Coastal drainage
discussion paper

Looking after all our water needs

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1 Introduction

This discussion paper has been produced through the Department of Water's coastal drainage plan, which has been initiated as part of the state government's renewed focus on strategic drainage planning, governance and funding. The plan is part of the Department's drainage and waterways sub-program. Related projects include the:

- Urban Drainage Initiative
- Wheatbelt Drainage Evaluation.

During the first year of the Coastal Drainage Plan, a review was undertaken of key issues being faced by stakeholders at the regional level. This approach was adopted because the majority of the rural drainage networks on the coastal plains are well established, and regional stakeholders have been dealing with management and operational issues related to the existing system for some time.

The issues and comments collated through this work were substantiated by field trips and a literature review, and have led to the production of this discussion paper, which provides:

- a history of the coastal drainage system
- discussions and analysis of the issues and comments collated during the site visits
- recommended areas of work required to tackle these issues
- proposed priorities for the second year of the coastal drainage plan.

It must be appreciated that the matters discussed were raised by stakeholders during initial consultation and are open to interpretation.
2 Coastal drainage system history

Drainage problems on the coastal plains of Western Australia were first recorded in 1833 in Fremantle; but it was not until 1848 that the first drainage channel was constructed. The channel was from Lake Kingsford to Claisebrook and was required to deal with flooding. Since this date, it seems that the construction of drainage to combat flooding was not regulated until 1858, at which point Perth City Council took over drain construction (Meinck G, undated).

In the early 1900s, the delineation was made between ‘urban’ and ‘rural’ drainage with the proclamation of the *Land Drainage Act 1900* and later the *Water Supply, Sewerage and Drainage Act 1912*. During this time, the Public Works Department managed and constructed drainage in parallel with the expansion of urban and rural land use. This department was eventually split into urban (metropolitan) and rural (country) areas in 1921 (Meinck G, undated).

The Public Works Department continued to expand drainage in the rural areas alongside the development of irrigation areas. Through the *Rights in Water and Irrigation Act 1914*, irrigation districts could be proclaimed. These incorporated open irrigation channels and the Public Works Department was instrumental in developing and managing them (Powell J M, 1998).

The purpose of drainage was to provide a mechanism to control the level of seasonal inundation of arable areas throughout the year. As such, drainage channels were designed to convey larger surface flows and reduce flooding that followed the more frequent and heavier winter rains. Removing the excess surface water created a number of benefits. The main benefit was improved crop and pasture production with associated benefits of preventing salinisation associated with irrigation, reducing agricultural disease and improving machinery/vehicle access.

It is important to note that during the time drainage networks were being developed, the ownership and responsibility for road and railway line crossings resided with whoever required the crossing to be built. If the road or railway line already existed before the drain was constructed, the infrastructure was owned by the Public Works Department. On the other hand, if a new road or railway line was being constructed and crossed an existing drainage channel, the infrastructure was regarded as a road or rail structure.

Under the *Land Drainage Act 1900*, landholders were able to get together and petition for a district in which drainage could be managed by a drainage board. These districts were approved as long as a majority of the landholders within the district supported the petition. Through this legislation, 13 districts were established (English L, June 1995). However, there were operational issues with the boards and in 1925 the former Act was replaced with the *Land Drainage Act 1925*.

The revised Act shifted the power to form drainage districts to the Governor and provided the power to vary them as seen fit. Management of the drainage districts remained with the drainage boards; however, under the Act they were given
increased powers to borrow and levy rates on land outside the drainage district where the land received a benefit from the drainage works.

When the Town Planning and Development Act 1928 came in, local governments were given the power to manage drainage activities within their jurisdiction. However, the drainage works within the drainage districts that were affected by this were relatively minor in overall length and capacity and this Act was more commonly used to deal with drainage in urban and peri-urban development.

The drainage boards continued to manage the drainage districts (as declared under the Land Drainage Act 1925) until 1985, when the Water Authority was created. The power to create boards under the Act was removed and responsibility for constructing and maintaining drainage within the drainage districts was given to the Water Authority—subject to Ministerial approval. At the same time, the Water Authority was given responsibility for the irrigation districts.

Very few new drainage works were required to be constructed within these drainage districts as the Public Works Department had already built up a comprehensive drainage network. There were six drainage districts in south Western Australia (see Figure 1), namely Mundijong, Waroona, Harvey, Roelands, Busselton and Albany. The drainage districts covered 321 000 hectares of the coastal plain. They included 2500 kilometres of drainage channels and managed rivers and creeks in the drainage network. There were also 337 public road bridges and 721 public road box and pipe culverts for which the Water Authority was regarded as responsible (English L, June 1995).

![Figure 1 Drainage Districts](image)
Drainage was also being constructed on coastal plains and rural areas outside of the drainage districts, notably in the Scott Coastal Plain. These works have continued largely unmonitored as there was no legislation to give powers to a particular body to manage them. However, two pieces of legislation should be noted:

- the *Rights in Water and Irrigation Act 1914* was amended in 1984 to give the Water Authority the power to prohibit drainage works that were likely to affect the water in a watercourse, wetland or underground water source. However, this power has rarely, if ever, been used in relation to rural drainage.

- the Soil and Land Conservation Regulations 1992 provided the Commissioner of Soil and Land Conservation with the responsibility for assessing and approving drainage. This applied predominately to drainage that would drain subsurface water with the aim of controlling salinity and did not apply to the majority of drainage on the coastal plains. However, under Regulation 6, it did include any drainage in the Peel–Harvey Catchment and therefore did have an impact on the Mundijong, Waroona and Harvey Drainage Districts (URS, December 2004).

The next major change in the way drainage districts were managed came in 1993 when, in response to government policy, the powers to raise rates for country drainage were removed from the *Land Drainage Act 1925*. The costs were instead to be met by the Water Authority. This latest amendment meant five parts of the Act were now obsolete (Parts 4, 5, 7, 8, & 9) and two largely obsolete (Parts 10 & 11) (English L, June 1995).

In 1994, the Water Authority commissioned a report – *Review of Rural Drainage Maintenance Practices with special regard to Nutrient Reduction* (Davies J & Muir B, May 1994). This was the start of a drive to shift the emphasis in drainage management from a ‘volume’ approach to a ‘water volume and quality’ approach in order to minimise the impact on the health of rivers, creeks and coastal water bodies.

