MEASURING SUCCESS IN STORMWATER MANAGEMENT – A STRUCTURED APPROACH TO MONITORING THROUGH LINKING ISSUES AND OBJECTIVES WITH OUTCOMES.

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ABSTRACT (200 WORDS MAXIMUM)

Monitoring is an essential function of any planning or operational framework. It generates the information needed to report on performance and progress, demonstrate accountability, and support good decision-making. What gets monitored, how it gets monitored, and the use of the resulting data generally reflects the interests of the parties defining the question that the monitoring programme is intended to answer. When the monitoring of stormwater management is determined solely by stormwater managers then the information derived typically answers only a limited set of questions. In this paper we outline a structured approach to monitoring stormwater management in the context of a statutory plan for the urban development of a sensitive peri-urban catchment in Auckland, New Zealand. This necessitates a broader set of questions aimed at understanding the relationship between land use change and environmental impacts over a long period of time. The approach aims to monitor the effectiveness of the plan by developing logical connections between the issues (enabling of development whilst mitigating storm water runoff and sedimentation), objectives, policies, methods, rules, and intended outcomes determined by an extended public and legal process. The approach will potentially provide the first catchment-scale evaluation of low impact development in New Zealand.

KEYWORDS

Low impact urban design and development (LIUDD), monitoring, policy effectiveness, evaluation,

PRESENTER PROFILE

Michael was, until recently, the Science Leader for Built Environments at Landcare Research New Zealand Ltd and is currently on extended leave working on a PhD. He worked as the research economist and then programme leader of the FRST funded Low Impact Design and Development research programme from 2003 to 2009. While the programme addressed multiple aspects of low impact urban design and development (LIUDD) – social, technical, engineering, economic, policy and planning – his particular interest is in economic costs, benefits and incentives.

1 INTRODUCTION

Monitoring is an essential function of the wider strategic planning and operational framework established by the Resource Management Act (RMA) and Local Government Act (LGA). It generates the information needed to report on performance and progress, demonstrate accountability and support good decision-making

Since 2007 (Feeney and Greenaway 2007; Feeney et al 2009) this conference has acknowledged and tracked the growing interest from New Zealand research and public policy agencies in monitoring to evaluate the cost- and environmental- effectiveness of policy and management interventions. This paper builds on that thinking and applies it to the context of Long Bay in Auckland.

After 15 years of debate and legal argument, the Environment Court is about to issue the final part of its decision setting out the basis on which urban development can proceed in this semi-rural catchment on the northern boundary of the Auckland metropolitan urban limit (MUL). Policy and storm water managers at the former North Shore City Council developed a structure plan for the area based on the principles of low impact urban design and development (LIUDD). These have survived the protracted legal process and provide the new Auckland Council with the first opportunity in New Zealand to implement and monitor the effectiveness of low impact approaches on a catchment scale.

This paper reports on the development of a monitoring framework for the Long Bay Structure Plan area, reflects on the broader set of questions that underpin integrated monitoring under the Resource Management Act 1991 and Local Government Act 2002 and shows how they affect the approach to monitoring the effectiveness of storm water management.

2 RMA AND LGA MONITORING IN NEW ZEALAND

2.1 THE POTENTIAL OF INTEGRATED MONITORING

In Feeney and Greenaway 2007 we outlined the requirements for monitoring under the Resource Management Act 1991 and the Local Government Act 2002 relevant to LIUDD and ICMPs. We noted that under the RMA, regional and local government were responsible for monitoring different things, with regional councils having particular responsibility for integrated management *of the natural and physical resources* of the region and territorial councils responsible for the integrated management *of the effects of the use, development, or protection* of land and associated natural and physical resources of the district. Both Acts define various monitoring responsibilities for regional and territorial councils.

In practice, however, we showed that we were not yet doing either state of the environment or plan effectiveness monitoring particularly well. In particular, the logical links between high-level outcome statements, policy interventions and environmental and other indicators monitored at national, regional, and local level are weak (Ericksen et al 2003, Feeney and Greenaway 2007).

We went on to discuss how, ideally, the councils' respective monitoring programmes should complement each other so as to build a coherent body of information capable of identifying causal links between land use and its environmental effects – and hence the effectiveness of various controls to avoid, remedy or mitigate adverse effects. We highlighted that an integrated approach to monitoring enables:

- monitoring and reporting to meet multiple information needs and requirements
- creation of links between monitoring activities carried out for different needs and requirements
- cooperation and coordination between different stakeholders with similar roles and responsibilities for monitoring
- integrated evaluation of multiple issues, actions and impacts

- the best use of existing information, resources and systems and avoidance of duplication and overlaps

- alignment of quality and data management systems.

We showed that there was a statutory mandate for increased plan and monitoring integration, how the evolution of non-statutory strategy and planning documents (including structure plans, integrated catchment management plans or ICMPs, design guidelines, codes of practice etc) has provided mechanisms for greater integration, and highlighted both the challenge that integrating monitoring across agencies presents and the opportunity that it provides for developing new types of indicators.

2.2 OPPORTUNITIES TO INTEGRATE

2.2.1 INTEGRATED CATCHMENT MANAGEMENT PLANS (ICMPS) AND LIUDD

In 2007 we went on to discuss how integrated monitoring might be applied in ICMPs recognizing that monitoring often needs to be conducted at multiple scales with indicators that represent both place and context specific issues and wider regional and national concerns.

In 2008 (Feeney et al 2008) and 2009 (Feeney et al 2009) we had the opportunity to report on the application of these ideas to the ICMP framework used by Auckland Regional Council and the finalization of the Central Papakura ICMP. These applications highlighted the potential usefulness of:

- programme logic models (like Pressure-State-Response or its derivative Driver-Pressure-State-Impact-Response) for assisting policy and programme managers to identify the key elements and dynamics of the system that they are attempting to influence

- a structured outcome framework within the logic model that outlines the sequence of institutional, behavioural, and social and environmental changes that lead to more sustainable forms of development

- a cost-effective suite of well-constructed indicators that both measure progress toward target outcomes at different scales and across the different domains of well-being, and also illuminate potential reasons for progress being different from that expected.

2.2.2 LOW IMPACT URBAN DESIGN AND DEVELOPMENT (LIUDD)

In 2009 (Feeney, Heremaia & Scott 2009) we also had the opportunity to report on the asset management strategy for the Styx catchment in Canterbury and, in particular, the potential for LIUDD to integrate built infrastructure (physical assets) and green infrastructure (natural assets) to deliver multiple services (amenity, recreation, ecological conservation or restoration, flood management, water supply, contaminant control etc).

In Feeney 2009 we reflected on the challenges of developing an integrated monitoring strategy for the Styx given the multiple statutory and non statutory requirements and objectives. In that case the PSR logic model was used to evaluate the conditions in the catchment, rationalize the multiple objectives and identify a key indicator set.

The evolution of thinking over this period and opportunity to test that thinking in challenging, real-life management contexts meant the team were well equipped to respond to a request from North Shore City Council in late 2009 to assist them with the development of a monitoring strategy for the Long Bay Structure Plan Area.

