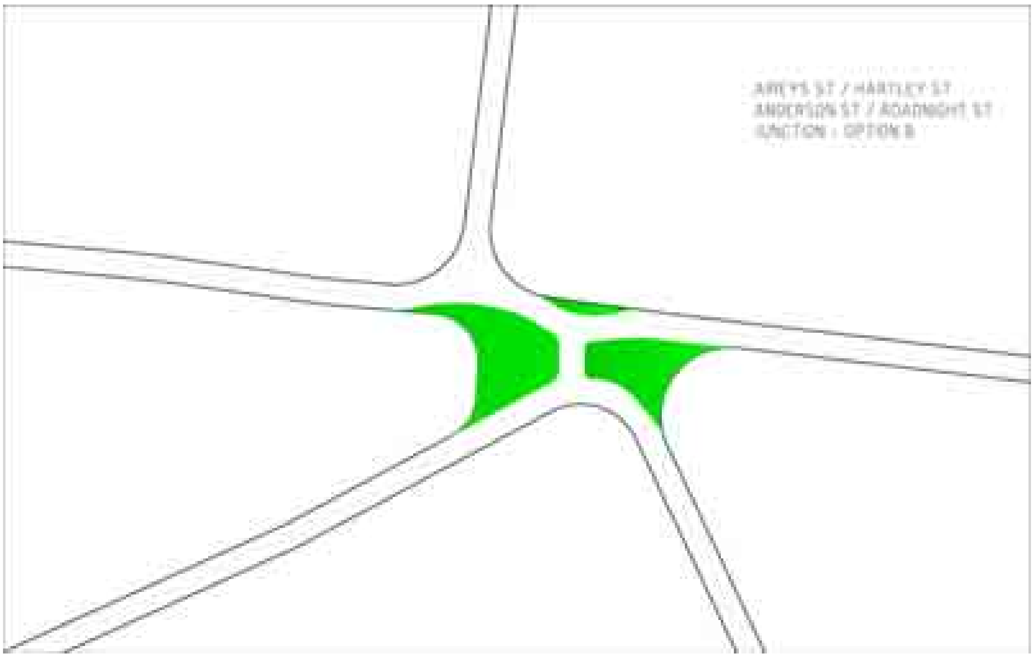
Figure 18 Preferred Layout



13.6 Road Concepts - Inlet Crescent

Three concepts were provided for Inlet Crescent with the objective of reducing through traffic, (particularly coaches):

- **Option A:** Forming a chicane on Inlet Crescent to restrict the size of vehicles capable of proceeding towards the lighthouse.
- **Option B:** Closing Inlet Crescent north of the junction with Reserve Road.
- **Option C:** Forming a choke on Inlet Crescent north of the junction with Reserve Road to restrict the size of vehicles capable of proceeding towards the lighthouse.

During Panel discussions fourth option was identified:

- **Option D:** Closing Inlet Crescent West of the junction with Reserve Road.

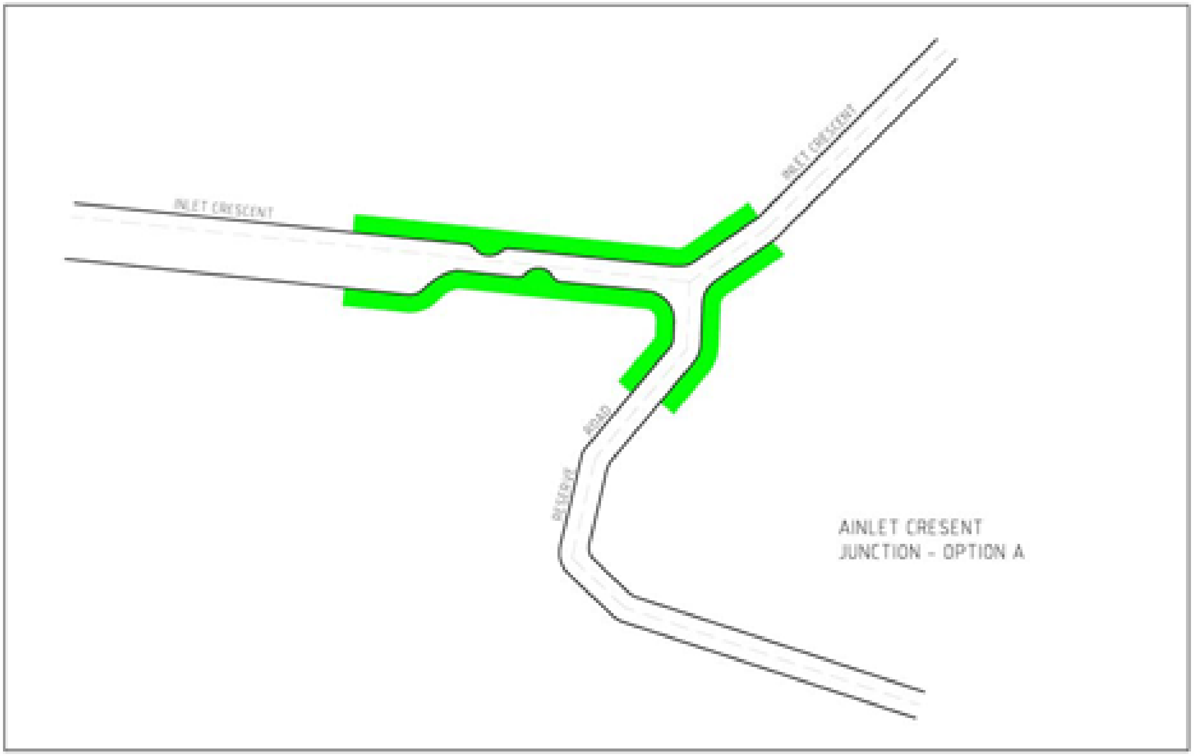
The opinion of the Panel was that the Inlet Crescent area needed to be further developed as part of a tourism precinct. This opinion was accepted by Surf Coast Shire staff.

Option A was considered suitable as an interim measure.

As development options for a tourism precinct to the issues at Inlet Crescent were outside the brief of this study this matter was not pursued further.

Option A is shown in Figure 19.

Figure 19 Option A



13.7 Discussion with Surf Coast Shire Council Staff

Following the development of the concepts a site meeting was held to discuss the concepts and related maintenance issues. Council was represented by Richard Bain and Steve McGarrigle. Brian Ashworth represented GHD.

The conclusions from that meeting are as follows:

13.7.1 Unsealed Streets - Chokes

During the Panel meeting concerns had been expressed about the difficulty of grading around any proposed chokes. However, slowing the traffic would reduce the frequency of the need for grading of the road as a whole. In practice the area within the angle formed by the choke and the existing road edge would require minimal grading, as it would not be heavily trafficed, nor trafficed by fast-moving vehicles.

By making the choke more gradual, with the angle of contraction being in the region of 15 degrees, the road would be able to be graded with the existing machinery.

By making the chokes longer the number of chokes could be reduced. As previously discussed a spacing of 60m or greater is considered to be appropriate. In locations where there are 'T' junctions a choke could be used to reduce the size of the junction, thereby discouraging use by large or fast-moving vehicles. The choke could be located opposite the side road.

13.7.2 Unsealed Roads - Swales

A concern arose with the use of vegetated swales. It was considered that the vegetation would be lost during regular cleaning operations.

