaken as a component of the Capel River Action Plan, which was prepared by GeoCatch in partnership with the Capel LCDC in 1999.

*Figure 13. Placement of large logs to protect the bank.*

**10. Bannister Creek living streams project**

This site is located on Bannister Creek, adjacent to Bywood Way in Lynwood, Perth (southern metropolitan region). The creek was originally a series of wetlands, but has been used as a main drain since 1979. The aim of the project was to transform a straight section of the drain (Figure 14) into a living stream. The function of the waterway to convey stormwater from the urban and industrial catchment into the Canning River needed to be maintained. As the creek is within a recreational reserve, enhancement of the creek aesthetics was also an objective.

In November 2000, large volumes of soil were removed from the site to 'meander' the creek and reshape the steep banks to a gentler slope, suitable for planting (Figure 15). Riffles were built to aerate flows and create habitat. Erosion control matting was used to stabilise sections of the stream banks and the area was revegetated. The Bannister Creek Catchment Group has undertaken the project with support from the City of Canning, the Water and Rivers Commission, the Water Corporation, the Swan Catchment Urban Landcare Program, ALCOA, the Natural Heritage Trust and the local community.

*Figure 14. Bannister Creek prior to restoration works.*

*Figure 15. Channel realignment, bank stabilisation and revegetation at Bannister Creek.*

The channel realignment and bank stabilisation works have been very successful. A storm event in winter 2001 caused severe damage to a main drain structure up-stream of the demonstration site, while the newly streamlined channel carried the increased flow without any problems.

