

Managing Flood Risk

Draft New Zealand Protocol



Prepared by The Centre for Advanced Engineering

The *Protocol* recommended herein was developed by the **Flood Risk Management Governance Group** comprising representatives of Local and Central government and the Institution of Professional Engineers New Zealand to improve management of flood risks in New Zealand.

The *Protocol* is offered for comment. These should be addressed to:

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Executive Summary

This *Flood Risk Management Protocol* provides regional and unitary councils with an improved framework for managing their flood risk management responsibilities. It is the first step in improving flood risk management across local government. Similarly it offers an opportunity to central government to work cooperatively with this framework, thereby improving their contributions and providing seamless support to communities. A similar opportunity is extended to Professional Associations, tertiary education institutes, Crown Research Institutes and consultants.

The *Protocol* is a collegial initiative developed by regional and unitary councils that is offered here as a recommended approach for discussions with others in local government, central government, communities and professionals and knowledge provider organisations. As these discussions progress, regional and unitary councils will continue with development of the details necessary for implementation within their authorities.

The key contribution of this *Protocol* is a framework through which better flood risk management decisions can be made. The important elements of this framework are identified as:

- Natural river and catchment processes as non-negotiable constraints on river modifications
- Interaction of natural and social systems, under the emerging umbrella of sustainability – floodplain management
- Context-based decision-making
- Continuing community engagement
- Appropriate forms and levels of protection
- Recognition and treatment of residual risks
- Adaptive management principles

The *Protocol* supports these elements with a series of key principles.

The systematic implementation of the *Protocol* by local government will allow councils to act comfortably within their own mandate, and bind them to better flood risk management for their communities.

Effective implementation requires not only political support for inter-organisational relationship management, corporate directions, and programme resourcing, but management commitment for ensuring corporate risk management systems are in place and for fostering programme integration within a catchment context.

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1 Introduction

1.1 Protocol Origins

This *Protocol* developed from the interest of regional and unitary councils to ensure that the best possible solutions for managing flood risk were systematically examined across their jurisdictions. The *Protocol* was developed by the Flood Risk Management Governance Group, comprising representatives of local and central government and the Institution of Professional Engineers New Zealand (IPENZ), to improve management of flood risks in New Zealand.

The Ministry for the Environment and the Department of The Prime Minister and Cabinet represented central government interests in flood risk management. Both levels of government realised the importance of a seamless approach to managing their respective responsibilities, thereby enabling holistic responses to flood risk and providing clarity of decision-making to communities and individuals.

IPENZ participated to provide their technical input and to expedite the transfer of the *Protocol* to their members.

The Group's early assessment of how well governments were managing flood risk indicated that most improvement would come from strengthening the key drivers of political direction and management systems, as both are critical to improving flood risk management between and within governments. Strong political and managerial leadership is necessary to give the direction and resources necessary to manage this risk in the integrated manner required today.

The *Protocol* project was set up in two phases. The first produced a report entitled "*Managing Flood Risk: The Case for Change*" and this draft *Protocol*. A third internal report, entitled "*Background Notes*", captures the content from the many discussions and presentations arising from the *Protocol* process. The second phase will be to address issues relating to the implementation of the *Protocol*. Concluding in 2007, this phase is the joint responsibility of the Governance Group and Central Government.

The *Protocol* recognises and builds upon the

long history of New Zealand's flood management. It is designed to take the next steps in the evolution of these crucial activities, in some cases to give more effect to what is already occurring. The changes sought are in line with those considered necessary for attaining sustainable community outcomes, so they are complementary to existing community interests and local government objectives. The particular challenge is to integrate the approach to flood risk management developed here into these other objectives in a systematic manner.

1.2 Protocol Objectives

The objective of the *Protocol* is to provide councils with a decision-making framework through which flood risk can be addressed in an integrated, holistic approach, whereby:

- Communities understand the risks and make good flood management decisions
- Rivers are managed as water and sediment transport systems (as part of catchments)
- Both natural and human uses are considered over the long term, where sustainable, affordable, outcomes are sought
- Context based solutions are implemented, guided by common principles and best practice, and supported by legislation and local government policies and plans.