Examination of Boundary Road showed that where there was established vegetation on the side of the road, material washed to the side of the road had been captured at the edge of the vegetation. This was due to the filtering effect of the grasses. The washed-out material was built up into a small berm on the edge of the road. This provided a good illustration of how a vegetated swale would be able to retain the majority of the road particles outside the swale itself.

13.7.3 Sealed Roads

It was considered that although heavy vehicles could still travel along a street with chokes at 20m spacing between chokes the spacing could be increased to 50m or greater without significant loss of traffic-calming effect.

13.7.4 Steep Roads

It was agreed that sealing was the only effective option to address water and traffic erosion on the steep gradients encountered on McConachy Road, Aireys Street, Beach Road and Philip Street.

It was considered that the provision of passing-places on the steep roads, illustrated on Concept D should be of the order of 75m.

13.7.5 Road Drainage

Where table drains are to be replaced by a piped stormwater drainage system, providing pipes under the road formation was considered an acceptable alternative to following the existing drain line.

13.8 Road Upgrades Proposals

It is proposed that road improvements be based on the following:

- Only upgrade priority streets (Some upgrades will involve traffic calming without sealing);
- Use alternative design and construction standards (including use of ‘softer’ and ‘informal materials);
- Install no additional street lighting;
- Maintain existing road pavement widths;
- Preserve existing vegetation where possible;
- Use traffic-calming to slow traffic and improve pedestrian safety; and
- Use designs that impart a meandering appearance to the streets to retain a rural character.

14. Stormwater Drainage System Objectives

14.1 Introduction

This section addresses drainage issues related to rainfall events in Aireys Inlet only. Flooding as a result of high flows in Painkalac Creek upstream of the township is outside the scope of this study.

The objective of urban stormwater drainage design in most urban and semi-urban developments has been to and dispose of stormwater as quickly as possible, through the construction of pits and drains, sealing and draining of roads, smoothing of surfaces, and lining and straightening of stream channels.

Aus-Spec Design Standards, which have been adopted by the Surf Coast Shire, require drainage systems to be designed based on storms with an Average Recurrence Interval (ARI) of 5 years

Stormwater drainage systems are now being seen as an important component in the creation of sustainable urban environments. As such, stormwater drainage systems are being designed using the concepts of Water Sensitive Urban Design (WSUD) to minimise pollution of receiving waters by stormwater treatment, limiting peak flows by storage, and providing biodiversity. It includes using wetlands in the overall design and aims for a 'natural' appearance.

The fundamental guiding principles of stormwater drainage design, as outlined in Australian Rainfall and Runoff (IEAust 1998), provide a useful context for considering stormwater drainage in Aireys Inlet:

- Drainage systems must be viewed in relation to the total urban system;
- Drainage systems should be designed and operated to maximise benefits to the community; and
- Drainage designers should be influenced by professional considerations such as ethics, environment, standardisation and innovation.

14.2 Local Considerations

Whilst some standard urban drainage practices may be applicable to Aireys inlet, the climatic, geological and environmental setting of the township requires a local approach to stormwater management.

Relevant local issues include the following:

- The town is located over a steep sided ridge with a flood plain located on the Western edge;
- There are high environmental values, the protection of which are key concerns of the local community;
- There is an existing drainage network in Aireys Inlet. However it only serves approximately 50% of the Aireys Inlet township; and
- Funding of a system wide upgrade of the piped system is impractical at this time.

14.3 Stormwater Drainage Objectives

The key objectives required of the stormwater element of the plan can be summarised as follows:

- To limit stormwater flows from future private developments and encourage reduction (or prevent any increase) from existing private properties;
- To provide outfalls for stormwater flows that do run off private property;
- To provide effective stormwater drainage from roads;
- To minimise localised flooding that may endanger public safety (this may include retention of peak flows);
- To control or eliminate nuisance flows that may damage property;
- To limit silt entering the piped drainage system;
- To construct swales and open drains in such a way that erosion of the drains is prevented and the opportunity to store peak flows is maximised;
- To construct outfalls from table drains and underground pipes to watercourses in such a way that erosion of the watercourses (including embankments) is prevented; and
- To improve quality of stormwater water discharged to receiving waters to meet the Urban Stormwater Best Practice Environmental Management Guidelines, CSIRO 1999 and Auspec Design Standards.

These objectives will be considered separately in following sections for the following drainage elements.

- Flows from private property;
- Collection and transfer;
- Treatment; and
- Outfalls.

15. Stormwater Improvements - Private Properties

15.1 Introduction

The majority of the area of Aireys Inlet consists of lots or blocks of privately owned land. Reducing the volume and intensity of flow discharges from existing properties and limiting flows from new properties will have a positive effect on the drainage issues of Aireys Inlet. Well-designed systems can limit flows from properties to that of an undeveloped site avoiding the need for downstream system capacity increases.

Stormwater drainage systems have traditionally been designed to collect, remove and dispose of stormwater as quickly as possible. If, at any point in the system, the rate of collection exceeds the drainage capacity then this can result in ponding, or even flooding. Such issues are often related to the lower parts of the drainage system.

GHD considers that where practicable the first, and often least expensive, approach to reducing drainage problems should be to reduce or prevent stormwater runoff. Drainage problems tend to occur where rainfall collected from large impervious areas is discharged to adjacent areas that have insufficient capacity to dissipate the flow. This causes runoff to move across the area as uncontrolled surface flow, or flooding. This issue is commonly associated where development occurs on sloping ground.

Techniques for modification of stormwater discharge can be applied to both new properties and existing properties.

In the case of existing properties an education process can encourage modification. The education process would include:

- Information on the benefits to the property owner in improving the sustainability of gardens;
- Information on the benefit to the community as a whole; and
- Improving awareness of grants such as assistance offered by Barwon Water to defray the cost of rainwater tank installation.

The following practices deal with the minimisation and control of stormwater runoff from private properties.

15.2 Site Modification

The simplest approach to reducing stormwater runoff from private properties is to limit the amount of impervious surfaces such as roof areas and paved or hard covered areas on each property.

If suitable areas are available on the property and slope stability won’t be affected, the water collected from impervious surfaces should be reintroduced for ground infiltration over a large permeable area. Suitable areas for infiltration would typically be stable, well vegetated, and undisturbed.

The minimisation and control of stormwater runoff can also be achieved by limiting the extent of site modification on each property. The following modifications should be avoided, or at least minimised:

- Regrading of property;
- Construction of driveways which alter drainage flow paths;
- Disturbance or compaction of native soils;
- Removal of vegetation from sloping ground;
- Conversion of native vegetation areas into landscaped areas;
- Construction of unstable earth fills; and
- Installation of drains with an inappropriate or inadequate discharge point.

15.3 On-site Stormwater Detention and Treatment

Natural, 'unimproved' land typically develops undulations that act as collection pools for stormwater. These natural undulations collect and detain stormwater, allowing infiltration to ground or evaporation to air over extended periods of time.

Grading and levelling associated with urban development almost always results in a loss of such natural flood storages.

