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AUCKLAND CITY COUNCIL – ISTHMUS DISTRICT PLAN REVIEW 2007/08

EUM/METROWATER TECHNICAL INPUTS

1.	PAPER TITLE:	Stormwater Quantity Issues
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2. PAPER ISSUE STATUS: Draft for Review

Issue No	Date	Contributors	Reviewer	Summary of main changes
1	11 June	R M	IM	
2	24 June	RM	GO	Edits and suggested additions on soakage
3	30 June	IG		Edits for clarity
4	14 July	RM	GO	Edits and new section on soakage

3. KEYWORDS

Stormwater, impervious area, streams, operation and maintenance

4. SUMMARY

The City's stormwater drainage network of streams, groundwater flows and pipes is an essential part of the city's infrastructure, providing for the health and safety and social and economic well being of the community. The ongoing operation and development of the network, together with the control of development within flood hazard areas, is essential to the functioning and growth of the city, health and safety of the community, and protection of environmental values.

With development, the amount of impervious area is increasing, creating a tension between providing for the growth of the city while protecting and enhancing environmental values. Impervious area coverage limits are an important factor in stream health. These limits, as well as appropriate Low Impact Design / Water Sensitive Urban Design,(herein after referred to as LID) should be considered in areas within the Isthmus where particular receiving environments need to be maintained and improved and in areas where stormwater is disposed of by soakage to the ground.

This paper considers three issues:

- Implications of additional impervious area on flooding, stream erosion and impacts on stream ecology
- Implementing Low Impact Design / Water Sensitive Urban Design (LID), and
- Control of activities and developments in flood plains.

5. RECOMMENDATIONS FOR CONSIDERATION FOR THE DISTRICT PLAN

Impervious Area and Low Impact Design

There are areas where the District Plan could assist in achieving improved outcomes in respect of the management of stormwater. Areas recommended for further consideration in the District Plan are:

1. Maintaining as a base level in non soakage areas the site coverage limits currently set within the current District Plan
2. Determine on a receiving environment basis those reaches of streams that require a level of protection and /or enhancement ,greater than provided for by having site coverage controls set at the base level. When this has been completed consider a combination of reducing impervious area limits and/or LID solutions to these identified areas. The implementation of LID options needs to takieinto account the higher risk of long term maintenance requirements of some LID systems
3. Consider from a stormwater perspective providing for increased development near the coast, particularly where streams have been piped. In these locations it may be possible to upgrade infrastructure to cater for increased flows at a reasonable cost.
4. For areas relying on soakage into the ground provide for an approach through the District Plan which limits site coverage to the current average level of impervious cover for new development, with any increases above that level being the subject of specific site assessment, utilising LID methods to ensure the effective impervious cover is not increased above the average limit.
5. Development within Flood Plains - Consider an approach which involves controlling activities within the 100 year AEP floodplain utilising a similar approach to draft proposed plan change 93.

6. OUTSTANDING MATTERS

The implementation of recommendation 2 for the District Plan requires that sensitive receiving environments be determined. This work would need to follow on from the initial development of prioritised catchments discussed in the watercourses and wetlands paper, to determine those reaches of streams that require a level of protection and /or enhancement .

Provide more detailed map of areas having suitable soakage for disposal of stormwater.

7.0 ISSUES AND SCOPE

7. Issues

Stormwater runoff is a term used to describe the water from rain, snowmelt or irrigation that flows over the land surface and is not absorbed into the ground, instead flowing into streams or other surface waters or land depressions.

The amount and rate of stormwater runoff is affected by the following factors:

- Impervious area – the amount of surface material where rainfall is not absorbed e.g. roofs, concrete, roads
- Rainfall intensity – the amount of rainfall
- Land form/topography – the steepness and shape of the land.

Where stormwater runoff and urban development is not managed effectively, there is potential for creating nuisances to residents. Improperly managed stormwater flows can damage property and cause environmental degradation through such effects as stream erosion. In heavy rainfall, land and buildings can flood, causing potential safety issues. .

The following issues related to stormwater quantity addressed in this paper:

1. Impervious area – Should there be controls in the District Plan on impervious area? If so what would be the purpose of these controls and what should they be?

   Impervious area is a significant factor in determining the amount of stormwater runoff that results from rainfall – particularly in lower intensity rainfall events. Because the city wants to provide for growth, there is potential for the impervious areas of the city to increase. This could potentially cause an increase in detrimental effects such as stream and ecology damage, property damage and flooding of buildings.

2 Low Impact Design (LID) (sometimes referred to as Water Sensitive Urban Design (WSUD) herein after referred to as LID) – To what degree should the City promote the use of LID practices, and how should these be incorporated in the District Plan?

   LID employs methods aimed to mimic as far as possible natural drainage systems and to minimise adverse effects by design. They can be utilised to manage the effects of development on a catchment. LID methods are currently utilised by Auckland City Council in their current District Plan to mitigate the effects of increasing impervious area in the Residential 8 zones.

3 Flood Hazards – What controls are required in the District Plan to provide for appropriate flood plain management?

   Flood plains are natural and built features that perform an important function in catering for the volume of stormwater in extreme events. Appropriate controls need to be in pace to manage the effects of development in the flood plain to ensure that the development itself is not subject to flooding and that it does not cause any adverse effects of neighbouring property.

7.2 Scope

This paper discusses the following:

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Issue 1: Impervious Area

- The potential implications of additional impervious area on flooding, stream erosion and impacts on stream ecology
- A range of methods to deal with the effects of impervious area
- The potential implications for the District Plan

Issue 2: LID

- The issues associated with implementing WSUD
- Options
- The potential implications for the District Plan

Issue 3: Flood Hazards

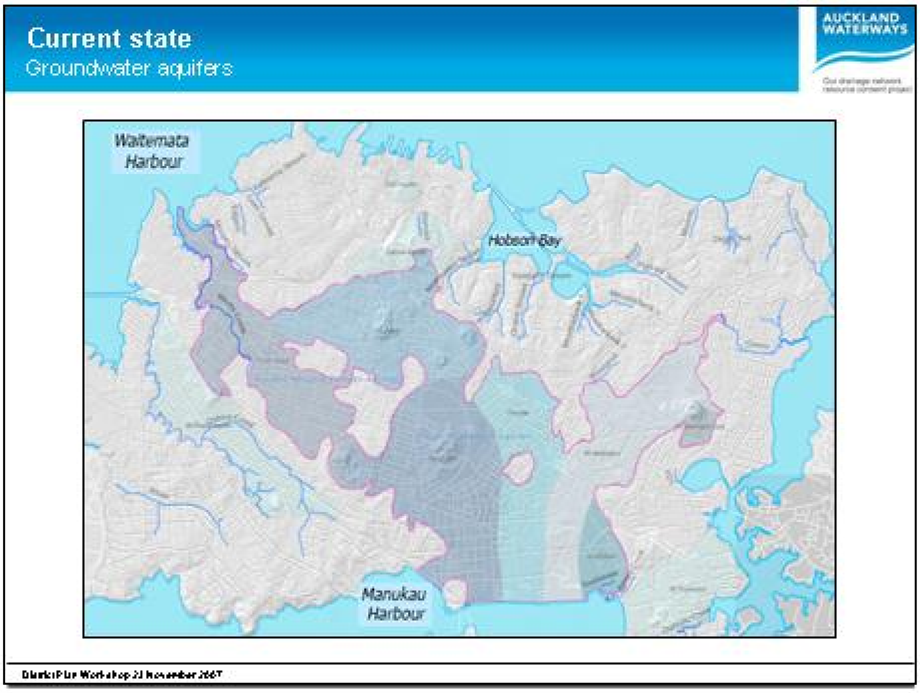
- The issues of developments occurring in flood plains
- Options
- The Potential Implications for the District Plan