The *Protocol* encourages wide assessment of risk and optimum and inclusive decision-making. It is consistent with the legislative and policy framework of local government but will lead to changes in both.

The *Protocol* is offered here as a recommended approach for consideration and refinement by the other organisations that are important to its successful implementation. Responses will be important for the next phase which will focus on implementation and in turn will lead to a final version of the *Protocol*.

How the expanded *Protocol* will be maintained is an issue yet to be resolved, as is its management over the long term.

1.3 Need for the *Protocol*

The preceding report “*Managing Flood Risk: The Case for Change*” sets out the factors which led to the *Protocol*. In brief these include:

- The dynamic nature of New Zealand’s geology and weather.
- Increasing development pressure for access to flood risk areas.
- Increasing cost of present flood mitigation measures.
- Increasing public expectations for protection.
- Increasing appreciation of the limitations of some mitigation measures.
- Appreciation that sustainability will require integrated approaches to our interventions in natural systems.

In recognition of these factors, after the experience of recent large floods in the North Island, and after more than a decade of operating under a new legislative framework, regional councils and central government recognised the need for an assessment of flood management practice.

1.4 Intended Users

The primary audience for the *Protocol* includes decision-makers in local authorities (elected officials and management) and those that advise them (engineers, planners, policy makers, and scientists) on matters pertaining to the management of flood risk. For decision-makers, the *Protocol* provides insight into the management directions necessary for effective implementation, and for advisors it is an operational framework for seeking the best flood risk management solutions.

The *Protocol* will also provide direction to other professionals who may seek to contribute their expertise to flood risk management responsibilities in local government.

1.5 Structure of the *Protocol*

The *Protocol* is set out in the form of seven elements each supported by key principles to assist in establishing the right approach to flood risk management. This structure is summarised in Table 1.

1.6 Definitions

The following definitions are based in part on the Australian/New Zealand Standard Risk Management, AS/NZS 4360: 2004*.

Flood Risk Management

The continuous and holistic management of flood risk.

Hazard*

A source of potential harm or a situation with a potential to cause loss.

Protocol

A system of rules and behaviours used between governments, organisations and individuals that, in this case, guide the way flood risk management is undertaken.

Residual Risk*

The risk remaining after implementation of risk treatment.

Risk*

The chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood.

Risk Analysis*

A systematic use of available information to determine how often specified events may occur and the magnitude of their consequences. The process includes risk assessment, risk management, and risk communication.

Risk Appetite

At the organizational level, is the amount of risk exposure, or potential adverse impact from an event, that the organization is willing to accept/retain. It is the degree of uncertainty an enterprise is willing to accept and is a key factor in evaluating strategic options.

Risk Assessment*

The overall process of risk identification, risk analysis and risk evaluation.

Risk Characterisation

The process within risk assessment, of estimating the probability of harm and the severity of impact of an identified hazard, and describing attendant uncertainty.

Risk Communications

The open exchange of information and opinion, leading to a better understanding of risk and risk related decisions.

Risk Criteria*

The terms of reference by which the significance of risk is assessed.

Risk Environment

The range of risks present or anticipated on the situation is assessed.

Risk Evaluation*

The process of comparing the level of risk against risk criteria.

Risk Identification*

The process of determining what, where, when, why and how something could happen.

Risk Management*

The culture, processes and structures that are

directed towards realising potential opportunities whilst managing adverse effects.

Risk Transfer

Shifting the responsibility or burden for loss to another party through legislation, contract, insurance or other means. Risk transfer can also refer to shifting a physical risk or part thereof elsewhere.

Risk Treatment*

The process of selection and implementation of measures to modify risk.

Vulnerability

The condition of being laid open to something undesirable or injurious.

2 Risk Management

2.1 Defining Flood Risk

Flood risk is a function of the probability associated with a flood hazard, the exposed values (such as infrastructure, production lands, recreational lands, and amenity values) and their vulnerability.