On-site stormwater detention systems constructed as part of urban development programs address this problem directly by providing additional or replacement flood storage close to the location that rainfall occurs. These detentions may take the many forms, ranging from artificially constructed pondage (such as farm dams) to simple rainwater collection tanks. The main objective of on-site stormwater detention is to prevent any increase in downstream peak flows from new developments by temporarily collecting and storing on-site storm flow.

Collected stormwater may subsequently be released at a controlled rate, stored for reuse or simply allowed to infiltrate to ground or evaporate to air.

Most common on-site stormwater detention systems will typically consist of a rainwater tank to collect roof runoff, with overflows directed into additional above-ground rainwater tanks or below-ground stormwater detention tanks.

Any overflows from the stormwater detention tanks should be discharged on-site over a large permeable area, where a stable and permeable area of suitable size is available.

Discharge off-site to the stormwater drainage system should be discouraged except on blocks where there is insufficient permeable surface to accept the overflow.

Stormwater systems for overflows from the private systems and roads and paths should incorporate retention and treatment such as bioretention, (refer Section 17).

The following objectives should be met in the design of on-site stormwater detention systems:

- No increase in downstream peak flows due to increased impervious area;
- All overflows from the stormwater detention system discharged to a suitable disposal point.
- New developments of two or more properties should provide treatment of the storm water to reduce its environmental impact.

15.4 Community Reference Panel Discussion

The Panel supported the concept of limiting the discharge of stormwater from individual properties.

15.5 Private Property Stormwater Control Conclusions

The stormwater flows generated from private properties have a major impact on the drainage problems of Aireys inlet. The following actions will provide stormwater runoff improvements from properties:

15.5.1 Site Modification

- Ensure that site modifications such as property regrading, soil disturbance and vegetation removal are kept to a minimum in new developments;
- Ensure that drainage is provided for all impervious surfaces on the property, and directed to a legal point of discharge, where appropriate via detention that minimises peak discharges for new developments;
- For existing properties, encourage, through education and grants, the source control of stormwater runoff. This includes limiting the area of paved surfaces, the reinstatement of natural drainage pathways, and revegetation with indigenous plants; and
- Institute provisions for the control of all private drainage discharge points.

15.5.2 Flow Detention

- Amend the planning scheme to make on-site stormwater detention / retention systems mandatory for all new developments. Detention systems should be designed to ensure no increase in downstream peak flow; and
- For existing properties, encourage, through education and information on grants, the installation or upgrading of on-site stormwater detention / retention systems.

15.5.3 Implementation

To implement the above improvements Council could consider the following.

- Use planning controls to minimise the impact of new developments;
- Enforce drainage aspects of building control; and
- Provide advice and guidance to influence property owner's decisions.

16. Stormwater Improvements - Collection and Transfer

16.1 General

The drainage issues of Aireys Inlet including the collection and transfer systems have been described in Section 6, The system modelling carried out in Section 7 has determined the parts of the existing piped system which are currently under capacity, and those parts that have inadequate capacity to meet future development and therefore require improvement.

Improving a drainage system for an existing community such as Aireys Inlet differs considerably from providing a system for a green field site.

A balance between the most effective design and stakeholder/community expectations needs to consider the following factors:

- Ability to pay - Major upgrades of piped systems have very high costs. In new developments this cost can be recovered as a developer's contribution, or a developer can be required to install systems as part of the development consent, whereas in existing communities costs must be borne by individual property owners, or carried by Council;
- Existing level of development – It can be difficult, disruptive and expensive to construct new drainage lines and systems through existing developed allotments;
- Limitation of existing piped systems – Limited capacity may exist in lower parts of the system that limit the ability to take additional flows from higher in the system;
- Flora and Fauna Protection – This constrains the ability to increase construction width, and hence capacity, of existing infrastructure due to ecological conservation requirements; and
- No discharge to cliff tops – This effectively limits the ability to divert or discharge stormwater flows to the east of the study area.

16.2 Improved Provision for Drainage and Stormwater Collection

Adequate drainage is required to collect flows from properties and roads that do not currently have an effective drainage system. The improved system should be designed to be capable of intercepting flows that currently flow across or along roads from higher land.

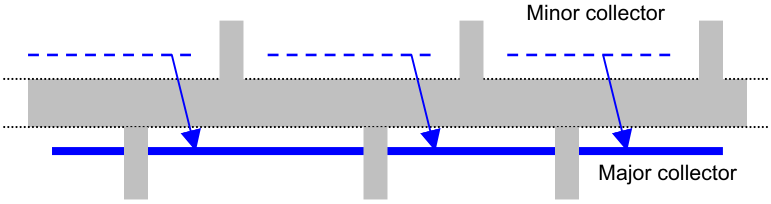
This provision may be in the form of open drains or pipes.

In practice this will involve collection on both sides of cambered roads. In some cases it may be possible, by regrading, to convert a cambered road into a simple cross fall, sloping against the natural slope and have a single drainage line.

The drainage collection system must have adequate capacity to collect flows from a storm with an average recurrence interval of 5 years. This capacity can be either, to transfer all flows downstream, or to have capacity to store peak flows for later discharge.

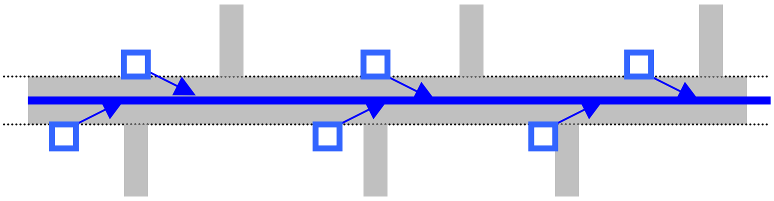
Where drainage is required on both sides of the road a reduced-cost option of providing the main drainage line on one side of the street and having smaller collectors on the other side of the street with regular cross connections may be used. Figure 20 below illustrates this approach.

Figure 20 Main Piped Collector Drain on One Side



Where protection of existing vegetation or preservation of roadside areas for re-vegetation is a priority the construction of a piped drainage system may be preferable. This may be in an alignment on either side of the road, or in certain cases under the road itself. Figure 21 below illustrates this approach.

Figure 21 Main Piped Collector in Centre of Road



16.2.1 Protecting table drains from erosion.

Erosion is caused by the abrasive action of flowing stormwater. The methods of reducing erosion are based primarily upon reducing the speed of stormwater flow, reducing the volume of stormwater, or protecting the surface with a resilient lining.

Some erosion protection work has been already been carried out in the Aireys Inlet area. This takes the form of rock lining of drains and placing of temporary weirs (sandbags) slow flow and collect silt.

The following two photographs Figure 22 and Figure 23 show examples of this work.

Figure 22 Rocks Lining of Drains

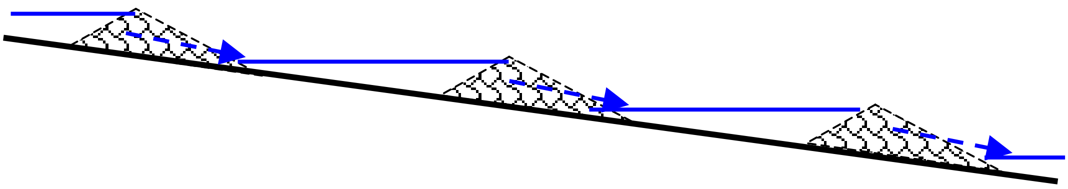
Figure 23 Sandbag Weir

Although these works has resulted in some reduction in erosion there have been community concerns about the aesthetic appearance of the works and its long-term effectiveness. This community concern is related to the visual appearance of the table drains, in which there has been difficulty in establishing vegetation growth on the bare clay soil and silts that flow into the drains.