8. NARRATIVE

8.1 General introduction to the stormwater / combined system

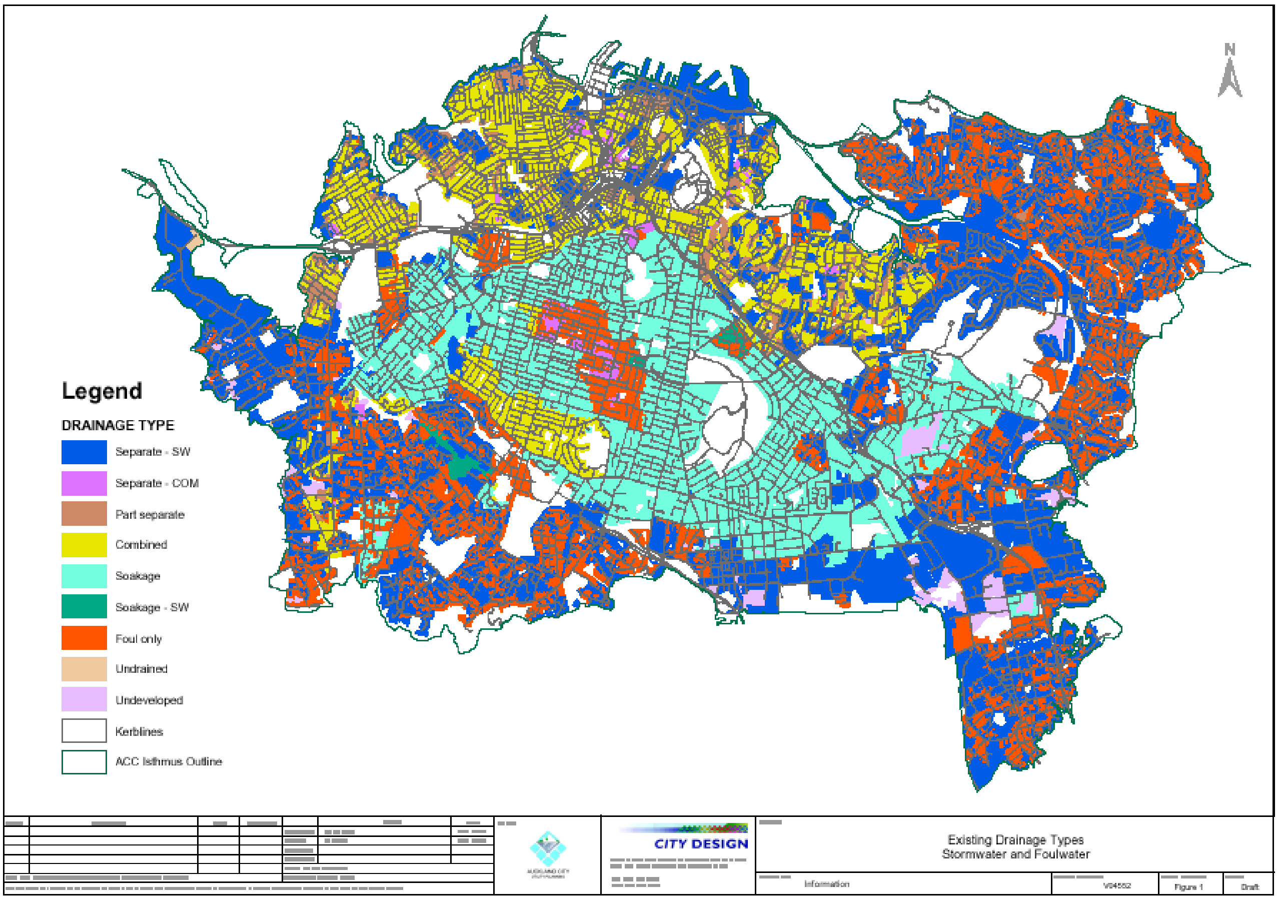
The Auckland City Isthmus is made up of some 38 catchments or Drainage Management Areas. The catchments are relatively small and steep and are highly urbanised, giving rise to significant impervious areas and high rates of stormwater runoff during periods of rainfall.

There is a significant variation in the geological make up of the Auckland Isthmus due to the numerous volcanic cones and their resultant lava flows. Because of this geology, approximately a third of the Isthmus partly utilises ground soakage for the disposal of stormwater and its conveyance to streams and ultimately the harbours. Overall approximately 20% of the city's stormwater discharge goes to groundwater.



The areas of the Isthmus not affected by lava flows generally have more impervious clay materials, and a network of urban streams.

A formal piped stormwater infrastructure has been provided since Auckland's earliest development. The older parts of the city were – and still are to a large extent – served by a combined stormwater and wastewater system. The expansion of the city through the subdivision of land has seen the development of a separate stormwater system of pipes which in many places discharge to local watercourses. Of these watercourses 5 are public watercourses managed by Auckland City Council and the remainder are numerous streams which pass through a combination of private and public property.



For reasons of economics, piped stormwater systems have been built to cater for relatively low return period storms, up to the 1 in 10 year event/ This isoften referred to as the primary system. The higher flows travel overland to streams, known as the secondary flow path. This design is not unique to Auckland City, and is common for most urban areas. Thus the Stormwater system comprises formal pipes and watercourses as well as informal overland flow paths. The combined system pipes, which act as the stormwater system where they are present, are being progressively separated from the wastewater system through a long term programme funded and managed by Metrowater.

Overland flow paths are a very important part of managing peak stormwater flows (above the 10 year event). These paths often involve other Council owned public infrastructure such as roads and parks. The flood plain outside the primary system provides for the effective storage of a large volume of water, limiting the rate that it flows downstream to the coast. The protection of this flood zone – if it is directly adjacent to a stream – is important, as is protecting the overland flow paths where they involve private property to ensure that flood flows can be managed to avoid more significant effects.

8.2 Regulatory Standards – Building Act

The regulatory standards that apply to buildings in relation to flooding are specified in the building code Clause E1 – Surface Water.

There are two main requirements in the code covering:
- Issues affecting other property, and
- The protection of the building itself.

For other property :- This requires that surface water resulting from a 1 in 10 year storm which is collected or concentrated by buildings or site works shall be disposed of in a way that avoids the likelihood of damage or nuisance to other property. This standard for damage to other property can be set at a higher level through the provisions of the Resource Management Act. This means that there is an opportunity under the District Plan review to consider if an alternative standard for the protection of other property from development is appropriate.

For buildings:- the code requires that surface water from a 1 in 50 year storm event shall not enter buildings. The buildings covered by the code are Housing, Communal Residential and Communal Non-residential.

It is usual to allow for a specified freeboard distance from any floor level above any specified flood level to allow for inaccuracies in the predicted water level, as well as for tolerance for dynamic effects such as waves from wind, or vehicles passing through flood waters. The building code specifies the following:-

> *The level of the floor shall be set at the height of the secondary flow plus an allowance for freeboard. The freeboard shall be:· 500 mm where surface water ponds to a depth of 100 mm or more and extends from the building to a road or car park, other than a car park for a single dwelling. 150 mm for all other cases.*
>
> *The 500 mm freeboard allows for waves generated by vehicles. Such waves will not be sustained unless there is at least 100 mm depth of water and an unobstructed path from the point where the wave is generated to the building.*

A number of other Local Authorities around New Zealand have adopted a flood risk standard at the 1 in 100 year return period. Auckland City Council considers that this standard is currently ultra viries the Building Act if it relates to restricting developments floor levels.

Although this is the current position, the Building Code performance requirements are currently being reviewed. The consultation document put out by the Department of Building and Housing proposes a 1 in 100 year return period flood standard as it is more stringent than the 1 in 50 year flood and reflects the planning controls adopted by a number of local authorities.