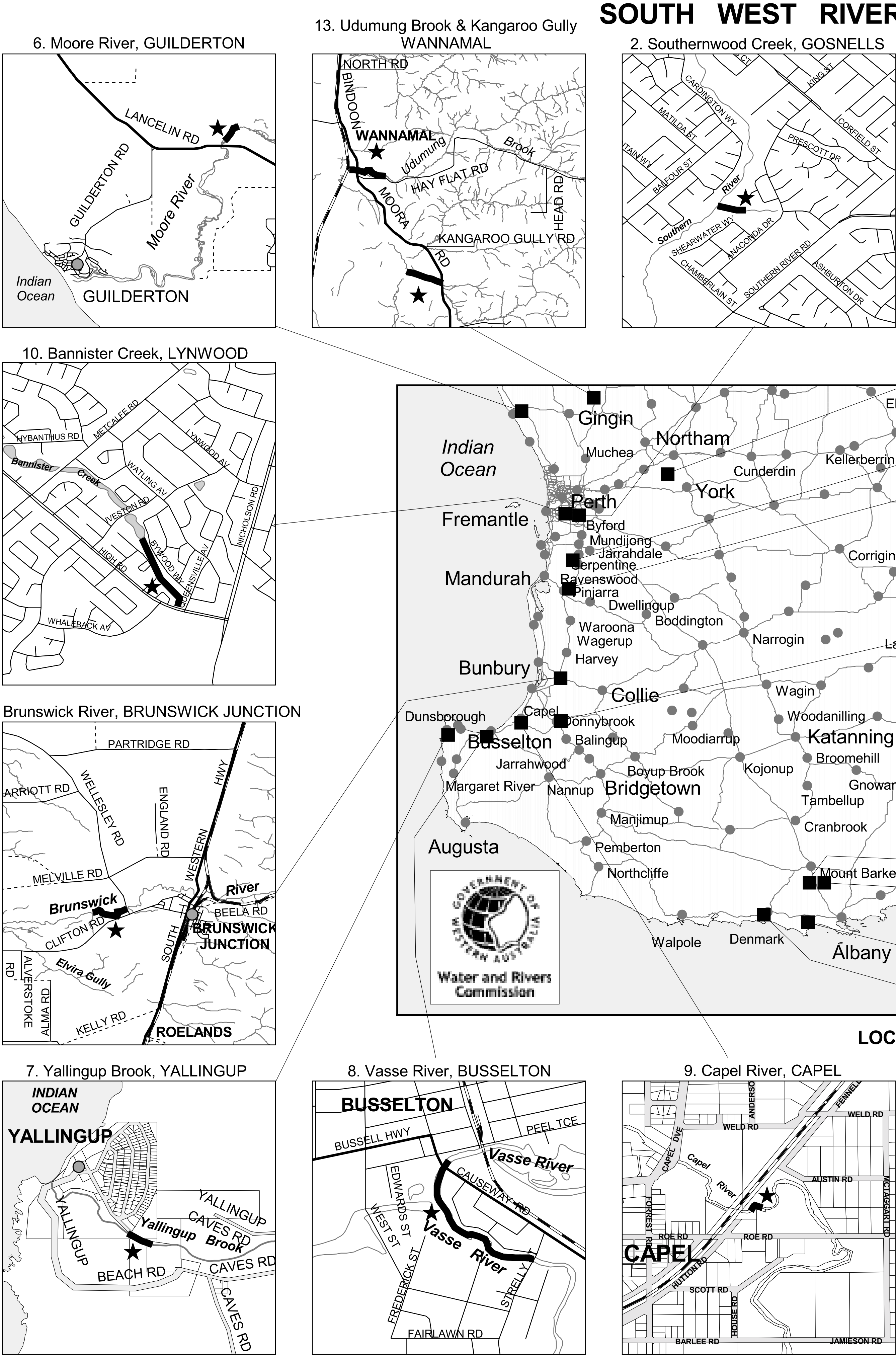
**11. Little River, Denmark**

Little River is a permanently flowing stream which discharges into Wilson Inlet on the south-coast of WA. The river is approximately 10.5 kilometres long and drains a 30 square kilometre catchment. Little River is undergoing erosion and sedimentation processes due to increased runoff caused by significant catchment clearing. The changes to the flow regime are resulting in ecological problems due to pools filling with sediment, increased turbidity and nutrient loads and the destruction of the benthic habitat and aquatic vegetation.

The Denmark Environment Centre undertook an erosion assessment to identify areas of concern affecting the general health of the Little River system. One of the recommendations of the report was to construct a sequence of riffle structures. A section of Little River west of Denmark was re-routed as it was proving a threat to the newly widened highway. Re-routing resulted in a 60 metre long straight drain, with steep banks and high velocity flows.

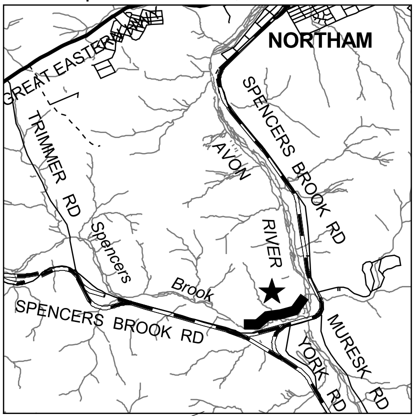
Five riffles were designed and constructed by Angus Mackenzie for the Denmark Environment Centre with assistance from the Main Roads Department. Construction was undertaken in seven hours using a truck and excavator. The small-scale works allowed for hand placement of some rocks. The riffles increased the pool area and reduced flow velocities, assisting fish migration. Little River has a range of native fish, including nightfish, western pygmy perch and various minnows. A gently sloping downstream face was required to provide a passage over the riffles by these small native fish. The requirements of aquatic fauna must be considered when designing instream structures. The river restoration works were designed using the method outlined by Newbury and Gaboury (1993).