The following improvements to these two measures will improve performance and appearance:

- **Rock Lining** – Promote vegetation growth in the rock by spreading topsoil and scattering with indigenous grass seeds. The grass roots will help to secure the rocks in place, assist in removal of nutrients from the stormwater, and prevent dispersion of the clay below the rocks. The foliage will also provide some filtering of, and encourage sedimentation of fine silts, hence soften the visual appearance of the drain;
- **Textile Reinforcement -** Reinforce the table drains with a textile or plastic mesh during installation or maintenance to provides a secure germination location and initial protection of grass seed while the roots establish;
- **Connection to a Carrier Drain –** Reduce the volume and velocity of water in the drain by providing connection to a piped drainage system at regular intervals;
- **Rock Weirs -** Construct 'riffles', which are permeable rock weirs. These should be spaced so each weir discharge to the pool of the weir below it. This reduces velocity of flow, hence erosion downstream of the weir. A typical section is shown in Figure 24 below.

Figure 24 Riffle Weirs Longitudinal section



The following two erosion control techniques are less suitable in Aireys Inlet due to their artificial appearance and should only be used where no technique with a more natural appearance is suitable.

- **Control Structures** - Control structures (such as concrete drop structures) may be constructed to reduce flow velocities. These provide hardened areas that will not erode in the turbulent zone; and
- **Corrugated steel half pipes** – These are narrow drain-lines constructed from half-sections of pipe with corrugations perpendicular to the direction of flow, intended to reduce velocity of flow and trap silt.

16.3 Swale Systems

Swales are a development of table drains that can improve the quality of water. Swales tend to retain water for longer periods of time. For this reason swales also vegetate more rapidly and are less susceptible to vegetation loss in dry weather. The increased volume of the swale can also be used to provide retention of peak storm flows reducing the peak flows downstream of the swale.

Constructing table drains as swales can address many of the issues of the existing drainage system.

The key constituents of an effective swale are:

- **Shallow side slopes and a wide bottom -** The shape improves the ability of vegetation become established and provides a large cross sectional area for the depth. The shallow slopes reduce the risk of falls;
- **Establishment of Grasses –** Grasses provide filtering of silt as it flows into the drain and slow the flow along the drain that will assist in causing silts to be deposited. The roots protect the surface of the swale from erosion and will take up nutrients from water that soaks into the soil; and
- **Shallow longitudinal fall wherever possible** - This minimises flow velocity reducing the risk of erosion and maximising the chance of silts being deposited before discharge.

Figure 25 below shows a typical swale.

Figure 25 Typical Swale

16.3.1 Suggested Swale Dimensions

In the case of Aireys Inlet a 0.3-0.5m wide base is recommended with sides sloping at no steeper than 1:4.

These dimensions have been selected to minimise the damage to roadside vegetation during the swale construction and allow adequate room between the swale and property boundaries to establish shrubs and trees.

Where there is an existing deep drain it may be preferable to pipe the drain and utilise it as carrier drain with connection pits to drain the swale.

16.3.2 Application of Swales

The swale can be used with sealed or unsealed roads.

In the case of unsealed roads the vegetation at the edge of the road captures the majority of the silt preventing it being deposited within the swale.

Issues with swale provision include:

- Erosion in swales can still be a problem on steep roads or steep slopes requiring rock lining or other erosion protection measures;
- The additional width of the swale also provides a limitation on its use where there is a requirement to protect existing vegetation; and
- The width and open nature of the swale may still allow dehydration in summer, which can result in a loss of vegetation.

16.3.3 Culverts and Driveway Crossings

Driveway crossings are a common source of problems. In some instances stormwater pipes have been installed to allow free-flow of stormwater in drains or swales, and in some cases no construction has taken place, and the crossing is little more than a miniature ‘ford’. Where pipes had been used to facilitate drainage flow, the diameter of these pipes is often inadequate.

Small diameter pipes should be avoided in drainage systems. Small diameter pipes concentrate the flow at entry and exit points increasing the risk of scouring and can be easily blocked by litter or debris carried in the stormwater flow. Larger diameter pipes, although they may also concentrate flow and cause some erosion are a better option. However the increased capacity, hence tendency to allow increased flow, may require beaching to assist erosion control. The minimum recommended culvert dia is 300mm larger diameter pipes or box culverts are preferred although this has a significant cost implication.

16.4 Piped Drainage Systems

Piped drainage systems are the standard urban stormwater drainage method employed in Australia, to convey stormwater from normal storm events without nuisance. In residential areas, piped drainage systems are typically designed to manage stormwater from particular storm events, but recognising that extreme rainfalls do infrequently occur. Piped drainage systems are therefore designed based on an Annual Recurrence Interval (ARI). This interval is a measure of the expected frequency of a storm event that may exceed the capacity of the drainage system, and results in some flooding. An ARI value of 5 years is required by Aus-Spec when designing drainage pipe capacity for new subdivisions, and has been used when modelling the performance of the existing pipe network. In localised areas, such as public open space, where occasional minor flooding can be acceptable, an ARI of 1-2 years may be acceptable. Acceptance of a lower ARI value and the attendant flooding can also reduce the cost of upgrades to the piped systems.

A high-flow piped drainage system, with its ability to rapidly transport stormwater from the collection point to the discharge, has the potential to exacerbate downstream flooding and water quality problems, as has occurred in many urban centres.

Acceleration of stormwater flows through the drainage system may increase downstream flood levels and contribute to localised nuisance flooding should the system surcharge. Fast-flowing stormwater is more likely to collect and transport silts, litter and other pollutants. Pollutant loads discharged to the town's riverine and marine waters may also increase, with stormwater flows conveyed directly to receiving waters with little or no natural filtering. High flow velocities in the proposed system also have the potential to cause scouring at the drainage outfalls.

Notwithstanding the problems associated with a high-flow piped drainage system, such a system may be appropriate in some parts of Aireys Inlet. A number of pipe and pit systems have already been constructed. New systems may be appropriate where the following conditions are satisfied:

- Pipeline alignment is along stable slopes with limited landslide risk;
- Pipeline construction will not exacerbate downstream flooding;
- Pipeline transport will not increase pollutant loads to receiving waters; and
- Construction is practicable (The site is accessible to heavy machinery, the road can be sealed and kerb and channel constructed, excavation of trenches is feasible).

16.5 Community Reference Panel Discussion

The majority of the Panel members concurred that some drainage improvements were required. There were concerns about the high cost of the piped solutions and maximising the use of swales, as a lower cost solution, was considered important. Some Panel members expressed concerns about the loss of existing vegetation and considered that piped drainage may be preferable to swales to prevent roadside vegetation loss.