In 1996, the Water Authority was split up and the Water Corporation formed. With this change, the provision of services to the drainage districts became a community service obligation of the Water Corporation with funding provided by the Economic Regulation Authority. The Water Corporation was guided and directed in the provision of services by the *Land Drainage Act 1925*, the *Water Corporation Act 1995* and service standards imposed by the operating licence issued and regulated by the Economic Regulation Authority under the *Water Services Licensing Act 1995*.

Also in 1996, South West Irrigation was formed as an irrigator-owned cooperative which took over ownership and management of the irrigation infrastructure. This cooperative managed the three irrigation districts of Waroona, Harvey and Collie, all of which significantly overlap with the drainage districts (Powell J M, 1998).

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1 A community service obligation arises when a government specifically requires a public enterprise to carry out activities relating to outputs or inputs which it would not elect to do on a commercial basis, and which the government does not require other businesses in the public or private sectors to generally undertake, or which it would only do commercially at higher prices (Treasury Department, April 2000).
While water quality was beginning to be seen as a key consideration for decisions made on drainage infrastructure, the current drainage design standards do not specifically address water quality.

When the Water Authority split, the Water and Rivers Commission was also formed. The commission was responsible for enacting the *Rights in Water and Irrigation Act 1914*. This Act was amended again in 2000, giving the power to provide local bylaws to regulate and control drainage and dewatering that was likely to affect the water in a watercourse, wetland or underground water source. However, as with the 1984 amendment of this Act, examples of where this power has been exercised in rural drainage are difficult to find.

In 2002, South West Irrigation became Harvey Water and the following year the irrigation system in the Waroona irrigation district was changed from open irrigation channels to a piped system. This made the irrigation channels redundant for the purposes of water supply during summer; however, some channels act as drains in winter and their maintenance is a consideration, and the ownership and management of these are now under question. It is proposed to convert the Harvey and Collie systems in a similar fashion.

In 2006, the Department of Water was created and given responsibility for drainage governance and planning reform for urban, coastal and inland drainage, including water law reform to cover all water-related statutes. This reform process is currently underway. One aspect of this work involves modernising and making drainage legalisation consistent state-wide and considering drainage both within and outside the drainage districts.
3 Discussion of issues

3.1 Best management practices

The primary function of the rural drainage system was to provide a service that supported and allowed agricultural use of the coastal plains, with secondary benefits of protecting infrastructure. There is anecdotal evidence that most drainage channels were never designed. Rather, they were simply dug as required (Davies J & Muir B, May 1994). The channels were then progressively enlarged to accommodate increased flows due to clearing of upstream catchments to expand agricultural areas (English L, 1994; and English L & Doubikin R, 1994). In other words, the drainage system was designed and constructed initially to carry surface water.

Due to the impact on downstream water bodies, water quality as well as quantity is now an important consideration in the design and management of drainage systems. There are varieties of best management practices that can be adopted to improve water quality and reduce flow rates.

- **Point source techniques.** Soils testing, fertilizer management, effluent management plans and surface water control (maximise infiltration and reuse).
- **Diffuse source techniques.** Fencing of waterways, vegetation buffer zone and paddock level retardation basins/artificial wetlands (allowing nutrient stripping, sediment deposition and/or reuse).
- **In-stream techniques.** Naturalisation, riffles, silt traps/trash racks, on/off line storage, re-profiling the drain into a shallower swale and excavating phosphorous-rich sediment and replacing it with retentive materials (allowing nutrient stripping, sediment deposition and/or reuse).

Retrofitting existing systems to install diffuse source and in-stream best management practices, particularly in main arterial channels, will inevitably create problems and be costly. A key finding from a major project in the Peel–Harvey Region was that implementing best management practice techniques (that require significant earthworks) in arterial drainage channels is unlikely to provide cost-effective solutions to improving water quality (Del Marco A, 2007).

In some situations, the costs and complexities will be increased further due to the existing drainage system being overly efficient at removing water and the need to implement additional works to remedy this. The reason for the system being viewed as being ‘overly efficient’ may involve a number of factors, including:

- changing rainfall patterns due to climate change (see Figure 2, page 7)
- different land-use practices and crops which are more tolerant to inundation
- channels being too deep and, hence, oversized.

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2 Dirk Brook catchment project undertaken to implement a range of best management practices in a rural drainage setting.
Initially, the drains were dug as required to maintain the production of wheat, oats, potatoes and citrus crops, which have a very low tolerance to waterlogging. There have since been changes in agricultural land uses and some crops are now more tolerant to waterlogging.


**Figure 2** Perth streamflow statistics 1911—2004. Gill J (2004)

One of the standard maintenance practices is to dredge the base of the drainage channel to remove vegetation and sediment build-ups. This tends to increase the depth and width of the channel (English L, June 1995). The capacity of the drainage channel was further enhanced due to the practice of the excavated sediments being placed alongside the drainage channels. These spoil banks act like levees and further increase the system’s capacity to convey flows. The greater depth may also increase the erosive capacity of the drain in high flows, facilitating the resuspension and movement of bed loads.

The impact of having a drainage system that is too efficient is that the ability of the catchment to retain floodwaters is reduced, thus increasing the potential for flooding downstream. Furthermore, by increasing the depth of the channel there is an increased risk of intercepting groundwater and/or exposing acid sulfate soils.

Therefore, best management practices must include maintenance regimes and procedures. Alternative maintenance practices include banded drain clearing, channel broadening and/or spot clearing/silt traps (Del Marco A, 2007).
A number of reports document best management practices for rural drainage\(^3\); however, the majority do not include maintenance practices. In addition, while they provide information about the general principles of best management practices, they do not provide:

- the information required to encourage uptake
- technical assistance for their design and/or construction
- assurance of their effectiveness to reduce sediment load and/or improve water quality.

Before producing a manual for rural drainage best management practices, the appropriate content needs to be determined. While there will be overlaps with the format and content of the Department of Water’s *Urban Storm Water Manual*, there are two areas that need additional consideration.

