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Assessing the health of Melbourne's waterways

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SUMMARY: The Melbourne Water Corporation (MW) Tributary Investigation Program is designed to assess stream health within a catchment or region. The major objectives of this program are to determine the current condition of a waterway, identify primary factors leading to a decline in stream health, provide a sound data set for monitoring long-term changes in stream health, and to provide recommendations as to how the condition of the waterway may be best managed for the future. A broad spectrum of physical, chemical and biological indicators is surveyed, which includes water quality (nutrients, water clarity & faecal contamination), sediment toxicants, physical stream condition, macroinvertebrates, fish, diatoms, macroalgae and platypus. Historical water quality data analyses and a review of the relevant literature are also undertaken. Surveys have been conducted in six catchments within Greater Melbourne. Major factors influencing stream health varied between catchments. An overview of the issues identified in this program, the benefits of measuring several environmental compartments to obtain an overall understanding of ecosystem health, and how the outcomes of these studies are down-loaded into the MWC work program, are discussed.

THE MAIN POINTS OF THIS PAPER
- A method for monitoring effectiveness of waterway management authorities is presented
- Focusing on waterway health rather than water quality provides more beneficial management outcomes
- Relevant issues impacting waterway health are identified
- Clear visions and goals for waterway health need to be developed in consultation with stakeholders to determine appropriate management actions

1. INTRODUCTION

Much effort and funds are invested by waterway management authorities in an attempt to enhance or maintain the condition of waterways. It is essential, therefore, that a long-term vision and measurable goals are established for waterways, and that a coordinated approach exists between management actions and monitoring business performance.

More effective control of major point sources of pollution (eg. wastewater treatment plant discharges) since the late 1970s and early 1980s, has meant that diffuse sources of pollution (eg. urban and agricultural stormwater) are now the most serious threat to the health of Port Phillip and Western Port (EPA, 1996; EPA, 1997). As a result, waterway management in these catchments has focused on actions directed at diffuse pollution. This new management focus requires a more comprehensive and integrated approach to monitoring (EPA 1997).

The term 'stream health' considers more than water quality, and also incorporates stream life, flows and physical condition. Physical condition includes bed and bank stability, riparian vegetation and in-stream habitat. Traditionally, waterway management has primarily aimed at improving water quality, but now there is a shift towards a broader assessment of waterway values to include the protection of aquatic ecosystems as well as domestic, agricultural, industrial, and recreational uses (ANZECC 1992).

This shift in management focus from water quality to stream health requires assessment not only of water quality but also biological and physical components of aquatic systems. Biological assessment should not rely entirely on a single indicator (ANZECC 1992). As different indicators respond in different ways to various environmental stress (Friedrich et al. 1996), and on different spatial and temporal scales (Chapman & Jackson, 1996), a variety of approaches are required to gain a full appreciation of waterway health. We suggest that the lack of multiple biological indicators has been the weakness of many stream health studies. As a result of individual limitations, the use of a single biological indicator fails to ensure that the most relevant impacts on stream health are identified.

The MW Tributary Investigation Program (TIP) is designed to assess stream health within a catchment. Major objectives of this program are to undertake a multidisciplinary approach to:
- determine the current condition of a waterway;
- identify the major values and beneficial uses that need to be maintained;
- identify primary factors leading to a decline in stream health;
- provide a sound data set that will allow for long-term changes in stream health to be determined and, therefore, enabling an assessment of business performance;
- provide recommendations to MW as to how the condition of the waterway may be best managed for the future. These recommendations are directed to the MW stream improvement works program, and other responsible authorities.

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To adequately monitor of long-term changes in stream health, catchments will need to be re-surveyed every five to ten years.

The TIP has connections with the MW environmental monitoring network, stream rehabilitation program and stream flow management plans. The environmental monitoring network includes physico-chemical, macroinvertebrate, physical stream condition and sediment toxicant monitoring. This monitoring is broad-scale, with the primary objective to detect long-term trends in stream health. The tributary investigations, on the other hand, are on a much finer scale and are aimed at developing site specific management actions, and determining the effectiveness of these actions.

2. METHODS & STUDY AREA

A broad spectrum of physical, chemical and biological indicators are surveyed as part of a tributary investigation. These indicators include: water quality, sediment toxicants, physical stream condition, macroinvertebrates, fish, diatoms, macroalgae and platypus. Historical water quality data analysis and a review of the relevant literature are also important components. In addition, other information on geology and soils, population density and distribution, future population growth, sewering, water harvesting and land use are collected.