16.6 Proposal for Collection and Transfer Improvements

It is proposed that stormwater collection and transfer system improvements be based on the following:

- Design of new drainage systems for a storm intensity that would occur once in every five years;
- Upgrade under capacity pipes that have been identified from the system modelling;
- Provide adequate stormwater collection systems for all streets, either in the form of open drains or piped systems. Generally these should serve both sides of the street;
- Where properties have access to roadside drains and no piped drainage system is provided, discharge stormwater to a roadside table drain;
- Properties located below the road or open drain need to be protected by providing a berm on the edge of the drain constructed to contain overflow;
- Swales are preferred where space permits, to provide additional peak flow storage and treatment;
- Swales/table drains should be protected from erosion; and
- Upgrade all driveway crossings in the study area to a minimum of 300 mm diameter with larger culverts being provided for swales and drains with flows that require larger capacity culverts should be provided with inlet trash screens. Initially, priority should be given to blocked or damaged structures and driveways with no crossing.

17. Stormwater Quality Improvements - Treatment

17.1 General

The following three types of stormwater treatment are considered appropriate for Aireys Inlet. They are compatible with the character of the township and they provide effective treatment of stormwater:

- Silt traps;
- Bioretention; and
- Additional Wetlands.

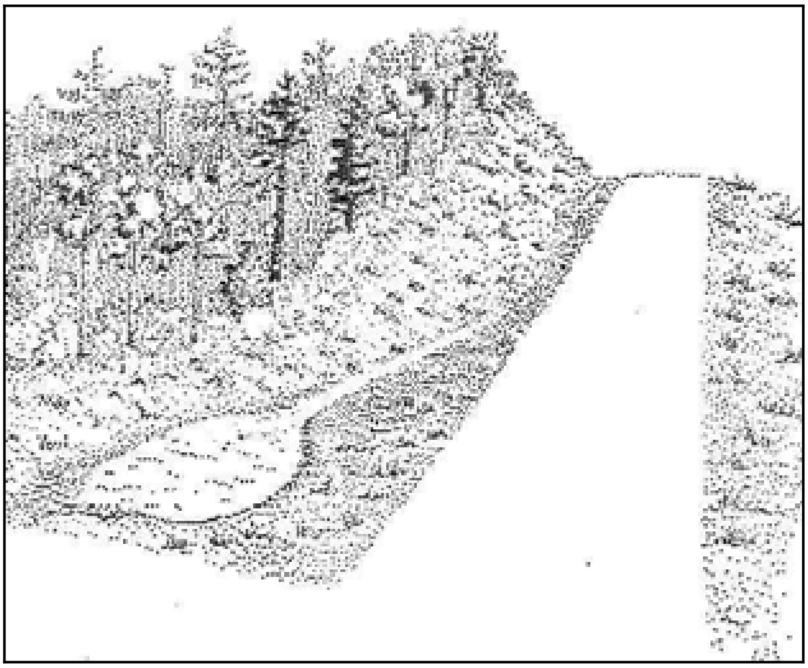
These techniques are compatible with the The Urban Stormwater Best Practice Environmental Management Guidelines CSIRO 1999 which were developed by EPA, Melbourne Water, Municipal Association of Victoria, local government, industry and Department of Natural Resources and Environment, to support the implementation of best practice.

17.2 Silt Traps

A number of tables drains and pipes in the study area discharge directly to natural drainage lines, typically as concentrated, high-velocity flows. These concentrated discharges allow for no natural trapping of sediment or gross pollutants, and may directly contribute to erosion of gully beds and banks.

Sediment traps can be provided at drainage discharge points. These will generally be shallow earthen depressions, as shown in Figure 26. They are designed to slow flow, provide peak flow storage and promote sedimentation. For the high flow pipe systems, purpose-built structures may be required, consisting of concrete pits or basins. Where discharge velocities are high, such as at culvert outlets, sediment traps should be combined with energy dissipation measures such as rock beaching.

Figure 26 Table drain sediment trap (from Holaday 1995)



17.3 Bioretention

Bioretention is a development of the silt trap, and swale, techniques that also filters runoff through a vegetated filtration layer. The system provides flow retardation through the filter media and is efficient in removing nutrients through the roots of the plants.

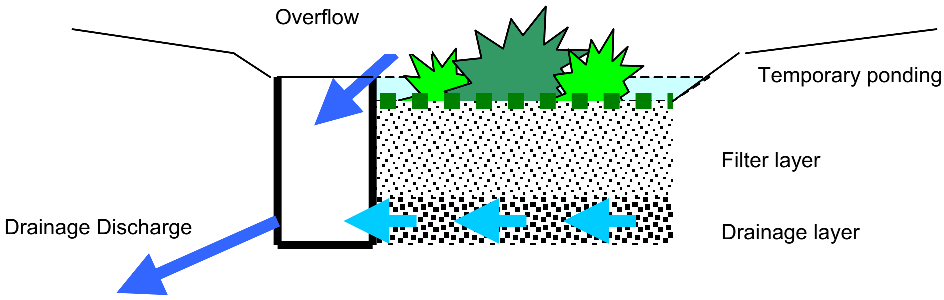
17.3.1 Bioretention systems

The elements of a typical bioretention system are:

- A drainage layer consisting of perforated pipes surrounded by a fine gravel;
- A fine filter, typically sandy loam, which is planted with indigenous vegetation. The top surface of the filter layer is set to form an area where water can pond and heavier particles can settle; and
- A pit which takes overflow from the ponding and drainage from the filter.

Figure 27 below indicates a typical section through a bioretention system.

Figure 27 Bioretention system



The vegetation in the bioretention system performs several functions:

- The roots provide protection from erosion;
- The plants take up moisture between rainfall events, drying and cracking the soil to prevent the filter clogging; and
- Plant roots take up nutrients and other pollutants.

17.3.2 Provision of Bioretention

Bioretention can be incorporated into a silt trap or used in a swale system.

In the case of Aireys Inlet use of bioretention in a swale system will provide treatment of water while minimising removal of existing vegetation for construction.

To meet best practice objectives of bioretention (Section 17.1) requires (approximately) a bioretention area of 0.7% of the impermeable area. Typically this would be distributed over the catchments where bioretention is needed. For a 10 square house (95m^2) on a block with 20m frontage onto a 5m sealed road the impermeable area is 145m^2. This would require 1.0m^2 of bioretention. Additional area will be required for blocks with larger hard cover area and to account for the additional road frontage of corner blocks.

17.4 Wetlands

17.4.1 Existing Wetlands

Currently there are two wetlands in the Aireys Inlet.

A purpose designed and constructed wetland exists in Inlet Crescent on public land. This treats all stormwater from East of the Great Ocean Road south of Albert Avenue.

There is also a dam in private land to the east of Gilbert Road which has some aspects of a wetland and provides limited treatment of flows from west of Gilbert Street that discharge to Sandy Gully.

17.4.2 Potential for Additional Wetlands

Generally, Aireys Inlet is steep with much of the urban development being close to the natural watercourses. This means that wetlands are inappropriate for treatment of the majority of the township stormwater due to the difficulty of finding a suitable location.

An area where wetlands could be used is to the west of the main ridge, which discharges in to Painkalac Creek. The flood plain, which is between the developed area and the Creek, may be suitable for the construction of wetlands. Wetlands in this location would also provide better outfalls to the drainage systems in this area that are currently discharging to inadequate outfall drains or directly to paddocks.

The size of wetlands for effective treatment of pollutants is proportional to the impervious catchment area. Typically the area of wetlands required is in the order of 2 - 2.50% of the total impermeable catchment area.