# SOUTH WEST RIVER

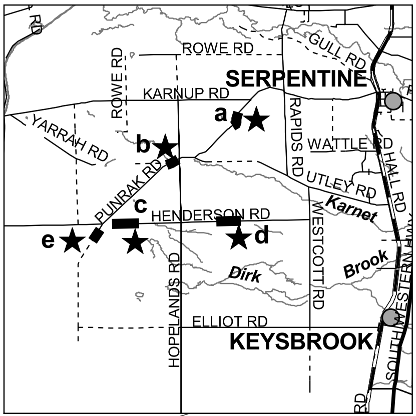


# R RESTORATION SITES

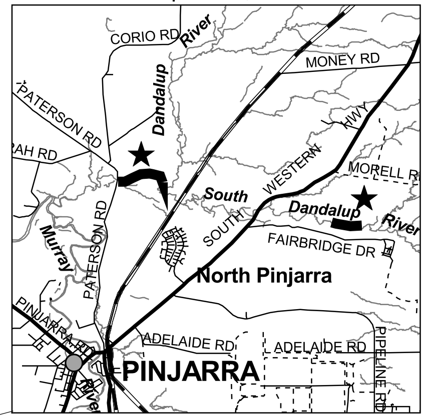
1. Spencers Brook, NORTHAM



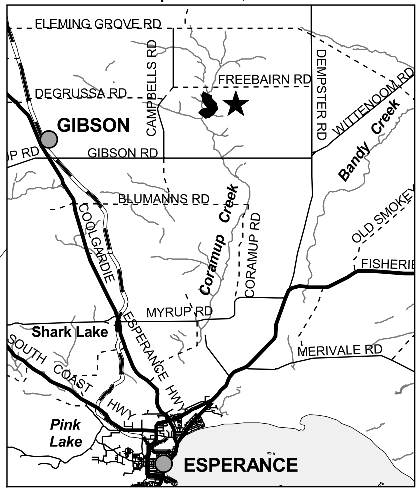

14. Punrack Drain
SERPENTINE - JARRAHDALE

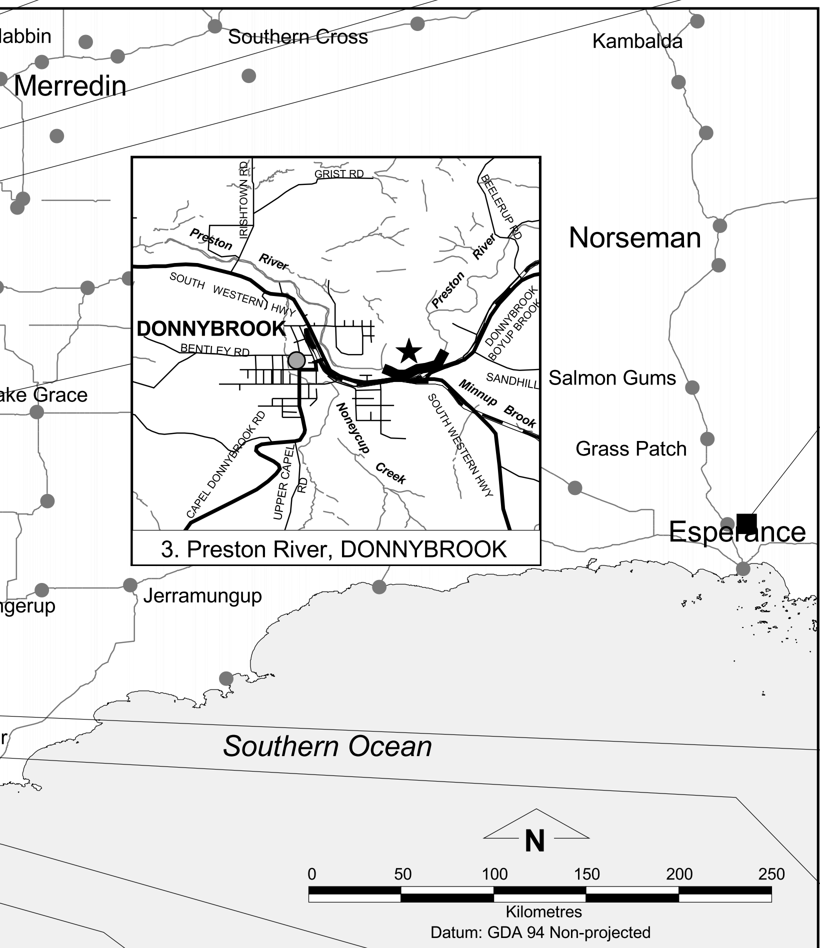



4. Dandalup River, PINJARRA




15. Coramup Creek, ESPERANCE

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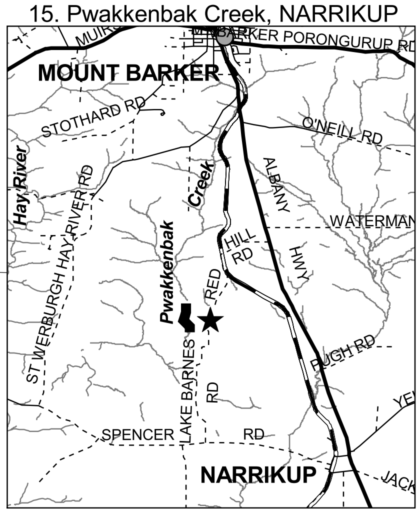
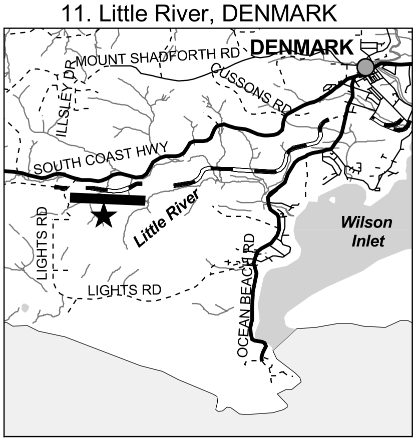
15. Pwakkenbak Creek, NARRIKUP

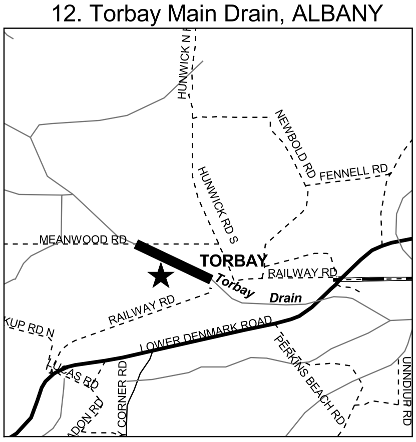



# ALITY MAP

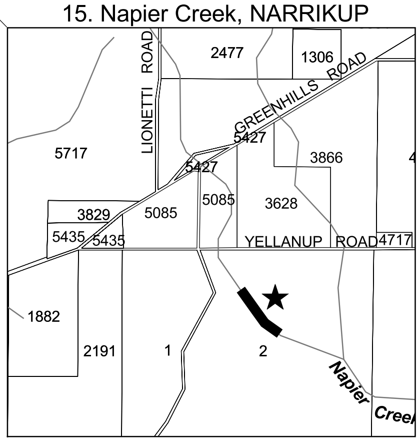
11. Little River, DENMARK




12. Torbay Main Drain, ALBANY




15. Napier Creek, NARRIKUP



Most of Little River has been fenced to exclude livestock. A revegetation and weed control program has also been implemented at the site. The combination of vegetation enhancement with structural erosion control works will gradually stabilise the channel and rehabilitate the area.

**12. Torbay Main Drain, Albany - use of riffle structures in waterway rehabilitation and erosion control**

This site is located on Torbay Main Drain (previously Undiup Creek) upstream of the Railway Road bridge near the Torbay townsite in Albany. Construction of the Torbay drainage system began around 1900, but in the 1950s new land was opened up for agriculture north of the Torbay townsite. In order to cater for the increased runoff expected from this cleared farmland, the then Public Works Department (PWD) designed a drain running from the Torbay Estuary to an area south and west of Redmond. Modifications to Undiup Creek entailed the construction of three massive drop structures to control erosion. As the PWD budget was limited, construction of the drain commenced from the Meanwood Road Bridge creek crossing and the creek itself was left in its natural state downstream of this point.