Increases in flood losses can be attributed to changes in any of these factors. In some cases these can combine to aggravate losses (such as increased flooding on land subject to ever-increasing levels of development). To manage these risks in a sustainable, effective manner requires a broad approach that should incorporate legislation, strategies, policies, and plans.

2.2 Adopting a Risk Management Approach

A risk management perspective provides the critical basis for flood hazard assessment. Its purpose is to:

- Reduce the effects of harmful or unwanted events
- Improve assurance of risk (individuals, companies, politicians) in times of rapid change and uncertainty
- Enable people to do those things they wish to do, in the confidence that the risks are properly managed and controlled.

The first step in risk management is to identify and characterise threats and potential threats. Protective or mitigative arrangements to these threats require understanding:

- Of what risk or part of the risk is being addressed
- On how effective the control will be and what percentage of the risk is reduced, removed or remains as a residual
- Of the effectiveness of the implementation of the control measures (what risk reduction is achievable in practice, how to address residual risk, etc.)

It is also vital to look at any downsides and possible adverse consequences of risk control. In delivering the best risk solution it is important to know:

- Who is affected by this risk?
- What their concerns, expectations, interests, attitudes, etc. are?
- What can realistically be achieved in balancing all the interests involved?
- How are risk solutions are to be delivered in terms of managing the risk and the effects of change, and in terms of community confidence that this is being properly managed?

Applying risk management to flood management encourages a comprehensive approach whereby hazards, community needs (societal, economic and environmental) and vulnerabilities are considered. This needs to be done in an interactive, holistic manner, thereby facilitating the right discussions towards meeting the objective of sustainability.

This approach will lead to improved risk management systems for flood hazards that must be embedded into the risk-based culture of the regulatory organisation and linked with other risk management systems in central government.

The required outcome is systems within systems, working together. Without these risk management systems being in place, the full benefit of the *Protocol* approach will not be realised.

Organisational risk management requires a structured approach emanating from policy. The first need is a political policy setting in terms of how the risk is to be addressed, and the second is a managerial policy setting to ensure the supporting systems and organisational culture are in place and functioning. The latter should include: clear statements of responsibilities and accountabilities; training, education and performance review; information systems; outcomes and outputs evaluation; and, regular management oversight.

Commitment sought:

Councils adopt a corporate-based risk management system to guide the management of flood risk.

2.3 Advantages of the *Protocol's* Flood Risk Management Approach

Traditionally, risk management has generally focused on controlling single hazards. Many risk management failures can be traced to not including stakeholders in decision-making at the earliest possible time and not considering risks in their broader contexts. In contrast, the *Protocol's* flood risk management framework is intended to:

- Provide an integrated, holistic approach to solving social, economic, cultural and environmental problems in context.
- Ensure that decisions about the use of risk assessment and economic analysis rely on the best evidence and are made in the context of risk management alternatives.
- Emphasize the importance of collaboration, communication, and negotiation among stakeholders so that public values can influence risk management strategies.

- Produce risk management decisions that are more likely to be successful than decisions made without adequate and early stakeholder involvement.
- Accommodate critical new information that may emerge at any stage of the process.

Systematic implementation of the *Protocol's* framework by local government will allow regional and unitary councils to provide the best possible data and information, advice, and plans and policies to meet their statutory obligations, and will provide a sound basis for collaboration with district and city councils on flood risk management.

Most aspects of public risk management in New Zealand require a cooperative, co-ordinated approach between and within levels of government. The *Protocol* allows each level of government to act comfortably within its own mandate, and encourages seamless management of risks to individuals and their communities.