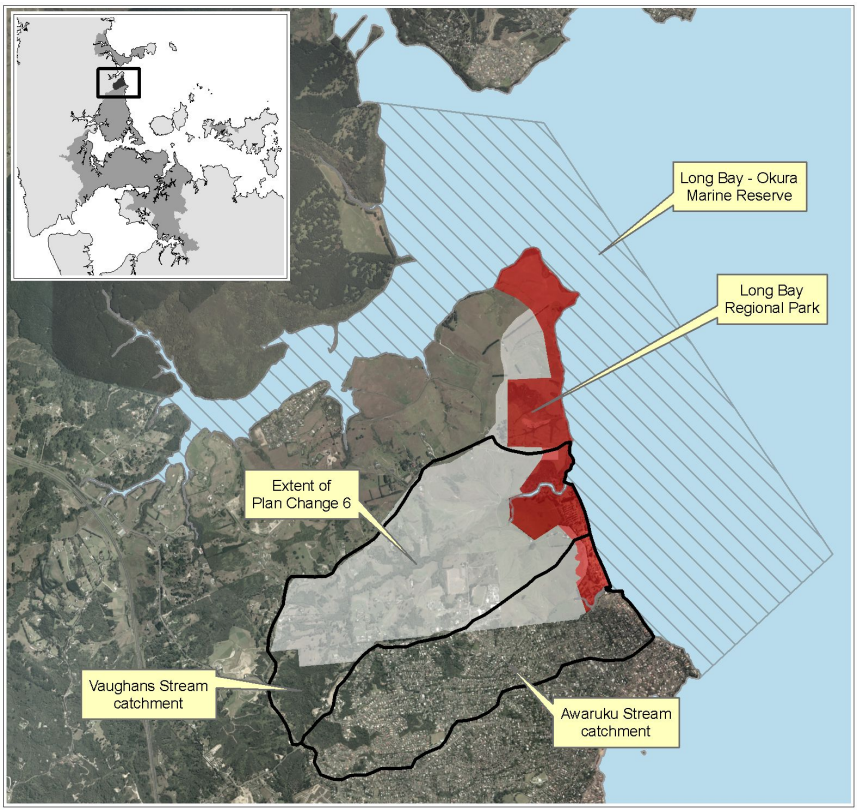
3 LONG BAY STRUCTURE PLAN

3.1.1 OVERVIEW

Long Bay is made up of three significant parts – the upper and lower catchments of the Vaughan Stream and lower catchment of the Awaruku Stream, the coastal cliffs and sandy beaches forming part of the Long Bay Regional Park – with nearly 1 million visitors annually, and the Long Bay-Okura Marine Reserve, established to protect the biodiversity and high quality beach, rocky reef, estuaries, mangrove forests and salt marshes at the mouth of the Long Bay and Okura catchments.

A significant proportion of the lower Vaughan and Awaruku Stream catchments (178 ha) will be developed for urban purposes in the near future, largely by a single developer. The upper Vaughan Stream catchment (182 ha) comprises a number of large lots in private ownership (an estimated 160 parties) and is zoned for rural uses and countryside/bush living. Provisions governing the development of these areas are set out in the Long Bay Structure Plan (LBSP) and the Operative North Shore District Plan. The LBSP area and its surrounding context are shown in Figure 1.

Figure 1: Long Bay Structure Plan area: overview.



Following an Environment Court decision in the mid-1990s to permit urban development of the Long Bay area the previous North Shore City Council, landowners, and other interested parties were involved in developing the initial version of the Long Bay Structure Plan. This was publicly notified in May 2004, generated much controversy and a large number of submissions, and the NSCC's subsequent decision on the plan change was appealed. The Environment Court issued an interim decision in July 2008 settling the strategic objectives and policies as well as many lower level policies and rules. A second interim decision was delivered in September 2010 addressing most of the outstanding matters and indicating where the parties had leave to make further amendments or to make provisions consistent and workable. The final version of PC 6 will be issued when these outstanding matters have been resolved.

An integrated approach to catchment management and land use change underpins the LBSP embracing a wide range of issues - sustainable development, urban design and form, heritage, coastal character, the quality of streams and the marine environment, terrestrial ecology, and earthworks and stormwater management. Stormwater

management is based on low impact urban design methods including extensive provision for on-site mitigation.

3.1.2 STRUCTURE AND CONTENT

The policy framework informing the direction and content of the LBSP is provided by a wide range of statutes and RMA and LGA planning documents. Figure 2 provides an overview of the planning framework that informs the LBSP. In some instances, provisions of the Operative North Shore District Plan apply in the LBSP area by virtue of cross-referencing; however the LBSP is largely a stand-alone planning document that addresses integrated management of the use, development and protection of the Long Bay environment.

Structure planning is a non-statutory processs of developing detailed planning for an area,including changes to the district plan and provision for funding, timing and sequencing of infrastructure provision. It takes into account key needs of the future community such as work opportunities, transportation, schools, and the like. The structure plan synthesises the policy direction set by higher level policies and plans in the context of the focus area to derive a workable set of planning objectives, policies, and rules. Figure 3 shows the LBSP within the wider regulatory and planning context. The LBSP is given effect as a proposed change to the previous North Shore City District Plan.

Broadly, the LBSP provides for a village centre in the lower Vaughan Stream valley, with higher density housing expected to be developed around this centre, and more conventional suburban housing located towards the outer zones. This suburban housing extends into the lower Awaruku Stream catchment. In the upper Vaughan Stream valley provision is made for countryside living at lower densities, provided that streams and areas of native bush are protected and/or enhanced at the time of subdivision or development. Upper and lower catchments (Stream Protection Areas A and B) are the primary discriminant in the LBSP.

A series of planning overlays identifies resources and values that require protection and/or enhancement such as heritage landscapes, terrestrial and stream ecological communities of the Vaughan Stream valley, and wetland enhancement. The zones and overlays both apply with the intention of managing land use change in a way that protects the natural environment.

In the lower parts of the Awaruku and Vaughan Stream catchments, precinct plans are required to be approved before development proceeds. Precinct plans demonstrate how the proposed development complies with the land-use strategy, objectives and policies of the LBSP by showing stormwater plans, transport networks, density/development typology, protection and management areas, staging, and suchlike, with sufficient detail for assessment by the consent authority. Any subsequent development or subdivision is expected to occur in accordance with an approved precinct plan pursuant to a further consent where necessary.