The Auckland Regional Council has also included the 100 year return period standard as part of its Plan Change 10[1]. The ARC has always proposed the 1 in 100 – it is in the operative RPS. However, previously it was only required to have regard for the RPS, but did not require that plans give effect to the RPS. By introducing PC10, and providing prescriptive policies, the ARC is requiring councils to give effect to the 100 year standard.

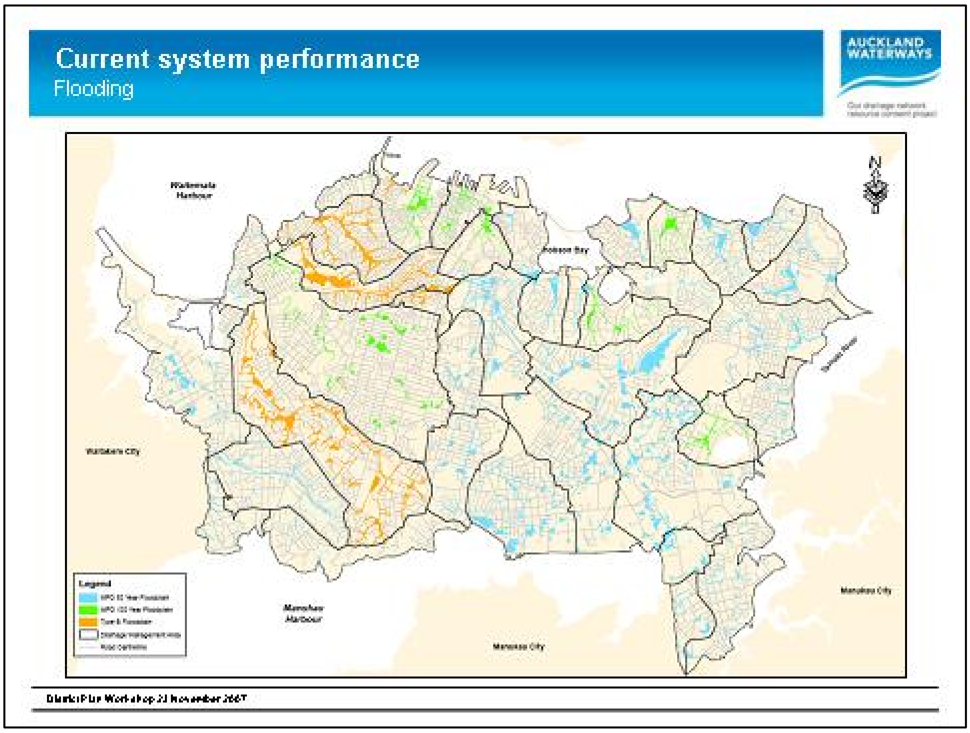
[1] Note that the ARC has always proposed the 1 in 100 – it is in the operative RPS. However, previously it was only required to have regard for the RPS, but did not require that plans give effect to the RPS. By introducing PC10, and providing prescriptive policies, the ARC is requiring councils to give effect to the 100 year standard.

Plan Change 10 is currently under appeal by Auckland City Council due to its apparent conflict with the current Building Act.

8.3 Current System Performance

During the 1 in 50 year rainfall event, it is predicted that some 1250 residential habitable floors across the Isthmus will be flooded – and up to 10% more would be flooded in the 1 in 100 year event. The corresponding areas of flooding are spread across the Isthmus such that nearly all catchments have habitable floor flooding. Flooding also occurs in commercial and industrial areas; however, these are seen as a lower priority than residential flooding due to both health and safety issues and that the Building Act permits the construction of buildings which are not residential or communal below flood levels.

The Integrated Catchment Study (ICS) included the development of catchment models to determine the extent of the flooding hazard. The models have been used to display the relevant flood hazards on Auckland City Councils GIS system. This is displayed in the figure below:



Design Events and Impervious Area

The effect of impervious area on the quantity of stormwater flows can potentially vary according to the magnitude of the storm event that is being designed for. During low intensity rainfall the ability of the pervious area of the ground surface to absorb rainfall is usually at a maximum as the rate of absorption is greater or equal than the rate of rainfall. As the rainfall increases the absorbing capacity of the soil reduces as it becomes increasingly saturated. In extreme rainfall events that may have a preceding long period of lower intensity rainfall that saturates the soil, the absorbing capacity (permeability) of the soil in lower permeability solis, may in effect be close to nil and the saturated ground acts as though it is impervious.

Thus in extreme rainfall events, such as a 1 in 50 year storm, the runoff that occurs, in areas of lower permeability soils, may be as much as from a close to fully impervious area. This means that limiting impervious area, in areas of the city with lower permeability solis, will not necessarily reduce stormwater flows in extreme events. Control of impervious area is therefore not a method that manages the extent of flooding in areas of low permeability soils.

However for lower return period events (up to the 10 year) the converse is true and impervious area will have a relatively greater effect on changes in stormwater volumes.

Soakage Areas.

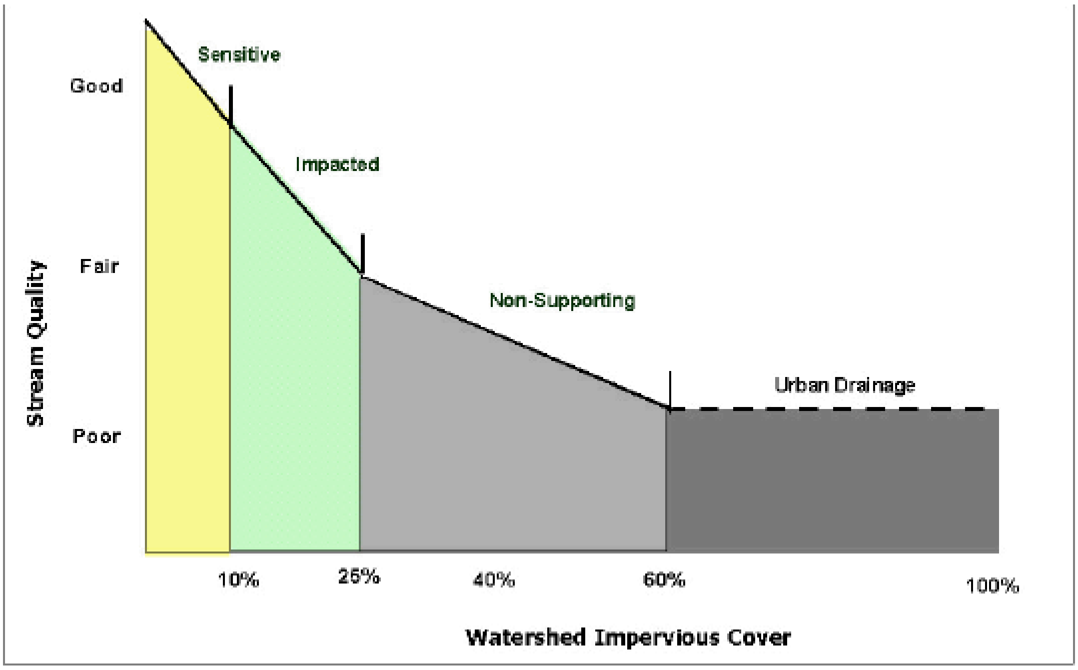
Also in areas of the Isthmus which rely on disposal of stormwater to the ground by way of soakage to highly permeable soils, then increased impervious area will have a more significant effect in these areas. This is because there is often little or no public stormwater systems available to cater for significant overland flows. The drainage system in soakage areas relies entirely on the ability of the water to get into the ground. The more pervious areas available the less the risk of overland flows developing and causing flooding problems further downstream. There are a number of areas in soakage catchments that are currently subject to flooding. The provision of solutions based around the provision of new public drainage is sometimes limited with the amount of public space available and the location of suitable aquifers adjacent to that public space. Experience to date suggests that the implementation of public drainage solutions for flooding in soakage catchments may be limited and, to reduce the risk of increasing property flooding, a precautionary approach to increased impervious cover is warranted.