3 The *Protocol* Framework

3.1 *Protocol* Elements

The core of the *Protocol* is a framework through which better flood risk management decisions can be made. The *Protocol* is based on the application of risk management concepts across seven key elements:

- Acceptance of the underlying importance of understanding *natural river and catchment processes as non-negotiable constraints on river modifications*, and in linking these as background to flood risk management decisions.
- Floodplain management through balancing the *interaction of natural and social systems*, and the effects of human interventions on both. Under the emerging umbrella of *sustainability* this is an immense but achievable challenge.
- Application of *context-based decision-making* to find the most suitable way of managing the risks and to ensure that the solution chosen is appropriate for the risks identified at local level.
- *Continuing community engagement* to ensure as far as possible their understanding of the risk and the choices, plus the development of commitment to personal risk management.
- The application of *appropriate forms and levels of protection* for existing and possible future assets under threat.
- Recognition and treatment of *residual risks* such that all risks are addressed. Ignoring any risk is not an option.
- Adoption of a strategic approach based on *adaptive management* principles to deal with anticipated changes in natural processes, hazards, exposed values and their vulnerability.

The *Protocol* supports these seven elements with a series of key principles which are required for effective implementation of the *Protocol* elements by decision-makers and

advisors. These are set out at a council level to provide guidance for elected representatives and senior management on what is important for implementation, and are summarised in Table 1.

Commitment sought:

These elements will form the basis of local government's approach to managing flood risk.

3.2 The Framework Premise

The *Protocol* framework provides a decision-making process through which risks are assessed. The process requires the use of the complete framework, with each risk analysis requiring consideration of each element in turn. All are important to consider but not all will be relevant to each case. This process is portrayed in Figure 1.

This perspective is important for:

- Ensuring that the issues relating to flood risk are considered in the wider physical (catchment), social, economic, environmental, and cultural contexts that the community has identified for the catchment area.
- Assessing these issues through a risk management perspective.
- Ensuring that external inter-organisational risks are recognised and managed.
- Ensuring sufficient management support to address the internal organisation needs for resources, expertise, communications, etc.

All decisions must be integrated through this framework. The decisions that have to be made about the management of flood risk are, of course, developed iteratively until the most acceptable mix of benefits and costs are determined.

Commitment sought:

Flood risk management decisions that are evolved iteratively through this framework.

4 Developing the *Protocol* Elements

This section sets out the principles required for implementation of the *Protocol* elements. These are set out at a Council level to provide guidance for elected representatives and senior management on what is important for effective implementation. These are summarised in Table 1.

4.1 Key Implementation Principles

Element 1: Natural river and catchment processes as non-negotiable constraints on river modifications

Principle 1

Understanding natural river and catchment processes is the first step in applying the Protocol.

Communities occupy natural systems and interventions create certain risks that must be recognised and managed. In the broader objective of sustainable development, community interests to establish a balance amongst social, environmental, economic and cultural objectives requires an understanding of the components, capacities and inter-relationships of rivers and their catchments.

The timescales involved in river/landscape interactions are wide-ranging, from seasonal to thousands of years. The inter-relationships amongst elements of these natural systems can lead to both abrupt and subtle changes that can impact on public risk.

Principle 2

Returning rivers to their natural pathways in whole or part is an option for consideration.

Considering the highly modified river systems of New Zealand, this option is a challenge, but an important principle to keep in mind. There will certainly be small-scale opportunities for allowing rivers to regain their natural pathways and clear aquatic habitat, and other gains can result.

This principle is of particular importance when considering the future of existing or planned river management schemes where costs and dis-benefits (such as reducing other economic or social opportunities) may make the schemes unsustainable.

Principle 3

Systematic assessments of catchments are the basis for catchment management strategies within which to apply flood risk management.

Understanding the inter-relationship of catchments and their river systems is necessary as these set the physical and ecological character and the amenity opportunity that need to be partnered with community aspirations.

Element 2: Interaction of natural and social systems as the basis of floodplain management

Principle 4

Decisions on flood risk management are made within the wider context of natural and social systems.

Just as the catchment system is the physical and ecological context for flood-risk decision-making, the economic, social and cultural aspirations of communities are the other. Establishing the natural and social context requires a systematic, systemic, strategic approach. The decisions communities take within this context will establish the nature of their commitment to sustainability in their Long Term Council Community Plans.

Principle 5

Catchment-based management strategies that integrate consideration of environment, economy, society and culture are the best approach to assessing risk associated with floodplain management planning.