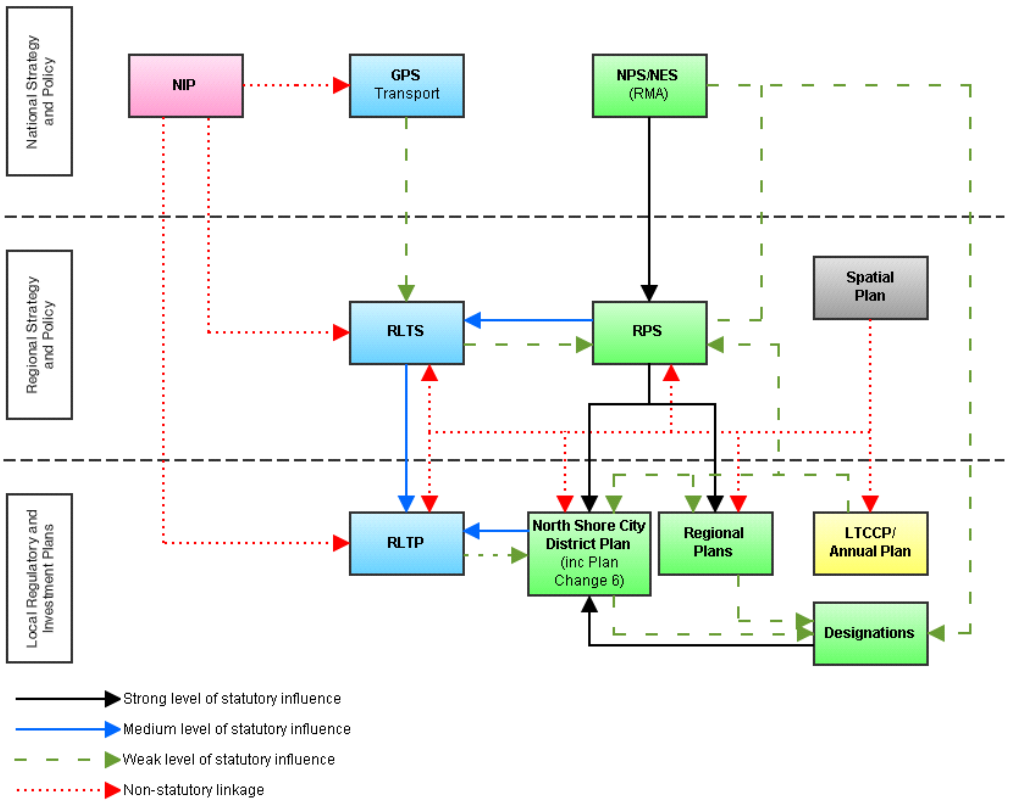


Figure 2 Local authority planning framework as at Oct 2010 (adapted from MfE 2010)

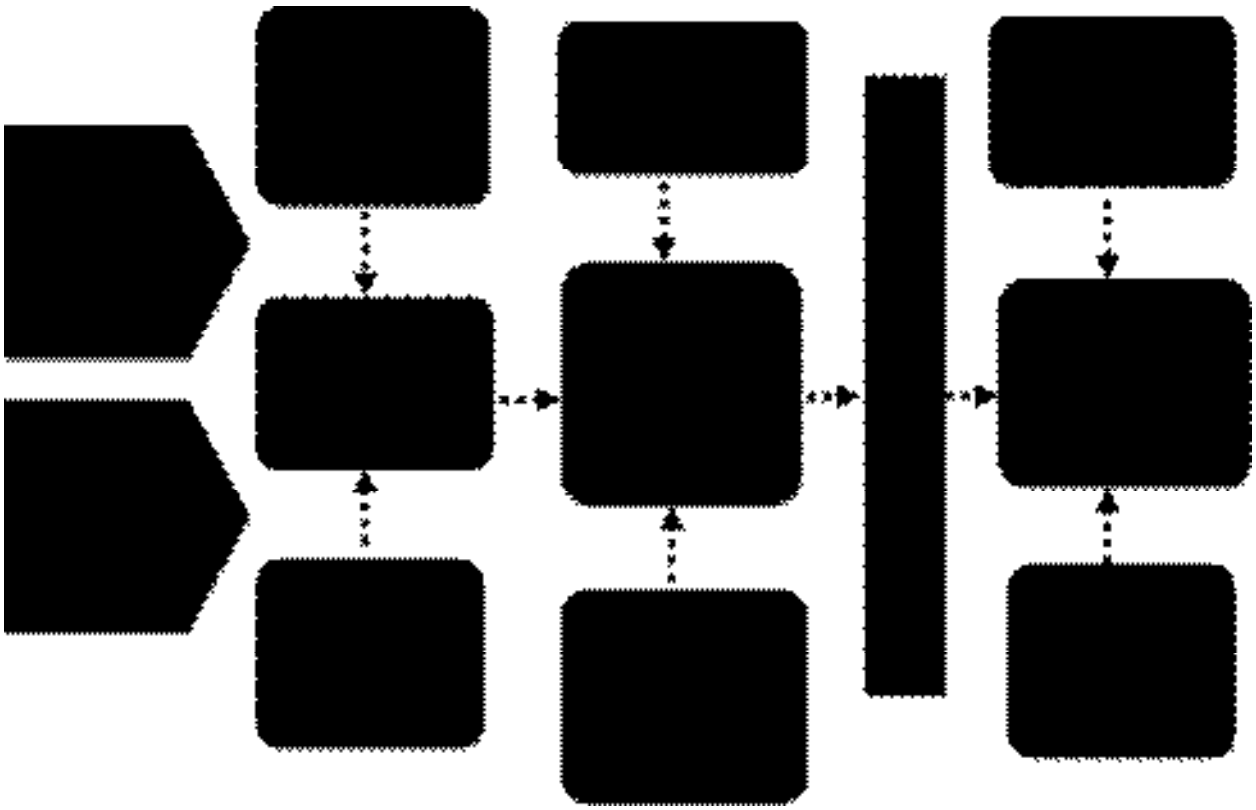


Figure 3 Regulatory and planning context of the Long Bay Structure Plan.

The various elements of the land-use strategy – Stream Protections Areas A and B, precincts, land use zones and management and protection areas – are all a key part of giving effect to the overall and localised vision for the LBSP area. Figure 4 overviews the LBSP land use strategy.

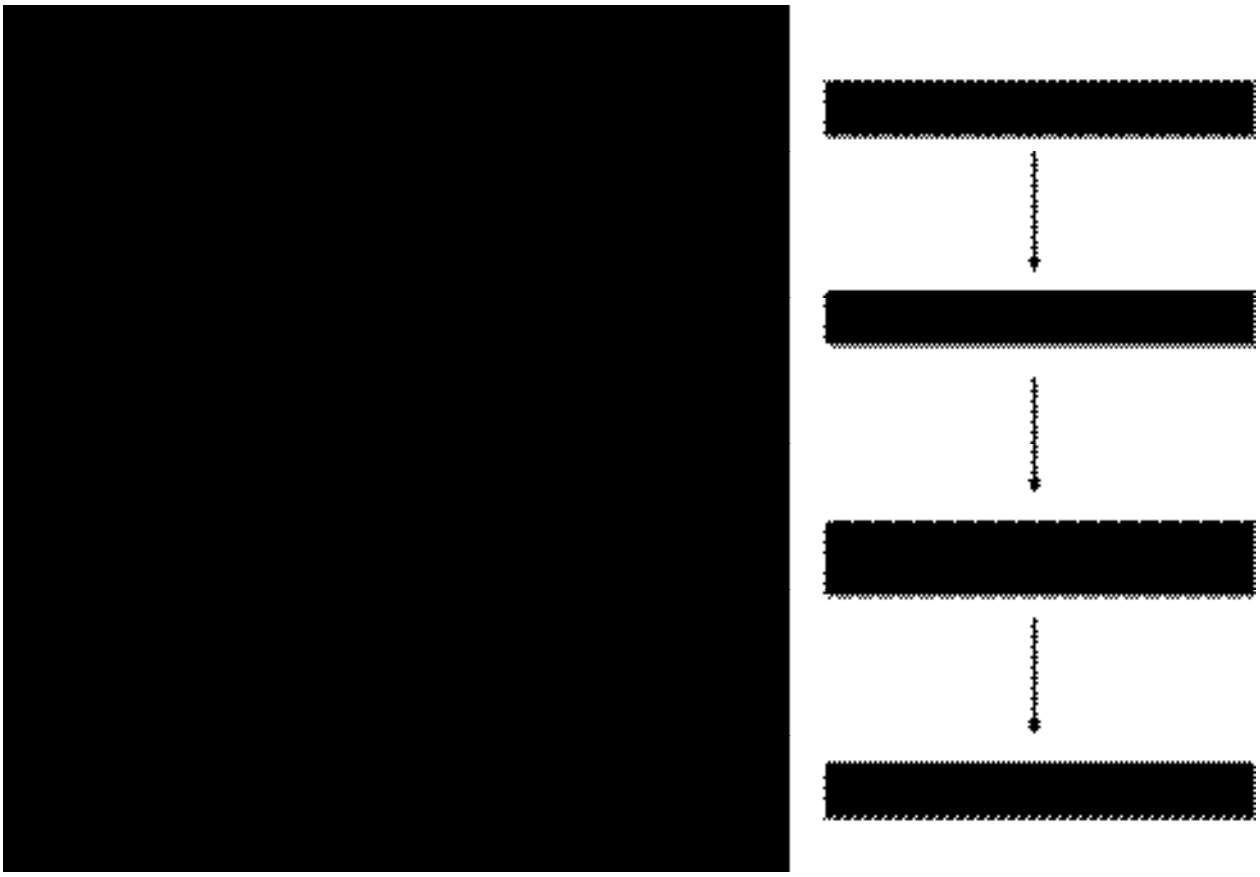


Figure 4 Long Bay Structure plan land use strategy – overview.