Streams

Stormwater quantity and the frequency of its occurrence can also have an effect on the health and state of urban streams. More frequent higher flows can cause increases in erosion, reduce stream bank stability and reduce the biodiversity of the stream. The relationship between flow, impervious area and stream health is a complex area and research is ongoing to understand the key influences. At a macro level there is understood to be a clear relationship between good stream health and catchment impervious area. This is demonstrated through the Impervious Cover Model (ICM)[2] which was developed by the Centre for watershed protection in the 1990’s. The ICM is a condensation of numerous sets of stream health data into a simple relationship between stream quality and watershed impervious cover.

[2] Appendix A , “Low Impact Design in the Long Bay Structure Plan; What Happened” Jan Heis, Dr David Kettle. Proceedings of the Stormwater Conference 2008 NZWWA

Figure A-1 The Impervious Cover Model (ICM)



Current impervious coverage for the Isthmus sits over 45% for residential zones and 71% in business zones[3]. On this basis, streams within Auckland City should be categorised as Non-Supporting. In the Air Land Water Plan urban stream management framework, which is primarily based on catchment imperviousness,[4] all of streams in Auckland City are ranked at the lower end of the grading scale. They are described as highly modified urban watercourses.

However, at a localised level the quality of the stream can vary significantly. Auckland City Council and Metrowater have undertaken research on streams in the Auckland urban area to provide water mangers with information for the management of streams. A single classification of “highly modified stream” due to the highly urbanised nature of the city may not indicate reaches of higher value or for potential for enhancement and improvement.

The Stream Management Classification considered three important aspects of streams:-

- Drainage
- Habitat
- Public Amenity.

The recommended actions in relation to imperviousness related to ensuring the drainage function of the stream was maintained to avoid flooding, and to limit increase in imperviousness to avoid flooding. Other actions related to improving habitat through maintaining water flows provide refuge habitat and improve connectivity along the stream length together with improving public access.

There are sections of stream that are considered worthy of protection and enhancement despite the current level of impervious area already existing.

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[3] Impervious data analysis city design 2004
[4] Pg 2 Auckland Stream management Framework Report Kingett Mitchell Ltd Dec 2005

9.0 Narrative Issue 1 & 2 –

9.1 Management of Stormwater quantity through both Impervious Area and LID

From a quantity perspective, the stormwater function seeks to manage the following effects:

- Flooding of habitable floors
- Minimising the effects of overland flows to avoid creating a nuisance
- Maintaining streams in order to perform their drainage function while maintaining their habitat and public amenity values.

In order to manage flows, stormwater networks in the city are generally designed to the following standards:

- Containing the 10% AEP (1 in 10 year rainfall event) discharge within the primary system (e.g.. pipes). For the Central Business District this is 5%AEP (1 in 20 year).
- Ensuring that the overland flow resulting from development does not create a nuisance in the 10% AEP storm
- Ensuring overland flows in the 2% AEP event avoid the inundation of habitable floors.
- Manage the depth and velocity of overland flow to minimise public health risk and potential for property damage.

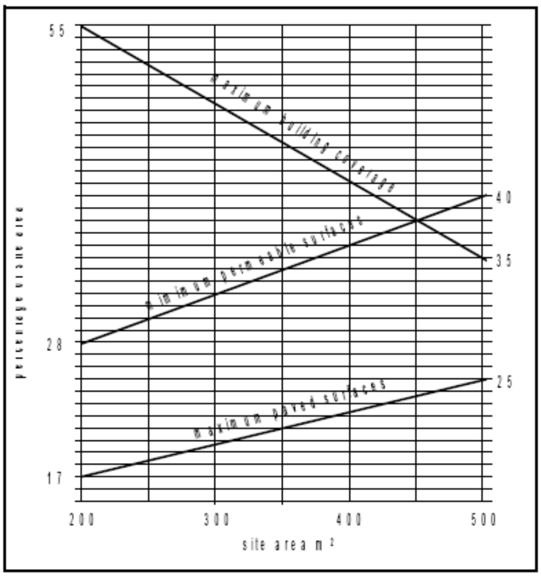
The basis of design flows for the primary system is related to the overall imperviousness of the catchment. This is determined by considering what maximum impervious area coverage is allowed to occur in the catchment under the District Plan rules. This is termed the maximum probable development (MPD).

MPD is considered to be the state that would exist when every available opportunity for development under the District Plan is taken up.

The current District Plan has the following minimum landscaped permeable surface requirement

Residential 1 and 3a (refer fig 7.5)

Figure 7.5 Residential 1 and 3a zone coverage & surface controls



Residential 2b and 3b	45% of net site area
Residential 2a and 2c	50% of net site area
Residential 4	85% of net site area
Residential 5-7 Council	Not less than 40% of net site area shall be landscaped to the satisfaction of

The reason for these limits is given in the text of the current District Plan. The key reasons for limits are:

- Amenity – aesthetically appropriate balance of landscaped area
- Reducing the amount of stormwater generated.

Business zones allow higher overall levels of site coverage. This means that site coverage can be up to 100%. This level is theoretically allowed for in the design of the primary stormwater system; however, for a variety of reasons the actual performance of the stormwater system will vary from the ideal design situation.

The most significant issue in the management of the stormwater is flooding and the effects of growth potentially exacerbating the situation.

In 2000 Auckland City Council and Metrowater undertook the Integrated Catchment Study to determine how the drainage network performed and to look at what range of options could be utilised to achieve improved network performance.

The outcome of the study was incorporated into the Drainage Strategic Review 2006 and the Water and Sanitary Services Assessment. To resolve existing flooding while at the same time providing for growth, the best approach was considered to be investing in the provision of public stormwater infrastructure. This was estimated to cost some $660m and has been budgeted for over 22 years.

A range of options were considered in the Drainage Strategic Review 2006 which included the following:

- Promoting LID utilising raintanks and or raingardens
- Restricting development until pubic infrastructure was upgraded

- Providing new public infrastructure (phased over a number of different time periods)
- Using a combination of public Infrastructure and WSUD

The options were assessed against a range of outcome/factors which included:

- Protecting residential floors from the 1 in 50 year AEP event
- Avoiding the likelihood of damage or nuisance to neighbouring property
- Risk to Council of liability for damage arising from permitting development which has potential to cause a nuisance
- Public costs
- Private costs
- Funding ability via Development Contributions
- Simplicity and acceptability
- Sustainability objective of maximising water reuse.

No District Plan options of reducing impervious area coverage controls were considered for the Drainage Strategic Review due to the long timeframe required to introduce any change in the controls and the uncertainty of the outcome through the appeals process.

Discussion on LID Options

In the Drainage Strategic Review LID options were not considered to be able to reduce existing flooding problems. This is because there are legal and practical impediments to any form of retrofitting existing development, and because of the high cost associated with these options.

The option of providing LID systems for new development would also not cater for the 1 in 50 year extreme event as the design of a system for a site is impractical for an extreme event. In addition the cumulative effects of LID utilised on a catchment wide basis need to be understood, so that higher peak flows are not accidentally created through changing the effective time of concentration of the catchment hydrological response.

The main purpose of LID is to reduce the downstream effects on the 1 in 10 year event causing nuisance or damage to other property.