Catchment management methodologies are not new in themselves and, while some councils use catchment management for certain decision-making, its use is not pervasive and not from the perspective of risk. No one solution is sought, rather a suitable methodology is required for developing the right approaches around the right issues.

Element 3: Context-based decision-making

Principle 6

Each solution will be uniquely defined by how communities seek to manage flood risks, in terms of their interests, the affordability of the

Management Commitments

Risk Management

- 1 Councils adopt a corporate-based risk management system to guide the management of flood risk.

Protocol Framework

- 2 These elements will form the basis of local government's approach to managing flood risk.
- 3 Flood risk management decisions are evolved iteratively through this framework.

Elements and Implementation Principles

Natural river and catchment processes as constraints on river management

- 1 Natural river and catchment processes are the first step in applying the Protocol.
- 2 Returning rivers to their natural pathways in whole or part is an option for consideration.
- 3 Systematic assessments of catchments are the basis for catchment management strategies within which to apply flood risk management.

Interaction of natural and social systems as the basis of floodplain management

- 4 Decisions on flood risk management are made within the wider context of natural and social systems.
- 5 Catchment-based management strategies that integrate consideration of environment, economy, society and culture are the best approach to assessing risk associated with floodplain management planning.

Context-based decision-making

- 6 Each solution will be uniquely defined by how communities seek to manage flood risks, in terms of their interests, the affordability of the risk management solution, and the nature of the risks at the sites being considered.
- 7 Flood risk management is a local decision-making responsibility.

Continuing community engagement

- 8 Communities are engaged in formulating flood risk management solutions.
- 9 Individual and collective right must be balanced.
- 10 A comprehensive risk communications strategy is in place and actively managed.
- 11 Enhancing individual responsibility in managing personal risk.
- 12 Roles and responsibilities amongst individuals, communities, councils and central government are clearly stated.

Appropriate forms and levels of protection

- 13 Data and information, appropriate methodologies and best practice guidance are available.
- 14 A long-term risk assessment of flood risk management solutions is mandatory.
- 15 All options to reduce or mitigate flood risk are considered.
- 16 Impacts and cumulative effects are assessed.
- 17 Enhancing aquatic, land and coastal environments is important.
- 18 Service levels are determined and actively managed.

Recognition and treatment of residual risks.

- 19 Residual risks are identified and addressed.
- 20 Routine risk analyses are undertaken on existing structures.
- 21 Super design events are considered as residual risks.

Changes in natural processes, hazards, exposed values and their vulnerability are anticipated adaptive management

- 22 Adaptive management is an integral component of flood risk management.

Table 1: Summary of principles required for implementation of the Protocol elements

risk management solution, and the nature of the risks at the sites being considered.

There are no common solutions in flood risk management, nor should they be imposed. Flood risk management is about identifying and mitigating risk. No one solution or combination of solutions is common. The principle advanced here is to let the nature of the risk and the community's response lead to the appropriate solution.

Principle 7

Flood risk management is a local decision-making responsibility.

The risk context is always local, although the implications can be regional and even national. In the context of public risk management it is important for local government to take a comprehensive approach to defining risks and mitigations in order to protect its communities.

Element 4: Continuing community engagement

Principle 8

Communities are engaged in formulating flood risk management solutions.

Community participation is a cornerstone of local government. People have to be involved, and individual as well as collective rights have to be respected when seeking solutions, as flood risks will generally impact on a large number of people.

Principle 9

Individual and collective rights must be balanced.

In accordance with societal views, New Zealand has locked into place a legislative stance giving strong weight to individuals and their rights, thereby lessening the ability to implement programmes of strategic community and societal importance. Resolving this issue is a major challenge for local government in their management of flood risk.

Principle 10

A comprehensive risk communications strategy is in place and actively managed.

The manner in which the community is informed of the associated risks before, during and after a flood event will directly affect whether the event is perceived as being

handled successfully or not. A systematic approach to communications is critical.

Principle 11

Enhancing individual responsibility in managing personal risk.