1. **Encouraging stakeholder engagement.** In Section 3.4 it is discussed that social, environmental and economic benefits; technical knowledge and ability and financial requirements may assist in encouraging stakeholder uptake. Further research is required to determine the full range of information that would be useful to ensure the manual and its content can be used to improve uptake of the practices by stakeholders.

2. **Water quality indicators.** Before being able to use water quality as a criterion of the drainage system, an assessment is needed of which water quality indicators should be considered and what permissible and trigger levels should be used. Discussions during the site visits indicated that nutrients (phosphorous and nitrogen), sediment load, temperature, carbon and pathogens were worthy of consideration. Figure 3 shows work that has been carried out by the aquatic science branch of the Department of Water that further explores this area.

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\(^3\) Summers R (undated; assumed 1999), *Best management practices for achieving reductions in nutrient and sediment loads to receiving waterways*, WA Department of Agriculture.

Regeneration Technology Pty Ltd (1999), *Best management practices for rural drains in the south west and south coast Drainage Districts of Western Australia*, Water And Rivers Commission.

WML Consultants (December 05), *Drainage reform options for Geographe Catchment Council*. 
A huge amount of monitoring data has been collected through research projects and demonstration sites. These projects have been managed by a variety of organisations ranging from government agencies through to community groups. The information highlights a number of issues.

1. **Access to data.** There is no central storage system or procedure for the data, and each organisation has therefore located its information in differing places. Hence, to make this wealth of information accessible to all stakeholders, a central data storage facility needs to be set up and promoted.

2. **Data quality and quantity.** The knowledge and experience of the organisations that have set up the monitoring programs varies considerably, and this is reflected in the diverse range in quality and quantity of data produced. While the end use of the data collected will dictate the level of quality and quantity required, there is a need to standardise the approaches used for developing and implementing monitoring programs. Some work in this area has been carried out[^4]; however, the documents have not yet been widely promoted or distributed.


Aquatic Science Branch (December 2007), *Standard Operating Procedures Water Sampling Methods and Analysis – Parameter Based*, Department of Water, Perth.
3 **Funding.** The majority of programs are funded through grants provided for a fixed period – nominally two years. To be able to gain an understanding of best management practices, the site needs to be monitored at least one full year before the works are installed and then for a longer period afterwards. Ideally, these periods should be greatly increased to take account of variable environmental factors, such as rainfall. There are, therefore, constraints made by the funding regimes that adversely affect the ability of organisations to monitor and evaluate these types of works appropriately.

Ideally, future research projects and site monitoring should be planned to fill gaps in the current knowledge base. These gaps need to be identified by reviewing the information required and the standard of the data and information available. While this review is required, a number of research topics were raised numerous times during the site visits.

- **Changing land use.** Programs are needed to document and assess land-use changes (e.g. urban development; mining expansions) and land-use practices (e.g. fertilizer use; shifts between cropping and livestock farming). Ideally, this should cover changes that have previously occurred, are currently occurring and are predicted to occur. Each of these current and future changes can then be investigated further to assess the impact they may have on the water quality and flow regimes within the drainage system.

- **Acid sulfate soils.** Development works on coastal plains are inherently at risk from exposing acid sulfate soils. There is also a risk of previously excavated but permanently submersed acid sulfate soils being exposed if flow regimes and/or groundwater conditions change. This change may occur due to a variety of reasons such as climate change and dewatering associated with mining operations. The impact of acid sulfate soils and how they react and interact with the other water quality indicators relevant to rural drainage has not been heavily researched. However, initial scoping work is been carried out by the Aquatic Science Branch of the Department of Water\(^5\).

- **Water reuse.** A demonstration site has been installed in the Peel–Harvey region where a business has benefited by storing drainage water offline and using it for irrigation (see Image 1). The reuse of water should be researched in greater detail. There are, however, inherent risks due to high nutrient levels and the potential for other contaminants. Therefore, the reuse concept must be carefully reviewed and policies and guidelines need to be developed to ensure it is appropriately managed and controlled.

\(^5\) A two-year project that started in June 2006 called *Tackling coastal acid sulphate soils and acidic drainage in the south west.*
Off-stream water detention basin, Dirk Brook demonstration site

There has been sufficient work completed to show that the rural drainage system does have an impact on the total water cycle, and is in part responsible for significant impacts on the ecology of downstream water systems that affects all three areas of the ‘triple bottom line’. Therefore, based on the precautionary principle, it would be inappropriate to delay implementing some change to the existing drainage system until additional data has been collected through monitoring and evaluating demonstration sites and/or more scientific evidence has been identified through research and development. However, in view of the lack of knowledge and understanding of the effectiveness of best management practices they should not be installed without a substantial monitoring and evaluation component to avoid long-term damage and unjustifiable costs through removal and re-installation.

3.2 Planning advice and assessments

The following stakeholders are able to influence drainage network planning and assessment.

- **Local government.** The *Town Planning and Development Act 2005* provides power to manage drainage activities within local governments’ jurisdictions; this is, however, more applicable to urban and peri-urban drainage.

- **Department for Planning and Infrastructure and WA Planning Commission.** Responsibility for land-use planning and overseeing local planning strategies put in place by local governments. Powers are provided through the *Town Planning and Development Act 2005* and *Land Administration Act 1997*.

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6 The precautionary principle: Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation (Commonwealth of Australia 1996).
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- **Environmental Protection Authority of WA.** Powers given under the *Environmental Protection Act 1986* allow a higher level assessment for works of a substantial and/or complex nature to be requested.

- **Water Corporation.** Authority to control connections into the system are provided through the service standards, as imposed by the operating licence that is issued and regulated by the Economic Regulation Authority under the *Water Services Licensing Act 1995*.

- **Department of Water.** Powers are provided to exercise strategic direction under the *Water and Rivers Commission Act 1995, Rights in Water and Irrigation Act 1914, Waterways Conservation Act 1976* and Peel–Harvey (Environmental Protection) Policy.

Historically, planning of rural drainage schemes has not incorporated broad scale stakeholder objectives (URS, December 2004). Stakeholders who connect into the arterial system include Main Roads WA, Westnet Rail, industry and landholders, and each of them design and/or install drainage. Examples of particular needs and concerns of these stakeholders in the Busselton Drainage District include:

- mining industries periodically release large amounts of water into the drainage system, resulting in poor quality water with the potential to affect the ecology of the system as well as creating the potential for erosion

- some landholders have raised and discussed with the Water Corporation the concept of reducing the capacity of the drainage systems and also adapting the trapezoidal drainage profile into a swale-style profile.