Collectively this meant that LID techniques are only appropriate for:

- Managing the effects of Increasing impervious cover in the Residential 8 zones
- Providing flow attenuation effects in combined sewer areas to limit increased wastewater overflows
- Aid disposal of stormwater in areas serviced by soakage systems
- Providing improved water quality outcomes (this issue is covered in a separate paper)
- Reducing stormwater flows (up to the 10 year event) to streams and hence reducing erosion risk.

Growth and District Plan

The growth strategy has been well developed for the City. This strategy involves intensification in defined areas of change, principally located around town centres and good transport nodes, and general intensification up to levels allowed in the District Plan.

In order to address increasing the density of development to achieve the stated growth goals, the District Plan introduced a new zone, “Residential 8”. This zone includes provision for increased site coverage up to a maximum of 80% where the effects of the additional site coverage above the 60% level are mitigated through the use of WSUD practices. The detailed requirements are covered in a specific On Site Stormwater Management (OSM) manual. These provisions were introduced in 2003.

In areas feeding to the public stormwater conveyance network, developers can choose from a variety of OSM devices (e.g., rainwater tanks, rain gardens, roof gardens, swales) to limit runoff quantity and improve quality. The particular requirement in respect to quantity is to limit the peak discharge in the 10% AEP storm event (1 in 10 year event) to the equivalent of that from the site with the standard 60% impervious area coverage (consistent with the design of the stormwater pipe system). There are mandatory maintenance requirements associated with the OSM programme which are a private cost to the property owner. There is also a Council regulatory enforcement regime based on a 2 yearly warrant of fitness.

In summary, the programme is structured to ensure ‘win-win’ outcomes:

- To the Developer: for a minimal outlay, it allows 33% more dwelling area (i.e., up to 80% impervious area coverage, instead of the normal 60% maximum)
- To the City: The programme:
  - yields appreciable CAPEX savings on infrastructural upgrading which would otherwise be required to discharge the additional flows from the increased impervious area
  - facilitates the ability to house additional populations in these more compact Residential 8 areas
- To Downstream Neighbours: the potential for flooding is reduced in storms up to the 10%AEP event.
- To the Environment: It assists in trapping pollutants at-source and reduces potential impacts on watercourses.

Impervious Area Mapping

The City has developed a sophisticated impervious area mapping system which uses colour aerial photography as its base, with image processing software applied to quantify impervious areas. This is supplemented by manual digitising in areas where image processing is unable to provide the required definition. The statistics are embedded in the City’s GIS, and the results are published as both thematic impervious area maps (a sample is shown in Figure 2) and statistics in spreadsheet form.

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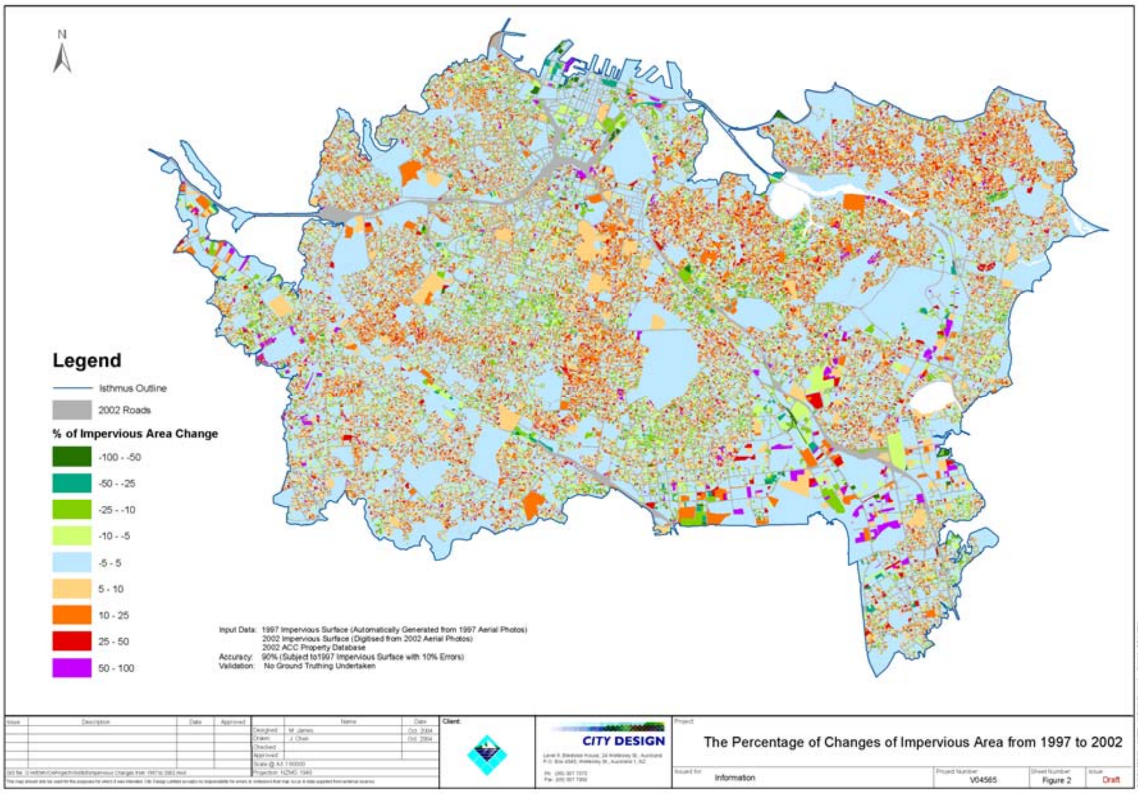

Figure 2 Increase In Impervious Area Across the City Between 1997 and 2002

The main application for this data is to analyse impervious area coverage at any level: at an individual lot , on catchment-by-catchment basis, or Isthmus-wide. These data are important in the following applications:

- Correlating land use impervious area and the incidence of flooding and pollution
- Checking compliance with mandatory site impervious area controls
- Calibrating catchment hyrological/hydraulic models in the 'as existing' condition
- Providing a basis for a possible impervious area-based stormwater charging mechanism.

9.2Status Quo Situation

There are a number of planning and operational components in place to manage the effects of stormwater in the Auckland City Council area.

Planning controls are provided for in the current District Plan, mostly provided for through controls over site coverage. Specific provisions are made in the residential 8 zones for increased site coverage if LID measures are utilised.

On the operational side of the stormwater service, Auckland City Council provides for the maintenance of the public stormwater system, along with a capital expenditure programme aimed at reducing existing flooding over a 20 year time frame while at the same time providing an upgraded stormwater system to cater for growth. The Stormwater Asset Management Plan provides more detail on the operation of the stormwater system.

There is a strong connection between the District Plan and stormwater management, as Impervious area controls effected through the District Plan relate to the design parameters for the reticulated stormwater system.

9.3Further Information/Details

9.4 District Plan Options Impervious Coverage

The key question to consider as part of the review is should the current level of imperviousness be maintained, or should it be revised?. Related questions are: What options are available to control impervious area effects? What issues are critical to stream health? and what are the practical issues that arise and what are the costs?

This paper considers four options both for non soakage and soakage areas This section sets out the advantages and disadvantages of each option.

Options Non Soakage Areas

1. Option 1: Reduce impervious area coverage limits

   Advantages

   Reducing the coverage limits would contribute to reducing stream erosion effects and enhancing stream ecological health. Additional benefits would be to reduce peak stormwater flows in lower return period events and reduce the potential for nuisance effects to be caused on neighbouring property. There would also be some improved amenity benefits for landscaping.

   Disadvantages

   The main drawback of this approach is that there is pressure on Auckland City Council to meet the region’s growth strategy targets of accommodating an increased population in the Isthmus. Reducing the allowable coverage of a site would mean that development would have pressure to increase in height to compensate. It is understood from the consultation undertaken on the Panmure Liveable Communities Plan that there was strong public opposition to increased height from development. This option would be counter to growth objectives.