Physico-chemical samples are taken on seven occasions, at roughly fortnightly intervals during base flows. There was also some high flow sampling, but due to the prevailing dry conditions during the study, this had limited success. The physico-chemical indicators used were temperature, pH, electro-conductivity, dissolved oxygen, turbidity, suspended solids, oxidised nitrogen, ammonia, total Kjeldahl nitrogen, soluble reactive phosphorus, total phosphorus, *E. coli*, chloride and fluoride. Sediment samples were collected on one occasion and were analysed for heavy metals, and in recent studies, for pesticides and nutrients.

The physical condition of waterways was assessed using the Waterway Condition Monitoring Program methodology (MPW 1995). This methodology involves an assessment of aquatic structure, shading, bed and bank stability, floodplain condition, riparian vegetation and the extent of weeds. Macroinvertebrates were sampled in spring and autumn. Fish, diatoms, macroalgae and platypus were surveyed on at least one occasion.

Originally, the proposed study catchments were prioritised according to several criteria, including questions such as:

- is there a lack of stream health information ?
- are significant changes occurring or proposed in the catchment ?
- is there an urgency to resolve perceived stream health issues ?
- is the study likely to be useful in light of proposed waterway management activities ?
- do opportunities exist that will enhance the study if it is conducted sooner (eg. concurrent studies in the catchment by external parties may provide useful additional information) ?

Selection criteria were modified for the second round of catchment selection, where the emphasis was a connection with proposed environmental restoration programs in the forthcoming year.

Studies that have been completed or are in progress are in the Watts, Corhanwarrabul, Andersons and Jumping, Lang Lang, western Mornington Peninsula, Woori Yallock and Diamond catchments (Figure 1). These catchments have provided a variety of waterway types and land uses, to which this stream health assessment methodology has been applied.

3. RESULTS

To demonstrate management benefits resulting from this approach to stream health assessment, outcomes from three completed catchment studies will be discussed.

3.1 Andersons & Jumping Creeks

Andersons and Jumping Creeks drain two small catchments in the middle Yarra River catchment, about 25 km north-east of Melbourne. High density residential land occurs in the headwaters of both creeks. Middle sections of these catchments have low density residential properties, averaging 10 to 20 ha lots. Lower sections of these creeks flow through the Warrandyte State Park. Residential density increases in the lower section of Andersons Creek where it flows through the township of Warrandyte.

Waterways within these catchments contained reasonable aquatic life, with native fish, platypus and invertebrates. Nutrients are high in Andersons Creek (Pettigrove 1994; Pettigrove & Coleman, 1998a; Coleman et al. 1998), but it was not the major issue. This is because, even though Andersons Creek had median nutrient levels (ie. total nitrogen of 3.4 mg/L and total phosphorus of 0.3 mg/L) more than three times greater than Jumping Creek, there were little differences in the structure of the algal communities