4 MONITORING FRAMEWORK

4.1 STATUTORY REQUIREMENTS

The RMA sets out clear requirements for monitoring statutory plans, including their efficiency and effectiveness, as well as the frequency at which monitoring and reporting needs to take place. Amendments to the LGA that are currently being considered mean that future long term council community plans (now long term plans or LTPs) prepared by the new Auckland Council will continue to inform statutory plans under the RMA. However, outcomes may be defined by the Council rather than the community and may therefore have a changed focus, although the guiding principle of meeting the needs of the four well-beings will remain. Requirements for monitoring outcomes and regular reporting will continue and these requirements become a key driver for developing a monitoring framework and plan for the LBSP.

Currently, there is no monitoring plan or programme for the LBSP area. While there was some monitoring being done by NSCC, the Auckland Regional Council and the Department of Conservation (ARC and DOC), there is no coherent approach to data collection and as a consequence there is insufficient information to assess the effectiveness of an innovative and integrated plan change like the LBSP.

While the scope of monitoring is not strictly prescribed, the RMA provides strong guidance on the need to address significant resource management issues. In practice, this means that in developing a monitoring framework and plan for the LBSP, focus has to be placed on prioritising monitoring according to the relative significance of the issues and the availability of resources such as money and time.

Table 1 summarises the different monitoring and reporting functions typically assumed by local authorities under the planning framework shown in Figure 2 (based on MfE 2010) and

highlights which types of monitoring will be relevant to the proposed LBSP monitoring framework.

Type of Monitoring	Monitoring function	Reporting
State of the Environment/progress towards community outcomes	Assessing the state of resources/environmental conditions Identifying key issues and measuring progress towards stated community outcomes	LTCCP State of the Environment (SoE report) Research/investigation reports
Evaluation of RMA plan effectiveness and efficiency	Effectiveness: measuring the effectiveness of policies and methods Efficiency: best suited for the job in light of chosen criteria, e.g., cost, compared with other equally effective methods	Stand-alone reports (every 5 years)
RMA/district plan operation	Measuring performance related to the operation of the RMA Consent processing, decision-making, notification, timeliness, inspections, etc.	Annual Plan Annual Report
Performance/effects of activities	Evaluating council services, programmes and activities under the LGA such as stormwater asset management Measuring performance against stated level of service requirements	Annual Plan Annual Report SoE report
Research/investigative	Occasionally commissioned reports to research specific issues and to inform council and nation-wide activities	Occasional, stand-alone reports

Table 1: Monitoring and reporting functions of local authorities

4.2 CONCEPTS

Building on earlier work, we used three conceptual models and the statutory requirement for stakeholder engagement to develop an integrated monitoring framework for the LBSP. These models helped develop the logical scope, structure, and organisation of the framework and informed the selection of indicators.

4.2.1 RMA PLANNING MODEL

The RMA, under section 35, requires every local authority to monitor:

- the state of the whole or any part of its region or district to the extent that is appropriate to enable the local authority to carry out its functions; and
- the efficiency and effectiveness of policies, rules or other methods in its policy statement or plan; and
- the exercise of any functions, powers or duties delegated or transferred to it; and
- the exercise of the resource consents that have effects in its region or district.
- Councils must take appropriate action where this is shown to be necessary.

The RMA is founded on the principles of cause and effect – plans incorporate issues, objectives, policies, and methods prescribing activities that in turn influence desired

outcomes. The monitoring framework we have developed seeks to address the following questions:

- Is the plan logically capable of achieving its desired outcomes?
- Has the plan been well implemented?
- Do the outcomes 'on the ground' correspond to the outcomes sought by the plan?
- Is there evidence that the plan's 'theory of cause and effect' has worked in practice? If not, what does the evidence suggest has happened?

4.2.2 POLICY EVALUATION CYCLE

The planning model adopted in the RMA is rational-adaptive, i.e. there is an iterative relationship between research, analysis, public consultation, planning, implementation, monitoring and evaluation RMA plans are required to undergo regular reviews, leading to increasing plan maturity over time. Monitoring and evaluation are essential components in this maturation process. Policy making is therefore both evidence-based and adaptive (Figure 5). The monitoring framework that we have developed recognises the adaptive context in which monitoring occurs and is structured to support regular evaluation (Figure 6).

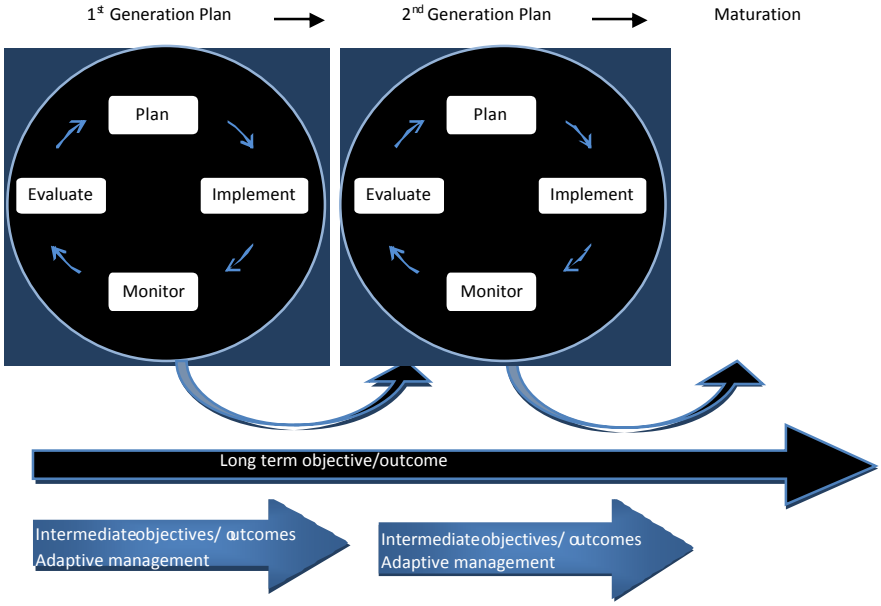


Figure 5 The policy evaluation cycle (based on Olsen 2003).