Personal responsibility is an equally important principle and individuals must be encouraged to take ownership for reducing their own risk. This can take the form of insurance cover, evacuation plans and safe areas, emergency stores, etc.

Principle 12

Roles and responsibilities amongst individuals, communities, councils and central government are clearly stated.

Element 5: Appropriate forms and levels of protection

Principle 13

Data and information, appropriate methodologies and best practice guidance are available.

Defining the flood problem is a first step and there are available methodologies to assist here. Traditionally it means understanding historical and projected flood frequency information, the effects of community activities and impacts of long-term community plans. It also needs to mean understanding the function of the river as a natural system and landscape component.

In adopting a holistic view of flood risk management, new requirements for data and information become necessary, such as health costs associated with flooding. Effort is required to identify what these new needs are and how these are to be collected, managed and used.

A concerted effort is required to manage data, information, methodologies, science and engineering knowledge, and best practise on behalf of councils. The "individuality" of councils and the commercial focus of Crown Research Institutes make such efforts extremely difficult, to the detriment of communities that fund both.

Principle 14

A long-term risk assessment of flood risk management solutions is mandatory.

A strategic management approach built around a flood risk assessment model is essential, developed with regard to possible changes in hazards (perhaps due to climate change), changes in community interests and assets, and perturbations to the desired risk management solution from the effects of the solution itself. While all these should be tested, not all will be important to reach risk management solutions at any one time and location.

An important aspect of this principle is the need to assess the costs, in sustainability terms, of choosing a risk solution and of not doing it. The community needs a sense of the long-term impact of the available options within their catchments.

Principle 15

All options to reduce or mitigate flood risk are considered.

There are many ways to mitigate flood risk. These generally fall into two groupings: structural and non-structural. Structural works are designed to contain floods and to limit erosion and deposition by controlling river behaviour. Non-structural methods, including land-use planning, emergency management, and flood-proofing buildings (through architectural design and water resistant construction materials), are designed to either remove people and assets from risk or to manage exposure to flood effects.

Cost benefit analysis is useful here. Learning how to factor in social (such as health) and cultural costs will be important for the future. Valuing environments for their ecologic and amenity values is equally important.

Principle 16

Impacts and cumulative effects are assessed.

Impacts and possible cumulative effects of the chosen risk management solution need to be anticipated as much as possible. These impacts can take many forms, from physical through to cultural. While some will be acceptable and others not, all require that decisions have to be taken on their management. Cumulative effects are a much ignored aspect of human intervention in New Zealand, and it is time that this gap was addressed. Doing nothing should no longer be an option.

It is important to recognise that rivers are a component of natural catchment systems and that any intervention can be expected to lead to responses over time, some of which will be negative. Natural system adjustments can occur over various timescales, and any perturbations can lead to an accumulation of effects, some overt, and some very subtle.

Principle 17

Enhancing aquatic, land and coastal environments is important.

Opportunities for enhancing these environments should be seen as an objective of the risk management solution. If this is not possible, then minimising impacts must be considered.

Principle 18

Service levels are determined and actively managed.

“Levels of service” usually relate to quality, quantity, reliability, responsiveness, and cost. Performance measures are identified and monitored on a regular basis. They are usually stated in technical terms such as the amount of water that can safely be conveyed by a structure.

As a requirement under the 1996 Local Government Act (no. 3), Asset Management Plans (AMP) are a statement of how river management assets are to be managed to ensure they meet their objectives. Specifically, these plans are undertaken to ensure that the most cost-effective, long-term asset management options are adopted, that the cost of deferred maintenance is quantified, and that improved accountability and understanding of current performance occurs through effective performance monitoring. AMPs can cover council-owned lands, stopbanks, bank protection works, river control works and management structures such as flood gates, outlets and culverts.

The process of asset management is now well established in local government. In terms of the *Protocol*, AMPs remain important tools. The AMP process must be expanded to include non-structural methods employed to manage flood risk.

Element 6: Residual risk

Principle 19

Residual risks are identified and addressed.