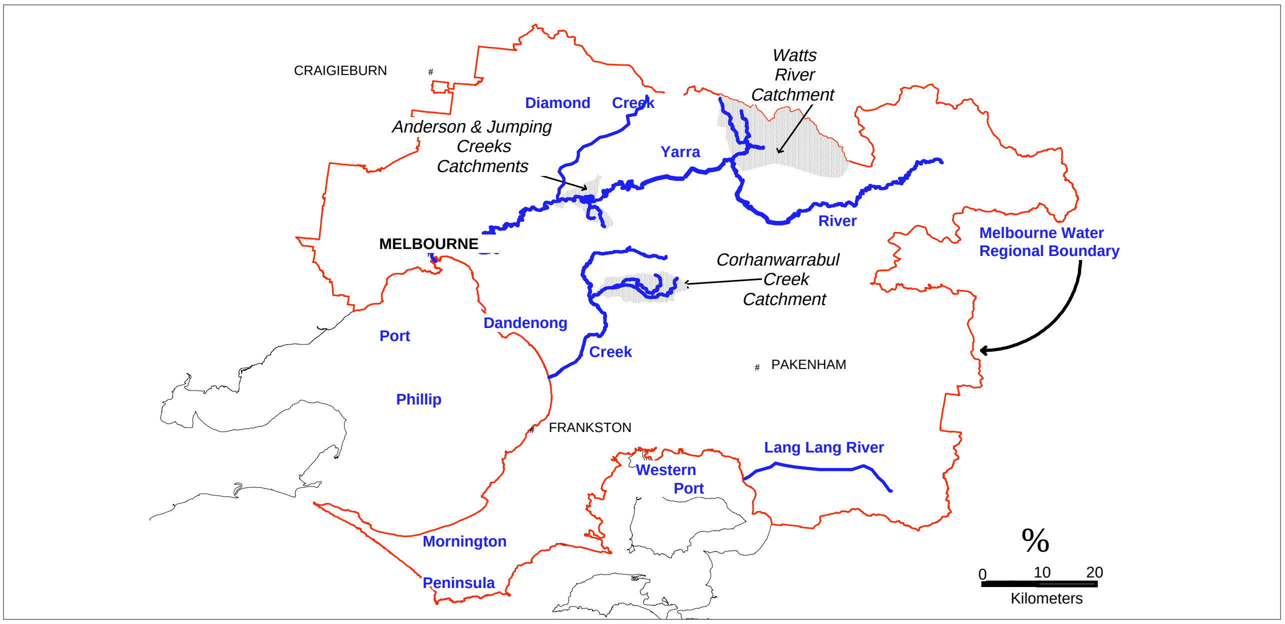

Figure 1: Location of the Andersons and Jumping Creeks, Watts River and Corhanwarrabul Creek catchments

(Pettigrove & Coleman, 1998a). Instead, the major impacts on stream health within these catchments were sediment loads (mostly from middle catchment reaches), toxicants (Harris Gully) and weeds (particularly in Andersons Creek). Table 1 summarises major values, issues and recommendations for these catchments. Relevant authorities are currently involved in the implementation of these recommendations.

3.2 Watts River

The Watts River is a major tributary of the Yarra River, having a catchment area of approximately 233 km^2. The catchment is situated about 120 km north-east of Melbourne. A large proportion of streams within the catchment are harvested for domestic water supply. Maroondah Reservoir is a major domestic water storage located on the Watts River. The upper part of the catchment, which supplies the water for the reservoir, is forested and has very restricted public access. Other than the township of Healesville, there is very little urban land in the catchment. Predominant land uses below the Maroondah Reservoir are grazing, mixed farming, hobby farming and some berry production.

Waterways within the Watts River catchment were in good to excellent condition. Water quality issues are not a priority and physical stream condition is only an issue in some reaches. The most important issue is adequate flows to protect aquatic ecosystems (Table 2).

Environmental flow allocations and the removal of barriers to fish migration are a priority for Grace Burn and Donnellys Creek, because they have large catchments upstream of water harvesting weirs. The catchments would provide excellent habitat for migratory fish. In addition, opening up these catchments is reasonably achievable. Environmental flows from the Maroondah Reservoir are a low priority because, with no multi-level offtake, and discharges coming from the hypolimnion, releases are likely to have poor water quality. Such releases may adversely

Table 1: Major stream values, issues and recommendations determined using a stream health assessment methodology in the Andersons and Jumping Creeks catchments (Pettigrove & Coleman, 1998a).

Major Values	Major Issues	Major Recommendations
• Native riparian vegetation - corridor for wildlife • Platypus • Native fish • Historical site on Andersons Creek - gold mining • Aesthetics	• Riparian weeds - eg. ivy, honeysuckle, exotic pines • Sediment - roads; urban development • Increasing urbanisation in headwaters • Toxicants in Harris Gully	• Integrated weed management strategy with appropriate authorities • Road management and maintenance of drainage lines • Stream frontage rehabilitation for middle sections of Andersons and Jumping Creeks • Construction of an artificial wetland in Andersons Creek to treat urban run-off and mitigate hydrology • Maintenance program for septics • Investigation of toxicant source in Harris Gully

Table 2: Major stream values, issues and recommendations determined using a stream health assessment methodology in the Watts River catchment (Coleman & Pettigrove, 1998).

Major Values	Major Issues	Major Recommendations
• Good physical stream condition in most reaches • Platypus • Native fish and freshwater crayfish (including significant species) • Recreational fishing • Domestic water supply for Melbourne and private diversions	• Physical condition of lower Watts River is poor • Environmental flows from MW impoundments • Environmental flows in New Chum Creek (private diversions) • Localised water quality issues from agricultural and urban sources	• Stream frontage rehabilitation in the lower Watts River • Environmental flow allocations • Stream flow management program • Removal of fish barriers on Grace Burn, Donnellys, Sawpit and New Chum Creeks

impact good native fish populations downstream.