While drainage districts have been established and further expansion is unlikely to occur, land-use changes within and adjacent to these districts are increasing pressures on the existing rural drainage system. The main issues come from urbanisation of rural land, increased run-off and combining drainage systems with different design criteria. In general, urban drainage needs to ensure development has adequate flood protection from 100-year average recurrent interval (ARI) flooding; while post-1977 rural drainage within drainage districts is designed for ~2 to 5-year ARI flooding (Public Works Department, December 1977).

The Scott Coastal Plain is one of the largest areas where drainage development is still underway. The development includes the establishment of a structured arterial drainage network. There is also a greater demand for paddock level development primarily due to more intensive farming systems being adopted. Farmers in the area consider this is in response to pressures of reduced profits and the deregulation of the dairy industry.

Therefore, while there are unlikely to be major developments within the drainage districts there are areas where rural drainage networks are still required. It is therefore important to review and consolidate the design procedures used by the various stakeholders. This review would require a staged approach to ensure it takes into account all stakeholder objectives and allows the review to be based on an agreed approach and criteria.
In addition to including water quality as well as water conveyance as a design criteria, a number of changing circumstances need to be considered and incorporated within the development of a single design procedure for rural drainage.

Urban development is occurring within the catchment and on the coastal fringes. In both situations, there is a need to assess appropriate ways of designing the transition lengths of the drainage system.

Within the catchment, the rural system will need to be able to cope with excess stormwater discharged from remote peri-urban developments. While the *Urban Stormwater Manual* (Department of Water, 2004–07) encourages developers to retain stormwater on site and infiltrated locally as much as possible, during heavier rainfall events there will be excess surface run-off that will be discharged into the rural system.

Urban developments along the coastal fringes are encroaching into areas where rural drainage networks discharge. The rural drainage has not been designed to manage an ARI of 100 and there will therefore need to be careful consideration of the increased risk imposed by the rural drainage overtopping. An example of this is the Five Mile Brook outlet, which passes through the area where the southern and eastern expansions of Dalyellup are planned.

Changes in agricultural practices need to be considered to ensure that the drainage networks are not too efficient at removing surface water. The Water Corporation maintains the existing system under the three-day rule (Water Corporation, June 2006). However, due to the use of pasture species that are more tolerant to waterlogging, the allowable period of inundation could be raised to six days (Davies J and Muir B, May 1994). However there are differing views on the applicability of the three-day rule and there are likely to be landholders who have set up farming practices that may be reliant on it.

In cases where drainage channels have become deep enough the system may be lowering the local groundwater, which can have adverse impacts on adjacent crop and pasture productivity. This was supported when drainage water was retained within the Mealup Drain by the installation of unauthorised locks (Bradby, 1997).

There have gradually been longer periods of below average rainfall and increasing temperatures in the south west (IOCI, 2002). This, combined with other factors, has caused a notable decline in stream flows over the last 30 years, as graphically represented in Figure 2 (page 7).

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7 While local infiltration may not allow flows to discharge directly into the existing drainage system, infiltrated water may still pose a risk when the infiltration basin is adjacent to porous drainage channels.

8 The three-day rule generally means that the drains should be capable of clearing water from adjacent rural properties within three days of a storm event, where contours and internal drainage make it possible. It also infers that maintenance and/or enhancement works are undertaken on request where inundation occurs for more than three days.
The design of drainage systems needs to take these trends into account and ensure that the impact on groundwater levels is not such that the drainage system detrimentally affects crop productivity or adjacent wetlands.

A consolidated design process would provide a tool that could be used to assist with the planning of drainage systems, as well as the assessment of developments. There is, however, a need for more decision tools to assist with planning and assessment.

Several locations were identified through the site visits where water reuse has been occurring\(^9\). While water reuse is worth considering, there are inherent risks that have been highlighted. These include how to manage changing water quality versus permissible water uses; who is responsible for managing the reuse; and what sureties of supply, if any, are provided to the person and/or organisation using the water. Therefore, strict and clear policies and guidelines need to be developed to help plan, assess and ultimately manage such situations.

Developments on the coastal plains, especially in estuarine areas, are inherently at risk of disturbing acid sulfate soils. The planning guidelines (Western Australian Planning Commission, November 2003) have been developed and are supported by a self-assessment form (Western Australian Planning Commission, October 2006). While this document is aimed at proposals that include rezoning, subdivision and development of land that contains acid sulfate soils, it may also be adopted as a planning tool in relation to the development of new and modified existing drainage networks.

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\(^9\) Myalup Drain receives primary treated sewerage discharges from the Harvey wastewater treatment plant and is subject to algal blooms. However, the water is pumped from the drain and irrigated onto leaf crops.

Upstream agricultural land use has become dependent on the operation of the Stirling floodgates on the Capel River.

A demonstration site on Dirk Brook where a turf farm benefits from storing first flush waters offline and then uses it for irrigation.
The design and planning of drainage networks will be required at a variety of levels, i.e. regional/catchment, sub-catchment and site levels. By using a whole-of-catchment approach, greater assistance and guidance can be provided in planning particular programs and/or projects. There are several issues that need to be reviewed before a multi-levelled planning framework can be put in place.

- The stakeholders involved at each stage need to be identified. In undertaking a whole-of-catchment approach, consideration needs to be given as to whether the natural as well as the man-made/modified drainage system should be included. By including the rivers and water bodies, water quality becomes an essential consideration in the planning, as the health of the natural system would be an objective of some of the stakeholders.
- To be able to undertake catchment and/or sub-catchment planning, the physical and environmental attributes of the existing system needs to be well documented and accessible. To enable efficient planning, a central data store is required to collate necessary information; for example, channel dimensions, catchment sizes, soil types, land uses (past and present), culturally significant sites, chokes points, and maintenance regimes and issues.
Many factors have changed as discussed above; for example, agricultural practices and changing climate trends. These factors have affected the groundwater and stream flow conditions significantly. In the natural system, stream flows have been further impacted upon by the construction of both major dams for public water and paddock level dams for local agricultural use. A better understanding of the performance and requirements of the current drainage networks is required before planning can be carried out effectively.