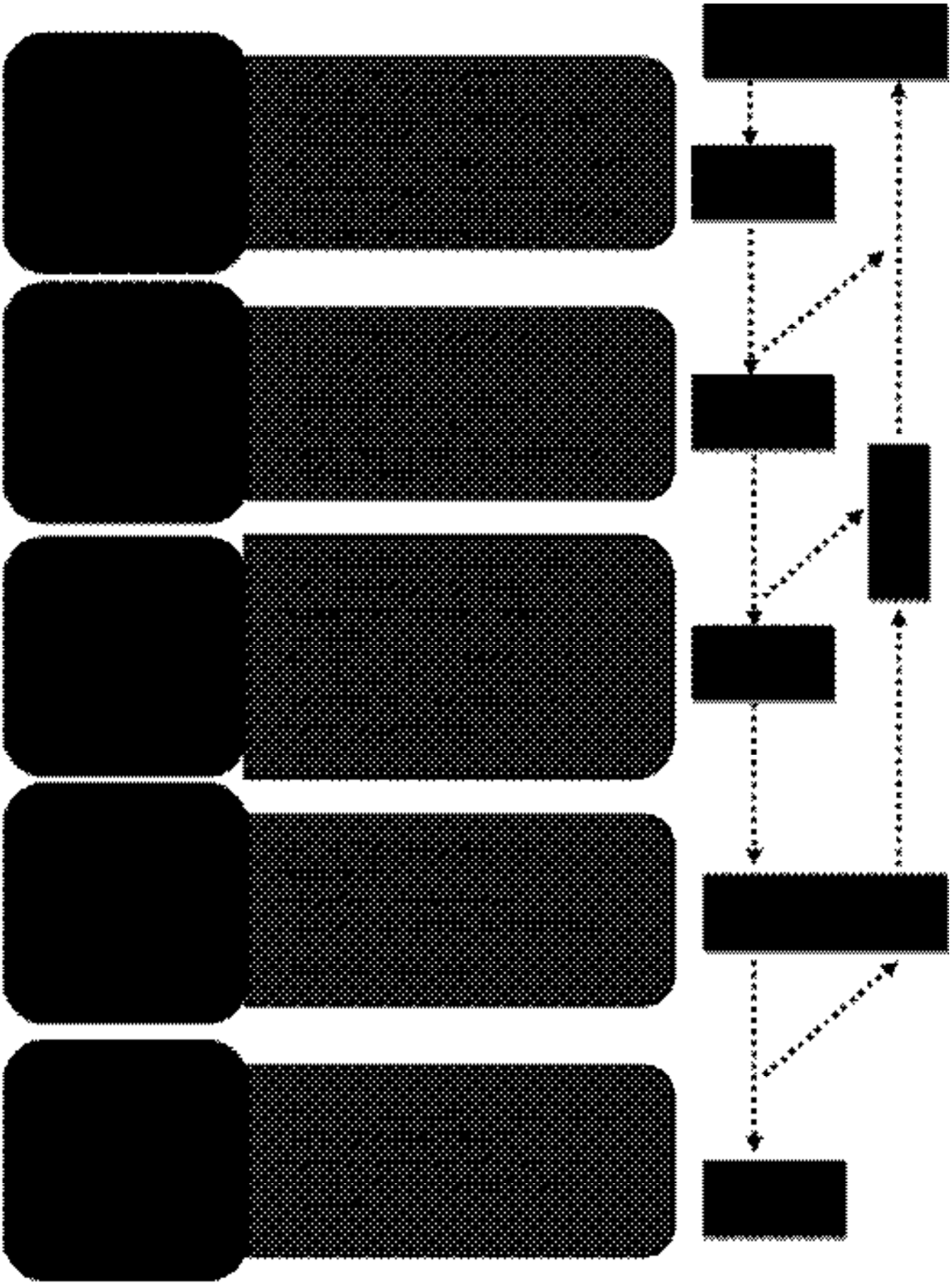
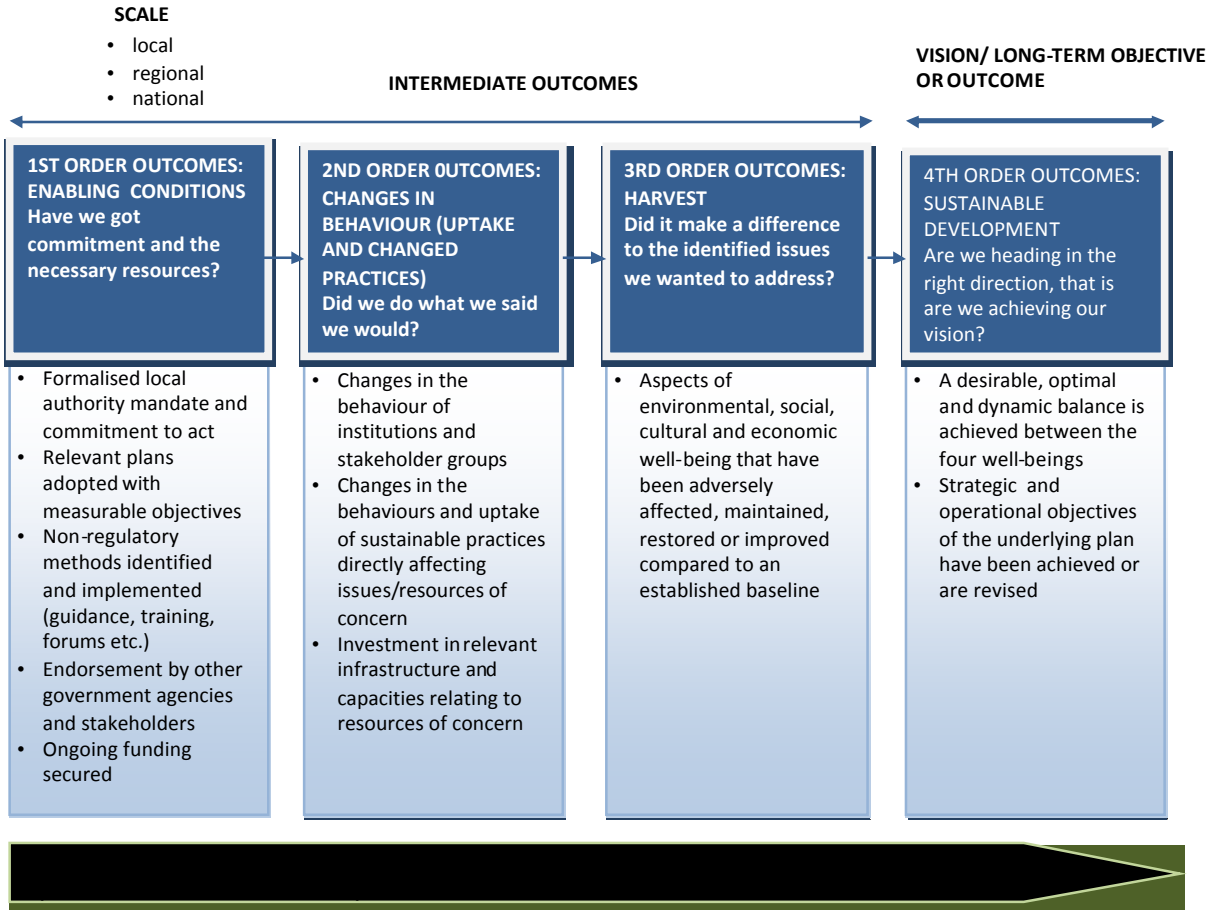


Figure 6 Indicative evaluation framework

4.2.3 ORDERS OF OUTCOMES FRAMEWORK

The orders of outcomes framework was developed by Olsen and others arising from ICM experience in the USA (Olsen 2003, Olsen et al 2007). The framework defines desired outcomes in a series of three intermediate and one final or longer term outcome categories (Figure 7). The intermediate outcome categories include a) the plans, systems and resources that need to be in place (enabling conditions), b) the uptake of learning and types of behavioural changes that follow from the implementation of proposed plan interventions, and c) consequent medium-term changes in the state of the environment. These intermediate outcomes are defined as 1st, 2nd, and 3rd order outcomes. The final 4th order outcomes are the long-term visionary objectives.