Poor physical stream condition in the lower Watts River was not only caused by excessive stock access and a lack of riparian vegetation, but also willow infestation. Willows are reducing hydraulic capacity and causing significant erosion by diverting flows into banks.

3.3 Corhanwarrabul Creek

Corhanwarrabul Creek is a tributary of Dandenong Creek (catchment area of approximately 74 km^2) and is located about 25 km south-east of Melbourne. Monbulk and Ferny Creeks are the primary waterways within the Corhanwarrabul Creek catchment. There is a mixture of urban and semi-rural land in the area, with several reserves in the lower catchment. Ferny Creek, and parts of the lower and upper Monbulk Creek, are urbanised. Most of Monbulk Creek is used for agricultural purposes, particularly cattle grazing. Headwaters of the catchment lie within wet sclerophyll forests of the Dandenong Ranges National Park.

Corhanwarrabul Creek catchment is in good condition for a largely urbanised system. Because of its relatively good water quality and biota, this catchment also plays an important role in maintaining the health of Dandenong Creek. A majority of the waterways have degraded riparian zones, although the headwaters are well vegetated. Channel morphology has been highly modified in the lower sections of Monbulk and Ferny Creek. It was concluded that comparatively small improvements in stream health will occur as a result of water quality improvements, compared to improving the physical condition of waterways within the catchment (Table 3).

Proposed developments in the catchment include housing, golf courses and a freeway. Development has been identified as a major issue in the catchment, because it will increase pressure on the already degraded riparian zones, alter current stream hydrology by increasing intensity and volume of run-off, and threatens wetland habitat important to *Galaxias pusilla* (which is listed under the Flora and Fauna Guarantee Act). Lower Monbulk Creek is a priority for fish barrier removal because it has better habitat and water quality than Ferny Creek.

4. DISCUSSION

MW has accepted the challenge of improving the health of waterways in the Greater Melbourne region, rather than focusing only on improving water quality. This approach has involved reviewing how we currently manage waterways and increasing public participation in waterway management.

We regard a healthy waterway as one that maintains high environmental values desired by the local community for that waterway. Therefore, such a

Table 3: Major stream values, issues and recommendations determined using a stream health assessment methodology in the Corhanwarrabul Creek catchment (Pettigrove & Coleman, 1998b).

Major Values	Major Issues	Major Recommendations
• *Galaxias pusilla* • Platypus • Native riparian vegetation - corridor for wildlife	• Proposed development in lower catchment (housing, golf courses, freeway) • Poor recreational fisheries • Downstream barriers impede passage of migratory fish into the catchment • Poor riparian vegetation • Willow infestation	• Further surveys and protection of *G. pusilla* habitat • Develop specific recommendations for planning proposals eg. minimum width of riparian zone • Improve in-stream habitat, particularly establish pool and riffle sequences • Identify major fish barriers and develop a program to remove barriers • Remove willows and other exotic riparian vegetation

waterway may not necessarily resemble its natural state prior to human settlement.

A healthy waterway has been defined as one which has the "ability to support and maintain a balanced, integrative, adaptive community of organisms having a species composition, diversity and functional organisation as compared to that of the natural habitat of the region as possible" (SER 1996). We argue that it is impractical to compare urban, rural and pristine catchments. Instead, we should focus practical actions to optimise the health of the waterway given constraints of catchment land uses.

Compared to a natural waterway, urban waterways are highly modified systems that have poor health. This often leads to these waterways being given low priority in waterway management programs, as exorbitant costs would be incurred to return the waterway to its natural state. However, many people living in cities and suburbs value urban waterways and cost effective actions could be undertaken to protect their values. For example, a recent public survey found that the public still valued indigenous vegetation along urban waterways (ResearchWise 1998). This could be achieved for reasonably little cost.

Visions for river health need to be made with consideration of community desires for the waterway (eg. ANZECC 1992; Fairweather 1997). It is through consultation with the community (or more practically the stakeholders) that the major environmental values of a waterway should be identified and endpoints, or goals, be developed for the management of the waterway.

The TIP has identified many environmental values and risks that will impact on the health of a waterway. MW has developed a process whereby the findings of these TIP reports can be directly transformed into the active management of these waterways (Figure 2). TIP studies are referred to the community and, following stakeholder consultation, detailed plans are developed for the waterway (Waterway Activity Plans or WAPs).