The constructed drain performed as it was designed to do; that is, to cater for the increased flow from the catchment while limiting flow velocities to below one metre per second in order to prevent erosion of the drain banks. However the resulting changes to the catchment hydrology and flow regime in the unmodified section of the creek downstream of Meanwood Road resulted in extensive bank erosion, bed incision and sedimentation. The initial design for this section of the Torbay Main Drain proposed the construction of three large, two-metre high drop structures, at a total estimated cost of $750,000 (1996 prices).

As the cost of traditional treatments was prohibitive, alternative stream stabilisation techniques were examined. A range of techniques was trialed, including the use of car tyres wired together and secured to the bank to prevent further erosion (Figure 16). This method has shown some success, with sediment accumulating in the tyres allowing vegetation to establish and stabilise the bank. Other changes to traditional drain management practices included maintaining access along only one side of the drain and allowing vegetation on the other bank to regrow (Figure 17). Rock gabions and mattresses (wire mesh cages filled with rock spalls) were laid on the banks to protect the area from erosion (Figure 18). Rock gabions were also used to build a one-metre high weir downstream of Meanwood Bridge. The weir was built to stabilise the bed level and reduce flow velocities near the bridge.

While the above measures had a limited amount of success in controlling flow velocities, it was the construction of a series of riffle structures during 1996 which has helped stabilise the banks of Torbay Main Drain. This work has also prevented further accumulation of deposited sediment in the delta, which had formed at the point where the drain entered the Torbay Estuary.

*Figure 16. Sediment accumulation in car tyres placed to prevent bank erosion.*

*Figure 17. Revegetation along the outer bank, while access is maintained along one bank. Riffle sequence directs high flows into the centre of the channel.*

A sequence of twelve riffle structures was designed and installed to provide control over about eight metres of fall in the four kilometre reach downstream of Meanwood Road. The riffles were constructed of rocks large enough to prevent them being dislodged by the flow of the river using a hydraulic excavator. The sequence was designed so that the tail-water of each riffle back-flooded to the base of the upstream riffle. This is fundamental to the success of the design, ensuring that flows are controlled by stepping down the sequence. Each riffle is built with the lowest section in the centre of the channel (Figure 19). Even at high flows, when the riffles are drowned out, the structures direct high energy flows away from the banks and to the centre of the channel, shown by the plume of bubbles in Figure 17.

The works, based on a theory by Newbury and Gaboury (1993), were designed and funded by the Water Corporation following a visit to the south-coast by Bob Newbury in March 1995. The sequence has been very successful at controlling erosion along the reach, for a total cost of $30,000 (1996 prices). The riffles stabilised during the first winter and minimal maintenance works have been required.

Experience from this site has shown the benefits of trialing alternative, cost-effective stream stabilisation techniques and demonstrated that drains and waterways can be maintained to operate efficiently while achieving environmental benefits.

*Figure 18. Rock gabions used to stabilise the outer bank.*

*Figure 19. Riffle built on Torbay Main Drain.*

## Trial sites under development

**13. Udumung Brook and Kangaroo Gully, Wannamal**

*- Udumung Brook*

A river restoration site is being developed on Udumung Brook, the uppermost tributary of the Brockman River. The restoration reach extends approximately 600 metres upstream and 350 metres downstream of the Midlands Road bridge.

Land clearing has changed the hydrology of the catchment and resulted in greater runoff. Udumung Brook has consequently become wider and deeply incised. This transition has also resulted in an unstable alignment, changing the location of meanders on the brook.

Work commenced in 2000, with the installation of five 0.5 metre high riffle structures designed to control bed erosion over the demonstration reach. Two of the riffles are used as livestock crossing points (Figure 20). The riffles also enhance the stream habitat, oxygenate the flow and improve water quality. Fallen trees that were causing flows to divert and erode into the banks were removed and realigned to protect the banks. Revegetation of the banks was also undertaken. Monitoring points have been established to assess the success of the works.