A certain amount of risk is inherent at any point in the lifecycle of every flood control system or operation. Residual risk is the remaining risk which cannot be defined in more detail after elimination or inclusion of all conceivable quantified risks in a risk consideration. Residual risk is a combined function of (1) a threat, less the effect of some threat reducing safeguards; (2) a vulnerability, less the effect of some vulnerability reducing safeguards and (3) an asset's value less the effect of some asset value-reducing safeguards. Managing residual risk effectively involves managing these components.

Councils and communities should determine the level of residual risk they are willing to bear. It may be necessary to decrease one or more of these risks to reduce the overall residual risk to the desired level. Decreasing any of these components has a cost implication, which needs to be analysed with respect to the resultant reduction in residual risk.

Principle 20

Routine risk analyses are undertaken on existing structures.

As flood risk management systems begin to reach their limits (for example through limits on the level of service, rising costs, or changing nature of hazards), councils face the immense ethical imperative of managing residual risk for their community. When communities begin to operate risk management solutions close to their limits of efficiency, they may also reduce their capacity for flexible responses to extreme events.

A proactive approach allows councils to confidently assess, manage and reduce risk on an ongoing basis.

Principle 21

Super design events are considered as residual risks.

The historical experience in flood management is that design standards are regularly exceeded in nature and it is now common practice to at least consider the effects of maximum credible events, rare though they may be.

Element 7: Adaptive management

Principle 22

Adaptive management is an integral component of flood risk management.

Risk changes with time. The nature of hazards may vary (or new ones emerge), the risk appetite of a community may change, or the risk management regime put in place may lead to undesirable outcomes. Both human and natural systems are complex, and the results of their interaction are no less complex. Constant attention is required.

4.2 Summary

These principles set out the implementation directions for council management and elected representatives. Many of these principles provide perspectives through which flood risk needs to be managed, while others are of more concrete nature. As with their elements all need to be considered in a systematic, systemic and iterative manner to ensure that the best possible risk management solution emerges.

While each decision will be the best to meet local needs, the process through which these decisions are made is common to all. This commonality of approach leading to local risk management decisions is the security offered by this *Protocol*.

While this framework conceptually replicates the long successful tradition of New Zealand flood management, what makes it different are the driving, integrating perspectives of:

- *risk management* (encouraging a wider assessment of options, anticipation of change and residual risks);
- *sustainability* (bringing natural and social systems together over the long term); and
- *catchment based management* (providing a natural framework within which to manage for sustainable outcomes).

These perspectives will encourage, if not enforce, a bolder, longer term, more integrated and dynamic approach to managing flood risks. Understanding these perspectives, determining community objectives and implementing integrated programmes based around the principles of the *Protocol* cooperatively

across local government is a weighty challenge. But until this is done, communities can not be assured that the best has been done to protect them.

It is expected that the elements and principles of the *Protocol* will evolve over time. Certainly not all aspects of this framework are available now and each council can expect to develop these as resources and priorities allow. While

recognising a full solution will take some time as councils align their programmes and address the politics involved, it is essential that commitment be made to bring this integration into effect as soon as possible and that decisions currently directing council programmes are taken with recognition of this large, strategic need.

This is the only way sustainable outcomes can emerge.

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feedback

CAE welcomes comments on this paper.
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CAE'S MISSION

To advance New Zealand's economic growth and social progress through broadening national understanding of emerging technologies and facilitating early adoption of advanced technology solutions.

CAE'S ROLE

CAE is helping transform New Zealand's technical infrastructure to advance economic growth and social progress:

- As pioneer
CAE is applying engineering knowledge and insight to technology-related economic and social issues so as to facilitate the development of new perspectives and solutions.
- As integrator
CAE is bringing together knowledge, money and resources to create opportunity.
- As knowledge broker
CAE is facilitating the cross-pollination of knowledge across disciplines and institutional boundaries to advance engineering knowledge and practice.
- As awareness raiser
CAE is helping to inform and educate New Zealand communities about technology matters to enable more informed community participation in decision-making.