   A further consideration is that in certain areas this may mean that stormwater infrastructure that is designed to cater for the current level of impervious cover will in fact now be oversized from a theoretical design perspective. However the current performance of stormwater infrastructure is often below the ideal 1 in 10 year performance standard, so a reduction in imperviousness increase would help to maintain current service levels.

2. Option 2: Maintain the Current plan impervious area coverage limits

   Advantages

   The key advantage is that this option maintains the design parameters for the stormwater infrastructure. It also protects the amenity values inherent in the rules for residential areas.

   This option provides for areas of increased impervious coverage through the residential 8 zoning where LID systems can be implemented to mitigate the effects on pipe capacity and stream erosion. The Status Quo does provide an ability to provide for growth.

   Disadvantages

The drawback is that continued development will impose a risk of incremental detrimental effects on the city's streams. However, as the streams are already in a significantly modified state, as a result of impervious surface levels being well in excess of the 25 % "threshold" indicated by studies, the incremental detrimental effects may be limited as most catchments appear to be in the range of 45 to 55% impervious currently.

This option provides for areas of increased impervious coverage through the residential 8 zoning where LID systems can be implemented to mitigate the effects on pipe capacity and stream erosion. The Status Quo does provide an ability to provide for growth.

3. Option 3: Increase impervious area coverage limits

Advantages

This option has the advantage of providing greater density of developments and hence more readily achieves the growth strategy targets. It effectively makes more land available for development and may help to mitigate the effects of increased land costs for development.

Disadvantages

The drawbacks are that there would be reduced amenity values of residential development. From a stormwater perspective, there would be increased stormwater runoff volumes and potentially peak stormwater runoff in lower return period storms which may exceed the capacity of the piped drainage system and increase the frequency of nuisance flooding. In addition, increased levels of impervious surface have the potential to adversely impact on stream erosion and ecology. It is noted that LID devices could reduce these effects, and it is would be appropriate to require LID devices if a greater level of impervious surface was considered appropriate.

4. Option 4: Provide for LID to achieve hydraulic neutrality

Implementation of a hydraulic neutrality strategy involves requiring all new development to install LID-type devices to limit the stormwater discharge from the site to some specified level, e.g.:

- Pre-development - eg site coverage for current pre re/development land use – this could be say a 20% impervious area cover)
- Greenfield – eg grassed land use

In relation to options 1,2 and 3, the use of LID provides an ability to mitigate the effects of increased impervious cover.

Advantages

The advantage of this approach is that it limits or reduces stormwater flows, and in effect reduces the effective impervious site coverage.

This has good logic in greenfields areas, where it assists in preserving the pre-development discharge regime and ideally with it local waterways and their valuable aquatic habitat and visual amenity values.

In contrast, without such a policy, the result is often the need to channelize streams – local examples of this are Oakley Creek and Wairau Creek (North Shore)

The benefits of applying a hydraulic neutrality regime in the re-development of urban areas are more subtle (note that, because it is dependent on individual properties being re-developed, the uptake of these effects is typically imperceptibly slow). Such benefits include:

- It will assist in reducing the smaller return period downstream nuisance impacts where the City's stormwater conveyance network is under-capacity
- Limiting increased degradation of the health of streams, and erosion. It is unclear whether this approach can return highly modified urban streams to higher ecological value

Disadvantages

The drawbacks are that LID does not necessarily reduce extreme event flood flows, it is relatively expensive to install, and it introduces a need for private property owners to maintain the devices for them to continue to work effectively. The long term maintenance issue is considered to be an issue which could be a fatal flaw in the effective long term implementation of LID systems. For the Residential 8 areas in the current district plan, the issue of maintenance was specifically recognised as an important issue and conditions of any resource consent require that there be a notice on the title of the property that a LID device is associated with the site and a specific maintenance plan applies. In addition there is recognised the need for a mandatory 2 yearly warrant of fitness for the specific LID device, and there are enforcement provisions available by the Council to follow up on maintenance requirements not undertaken. However, this requires Council management systems and resources to put into effect, and if a LID option is chosen for implementation , then Council resourcing would be an integral part of the regime. The Residential 8 programme is only mandatory in the situation where site coverage exceeds the 60% level, so in effect developers can avoid the requirement for LID requirements if they keep development below the 60% threshold.

Experience with other privately operated drainage systems , such as soakage devices, indicates that there is a high potential rate of failure due to low or no maintenance carried out by private owners.

Manukau City Council does not permit the use of on site privately owned stormwater attenuation of low impact design measures for individual residential lots due to concerns about ongoing liability, maintenance, enforceability of performance and overall maintenance cost.[5]

There are overseas examples of utilising WSUD:-

- City of Portland, OR, USA: when sites are re-developed, they must meet the greenfield runoff standard – the City is not concerned that this policy would ultimately result in stormwater pipes running only part full (i.e. they are doing it for green/sustainability reasons)
- City of Calgary, Canada: in the CBD, high rise buildings must meet the greenfield runoff standard – this is done by designing-in storage on roof-tops.

However, the longer term effectiveness of these programmes relying on dispersed privately owned systems is considered to be in the high risk category.

9.5 Discussion Non Soakage Areas

Managing the amount of impervious area is important for the Council. The main drivers for limiting impervious area within the Auckland City Council Isthmus area are to:

- Provide for amenity values
- Limit the effects of increased stormwater flow on streams

[5] Paper titled "Manukau City Council Experience To Date With Contaminant management In preparing Integrated Catchment Management Plans" N Brown, M Hassan Proceedings of the Stormwater Conference 2008 NZWWA

- Provide a design basis for the primary stormwater system to cater for stormwater flows to avoid the nuisance to other property.

In extreme rainfall events impervious area coverage is considered to be less important because pervious areas of the city are likely to be in a saturated condition giving rise to high runoff rates. These are catered for by secondary flow paths and the protection of flood plains and development of habitable floors above the 50 year flood level.

While the relationship between impervious area cover and stream health is generally understood at a macro level, the relationship is more complex on an individual stream reach level, and there are a number of streams which exhibit habitat and public amenity values worthy of preservation. These areas are receiving environment specific and hence any policy to protect their values should also be receiving environment specific.

As an example, the Freemans Bay catchment is completely piped in its lower reaches and there are no stream values to protect so general impervious area controls for stream management reasons are not required. However, in the upper reaches of the catchment there may remain small sections of open stream worthy of protection. One tributary beginning in Western Park has an open park environment protecting its values, while other sections may border on infill development. To protect the stream values local receiving environments and values would need to be assessed, and an analysis of the benefits of controlling impervious area made for that reach.

The best option to limit the effects of impervious area, while at the same time providing for growth, is not clear cut. Options to provide for effective Hydraulic Neutrality are available but are considered to be high risk if they rely on many distributed privately owned LID systems such as raintanks and or raingardens. This high risk is due to the need for an obligatory maintenance regime and regulatory enforcement system to ensure the LID system effective long term performance.

If impervious area cover is limited in localised receiving environments, then it could be worth considering a combination of District Plan coverage limits and/or LID methods.

There is an argument to say that the best areas for high density developments are those near the coast, particularly where streams have been piped. In these locations it may be possible to upgrade infrastructure to cater for increased flows at a reasonable cost. Costs and potential risks increase as you move further up the catchment.

Option 3 where impervious coverage is increased, is not considered to be desirable due to the effects on the current stormwater drainage system capacity. However, if increased densities were desirable, then this would best be targeted at where public infrastructure could most easily be upgraded, such as in coastal areas with short reaches to the coast.