Figure 7 Orders of outcomes framework (based on Olsen 2003, Olsen et al 2007)



We have applied the orders of outcomes framework as a tool to:

- Clarify and test the logic structure of the LBSP by identifying the links between the issues, objectives, policies, and methods proposed
- Define the expected outcomes of the plan (these are not required by the RMA and so are implicit rather than explicit in the LBSP), and
- Structure those outcomes in a manner that clarifies the causal linkages between them and facilitates the selection and prioritisation of appropriate indicators (the RMA does not require the specification of indicators for monitoring outcomes).

4.2.4 DRIVER-PRESSURE-STATE-IMPACT-RESPONSE

The DPSIR is a model of understanding system interactions developed by the OECD for initial situation analysis and indicator selection (OECD 2003). In the context of a monitoring framework for the LBSP we have applied the model both for the analysis of the

eight major issues identified in the LBSP e.g. for streams and waterways (Figure 8) and in deriving indicators for specific target outcomes.

4.2.5 STAKEHOLDER ENGAGEMENT

Under the RMA, there is a statutory requirement to involve stakeholders, including tangata whenua, in policy making. Therefore, it becomes best practice also to involve stakeholders in plan effectiveness monitoring. The development of the proposed monitoring framework has involved some preliminary involvement of stakeholders. Completion of the framework and subsequent development of the monitoring plan will require significantly increased levels of stakeholder engagement. However that is not the focus of this paper so will not be addressed further.

4.3 CASE STUDY – STREAMS AND WATERWAYS

The concepts outlined above have been developed into a six step process to developing a monitoring plan. We have called this the monitoring framework. The monitoring framework and associated key steps are outlined in Table 2.

STEP	EXPLANATION/TOOL
1. ISSUE SELECTION	• Link to LBSP objectives • Issue prioritisation
2. ISSUE ANALYSIS	• Issue context (DPSIR analysis) • Analysis of external factors
3. INFORMATION STOCKTAKE	• Comprehensive analysis of existing reports, monitoring activities and indicators
4. PLAN LOGIC ANALYSIS AND OUTCOME INTERPRETATION	• Interpretation of expected outcomes (plan logic analysis) • Application of orders of outcome framework • Prioritisation of outcomes if necessary

5. INDICATOR DERIVATION AND PRIORITISATION	• Assignment of indicators to interpreted outcomes
	• Indicator integration across:
	  ○ LBSP issues
	  ○ other RMA & LGA plan issues
	  ○ other monitoring programmes
	• Indicator prioritisation

6. INDICATOR SPECIFICATION	• Detailed analysis of monitoring requirements for each selected indicator

Table 2: Monitoring framework.

4.3.1 STEP 1 ISSUE SELECTION

The LBSP identifies eight key issues - integrated and sustainable management, heritage, coastal and landscape character, streams and waterways, earthworks and sediment control, ecology, urban form, building design and development. The issues also have spatial dimensions that are recognized by the protection and management overlays, and zoning and precinct distinctions in the land use strategy (Figure 4). While there is significant overlap between them, the plan identifies specific objectives for each issue. The monitoring framework therefore initially addresses each issue separately to ensure a robust and comprehensive set of potential indicators are identified. These are then rationalized across issues and objectives later in the process (Step 5) to provide an efficient indicator set. The framework also recognizes that the relative importance of issues alters through time e.g., compliance with provisions to manage earthworks and

sediment will be a high priority in the early phases of development, monitoring built density a little later. In this paper we illustrate the remaining steps in the process using examples for the streams and waterways issue.

4.3.2 STEP 2 ISSUE ANALYSIS

The LBSP identifies 2 objectives with regard to streams and waterways:

- To protect and enhance the water quality, level and flows, habitat values and fauna of the Vaughan Stream, including its tributary waterways in the upper valley, identified waterways in the lower valley, and their margins, and to avoid adverse effects on the recreational values of the Long Bay beach and the ecological values of the Long Bay Okura Marine Reserve.
- To improve the water quality, habitat values and fauna of the Awaruku Stream and reduce the adverse effects of discharges from the stream on the Long Bay Beach and the Long Bay Okura Marine Reserve.

To achieve this, the plan explicitly acknowledges that it intends to apply a "low impact, treatment train approach" to stormwater management, including limitations on landform modification and impervious cover; use of on-site storm water mitigation measures for developments, roads and accessways and retention of the majority of streams and waterways; as well as the provision of catchment-wide facilities. In this regard, the streams and waterways provisions of the LBSP are unique in Auckland.

However the logic that connects these objectives, policies and rules is complex and not always explicit or clear. We used the DPSIR tool to develop a systems map of the streams and waterway issue (Figure 8) and to identify factors that may not have been considered.

While the coverage of the LBSP with respect to the streams and waterways issue appears to be very good there are some significant gaps, as follows::

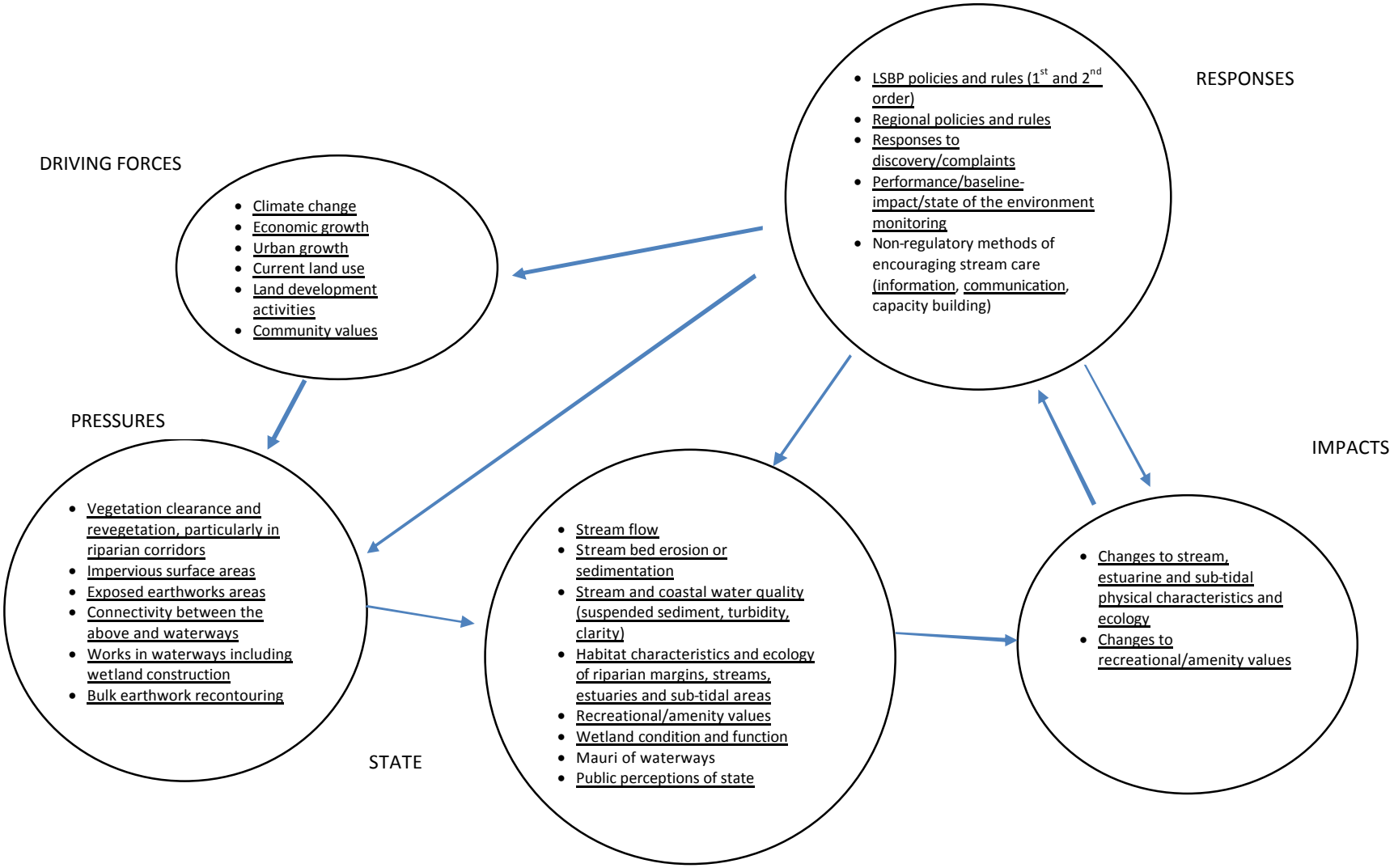
- the absence of recognition of cultural or community values and attributes of stream and waterway health,
- the failure to recognise the importance and effectiveness of non-regulatory options in managing streams and waterways, particularly as regulatory requirements are only triggered by nearby development. This leaves open the risk of stream degradation from factors such as weed infestation or cumulative effects that arise from more distant activity – for example, other development in the upstream catchment.