Stakeholder involvement for Andersons and Jumping Creeks WAPs, for example, entailed several meetings with representatives from local council, ‘friends’ groups, Parks Victoria and the Country Fire Authority. The initial meeting was a briefing session — discussing the current state of the waterways (as determined by TIP report findings) and MW proposals for what could be done. A key element of the briefing session was to gain an understanding of the stakeholder’s expectations for the waterways. Following the briefing session, the rest of the meetings were progress reports on the development of the WAP, so that any problems could be addressed as early as possible.

The current state and desired health of the waterway is discussed at the start of the development of the WAP, and measurable goals are identified. Wherever possible, these goals should be expressed as a biological endpoint (Karr 1997). Whether or not this goal is achieved could be determined by performance monitoring. For example, a goal for a waterway may be to have a sustainable native fish population. Whether or not this goal is met could be determined by regular monitoring of fish populations.

Once the goals are identified for a waterway, a detailed work program can be developed, costed and prioritised. For example, re-establishing a sustainable native fishery in a waterway may be achieved by removing fish barriers, creating suitable in-stream habitat, and ensuring that the water and sediment quality are adequate to support native fisheries. Effectiveness of the works needs to be monitored to ensure that the best approach has been selected to achieve goals for the waterway.

The application of this approach to stream health assessment has been a learning process. A major change to the program has been reduce the detail in the TIP report. Survey reports investigating water quality and biota are now produced by consultants. The major finding in these reports and any follow-up investigations resulting from recommendations made in these surveys are summarised in the TIP report (eg. Pettigrove, 1998).

The use of multiple indicators has proven to be a valuable method for assessing stream health in Melbourne waterways — enabling a glimpse of stream conditions at various spatial and temporal scales, and ecological levels. This gave more confidence in determining management priorities.

Two indicators that have been temporarily modified in their application are diatoms and macroalgae. Algal assessments are now targeted for specific catchments where nutrients are considered to be an issue — particularly in waterways where point source impacts, such as local wastewater treatment plants occur. Currently, information on algal biomonitoring in Australia does not allow for fine scale discrimination of water quality between sites.

5. CONCLUSIONS

The Melbourne Water Tributary Investigation Program has demonstrated that it is an effective approach to assessing stream health for waterway management in a variety of catchments. It is recognised that stakeholder values play an important role the establishment of goals for the health of waterways, particularly in urban waterways where stream restoration to pristine conditions is unrealistic and management could be driven by amenity.

The Tributary Investigation Program has now reached the stage where findings are being incorporated into planning activities. The process whereby these reports are transformed into the active management of waterways (Figure 2), therefore, currently represents the desired process.

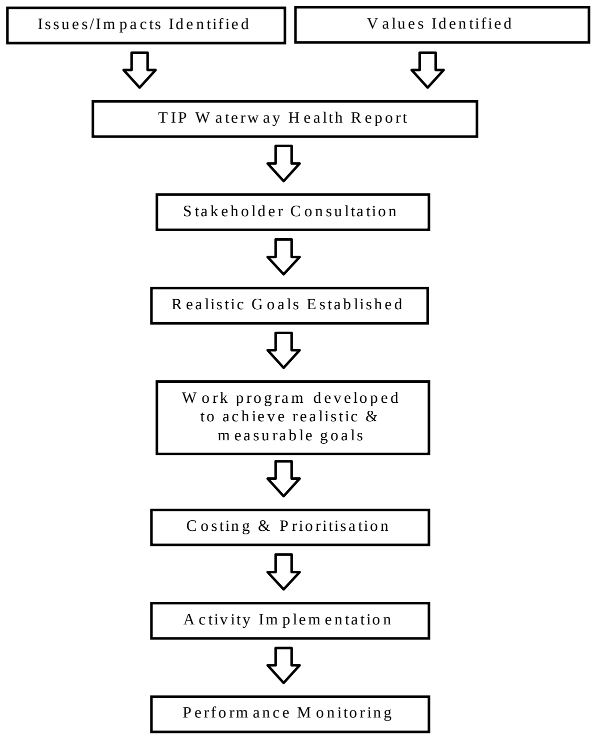

Figure 1: Melbourne Water process for incorporating Tributary Investigation Program (TIP) studies into the management of waterways.

6. ACKNOWLEDGMENTS

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