Recommendation Non Soakage Area

Because the issue is not clear cut and there is a need to provide for specific receiving environments, the city could consider a hybrid option. This option involves a combination of:-

- Maintaining as a base level the coverage limits currently set within the District Plan (Option 2)
- Determine on a receiving environment basis those reaches of streams that could be considered require a level of protection and /or enhancement greater than the base level. When this has been completed consider a combination of reducing impervious area limits and/or WSUD/ LID solutions to limited areas, bearing in mind the high risk long term maintenance requirements of WSUD/LID systems

The advantage of this hybrid option is that it provides a precautionary approach of not increasing the current impervious area limits to maintain amenity values and limit significant further detrimental effects on streams. It also provides for the design parameters which have been assumed for the design of the stormwater network system, and thus maintaining existing service levels. In addition, however, it would define areas where further controls are required and then assess those areas on a Best Practical Option approach utilising District Plan coverage criteria and or WSUD systems.

9.6 Outstanding Matters/Additional Research

For the hybrid option, determining which local stream receiving environments are worthy of protection and enhancement through District Plan controls on impervious area. Refer to the catchment priorities outlined in the Watercourses and Wetlands paper.

9.7 Interim Conclusions [District Plan Implications] Non Soakage Areas

Consider a hybrid options which involves a combination of:-

- Maintaining as a base level the coverage limits current set within the current District Plan (Option 1)
- Determine on a receiving environment basis those reaches of streams that require a level of protection and /or enhancement greater than the base level. When this has been completed consider a combination of reducing impervious area limits and/or LID solutions to limited areas, bearing in mind the high risk long term maintenance requirements of LID systems
- Consider from a stormwater perspective providing for increased development near the coast, particularly where streams have been piped. In these locations it may be possible to upgrade infrastructure to cater for increased flows at a reasonable cost.

10.0 Options Soakage Areas

5. Option 1: Reduce impervious area coverage limits

   Advantages

   In soakage areas there is generally very limited public infrastructure to cater for overland flows and it is important to maximise the opportunities on each site for allowing stormwater to soak into the ground. Critical to this is maintaining sufficient pervious areas. Reducing the coverage limits would reduce the risk of growth causing increased flows and exacerbating existing flooding problems.

   Reducing the coverage limits would also contribute to reducing stream erosion effects and enhancing stream ecological health. Additional benefits would be to reduce peak stormwater flows in lower return period events and reduce the potential for nuisance effects to be caused on neighbouring property. There would also be some improved amenity benefits for landscaping.

   Disadvantages

   The main drawback of this approach is that there is pressure on Auckland City Council to meet the region's growth strategy targets of accommodating an increased population in the Isthmus. Reducing the allowable coverage of a site would mean that development would have pressure to increase in height to compensate. It is understood from the consultation undertaken on the Panmure Liveable Communities Plan that there was strong public opposition to increased height from development. This option would be counter to growth objectives if increases in development height were not relaxed..

6. Option 2: Maintain the Current plan impervious area coverage limits

Advantages

The advantage of this option is that it allows for the growth of the city up to the current plan coverage limits. This option provides for areas of increased impervious coverage through the residential 8 zoning where LID systems can be implemented to mitigate the effects on pipe capacity and stream erosion.

Disadvantages

Increased impervious area up to the current district plan limits will increase the risk of flooding in soakage catchments as cost effective public stormwater infrastructure solutions may not be available. Current flooding with impervious surface coverage at 40 to 50% catchment wide, are proving difficult to resolve with public infrastructure given the significant peak flows in comparison to ground soakage rates.

A further drawback is that continued development will impose a risk of incremental detrimental effects on the city's streams. However, as the streams are already in a significantly modified state, as a result of impervious surface levels being well in excess of the 25 % "threshold" indicated by studies, the incremental detrimental effects may be limited as most catchments appear to be in the range of 45 to 55% impervious currently.

This option provides for areas of increased impervious coverage through the residential 8 zoning where LID systems can be implemented to mitigate the effects on pipe capacity and stream erosion.

7. Option 3: Increase impervious area coverage limits

Advantages

This option has the advantage of providing greater density of developments and hence more readily achieves the growth strategy targets. It effectively makes more land available for development and may help to mitigate the effects of increased land costs for development.

Disadvantages

The drawbacks are that there would be reduced amenity values of residential development. From a stormwater perspective, there would be increased stormwater runoff increasing the frequency and severity of stormwater flooding in soakage areas. In addition, increased levels of impervious surface have the potential to adversely impact on stream erosion and ecology. It is noted that LID devices could reduce these effects, and it is would be appropriate to require LID devices if a greater level of impervious surface was considered appropriate.

8. Option 4: Provide for LID above a threshold site coverage limit

This option provides for development to occur up to a predefined threshold, such as say, the current average coverage levels of 45% site coverage as of right, but for development above that level to provide for LID methods to limit the effects of increased coverage to the same as the threshold level.

Advantages

The advantage of this approach is that it allows for development up to a predetermined level with limited controls. However above the coverage limit , then the effects of increased coverage are mitigated through the use of LID methods.

- It will assist with reducing the impacts of increased runoff from increased impervious area coverage by ensuring that stormwater can effectively soak into the ground.
- Limiting increased degradation of the health of streams, and erosion.

Disadvantages

The drawbacks are that LID does not necessarily reduce extreme event flood flows, it is relatively expensive to install, and it introduces a need for private property owners to maintain the devices for them to continue to work effectively. The long term maintenance issue is considered to be an issue which could be a fatal flaw in the effective long term implementation of LID systems. For the Residential 8 areas in the current district plan, the issue of maintenance was specifically recognised as an important issue and conditions of any resource consent require that there be a notice on the title of the property that a LID device is associated with the site and a specific maintenance plan applies. In addition there is recognised the need for a mandatory 2 yearly warrant of fitness for the specific LID device, and there are enforcement provisions available by the Council to follow up on maintenance requirements not undertaken. However, this requires Council management systems and resources to put into effect, and if a LID option is chosen for implementation , then Council resourcing would be an integral part of the regime. The Residential 8 programme is only mandatory in the situation where site coverage exceeds the 60% level, so in effect developers can avoid the requirement for WSUD requirements if they keep development below the 60% threshold.

Experience with other privately operated drainage systems , such as soakage devices, indicates that there is a high potential rate of failure due to low or no maintenance carried out by private owners.

Manukau City Council does not permit the use of on site privately owned stormwater attenuation of low impact design measures for individual residential lots due to concerns about ongoing liability, maintenance, enforceability of performance and overall maintenance cost.[6]

There are overseas examples of utilising LID:-

- City of Portland, OR, USA: when sites are re-developed, they must meet the greenfield runoff standard – the City is not concerned that this policy would ultimately result in stormwater pipes running only part full (i.e. they are doing it for green/sustainability reasons)
- City of Calgary, Canada: in the CBD, high rise buildings must meet the greenfield runoff standard – this is done by designing-in storage on roof-tops.

However, the longer term effectiveness of these programmes relying on dispersed privately owned systems is considered to be in the high risk category.

10.1 Discussion Soakage Areas

Managing the amount of impervious area is important for the Council. The main drivers for limiting impervious area for soakage areas within the Auckland City Council Isthmus area are to:

- Provide for sufficient space within a site to effectively dispose of all water from that site, including coping with flows in extreme rainfall.
- Provide for amenity values
- Limit the effects of increased stormwater flow on streams

[6] Paper titled "Manukau City Council Experience To Date With Contaminant management In preparing Integrated Catchment Management Plans" N Brown, M Hassan Proceedings of the Stormwater Conference 2008 NZWWA

In areas of the Isthmus which rely on disposal of stormwater to the ground by way of soakage to highly permeable soils, then increased impervious area will have a more significant effect in these areas. This is because there is often little or no public stormwater systems available to cater for significant overland flows. The drainage system in soakage areas relies entirely on the ability of the water to get into the ground. The more pervious areas available the less the risk of overland flows developing and causing flooding problems further downstream. There are a number of areas in soakage catchments that are currently subject to flooding. The provision of solutions based around the provision of new public drainage is sometimes limited with the amount of public space available and the location of suitable aquifers adjacent to that public space. Experience to date suggests that the implementation of public drainage solutions for flooding in soakage catchments may be limited and, to reduce the risk of increasing property flooding a precautionary approach to increased impervious cover is warranted.

