

**APPENDIX 1  
LITERATURE SEARCH ON  
PIPES AND OPEN CHANNEL  
COMPARISONS FOR LARGE  
SCHEMES**

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# LITERATURE SEARCH ON PIPES AND OPEN CHANNEL COMPARISONS FOR LARGE SCHEMES

## 1.0 Background

The agreed extension of project SFF 05-177 deals with the development of a generic methodology to allow a robust comparison of open channel and piped distribution systems for large scale irrigation schemes, in the NZ context. Milestone 1a of the extension project is a report of an international literature search for investigations of the pros and cons of open channel and piped systems for large scale irrigation flows. This work was undertaken as a detailed web based search of international literature and personal email and telephone contacts with various organizations and persons involved in open channel to piped conversions, and experienced engineering consultants involved in projects where large diameter pipes have been used.

## 2.0 Results

### 2.1 *Web Based Search*

The web based search did not reveal any reports where the comprehensive comparison of open channels and pipes was specifically referred to. This is not surprising in that decisions to make conversions have normally been made on the basis of political or environmental imperatives.

Enquiries made of professionals in NZ, Australia and in overseas jurisdictions have confirmed this result – apparently the conversion from existing open channels to piped systems have been justified from a narrower viewpoint than is needed in the NZ context, as exemplified by the conversions undertaken and in progress and underway in Australia, Turkey and Malaysia.<sup>1</sup>

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<sup>1</sup> Lars Kamerling, Amiantit, has made extensive enquiries amongst clients and has not encountered any formal open channel/piped conversion analyses.

## **2.2 Engineering Literature**

Economic aspects are one of the criteria of relevance to an assessment of relative merit. The two economic variables are initial and on going costs. The engineering handbooks and relevant texts contain engineering economic approaches to the selection of the most economic pipe type, in situations where the pipe options are all possible on technical grounds. Most commonly, the procedure involves a comparison of capital and annual costs. Annual costs of replacement are normally generated by estimating salvage value of each pipe type at the end of an arbitrary service life and maintenance costs necessary to justify the salvage value used. This approach has some merit when comparing like with like in the design phase, but has little relation to actual costs likely to be incurred during the service life<sup>2</sup>.

Contacts were made with NZ suppliers of different pipe types and with pipe users to establish realistic service life assumptions and these will be useful when detailed assessments and case studies are undertaken.

## **2.3 Australian Experiences**

Based on email contact and telephone discussions with the major water authorities in Victoria and NSW, and the large private water supply and irrigation companies in these States, the two main reasons for conversion of open channels to pipes given were: a) water savings in situations where losses from open channels from seepage, evaporation and operation were considered to be unacceptable in areas of water shortage – an economic issue; and b) where environmental restoration was a key objective – to reduce seepage in order to lower groundwater levels in saline areas and return water to surface water bodies in order to restore ecosystem health. In such cases, the conversion decision was taken, and the analysis thereafter focused on choice of pipe material for relative longevity, ease of maintenance and reduced risk of physical damage from corrosion, abrasion or chemical degradation<sup>3</sup>.

## **2.4 Malaysian and Turkish Experience**

The Government of Malaysia has been progressively replacing open channel irrigation supply systems to piped networks since the mid 1990s, because of the difficulties and costs in maintaining function of the open channels and water shortages in nationally important granary areas<sup>4</sup>. The reasons given by the Turkish Government for replacing recast concrete open channels distribution systems are based on operational inflexibility of open channels to meet modern water demands, water savings and interference of above ground infrastructure with farm transport systems.<sup>5</sup>

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<sup>2</sup> Don Preston, MWH, pers.comm.

<sup>3</sup> Discussion with the following: Gordon Henderson, Beca, Auckland; Lance Thompson, NZ Steelpipes, Auckland; Brett Tucker, Murrumbidgee Irrigation Ltd., Griffith, NSW; Doug Meill, Irrigators Council of NSW; John Martin, Grampians Wimmera Mallee Water Authority, Horsham, Victoria; Kim Alvarez, Dept. of Natural Resources, NSW; Peter Millington, consultant, Sydney.

<sup>4</sup> National Water Resources Study, Government of Malaysia, 2000

<sup>5</sup> Author worked on aspects of GAP Project in Turkey, 1998

## 2.5 New Zealand Experiences

Most of the gravity-supplied surface irrigation schemes in NZ have traditionally relied on open channel distribution systems for a number of sensible reasons: adequate gradients to convey high flows by gravity in open channels; tradition; generous access to run-of-river flows; and reliance on border dyke on-farm irrigation methods. This was the most cost-effective and appropriate method for large schemes at the time, and there are some 250,000 ha of land developed under this system.

In recent years, environmental and market pressures have been building to reduce water losses and increase on-farm efficiency in the large community schemes. This has resulted in conversion of about 30 percent of the land under rostered surface flooding supply systems to pumped centre pivot irrigation systems with a better ability to meet short term water demands<sup>6</sup>. These conversions still rely upon open channel supplies to farm boundaries. This on-farm change mimics the parallel development of an additional 250,000 ha of private schemes, all dependent on pumping and piped reticulation.

There have been three small community irrigation schemes developed in NZ using piped reticulation – Keri Keri in the 1970s, Waimea East in the 1990s and Downlands under construction. In all cases open channels were contra-indicated by physical circumstances, so no comparisons were relevant. Large diameter piped reticulation options have been included in a number of irrigation proposals in recent times – Barrhill Chertsey and Central Plains – but no comprehensive analyses as proposed under this study were carried out<sup>7</sup>.

There has therefore been no NZ experience with the use of extensive networks of large diameter piping under pressure to replace the function of the traditional open channels to bring water to farm supply points. This is changing, with plans afoot to investigate the replacement of two open channel lateral supply races in the Ashburton Lyndhurst scheme supplied by the Rangitata Diversion Race (RDR)<sup>8</sup>. The reasons given for the interest are reduced water losses and ability to supply water under gravity pressure thus reducing electrical energy use.

Large diameter steel pipes have been used in NZ as penstocks in Hydro Electric Power schemes for at least 40 years; and city water supplies have long relied upon a variety of medium sized piped reticulation systems – based on steel, asbestos cement and PVC mains. Newer piped products based on HDPE (high density polyethylene) and FRP (fibre reinforced polymer pipes) are being used to replace older mains, but the service life experience of these pipes is limited.

## 3.0 Findings and Conclusions

No formal assessment methodologies were found in the international experience that address the special features and issues of the NZ situation related to open channel and piped reticulation options in large scale water enhancement schemes.

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<sup>6</sup> Craig McKenzie, farmer, ALIS pers.comm.

<sup>7</sup> NPV estimates in Barrhill Chertsey carried out by Aqualinc Research Ltd found that the NPV of open channel options and piped alternatives were similar, but the investigations were not exhaustive.

<sup>8</sup> Craig McKenzie, farmer, ALIS pers.comm.

The reason for the lack of similar assessments as proposed in this project has become clearer. Very few countries possess the unique features of the NZ situation – relatively steep gradients from water source to use point, giving the prospects of gravity pressure supply in pipes, and the ability to access source water at higher elevations.

The rationale for conversions in overseas jurisdictions tends to be dominated by political imperatives to gain water savings and environmental benefits; and in some developing countries, by problems with maintaining function of the open channel systems over time.

It was concluded from this survey that it is necessary to develop methodologies that are specific to the NZ circumstances if a robust assessment of the pros and cons of piped and open channel distribution options is to be possible.