In developing a tiered planning framework, a variety of tools can be designed to assist in both the planning and assessment of proposed works and strategies. These may include the following.

- **A drainage length classification system.** For different classifications of drainage reaches there would be guidelines as to what level of works would be permissible; for example, the magnitude of modifications allowed for improving the efficiency of flow (e.g. removing snags) and permissible riparian vegetation. The classification allocated to a particular reach of drainage may be based on a variety of aspects, including location within the entire drainage network, primary purpose of the channel, obligations of the responsible stakeholder, etc.

- **Downstream impact assessment tools/models.** To be able to assess the impact of drainage water flows and quality there needs to be a way to assess how it interacts and affects the receiving water body. The level of permissible impact can only be identified by undertaking a catchment-wide assessment, which would then provide nutrient target levels. While there has been work on a variety of Decision Support Systems\(^\text{10}\) that model the catchment and assess the impact on downstream water quality, these models currently only assess phosphorous and nitrogen loads. There is a need to increase the range of water quality indicators and to make the models more sophisticated to allow assessments of land use and drainage network changes at the sub-catchments and site level.

- **Reviewing ecological water requirements (EWRs).** Due to hydrological changes to stream flows in the natural system, the discharge from the drainage system is in some locations an important consideration of EWRs. The assessment of EWRs is further complicated in view of defining the water needed in the drainage system to preserve its ecological character and how the ecological character of the artificial drainage system should be defined. Links need to be made with the process used to assess EWRs and guidelines set to inform stakeholders of areas where these need to be considered and how proposed works may affect them.

To enable the above planning framework to be implemented, the current policies, regulations and processes need to be reviewed to ensure that appropriate powers are provided to the relevant authorities. The framework needs to consider the technical capabilities and expertise of stakeholders, and ensure that appropriate

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\(^{10}\) Decision Support Systems have been established or are in progress for the Torbay Catchment, Peel–Harvey, Leschenault, GeoCatch and Scott Coastal Plain catchments.
responsibility is given when key decisions are made within the assessment process; for example, the Department of Water should be made a clearance authority. Several projects\textsuperscript{11} have been undertaken to address specific related areas, which could be built upon to provide a more complete framework.

### 3.3 Governance

Outside of the drainage districts there is no governance structure for drainage networks. Funding for both construction and maintenance has to be sought via grants or raised by those requiring the infrastructure.

Within the drainage districts there is fragmented ownership and management\textsuperscript{12} of the drainage network. Each stakeholder is guided by differing statutory legislation and associated obligations and there is insufficient networking to merge the requirements or enable more cohesive management of the system as a whole.

Many of the stakeholders have clear and defined management objectives which determine the level and style of maintenance applied; for example, Main Roads WA and WestNet Rail require their infrastructure to be unaffected by floodwater.

Similarly local government aims to mitigate the risk of flooding of peri-urban infrastructure by assessing and approving surface water drainage systems under the *Town Planning and Development Act 1928*. However, the designs of these larger systems that discharge into arterial systems maintained by the Water Corporation are influenced by the permissible discharge rate imposed by the Water Corporation. In these events, the peri-urban stormwater system needs to be designed to retain excess water and control the discharge rate.

Although landholders have varying levels of tolerance to their land being inundated, they are not constrained by statutory legislation in relation to how they develop surface water drainage on their land. The only restriction placed on these landholders is the number of outlets they are allowed into the arterial system that is maintained by the Water Corporation.

The Water Corporation is a service provider and is guided predominately by the *Land Drainage Act 1925* and its service standards, which were imposed by the operating licence issued and regulated by the Economic Regulation Authority under the *Water Services Licensing Act 1995*. However, the *Land Drainage Act 1925* has become (through numerous amendments) largely obsolete (English L, June 1995), and the

\textsuperscript{11} Planning Bulletin Number 64 provides planning guidelines for dealing with acid sulfate soils (Western Australian Planning Commission, November 2003).

The Peel–Harvey Water Sensitive Urban Design local planning policy is a model local planning policy to assist local government to determine strategic and statutory proposals within the EPP Policy Area of the Peel–Harvey coastal catchment (Peel–Harvey Catchment Council, March 2006).

\textsuperscript{12} In the GeoCatch area, management of a channel visited by the lead team changed from the Water Corporation to the land holder (as it was defined as a remnant creek line) and then back to a Water Corporation drain, within a reach no longer than 100 m.
powers provided to the Water Corporation are now restricted to those required to enter land and construct and maintain drains (Part 6).

In undertaking the service provisions, the Water Corporation annually inspects the arterial system and produces asset deficiency reports. These are used to plan maintenance work and form part of the Asset Management Plan (Del Marco A, 2007). The Water Corporation uses the asset management plans to ‘specify the frequency and maintenance of assets and to continually review and modify procedures in light of performance’ (Water Corporation, June 2006).

Although these processes are in place, as a general rule system maintenance is based on the three-day rule (Water Corporation, June 2006). This has generated a reactive system so that a major portion of maintenance work is in response to landholder complaints (Davies J and Muir B, May 1994). With the migration of people along the south-west coast there has been an increased demand on rural land for residential lifestyles; as a result, rural land is being rezoned and subdivided. Through this changing land use, new landowners expect a higher level of service from the rural drainage networks. With a reactive system such as the three-day rule, the Water Corporation is likely to receive increased requests to undertake remedial maintenance works.

In addition to conveyance structures, there is also other infrastructure for which maintenance needs to be funded. These include control structures (e.g. drop structures and floodgates) and access structures (e.g. road and rail crossings). The maintenance of the control structures generally lies with the stakeholder responsible for the conveyance structure in which it resides. However, the responsibility for access structures is mixed and depends on who required the crossing to be built. This has led to the Water Corporation being responsible for over 1000 public access structures in both the drainage and irrigation districts (English L, 1995). Several attempts have been made to streamline the ownership of the public access structures, but these have failed due primarily to the stakeholders who were asked to undertake the responsibility being inadequately resourced and funded.