For the eastern catchment with an estimated impermeable area of 240 000m^2 this would result in a requirement for wetlands of 4 800 - 6 000m^2.

The wetlands treatment process includes enhanced sedimentation, filtration and pollutant and nutrient uptake. There are three main parts to an effective wetlands sedimentation system: An inlet zone for the removal of coarse sediments; a heavily vegetated zone to remove smaller particles and take up nutrients (macrophyte zone); and a bypass channel to protect the macrophyte zone from high flows.

Discussions with DSE indicate that there is an area of crown land of approximately one hectare adjacent to the river which may be made available for wetland construction. However, it would be difficult to serve all the area from this site and the following locations may be more appropriate should land become available:

- A wetlands immediately to the west of the junction of Bambra Road and Beach Road either for the whole site or for the southern half of the catchment; and
- A location between Aireys Street and McConachy Street to serve the northern part of the Catchment.

17.5 Community Reference Panel Discussion

The Panel members supported the concept of improving water quality but were concerned about the cost.

17.6 Proposal for Stormwater Quality Improvements

It is proposed that stormwater quality improvements are based on the following:

- Increased removal of silt from existing pits and drains;
- Bioretention in conjunction with silt traps and swales for systems where a wetland is not practical (particularly flows discharging to Sandy Gully, and the River Reserve area discharging to Painkalac Creek); and
- A new wet lands for flows on the western side of the ridge that currently discharge to Painkalac Creek. (This may be subject to successful negotiation with the landowner.)

18. Stormwater Outfall Improvements

18.1 Introduction

Discharge of fast moving water, particularly in large volumes and to unprotected water courses and land, can lead to severe erosion problems close to, and immediately downstream of, the point of discharge.

Conversely discharge of waters with a high silt load to a slow moving waterway or to land can cause siltation downstream of the discharge point. There are several instances in Aireys where the siltation has built up to the point of causing partial blockage of the discharging pipe.

Some of these factors are addressed in other sections of this report. The following section addresses the control and treatment of stormwater at the point of disposal.

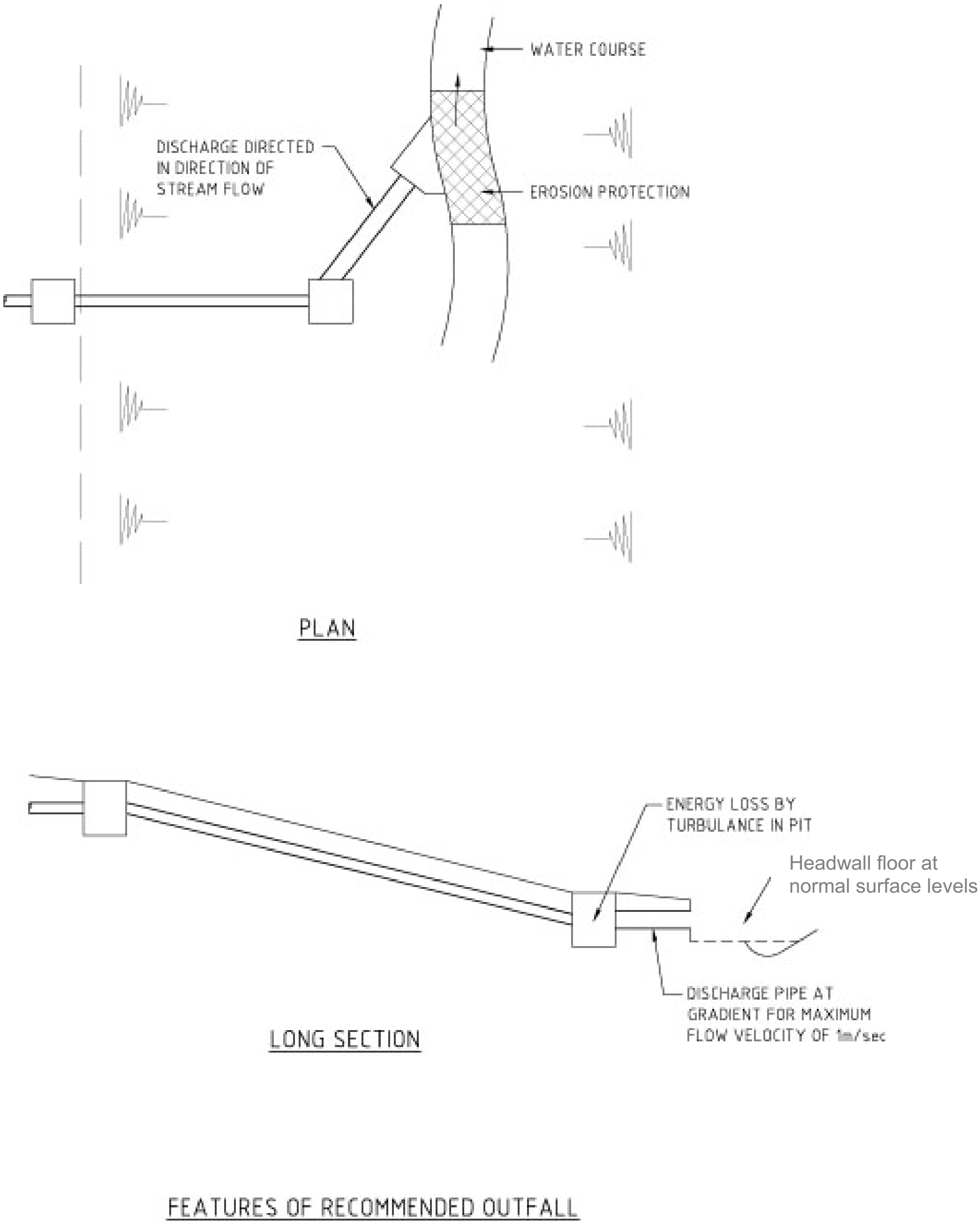
18.2 Outfall to Natural Watercourses

The attributes of a well designed outfall are:

- The discharge point is at the natural water level in the watercourse so the water at the discharge point cushions the entry from the outfall;
- Silt collection is provided at a convenient point for removal of the silt by maintenance crews;
- The velocity is limited at the point of discharge to a rate that minimises erosion. (Typically less than 0.6m/sec);
- The flow is directed along the watercourse rather than across it to minimise turbulence; and
- Erosion protection in the form of a headwall and beaching is provided.

A sketch of a suitable outfall is shown in Figure 28 below.