The adoption of a low impact approach to storm water management provides for some significant spillovers in benefits between issues e.g., natural character aspects of the upper catchment are reinforced by strategies to minimise impacts on the stream network, and the potential for sediment production is potentially significantly reduced by maximising onsite infiltration, detention and treatment of storm water.

4.3.3 STEP 3 INFORMATION STOCKTAKE

The issue of streams and waterways is extensively covered in evidence to the Environment Court and well covered by existing baseline, monitoring and performance information, particularly hydrological data. Of particular note is the importance of two

Figure 8 DPSIR model – Streams and Waterways.



recent ad hoc data collection surveys: one associated with the detailed stream walk survey; the other with the analysis of vegetation cover associated with recent aerial photo records obtained by the previous NSCC.

While there is a significant amount of baseline data, the LBSP establishes some specific spatial distinctions that may not be well matched by current data and sampling. In particular the LBSP makes major distinctions in the storm water management requirements between two different Stream Protection areas, land use zones, and precincts. This may require a more geographically specific set of baseline data than currently exists and needs to be addressed urgently.

The potential for complementing streams and waterway data collected and held by Auckland Council with that from community organisations, schools, and researchers is also significant. A key challenge will be to integrate such information to maximise their use for evaluating the effectiveness of the LBSP.

4.3.4 STEP 4 PLAN LOGIC ANALYSIS AND OUTCOME INTERPRETATION

The heart of the framework is the plan logic analysis and interpretation, structuring and prioritising of desired outcomes using the orders of outcomes framework. A separate plan logic analysis has been developed around each key issue identified in the LBSP and includes the following elements:

- definition of the issue
- identification of other laws, strategies, plans and guidelines that affect the issue
- identification of agencies with responsibilities for the issue
- the LBSP objective for the issue
- how the LBSP seeks to achieve this objective (policies and methods)
- other means of control being applied
- consequent gaps and outstanding concerns
- derivation of interpreted outcomes by order:
    - 1st order (prerequisite/enabling conditions)
    - 2nd order (implementation of plan interventions, compliance with policies, rules and conditions, changes in human behaviour and practice)
    - 3rd order (changes in environmental, social, cultural or economic states)
    - 4th order (achievement of the long-term vision across the four well-beings).

Table 3 outlines the outcomes derived for the streams and waterways issue and demonstrates the logical hierarchy of influence from prerequisite and enabling conditions (first order outcomes) through to long term goals (fourth order outcomes).

Our logic analysis did not identify major gaps between interpreted outcomes and the Standards and Rules included in the LBSP for streams and waterways (this was an area of considerable focus during the Environment Court hearings), but did highlight:

- The importance of comprehensive baseline monitoring that provides reference points for target outcomes like "retain", "maintain unaltered", "no adverse effect", "increase" etc.
- The potential for failures in implementation where outcomes and some aspects have been specified but others, such as timing and prioritisation, have not e.g. the goal that stormwater management devices are installed as soon as possible after site construction is complete.

Aspect	Description
1. INTERPRETED 1st ORDER OUTCOMES:	Success will look like this: • LBSP is operational • Consents where required have been granted. Consent applications include a storm

Aspect	Description
Enabling conditions	water control report • Bulk earthworks plans have been approved and signed • Site management plans have been approved and signed • Planting and maintenance plans have been approved and signed • Weed and pest management plans for conservation areas have been approved and signed • Precinct plans, including detailed landscape concepts for proposed reserves and public areas, and areas to be set aside and protected and/or vested in the Council, have been approved and signed • All proposed on-site stormwater management techniques are covered by an approved covenant or consent condition registered against the property title • A monitoring plan is in place and regularly reviewed/updated • Roles and responsibilities for monitoring are identified and agreed to
2. INTERPRETED 2nd ORDER OUTCOMES **Changes in human behaviour / implementation of interventions**	Success will look like this: • Developers comply with the rules of the LBSP, applicable consent conditions, covenants and approved plans • Stormwater management devices are installed as soon as possible after site construction is complete. • In Stream Protection A Areas, each development incorporates appropriately designed and sized 'dual purpose' rainwater tanks plus revegetation, bioretention (rain gardens, stormwater planters, tree pits), pervious paving and other similar devices to mitigate stormwater generated by hard surfaces (driveways, paths, patios, decks). • Development in the 100 year flood plain is limited to roads, water supply, wastewater, stormwater facilities and reserves that cannot be located elsewhere. • Riparian and ecology/storm water areas are fully planted in indigenous vegetation and stock proof. • Appropriate maintenance and management systems for on-site systems and plantings are in place and functioning. • There is no direct piping of stormwater discharges to streams and there are no stormwater works on steep or unstable slopes. • Runoff from all sites is discharged into a primary stormwater system and not to the street. • Runoff from residential driveways and car parking areas enters the primary stormwater system via a sump to trap silt and floatable debris and, in the Long Bay 5 zone, is treated on-site to remove a minimum of 75% of total suspended sediment on a long term average basis prior to entering the primary stormwater system. • Bio retention should be used in preference to proprietary stormwater treatment systems. • Pervious surfaces (paving, green roofs, uncovered slatted wooden decks etc) are widespread.