As drainage channels are primarily located close to rural agricultural lands, livestock control is important. Benefits of excluding livestock from the drainage reserve include lowering maintenance requirements by reducing livestock-generated erosion and sediment mobilisation, and improving water quality by stopping livestock from urinating and defecating directly in the water. However, it is recognised that crash grazing can be used as an effective practice to maintain low fire-fuel levels in the drainage reserves. Presently no licence or written agreement is required by landholders to allow livestock to graze within the drainage reserve, and fencing is not required. If fencing was stipulated, then both the landholder and Water Corporation would be liable to pay an equal portion of the costs under the Dividing Fences Act 1961 (Del Marco A, 2007).

With the transition of irrigated systems from open channels to pipes, the ownership and responsibility for the redundant channels is now also in question. This is an ongoing issue that is yet to be resolved. Some of the channels are modified remnant
creek lines and there is an onus on Harvey Water to undertake a level of retrofitting to naturalise and improve the ecological health of these systems (see Image 2). The irrigation districts overlap significantly with the drainage districts, and the responsibility and management of them should therefore be considered as part of any work carried out in relation to the drainage network.

Lead team visit to see one of the drop structures that impedes fish passage on the irrigation channel on Bancell Brook

While it has been ascertained that there are differing stakeholders, at the location where their respective drainage systems confluence there is already a need for collaboration. In drainage districts, the Water Corporation is pivotal to this as it maintains the arterial system into which other stakeholders discharge their systems. It is worth noting that, at a site level, the Water Corporation along with other stakeholders has worked to achieve agreed outcomes, such as the Dirk Brook Project.

Catchment level stakeholder cooperation has also been achieved along the south coast where the Water Corporation is responsible for managing the opening of the bars at the Torbay and Wilson inlets. The opening of the bars is a contentious issue with many differing opinions and is the subject of much debate. While the Water Corporation works proactively with the other stakeholders to maximise environmental gain, it is obliged to open the bar to assist with agricultural practices.

There is a clear need for a legislative review to consolidate and reform the law of water resource management to ensure application of a more consistent management regime. The Department of Water has initiated a review and one of the areas being

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13 The Dirk Brook project was a partnership project between the Serpentine–Jarrahdale Land Conservation District Committee, local community, Serpentine–Jarrahdale Landcare Centre, Water Corporation, Department of Environment and the Department of Agriculture and Food. It included the design and implementation of management practices to reduce nutrients entering the watercourses lower in the catchment and provides a demonstration site for other land managers on the coastal plain.

14 This review incorporates certain legislative amendments proposed under the Water Resources Legislation Amendment Bill 2006 and aims to replace the water resource management provisions of key Acts including: Rights in Water and Irrigation Act 1914 and Land Drainage Act 1925.
considered is how to provide a state-wide, consistent but flexible, management regime to apply to the three main categories of drainage – urban, rural and wheatbelt.

In order to assess fully the current issues, barriers and constraints that stakeholders face, one option would be to trial a management committee on a catchment level, comprising relevant stakeholders. There is no power under the Land Drainage Act 1925 to set up and implement such plans, and powers under the Local Government Act 1995 do not apply within areas declared as drainage districts. However, such a committee could be formed as a water resources management committee under the Rights in Water and Irrigation Act 1914 (Star J, Postma D and Morup R, 2004). This committee would then be given power to exercise authority in accordance with a local area management plan.

Before undertaking such a task, consideration needs to be given as to whether the drainage management framework should include stakeholders linked to the entire drainage network, i.e. the man-made/modified and natural system, or only those linked to the man-made/modified system:

By omitting the natural system, downstream impacts are not likely to be as strongly viewed as a governance consideration; in addition, stakeholders related to remnant creek lines that are within the system will not be represented.

Conversely, by including the natural system, the range of stakeholders becomes even more diverse and potentially difficult to manage.

### 3.4 Stakeholder engagement

Stakeholder engagement occurs in a variety of forms, including participation in demonstration sites and research programs, uptake of best management practices and collaborative planning and assessment.

A considerable amount of work has been undertaken to encourage and increase stakeholder uptake of best management practices, with limited success. The range of initiatives trialled includes community workshops, demonstration sites, field trips and one-on-one programs. However, while funding support is often provided, these initiatives depend largely on voluntary adoption of the best management practices through an educational approach (URS, October 2005).

It has been argued that insufficient attention has been directed at answering critical questions about values and interests related to best management practices, such as where we are going, is this desirable, what should be done and who gains and loses from different decisions and by what mechanism of power? (Duxbury L, undated)

The question can be asked whether we are providing the right information through the educational approaches. While the primary goal of implementing best management practices is to improve water quality, there are many other aspects related to this such as social, environmental and economic benefits.
The effectiveness of best management practices is not fully understood so it is not possible to assess their cost effectiveness. There is also a lack of technical knowledge and ability. Uncertain financial requirements to assess and implement best management practices is also seen as a potential disincentive.

Moving away from educational approaches, there are other mechanisms that encourage change in our social structure that need to be explored. These include regulatory measures, economic benefits and market-based incentives (URS, October 2005).

There is a need to assess what is an appropriate model for implementing change, including:

- a marketing strategy to promote proposed changes to a range of stakeholders
- a review of how planning tools and governance structures can be adapted to support this change.

### 3.5 Summary of issues

The range of issues raised through the Gap Analysis are summarised below. While an attempt has been made at placing each issue under one area, it should be appreciated that some issues overlap across different areas.

<table>
<thead>
<tr>
<th><strong>Best management practices</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Triple bottom line benefits of best management practices have not been reviewed, compiled or documented.</td>
</tr>
<tr>
<td>- The design, installation and management of monitoring and evaluation plans are uncoordinated and highly variable in quality and therefore open to misinterpretation.</td>
</tr>
<tr>
<td>- There is no central data store of the system’s attributes (e.g. physical, geotechnical, hydrological and environmental details).</td>
</tr>
<tr>
<td>- The objectives of the existing system have changed but have not been reviewed (e.g. in relation to climate and land-use practices).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Planning advice and assessments</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Capacity and flooding issues are of concern at the transition between rural and peri-urban and/or urban systems.</td>
</tr>
<tr>
<td>- Different designs are applied by various stakeholders in an uncoordinated approach; in addition, some of these designs are outdated and require review.</td>
</tr>
<tr>
<td>- There is no process in place for assessing, allocating or managing reuse of drainage water.</td>
</tr>
<tr>
<td>- Water quality indicators that should be applied to rural drainage have not been identified or agreed.</td>
</tr>
<tr>
<td>- There is no structured framework for the planning and assessment of drainage works on a catchment or sub-catchment scale.</td>
</tr>
<tr>
<td>- There are limited policy and decision tools to assist with land-use planning, development and assessment.</td>
</tr>
</tbody>
</table>
## Governance

- Management of the whole system is fragmented and stakeholder responsibilities are driven by a wide range of legislation.
- The natural and man-made/modified drainage systems are currently managed independently.
- Ownership and funding arrangements of the same system structures varies for different stakeholders.