Figure 28 Sketch of Outfall Detail



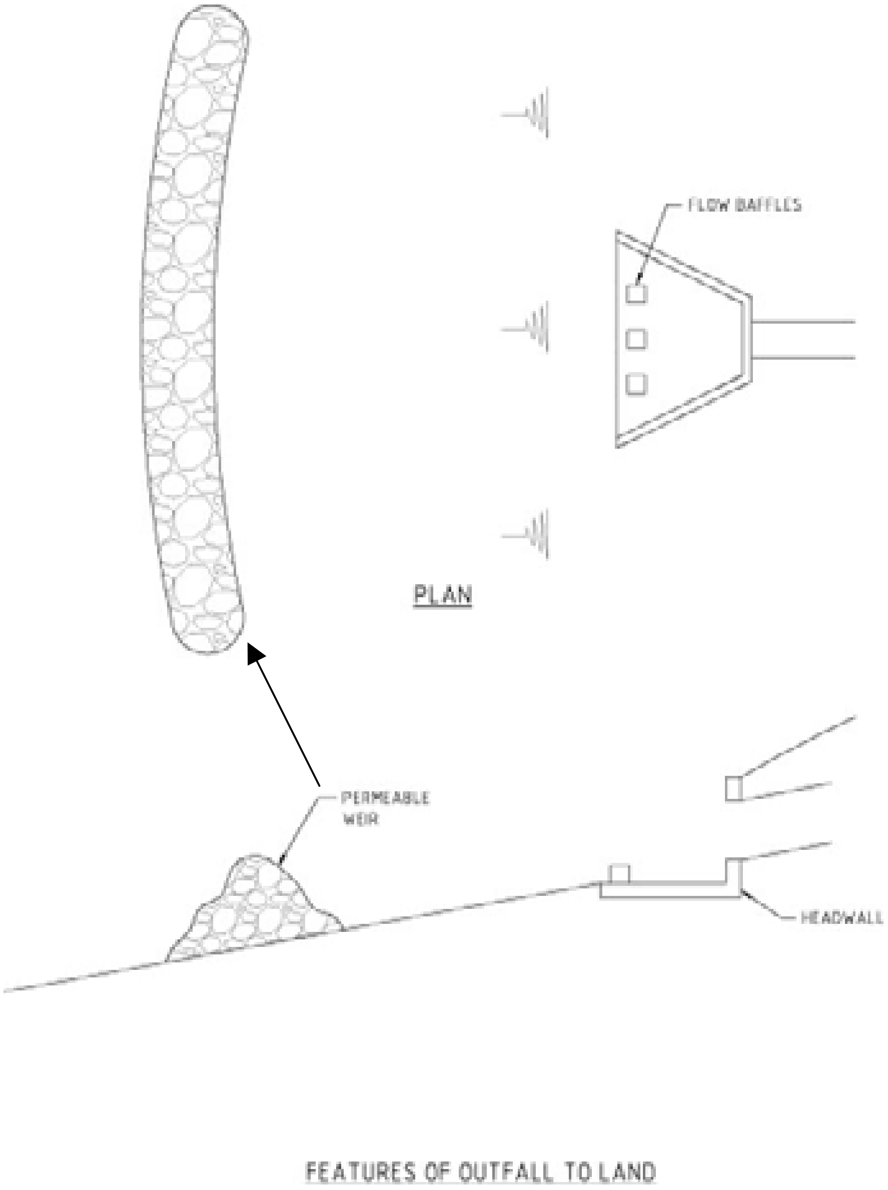
18.3 Outfall to Land

The discharge of piped systems and road drainage from large areas to land should be avoided where possible. Where an outfall to land cannot be avoided drainage discharge points and outfalls should be constructed to:

- Protect the outlet from blockage; and
- Ensure dissipation of flow across a wide, well-vegetated area.

Discharge points can be designed to achieve the desired outcomes. A sketch of a suitable outfall is shown in Figure 29 below.

Figure 29 Outfall to land Sketch



18.4 Community Reference Panel Discussion

The Panel accepted that the high erosion at locations such as the Aireys Street table drain outfall to the watercourse needed attention.

18.5 Proposal for Outfall Improvements

It is proposed that outfall improvements are based on the following:

- Improve outfall design to natural watercourses as described in Section 18.2 above;
- Construct all drainage outfalls to land to provide dissipation of flow across a wide, well-vegetated area as described in Section 18.3 above; and
- Initiate a maintenance program for all outfalls to repair erosion and remove silt.

19. Budget Cost Estimates

19.1 Background

GHD budget cost estimates are based upon concept level estimates only for the works identified during the Panel process. All budget cost estimates are derived from a combination of published construction costs and recent GHD experience of similar works and are based upon 2007 Australian dollars. No allowance has been made for inflation or increases in CPI since the preparation of these estimates.

The accuracy of the estimates is of the order of +/- 25%. GHD does not warrant that the works can be conducted for the estimated sum. A process of commercial tender may achieve refinement of costs estimates.

Further consultation with each of the improvement catchments areas may affect the levels of works required.

19.2 Road Costs

19.2.1 Unit Costs

An estimated construction cost per metre length has been calculated for each concept as follows including traffic chokes on unsealed roads.

Table 5 Road Unit Costs

Construction	Cost/m length
Sealed road 7m wide road shared surface	450
Sealed Road 6m wide road + 1m exposed aggregate concrete footpath	410
Sealed Road 5m wide	360
Sealed Road 3.5m wide	275
Providing landscaped traffic chokes on unsealed roads	70

19.2.2 Overall Road Costs

Based on the above unit costs the budget estimates for construction are:

Construction costs	$1 820 000
Contingencies 25%	$ 455 000
Engineering 20%	$ 365 000
Total	**$2 640 000**

Details of costs of individual streets are provided in Appendix I.

19.3 Drainage Costs

19.3.1 Table Drains/Local Collection Unit costs

An estimated construction cost per metre length has been calculated for various roadside drainage options. The rate includes driveway crossings and pits where a piped carrier drain is provided in Table 6.

Table 6 Drainage Unit Costs

Drainage Provision	Total cost per m
Swale	115
Rock reinforced swale	130
Swale and pipe	315
Rock swale and pipes	330
Pipe and 2 swales	470
Pipe and 2 rock lined swales	485
Rock reinforced swale and pipe	330
Fully piped	440

Estimated construction costs have been tabulated in Appendix J to provide drainage systems for the majority of streets in Aireys Inlet. This gives budget estimate for construction of $3 325 000.

The total cost has been discounted by 25% to allow for existing table drains already in place. This produces a budget estimate for construction of $2 494 000.

19.3.2 Outfall Costs

There are a variety of outfalls. An average construction costs has been estimated at $10 000 per outfall.

With fifteen outfalls to be addressed this results in a budget estimate for construction of $150 000.

19.3.3 Water Quality Improvements

Wetlands

Based on experience of previous wetlands the budget estimate for construction of a wetland is $400 000.

Bioretention

The additional cost of 1m of bioretention over the cost of swale construction is estimated at $100/m$^{2.}$

Estimated Construction costs have been tabulated in Appendix J to provide drainage system for the streets in Aireys Inlet that cannot drain to a wetland. The budget estimate for bioretention construction is $92 000.

19.3.4 Pipe Upgrades

A plan showing the existing drainage identifying the pipes requiring upgrades is included in Appendix C. Unit costs for recent projects have been used to provide the unit costs used in existing pipe upgrade calculations. Budget estimates for construction have been tabulated in Appendix K and are summarised below:

- Existing pipe Upgrades $1 134 000
- Upgrades to provide for future development $344 060

19.3.5 Overall Drainage Costs

Based on the above unit costs budget estimates for construction are:

Construction Costs

Road Drainage	$2 494 000
Outfalls	$150 000
Existing Pipe Upgrades	$1134 000
Future pipe Upgrades	$344 000
Bioretention	$92 000
Wetlands	$400 000
Construction Cost Sub Total	$4 614 000
Contingencies 25%	$1 154 000
Engineering 20%	$923 000
Total	**$6 691 000**

19.4 Cost Summary

The overall budget estimates for construction for the Road and Drainage Plan are:

Roads	$2 640 000
Drainage	$6 691 000
Total	**$9 331 000**
Say	**$9.4M**

19.5 Community Reference Panel Discussion

The Panel expressed concern about the total cost of the scheme and the possible cost per property should full recovery of costs form existing landowners be considered by Council.