Stream health in soakage catchments may currently be more independent of rainfall events due to the attenuation effect of groundwater aquifers on stream flows. However increasing impervious coverage which results in increased overland flow, will likely have a detrimental effect on stream health.

The best option to limit the effects of impervious area in soakage areas, while at the same time providing for growth, is not clear cut. Options to limit the effects of increased impervious cover are available but are considered to be high risk if they rely on many distributed privately owned LID systems such as raintanks and or raingardens. This high risk is due to the need for an obligatory maintenance regime and regulatory enforcement system to ensure the LID system effective long term performance.

Option 4 where impervious coverage is set at the current average impervious coverage of the catchment, approximately 45%, and where development above this level is mitigated with the use of LID methods, is considered to be the option which best balances the competing risks.

10.2 Interim Conclusions [District Plan Implications] Soakage Areas

For areas having suitable soil conditions to allow on soakage into the ground provide for an approach through the District Plan which limits site coverage to the current average level of impervious cover for new development, with any increases above that level being the subject of specific site assessment, utilising LID methods to ensure the effective impervious cover is not increased.

11.0 NARRATIVE: Issue 3 – Flood Hazards

11.1 Introduction/Background/Prior Work

The issue of flooding causes has been discussed under section 7.1. The main issue for discussion in this section is the role of the District Plan in providing appropriate controls on development within the flood plain or affecting the flood plain. (In this discussion, flood plain is used in relation to overland flow paths as well)

11.2 Current Quo Situation

The current District Plan (Isthmus section) under the section on natural hazards has rules related to activities or development in land subject to flooding or instability.
The following standard is set under section 5D6.1

Activity	**AEP - annual exceedence probability**			
	1 in 10 year flood	1 in 50 year flood	1 in 100 year flood	Flood Prone Area

Non-habitable residential	200mm			
Business		300mm		200mm
Residential			500mm	300mm
Community including - schools, halls, utilities.			500mm	300mm

Development on a flood plain not meeting these standards is a restricted discretionary activity.

This section of the District Plan is inconsistent with the freeboard applied, does not provide a clear understanding of the flood standard to be achieved and does not give reference to effects on other property.

This section of the District Plan was the subject of a revision through the Proposed Plan Change: Plan Modification 93. However, this plan change was not proceeded with pending the full review of the District Plan.

The issues related to the standard for setting minimum floor levels in the current District Plan versus that required by the Building Act has been discussed earlier in this paper. It has been pointed out that there is a need better alignment in the new District Plan. The proposed Auckland Regional Council Air Land Water Plan also proposes a 1 in 100 year standard.

The Building Code is currently under review, and may impose a different standard for minimum floor levels of buildings – likely the 100 year flood level for residential and communal buildings.

For reasons of consistency, practicality and simplicity, it is recommended that the freeboard for structures above the relevant flood plain be fixed at 500mm.

The objectives in relation to flood hazard management should be:

> ‘To manage the hazards posed by flooding so as to avoid, remedy or mitigate adverse effects on land, buildings and the environment.”
>
> ‘To protect indigenous riparian vegetation near streams and watercourses, in order to minimise the effects of flooding, minimise erosion of watercourses, to protect water quality and in stream and streamside biota.”

11.3 Future Issues

No issues in this section.

11.4 District Plan Options

Option 1. Do not have controls in the District Plan but rely on the provisions of the Building Act and the stormwater bylaw to appropriately manage activities and development within the flood plain.

Advantages

The only possible advantage of this option is seen as some administrative reductions in not having a resource consent process under the District Plan.

Disadvantages

The disadvantage of this option is that the controls available under the Building Act rely of appropriate development checks at the time of building consent. There may be little advance knowledge that there are flood hazard issues on the property. The checking procedure would rely on development planners/engineers in Auckland City Environments, and there would be a more limited range of criteria available to vet development applications. This means that flood protection outcomes are at a high risk of being achieved.

The bylaw is not seen as a very effective tool to avoid development options as there is no effective trigger to establish that approval under the bylaw is required. The bylaw is more useful as a means of regulation after breaches rather than prevention.

Option 2. Limit development within a specified return period flood plain (and significant overland flow path).

Under this option, development within a specified return flood plain would be limited by requiring that any development activity , including undertaking earthworks that would alter an overland flow path, or construction of a fence or retaining wall that would alter a flow path, to get a resource consent.

Advantages

The advantage of having a resource consent process to determine the effects of any particular activity or development means that proposals can be assessed on a case by case basis and adverse effects can be considered accordingly.

Disadvantages

The disadvantage of this option is that there is an additional administrative consent process for activities within flood plains involving costs, however this is not considered to be onerous given the significance of the issue.

Option 3. Prohibit all development within a specified return period flood plain.

Advantages

The advantage of this option is that there is certainty of outcome, protection of all flood plains and downstream properties.

Disadvantages

The disadvantage is that this option doesn't allow for development to take place where the effects are limited to no more than minor, and hence it decreases opportunities for sensitive development. There are significant implications for private property rights across the city.

11.5 Discussion

The control of development within the 50 and/or 100 year Annual Exceedance Probability flood plain within the city is considered to be a significant issue and one which Council must consider as part of its duties under the RMA. It is considered that Option 2 provides the greatest certainty of Council achieving its objectives of:-

> 'To manage the hazards posed by flooding so as to avoid, remedy or mitigate adverse effects on land, buildings and the environment."
>
> 'To protect indigenous riparian vegetation near streams and watercourses, in order to minimise the effects of flooding, minimise erosion of watercourses, to protect water quality and in stream and streamside biota."

Appropriate rules within the District Plan would need to be drafted and they would cover appropriate levels of freeboard for habitable buildings. There may also be a level of permitted activities within floodplains such as trimming of trees, removal of pest plant species etc. The draft proposed Plan Change 93 could be used as an input for rule drafting.

The appropriate standard for triggering a resource consent is recommended as the 100 year AEP flood plain as under the RMA a higher standard is allowed for effects on other properties, and it would align with likely future changes to the Building Act.. It is also consistent with past practice and the Regional Policy Statement.

For reasons of consistency, practicality and simplicity it is recommended that the freeboard for structures above the relevant flood plain be fixed at 500mm.

11.6 Outstanding Matters/Additional Research

The actual flood level for protection of buildings under the Building Act is currently under review, and may be changed from the current 50 year AEP to the 100 yr AEP.

11.7 Interim Conclusions [District Plan Implications]

Consider an approach which involves controlling activities within the 100 year AEP floodplain, utilising a similar approach to draft proposed Plan Change 93.

12.0 REFERENCES

No	Author	Title	Date	Comment
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2	Auckland City Council	Water and Sanitary Services Assessment. Incorporated into Auckland City LTCCP 2006 – 2016 Volume 3 Part 3	June 2006	
3	Three Waters Project Team	Three Waters Draft Strategic Plan: Discussion Version	April 2008	Updated version for discussion with participating organisations
4	Jan Heijs Dr David Kettle	Low Impact Design in the Long Bay Structure Plan;What Happened? Paper in Proceedings of the Stormwater Conference 2008 NZWWA	2008	
5	N M Brown, M	Manukau City Council Experience To Date With Contaminant management In preparing Integrated	2008	

	Hassan	Catchment Management Plans" Proceedings of the Stormwater Conference 2008 NZWWA		