## Stakeholder engagement

- It is not well understood what information drives changes in best management practice or how to promote it.
- There is not a well-developed coordinated approach for marketing drainage reform.
4 Recommended areas of work

A varied and extensive range of work is required to address all the issues summarised in Section 4.5. While the required works have been split into the four areas, overlaps exist. An attempt has been made to delineate these overlaps in Figure 5 below.

Figure 5 Mind map of proposed work areas

There are also overlaps with work being carried out by the Urban Drainage Initiative. Therefore, there needs to be collaboration to ensure consistency in these shared areas.

In relation to best management practices, it is worth noting research that has been carried out to assess the movement of phosphorous in the Peel–Harvey catchment. This research has yielded two interesting results (Weaver D, November 2006):

- the drainage system has been shown to assimilate a major proportion of the phosphorus leached in from agricultural paddocks in the upper reaches of the catchment
- the urban and peri-urban areas of the catchment contribute approximately 20 per cent of the phosphorus load that enters the inlet.

This highlights that point and diffuse source management techniques need to be aimed at both urban and agricultural practices to minimise downstream impacts such as algal blooms. Therefore, while the proposed work areas are given below it is strongly recommended that work is undertaken by the Urban Drainage Initiative to
increase the uptake of residential and industrial best management practices to improve estuary water quality.

4.1 Best management practices

Triple bottom line benefits

Linked to the ‘Review of what drives change’ (see below) there is a need to collate and document the triple bottom line benefits of best management practices. This information will have multiple uses including:

- providing the baseline data required for implementing the ‘marketing strategy’
- allowing stakeholders to review the best approaches for site specific situations.

Best management practices, knowledge and understanding

Relevant information on best management practices for the rural drainage networks needs to be collated and placed in a format that can be continually reviewed, modified, updated and used as an effective decision-making tool. In collating information, all stakeholders will need to be consulted to ensure that the information covers stakeholder-specific responsibilities, issues and benefits. Many of the best management practices are detailed in the Department of Water’s Urban Stormwater Management manual; however, rural specific details that are required which will be drawn and/or identified from the work on the ‘Triple bottom line benefits’, ‘Monitoring data central storage system’ and ‘Review of what drives change’. This and other works will also enable a review of knowledge and understanding of the effectiveness of best management practices.

Monitoring guidelines

Standards for the design, installation and management of monitoring and evaluation plans are required. Ideally, these need to include recommended approaches for monitoring both the water quality and flow capabilities of drainage conveyance structures and best management practices. A range of resources at various levels is required to be able to influence the work undertaken by all stakeholders, e.g. pictorial flyers through to detailed documents.

Monitoring data central storage system

This is similar to the proposed ‘Knowledge space’. Large amounts of monitoring data exist at various levels of quality and quantity. There are two aspects to this work. The first is to collate the data and associated information; the second is to upload it to a central data store. A review of this data can be used to support work carried out on the ‘Triple bottom line benefits’, ‘Review of what drives change’ and ‘Water quality indicators’. The Department of Water’s water information network (WIN) would be a suitable system for uploading the information. This system allows varied data to be
uploaded and through metadata informs potential users of the data background, e.g. quality and age.

**Drainage specifications central storage system**

The attributes of the drainage system should be stored in a central location to enable stakeholders to access it. The system should include as much information as possible including the physical sizes, soil types, current and historical land uses, vegetation, cultural issues, maintenance regimes and who owns and manages particular sections. Ideally, stakeholders should be able to populate the database with updated information. However, there may need to be restricted certain rights for particular stakeholders such as the ability to delete and change some of the information.

**System review**

System review is a significant undertaking that involves two aspects. The first is to model each drainage catchment to enable the system’s performance to be reviewed in relation to climate change, land-use change and changing agricultural practices. The second is to assess the expectations of stakeholders. The findings from these two studies can then be used to assess and trial changes to the system that would allow the actual performance and stakeholder requirements to be matched more appropriately. This would require a model that provides detail at specific locations within the modelled catchment and not just at the end point.

**4.2 Planning advice and assessments**

**Review and streamline rural drainage design**

The design procedures used by each stakeholder need to be collectively reviewed, with an aim of streamlining the design of rural drainage within the coastal plains. The method of undertaking this review needs to be planned carefully, as there are a number of factors to be considered including the ‘System review’, ‘Water quality indicators’ and statutory system performance requirements imposed on stakeholders. To ensure success, the common objectives need to be agreed by all the stakeholders prior to the review being undertaken.

**Water reuse**

While water reuse is occurring in some locations, there is a need for a coordinated approach on how to proceed with increasing reuse of this valuable resource. This requires policies and guidelines that enable the allocation of water reuse to be appropriately planned, assessed and managed. This requires a program into permissible water quality for various uses (linked to ‘Water quality indicators’), water quality monitoring requirements (linked to ‘Monitoring guidelines’), responsibilities and liabilities (linked to ‘Drainage management framework’).
Water quality indicators

To enable the system’s performance to be assessed in relation to water quality, the indicators and their permissible levels need to be determined. There may be a need to have sliding scale levels dependent upon the location within the catchment, the type of drainage channel, potential for water reuse and/or the adjacent land use. While an initial assessment of these can be made based on currently available data and through stakeholder negotiations, the values may require review upon completion of the ‘System review’, ‘Triple bottom line benefits’ and ‘Water reuse’.