20. Financing Options

This section considers the various forms of funding for the upgrade works.

20.1 Council Support

20.1.1 General Support

The Council has to date supported the cost of preparing this plan. It may choose to provide further funds from general Council funding in order to further develop the proposals.

Within towns such as Aireys Inlet improving the roads and drainage will result in improved services to residents (both permanent and holiday-house owners) and to recreational visitors (tourism). For previous schemes the council has met the portion of the works that can be attributed to be of benefit to the general public.

20.1.2 Pathways project

The Pathways Project has identified budget sums for pathways across the Shire. This includes pathways for Aireys Inlet. If the recommendations of this plan are accepted there will be savings on the pathways budget for the following reasons:

- Shared surfaces for pedestrians and vehicles will mean that no pathway is required.
- Crushed rock surfacing on separate pathways, as discussed in Section 12.4 of this report will have a lower cost than sealed footpaths.

The savings on the pathways project could be redirected toward this project.

20.2 Future Developers

The drainage model indicates two levels of upgrade to the drainage system are required, with a higher level of upgrade for the predicted final level of likely urban development.

Surf Coast Shire needs to consider implementation of a requirement for developer funding to support some of the upgrade work. This could be done by addressing each development in isolation. The preferred method however would be production of an overall Developer Contribution Plan.

20.3 Corangamite Catchments Management Authority (CCMA)

CCMA has indicated that it may be able to support projects that result in improvement to the catchments discharging to Painkalac Creek and the Ocean, and the quality of water discharged to those receiving bodies.

CCMA support could be in the form of a direct grant, and/or brokering grants from other sources.

Before CCMA can give indications of the level of support they will need to receive an application for funding of particular projects.

If Council was successful in attracting CCMA funding, this support is most likely to be made available for the construction of a wetlands and/or the construction of bioretention facilities to improve water quality.

20.4 Vic Roads

Run off from the Great Ocean Road contributes to the considerable flooding problems at the junction of Hopkins Street and Berthon Street. Initial discussions with Vic Roads indicate that although VicRoads have not contributed to drainage schemes in the recent past they may be prepared to consider contributing to a drainage scheme.

Before they can give indications of the level of support they will need to receive an application for funding.

20.5 Property Owners Contribution to Road Improvements

There is a need to acknowledge in determining the level of contributions that some property owners have already contributed to previous road special charge schemes or made developer contributions within Aireys Inlet.

In assessing cost apportionment of road improvements it is necessary to consider how the benefits from road improvements apply to the community. The following table indicates the relationship between the benefits and beneficiaries.

Table 7 Beneficiaries of Road Improvements

Improvement	Benefits	Beneficiaries
Sealing of Road-	Smoother surface resulting in less wear on vehicles and safer roads No dust No mud	Residents or landowners with properties on roads
		Residents or landowners who use street for access to properties
		Residents or landowners that occasionally use the road for access to facilities and services
Sealing of Road -	Reduction in pollution of watercourses.	All of Aireys Inlet residents and the wider community
Traffic Calming	Safer pedestrian access Reduced risk of vehicle accident	Residents or landowners who use street for access to properties due to slower traffic
		Residents that occasionally use the road for access to facilities and services due to slower traffic
Alternative Materials and Techniques –	Retention of rural character of town	All of Aireys Inlet residents and the wider community

Identification of the beneficiaries will be subjective, as catchments for road improvements will overlap.

20.6 Property Owners Contribution to Drainage Improvements

In the case of drainage improvements it is appropriate to consider the main beneficiaries of any improvement to be all the residents in the individual catchments. This allows an objective identification of the beneficiaries.

It will be necessary to take into account the contributions that some property owners have already made to previous special drainage charge schemes or have been made as developer contributions.

Drains in front of the properties in the lower parts of the catchment that need to carry greater, accumulated flows are likely to be larger, and more expensive, than drains higher up the catchment. However this is due to the flows from the higher parts of the catchment contributing to the flow in the lower sections. The apportionment should therefore be even, hence equitable across the catchment.

Table 8 Beneficiaries of Drainage Improvements

Improvement	Benefit	Beneficiaries
Upgrading existing roadside drainage and or providing new piped system to take flows from private properties	Providing a drainage outfall to all properties	All residents not served by a piped system in drainage catchment
Upgrading drainage to take flows from roads	Avoiding road flooding	All residents in drainage catchment
Upgrading outfalls to reduce erosion of land and watercourses	Reduced erosion at outfall locations	All residents in drainage catchment
	Reduced pollution to receiving waters	All of Aireys Inlet residents and the wider community
Treating stormwater to reduce impact on receiving water	Reduced pollution to receiving waters	All residents in drainage catchments
		All of Aireys Inlet residents and the wider community

20.7 Community Reference Panel Discussion

The Panel understands that property owners would be required to contribute to any upgrade to the roads and drainage of Aireys Inlet. They believe that the apportionment of costs will need to demonstrate equity to all with the benefits to tourism being funded from other sources than the residents.

21. Improvement Catchment Areas

21.1 Community Reference Panel Discussion

During the consultation process with the Panel it proved impossible to get clear recommendations for the application of concepts to particular streets. The compromise arrived at with the Panel was that smaller improvement catchment areas be selected for further consultation and development of proposals

The areas have been selected based on each area having road and/or drainage issues that are common to the majority of properties within that area. Suggested improvement catchment areas are described in the following sections and shown in Appendix L.

21.2 Hopkins Street Catchment

Hopkins Street is the busiest residential street in Aireys Inlet, providing access to approximately 20% of the residential properties in the town. Other well trafficed streets in the area are Hartley Street between Hopkins Street and Aireys Street and Boundary Road. Parts of Aireys Street, Anderson Street and Eagle Rock Parade are very steep causing significant erosion from stormwater and wheel spinning from vehicles. The end of Eagle Rock Parade has drainage and parking issues.

The large bare area at the junction of Hartley Street/Anderson Street/Aireys Street/Roadknight Streets has been identified as an issue within this area.

The Hopkins Street catchment drains to Sandy Creek with a considerable discharge through the junction of Hopkins and Berthon Streets where significant flooding has occurred in the past. Less than 5% of the catchment has piped underground drainage.

21.3 Pearse Road

Pearse Road is the second busiest street in Aireys Inlet. It provides a main access to approximately 15% of Aireys Inlet, and the CFA station. The catchment area contains steep sections of streets in Beach Road, Aireys Street, Philip Street and the Northern Section of Pearse Road.

The Pearse Road area drains to Painkalac Creek. Approximately 50% of the catchment has piped underground drainage.

21.4 Boundary Road East

Boundary Road East runs from the Great Ocean Road to Eagle Rock Parade. As the Great Ocean Road Meanders inland, many travellers use Boundary Road East to attempt to regain ocean views. Boundary Road East is also used for access to surf beaches. The Boundary Road East catchment area also includes parts of Hartley Street and Eagle Rock Parade.

The Boundary Road East area drains into bushland to the North. There is no piped underground drainage in this catchment.