3. INTERPRETED 3rd ORDER OUTCOMES
Effects on the state (environmental, social, cultural, economic)
	Success will look like this:
	• The natural drainage patterns of each site are retained.
	• In the Stream Protection A area:
	  ○ there are no modifications to natural waterways and their ecology.
	  ○ stream flows, including base and peak flows, are not adversely affected. Post development peak flow rates and average run-off volumes are limited to predevelopment peak flow rates and volumes for rainfall up to the 10% AEP event.
	• In the Stream Protection B area:
	  ○ waterways maintain a natural land form, provide the physical habitat to sustain healthy, appropriate ecological communities, and protect the coastal and marine receiving environments,
	  ○ hydrological status and functioning, including base and peak flows, are not

Aspect	Description

	adversely affected.
	• Riparian margins are fully vegetated in appropriate native vegetation, protected from livestock, and free of weeds and pests.
	• On and off-site stormwater management are integrated with other activities:
	  ○ there is a significant net increase in native vegetation and improved connectivity of bush areas in the catchment
	  ○ stormwater devices and management add to amenity, landscaping, habitat and recreational opportunities
	  ○ the urban form provides adequate space for both on-site and off-site stormwater mitigation.

4. INTERPRETED 4th ORDER OUTCOMES Sustainable development	Success will look like this: • The water quality, level and flows, habitat values and fauna of the Vaughan Stream and its margins are maintained in a healthy and natural state and in the lower Awaruku Stream they are improved. • The recreational values of the Long Bay beach and the ecological values of the Long Bay Okura Marine Reserve are maintained or enhanced.

Table 3: Plan outcome analysis (streams and waterways)

From the analysis outlined in Table 3 we drew some conclusions with regard to how the orders of outcome influence the monitoring strategy.

- Monitoring of 1st order outcomes has a high level of priority because the appropriate consent conditions and plans (stormwater, bulk earthworks, site management, planting and maintenance, weed and pest management, precincts) provide the primary means for controlling activities.
- Most 1st order outcomes involving the completion of these plans are common across issues and required under law.
- Less clear and more complex is the monitoring of the adequacy of plans and consent conditions. Second and 3rd order outcome indicators are critical in providing the understanding to support improvement in plan provisions and consenting.
- Similarly indicators for 1st order outcomes generally measure whether or not an action has taken place but not how well it was done, e.g., the quality of stormwater plan is assessed 'on paper' during decision-making on the application (and is deemed acceptable if consent is granted). Again, 2nd and 3rd order outcome indicators assess the quality of the result 'on the ground'.
- Consequently monitoring of 2nd order outcomes is a high priority because:
  - they indicate compliance with the provisions of consents and plans
  - many issues will be difficult and expensive to address by the time 3rd order outcome indicators identify a breach.
- 2nd order outcomes rely heavily on inspection methods, frequency and thoroughness. This highlights the need for regular evaluation of inspection compliance, i.e. auditing.
- In the streams and waterways case some specific needs were identified:
  - A method for routinely surveying the operation and maintenance of on and off site storm water devices and changes in impervious area.
  - A method for routinely surveying and recording changes in vegetation cover by type and location.
  - Additions to the process for issuing code compliance certification to cover registration of covenants for storm water devices on property titles, runoff

from impervious surfaces flowing to an onsite storm water management system, and appropriately sized, connected and operating rain tanks.

- The LBSP says little about non-regulatory methods of achieving 2nd and 3rd order outcomes. Technical guidelines and specifications are well covered in a series of specific publications - the Long Bay practice notes. These are accessible on the web. But the unique elements of the LIUDD approach will require additional investment in education, training and information provision across the development sector and community.
- 3rd order outcomes (typically expensive to monitor) can be more easily prioritised and measured selectively if 1st and 2nd order outcomes are well monitored because doing so significantly reduces the risk of not achieving 3rd order outcomes. The selection of 3rd order outcomes can then be limited to sufficient outcomes and indicators to verify that the expected consequences of 1st and 2nd order outcomes are achieved, or to explain why they have not been achieved.
- One specific issue related to 3rd order outcomes was identified. It is likely that regional freshwater monitoring sites in the Vaughan Stream catchment do not match critical spatial criteria in the LBSP land use strategy (for example, sampling sites do not agree with boundaries between the Rural 2 area and the two stream protection areas. Further discussion will be required to address this matter.
- Fourth order outcomes are limited to the two key foci of the issue in the LBSP – the maintenance of the natural state of the upper Vaughan catchment, and the management of the lower Vaughan and Awaruku catchments to maximise amenity and recreational value in an urban context while protecting the coastal and marine receiving environments.

4.3.5 STEP 5 INDICATOR DERIVATION AND PRIORITISATION

The next step is to identify feasible indicators for each outcome. By assigning indicators to each outcome by order, the causal links leading to achievement of (or failure to achieve) different outcomes have a higher likelihood of being identified. Indicators are derived in three ways:

- Selection from those used in existing monitoring programmes addressing similar issues. This will support future meta-analyses and comparisons between contexts and wider scale (regional, national) state and performance reporting.
- Use of the DPSIR model to identify different types of indicators for each outcome. This will encourage consideration of non-traditional indicators that may be more efficient, particularly meaningful to specific stakeholder groups, or cover more than one outcome.
- Development of linked indicators specific to the issues and outcomes of the LBSP. While less readily comparable between contexts these can be designed to be efficient and specifically target the key issues of concern in the LBSP.

In the case of streams an initial indicator derivation exercise identified between 60 and 70 potential indicators. From these, a cost effective and efficient set within the constraints of available resources and other monitoring demands needs to be selected. In reality, it is likely that the Council will either monitor a relatively small number of key indicators across all issues of the LBSP and/or focus on single priority issues in greater detail at strategic intervals.

A number of indicator prioritisation systems are available and could be used. Some have been incorporated and tested in the proposed framework. In the storm water case study we used five criteria – issue relevance, policy relevance, analytical validity, cost effectiveness and simplicity/ease of understanding. In practice, both the indicator derivation and prioritisation processes should rely heavily on the input from a range of stakeholders in order to make rational and well informed decisions on indicator selection.

4.3.6 STEP 6 INDICATOR SPECIFICATION

Once indicators have been selected and prioritised, a specification needs to be prepared for each indicator to ensure consistency of data collection over time and across different personnel/organisations. In the monitoring framework we provide an outline of what the specification should contain.

5 CONCLUSIONS AND RECOMMENDATIONS

This paper has outlined a structured analytical approach to developing integrated monitoring of a complex urban development plan for a sensitive peri-urban catchment. The LBSP adopts a low-impact urban approach as the central means of avoiding adverse effects of development on the environment (including the coastal marine area and Long Bay Regional Park), for creating a sustainable community with a high standard of amenity, and for conserving local cultural resources.

One of the principal means of verifying whether these goals are achieved is to monitor and evaluate the effectiveness of the LBSP in achieving its outcomes on an ongoing basis. The monitoring framework described in this paper has been based on a detailed review of both New Zealand and international literature and approaches to ensure it is based on accepted best practice. It has been tested successfully in four case studies, one of which (streams and waterways) is covered here.

The monitoring framework provides a step-by-step approach to developing a monitoring plan in a rational and structured manner, based on a number of key underpinning concepts. The orders-of-outcomes framework is the central concept and has been instrumental for the interpretation of LBSP outcomes. It has guided both the identification of intermediate outcomes that need to be monitored to demonstrate plan effectiveness and the identification of key indicators to measure outcomes.

The monitoring framework also provides the means for integrating and prioritising monitoring to optimise the use of available resources. In particular, the framework provides rational methods for prioritising issues, outcomes, and indicators. Limited funding allocated to monitoring each year will be a constraint on the scope of the work undertaken, but it will also focus attention on matters of high priority.

With the monitoring framework in place, the next step needs to be preparation of a monitoring plan and programme for the LBSP. Of particular importance in this context is the involvement of the many stakeholders who have an interest in the successful achievement of the outcomes of the LBSP.

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