*Figure 20. Livestock crossing on Udumung Brook.*

*- Kangaroo Gully*

Kangaroo Gully is located on the western side of the Bindoon-Moora Road, directly opposite Kangaroo Gully Road in Wannamal. The creekline was severely degraded and livestock had access to the area.

Restoration work was undertaken by the landholder following advice from the Commission. The landholder fenced off and revegetated the creekline and large woody debris and rocks were strategically placed in the creek to prevent further erosion and protect the remaining wandoo trees that were being undercut.

The work was part of a fencing initiative by the landholder who has erected 4.5 kilometres of fencing along sections of the Brockman River, Romany Creek and Kangaroo Gully. Romany Creek is headcutting severely because it was straightened to stop it meandering over the floodplain.

The approximate cost of the work was $6000 (2000 prices), funded through the Swan Canning Urban Landcare Program (SCULP). Over $7000 was also provided in-kind by the landholder who carried out the work. This was part of a SCULP project called the Romany/Kangaroo Gully project and is managed by the Wannamal Lake Catchment Group. The catchment group has several SCULP and Natural Heritage Trust rivercare projects under way in the catchment, including work on the upper Brockman River.

**14. Dirk Brook Catchment Project – best management practices for rural drains**

Five demonstration sites are being developed along sections of the rural drainage network in the Dirk Brook catchment in the Shire of Serpentine-Jarrahdale. A range of best management practices for rural drains, aimed at improving water quality and providing habitat, are being trialed at these sites. They include introducing meanders, installing pool-riffle sequences, constructing wetlands, reshaping banks and restoring fringing vegetation.

Engineering works at the demonstration sites were carried out during May and June 2001. The total cost of the engineering works at the five sites was approximately $120,000, funded by the Water Corporation. The costs do not include excavation of the wetland at site E, which was a contribution to the project by Greenacres Turf Farm. Revegetation of the sites was an additional cost.

The work was undertaken by the Dirk Brook Project Team, consisting of representatives from the Serpentine-Jarrahdale Community Landcare Centre, the Shire of Serpentine-Jarrahdale, local community and industry, as well as the Water and Rivers Commission, the Water Corporation and the Department of Agriculture.

*- Site A*

The first site is located near the headwaters of the Punrack Drain (see map, centrefold). The original channel consisted of a straight, weedy drain with steep banks. Works were implemented to create a more natural waterway, improve the habitat value and increase the opportunity for sediment and nutrient stripping along the reach.

Earthworks were carried out to build one and a half meanders along a 250 metre reach of the drain (Figure 21). The channel was widened and the banks graded to a gentle 1:4 slope. A 0.3 metre high riffle was built at the central inflection point along the new channel and the site was revegetated with local native species.

*- Site B*

Construction of a treatment system off-line (that is, branching off from the main channel) was trialed along a reach of Punrak Drain located further downstream, near the corner of Hopelands and Punrak Roads.

Two agricultural drains, spaced 120 metres apart, crossed the 30 metre wide reserve adjacent to the southern bank and entered the main drain. The project team recommended enhancing the water quality by filtering the flow from the side drains through an off-line sedge/rush bed system. The design involved maximising use of the reserve to strip sediments and nutrients from the side drains prior to entering the main drain.

A ‘U’ bend channel was excavated through the reserve, with gently sloping banks (Figures 22a & b). The existing side drains were partially blocked and flows diverted through the excavated treatment channel. A rock chute was built at the old exit point of the downstream side drain. The chute will allow the exit point to function as a flood protection overflow to the main drain during peak flows.

During the first flush and low flows, drainage water will be filtered through the sedge/rush bed, once it is established. Higher flows will result in flows from the main drain flooding the sedge/rush bed area. By increasing the retention times of flows, water quality can be improved by maximising sediment and nutrient stripping. Revegetation along the project reach is also being undertaken to improve the health of the waterway.