Planning and assessment process and tools

Planning is required at the regional/catchment, sub-catchment and site levels. A framework needs to be developed that ensures appropriate stakeholders are consulted at each level of planning. To facilitate and support the development of such a tiered approach, a range of tools is required. Some tools can be adapted from existing resources such as the acid sulfate soils self-assessment form. Other tools need to be developed such as catchment models through the ‘System review’ work, policies and guidelines developed to assess ‘Water reuse’ and a consolidated design process which is the ultimate objective of the ‘Review and streamline rural drainage design’. As part of the planning framework, the technical capabilities and expertise required for making key decisions within the assessment process also needs to be considered, to ensure the appropriate organisations and agencies are nominated as clearance authorities.

4.3 Governance

Legislative reform

The current legislative review being coordinated by the Department of Water has already considered how to provide a State-wide, consistent but flexible, management regime to apply to the three main categories of drainage: urban, rural and wheatbelt (Department of Water, April 2007). Findings from work on the ‘Planning and assessment process and tools’ and ‘Drainage management framework’ need to feed into this process to ensure processes identified and recommended can be supported by providing the appropriate legislative powers to stakeholders.

Drainage management framework

The concept of a drainage management framework can be trialled by setting up local area management plans and delegating the power to administer these to Water resources management committees, under the Rights in Water and Irrigation Act 1914. This would allow a review of whether committees comprising multiple stakeholders are an effective way of streamlining the currently fragmented management of the rural drainage system. Learnings such as any statutory requirements that impede the collaborative management of drainage system can then be fed into the legislative reform.
4.4 Stakeholder engagement

Knowledge space

A significant amount of work has been undertaken in relation to various aspects of the coastal drainage system. This information is available in a variety of forms including papers, reports, case studies, etc. To avoid crossovers and duplication in work undertaken by stakeholders, there needs to be a central location where these documents can be stored and accessed. As an intermediate action, a web page\textsuperscript{15} could be set up and attached to the Department of Water website where the titles, a brief description and the location of the documents could be listed.

Review of what drives change

Research into what drives each of the stakeholders to change needs to be reviewed\textsuperscript{16}. This would include an interstate desktop study as there is considerable work being undertaken in other states in the development and use of marketing strategies. By understanding what drives change, a review of areas where further research and/or monitoring is required can be undertaken, which could then influence work area priorities.

Marketing strategy

A marketing strategy is required to increase the update of best management practices. This is heavily linked and dependent upon the 'Review of what drives change'. The marketing strategy needs to identify different approaches for each stakeholder and would enable numerous groups, agencies and organisations to plan and implement best management practice projects more strategically.

\textsuperscript{15} The Victorian Water Resource Data Warehouse includes documentation and could be used as a template on which to design such a system: \url{http://www.vicwaterdata.net/vicwaterdata/home.aspx}.

\textsuperscript{16} Considerable work has already been undertaken as part of the Watershed Torbay whole-of-catchment restoration planning and research project: \url{http://www.torbay.scric.org/pub/compend.html}. 
## 5 Program priorities for 2008

The following three projects have been identified as priority targets. The level of completion for each varies and depends on the availability of resources, input from key stakeholders and legislative processes.

<table>
<thead>
<tr>
<th>Project title:</th>
<th>Development of agreed processes and guidelines for reviewing and revising existing rural drainage design manuals and operating and maintenance practices.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project aims:</td>
<td>Establish an approach for reviewing and updating existing drainage design manuals, performance assessment criteria and maintenance practices, that is endorsed by key stakeholders who are responsible for the design of drainage conveyance and control structures in the coastal plains.</td>
</tr>
<tr>
<td>Project overview:</td>
<td>This project requires participation from a range of stakeholders who are responsible for drainage design and maintenance. The aim is to reach agreed principles for the development of drainage design manuals that take into account the current conditions. The main conditions that have changed and need to be considered include: inclusion of water quality as a design criteria, climate change and resultant changes to hydrological patterns, potential acid sulfate soils, agricultural practices and the increasing transition of rural to urban land use.</td>
</tr>
<tr>
<td>Primary work area:</td>
<td>Review and streamline rural drainage design.</td>
</tr>
<tr>
<td>Related work areas:</td>
<td>Planning and assessment process and tools. Water reuse.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project title:</th>
<th>Assessment and collation of information and data for coastal (rural) drainage BMP techniques.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project aims:</td>
<td>Produce a collection of available information and data on rural drainage BMP techniques that can be used as a ‘tool box’ for encouraging increased uptake of BMPs by different stakeholders, and allows a gap analysis of missing information and data to allow future monitoring and evaluation and research and development work to be focused.</td>
</tr>
</tbody>
</table>
| Project overview: | This project aims to review BMPs and provide a ‘tool box’ that allows the easy identification of which BMP suits specific conditions. It will also identify the benefits provided to stakeholders, and review the disincentives and motivators to encourage uptake. The project has been split into the following three components:  
  • Identify and list what information is required.  
  • Collate available information to populate the above list.  
  • Undertake a gap analysis of what information is missing. |
<p>| Primary work area: | Triple bottom line benefits. |
| Related work areas: | Best management practices, knowledge and understanding. Review of what drives change. Monitoring data central storage system. |</p>
<table>
<thead>
<tr>
<th>Project title:</th>
<th>Development and trialling of a drainage management framework for coastal drainage systems.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project aims:</td>
<td>To determine whether a drainage management framework is an effective way of ensuring that clear policies, leadership, roles and responsibilities can be provided to minimise the impacts of barriers to change, equity and enforceability that exist under current policy and legislation.</td>
</tr>
<tr>
<td>Project overview:</td>
<td>This project is heavily reliant on the current legislative reform with the proposed Water Resource Management Bill 2008. It is, therefore, proposed to review this project in January 2008 after the reform process has made progress.</td>
</tr>
<tr>
<td>Primary work area:</td>
<td>Drainage management framework.</td>
</tr>
<tr>
<td>Related work area:</td>
<td>Legislative reform.</td>
</tr>
</tbody>
</table>

17 As part of the Watershed Torbay Whole of Catchment Restoration Planning and Research Project a Drainage Committee was set up and trialled for four years. The learning’s from this project should be considered as part of this works <http://www.torbay.scric.org/oldtorbay/issues/drains/sourcedoc.pdf>.
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