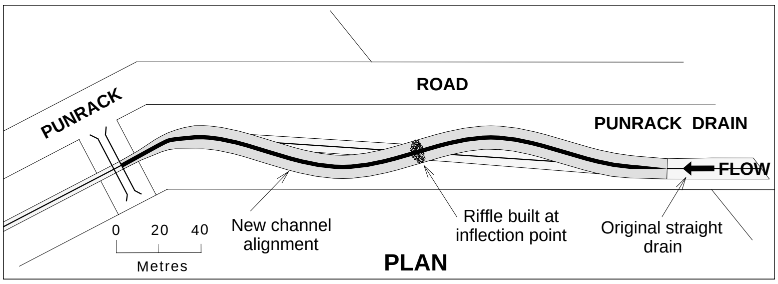



*Figure 21. Drain realignment in the Dirk Brook Catchment, site A.*

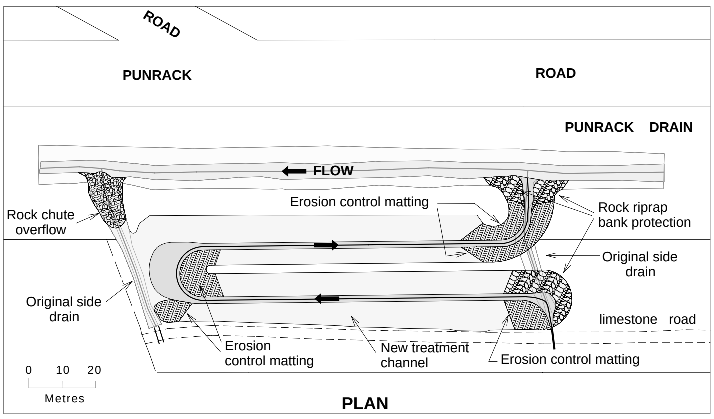



*Figure 22a. Design to treat side drains prior to entering the main Punrack Drain, site B.*

*Figure 22b. Treatment channel built adjacent to the main Punrack Drain, site B.*

*- Site C*

A sequence of five 0.5 metre high riffles spaced 300 metres apart was built along a lower branch of Punrak Drain adjacent to Henderson Road, downstream of the Hopelands Road bridge. Hydrological modelling showed that the capacity of the drain was more than adequate to convey the drainage flows required, allowing the works to be undertaken without causing flooding problems.

Planting of sedge and rush beds is planned along the reach and the embankments will be revegetated with taller species to shade the drain. By reducing flow velocities and encouraging sedimentation, nutrients in the water column can be removed through biological processes or remain bound in the bed material. Water quality is also improved as the riffles create turbulence that aerates the water, which in turn supports microbial activity that breaks down organic matter and assimilates nutrients.

*- Site D*

Two riffles were constructed on the branch of Punrak Drain near Henderson Road, upstream of Hopelands Road. Earthworks were carried out to reshape the banks to a less steep slope and prepare the area for revegetation. The aim of the works is to improve the water quality and habitat of the reach by creating pool and riffle zones and enhancing the fringing vegetation. However, the narrow reserve and the need to retain an access track along the northern bank limited the scope of the works at this site.

*- Site E*

An artificial wetland with a capacity of about 80,000$m^3$ has been built at Greenacres Turf Farm to improve water quality and enhance the habitat value of the area. Nutrient rich drainage water from Punrak Drain near Yangedi Road is being stored in the wetland and used to irrigate turf.

The bank of the drain was breached to allow flow from the drain to fill the wetland. A 0.6 metre high riffle was built downstream of the entry to set the level of the wetland and divert nutrient-rich first flush and low flows into the area. Spoil was used to construct an island in the centre of the wetland, which is being revegetated to create bird habitat.

Using the water for irrigation will reduce the application of fertilisers on the turf farm. Nutrients will be taken up by the turf and effectively exported off site when the turf is harvested. It is estimated that the scheme will remove approximately 27 kilograms of phosphorus per hectare of irrigated turf. Nutrients will also be removed from the water column through sedimentation and absorption by wetland plants.

A comprehensive monitoring program is being undertaken to assess the project's success in reducing the amount of nutrients being transported downstream. This innovative project will demonstrate the potential environmental benefit, as well as increased profitability to landholders, of effectively managing drainage waters.

**15. South Coast Region demonstration sites**

A number of experimental sites are being established on waterways in the south-coast region, including Pwakkenbak, Napier and Coramup Creeks. The sites demonstrate a range of small scale and low cost works to rehabilitate problem areas in streams. The sites will continue to be developed and monitored to assess the success of the works and to promote wider application of the techniques to other waterways in the region.

*- Pwakkenbak Creek*

A drain rehabilitation project commenced on Pwakkenbak Creek near Narrikup in 1999, with support from the landowner, the Wilson Inlet Catchment Committee, GreenCorps and the Commission. Six low rock riffle structures were installed along a one kilometre reach of the straight drainage line to reduce bed erosion. The area was fenced to exclude livestock and trees were planted along the banks.

The success of plant establishment was minimal during 1999/2000, possibly due to weed competition and grazing by kangaroos. The plantings will be replaced and further rock stabilisation works trialed to stabilise the area.

*- Napier Creek*

Channel stabilisation works are being trialed along Napier Creek, downstream of Yellanup Road near Narrikup.

For the first 500 m downstream of Yellanup Road, the channel is only about 2 metres wide and less than 0.5 metres deep. However, about 2 kilometres downstream of the road, the channel has increased to nearly more than ten times its natural size and flood flows no longer over-top the banks. Damage to fringing vegetation due to livestock access caused an increase in flow velocity and weakened the creek banks. Granite bars have also been exposed by the severe erosion.

The widening of the channel threatens fences and access tracks, and there are small lateral gullies forming in places which threaten farmland. Although the granite bars control further incision from occurring in this downstream section, they do not control the advance of several head-cuts into the upstream catchment. This erosion could continue for several hundred metres, threatening further farmland and Yellanup Road. To stabilise the head-cuts and halt the channel deepening, two rock chutes were constructed in April 2001.

The experimental works are being monitored to assess whether the chutes are successful in preventing upstream migration of the incision. Although the incision appears to be controlled, the consequent widening of the channel due to bank collapse is continuing as the channel adjusts to the new bed level. Livestock have been excluded from the site since 1999 and the property has been planted with blue gums.

- *Coramup Creek*

During the 1999 floods in the Esperance region, a large channel was scoured through the floodplain of Coramup Creek. Techniques to stabilise the new channel are now being trialed by the landowner and the Commission.

The eroding bank was protected by installing groynes constructed from old fencing material. The groynes are angled into the channel to deflect flows away from the bank and a shallow channel was excavated in an attempt to redirect low flows along the centre of the channel.

The site will be monitored and maintained by selective rearrangement of logs in the old channel and through encouragement of natural regeneration of fringing vegetation.

## Please let us know about your river restoration site!

Help build a Western Australian network of shared experiences in the restoration of our waterways. To include information about your trial restoration site in future updates of this Water Note, please send details to:

Engineer, Stream and Stormwater Management Section
Water and Rivers Commission
PO Box 6740
Hay Street
East Perth WA 6892

Information should include site location, a description of the problems at the site and how these were addressed, contributors to the project and contact details for further information.

## Approval for access

Please note that approval for access to some of the demonstration sites will need to be obtained.

## Disclaimer

The Water and Rivers Commission does not accept liability for any damage caused or injury obtained by a person while visiting any of the sites or inspecting the works that have been undertaken by the Commission. Please exercise due care when visiting the sites to prevent personal injury or damage to property. For example, please close any farm gates that you open.

## References and further reading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