

MANAGEMENT OF THE TRUSTPOWER LTD DAM PORTFOLIO

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ABSTRACT

In recent years TrustPower has undergone a rapid transition from a part owner of three dams in the Kaimai ranges south of Tauranga and the Hinemaiaia and Wheao schemes near Taupo in 1998, to the present ownership situation. Today TrustPower owns 22 dams comprising a range of structure types, including arch, earthfill, rockfill, concrete gravity and a number of embankment canal systems. The dam classifications for the dam portfolio vary from small to large and the NZSOLD potential impact ratings vary from very low to high. The portfolio includes some of the largest dams in New Zealand, for example Matahina Dam a 70m high central core rock fill, Patea Dam an 80m high earthfill dam and Mahinerangi Dam a 40 m high concrete arch dam with concrete gravity abutments.

The dam structures vary significantly in terms of age, potential impact and risk to TrustPower. The Dam Safety Management Procedures (including monitoring and surveillance systems, inspections and reviews) that existed for each dam also showed considerable variation in comparison.

The approach adopted for dam safety management is described, and the interrelationship with commercial objectives and commonly accepted standard practices.

KEYWORDS - Dam Safety, Risk, Surveillance Systems

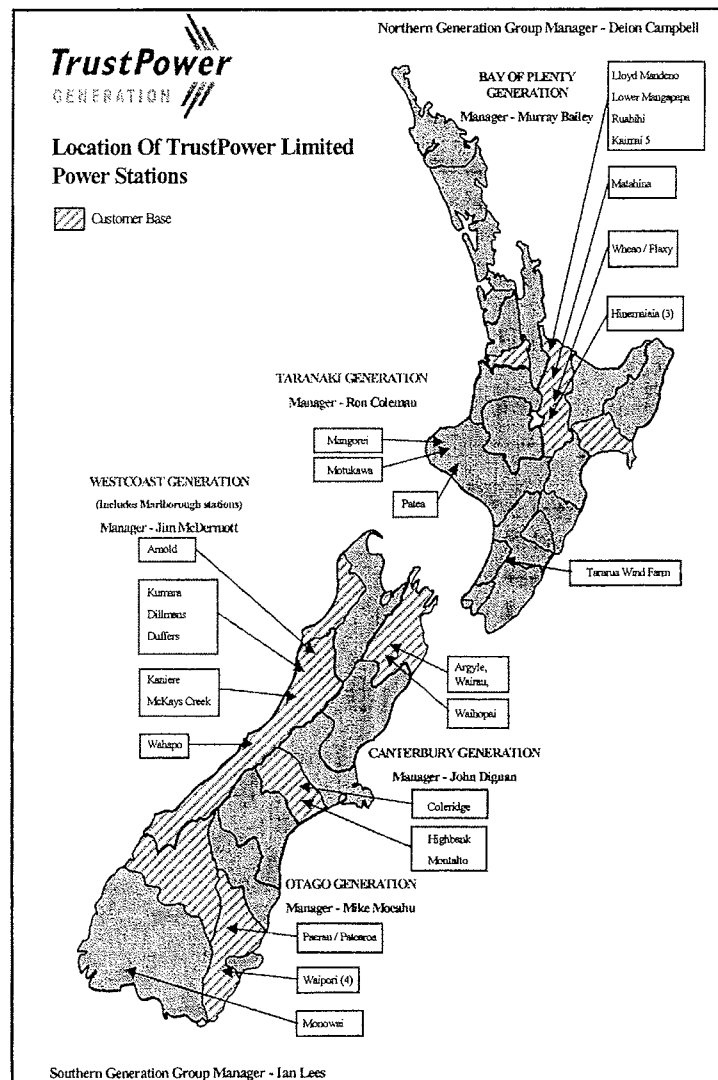


Figure 1: TrustPower Ltd Power Schemes

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INTRODUCTION

TrustPower Ltd started business in 1925 as the Tauranga Electric Board. In 1998 the New Zealand Government instigated legislative measures that required power boards and the government owned energy sector to divest assets and become either a generating and retail business or a transmission company. Contrary to the path most other Regional Electricity companies took, TrustPower Ltd elected to sell its lines business and operate as a generating and retail business.

TrustPower Ltd has grown significantly over the last three years and is currently New Zealand's fourth largest electricity retailer, and owner of 33 generating assets (Figure 1) spanning the entire length and breadth of New Zealand. This includes 33 hydro and 1 windfarm. As a result of the growth, TrustPower Ltd purchased several hydro-electricity schemes which incorporated numerous dams including arch, earthfill, rockfill, concrete gravity structures, and a number of embankment canal systems. Prior to purchase by TrustPower these structures were owned by 7 different power companies each with its own dam management programme. This placed a significant challenge on TrustPower Ltd to unify the systems to an acceptable, consistent level.

DESCRIPTION OF DAM PORTFOLIO

The structures (Table 1), are spread from the Bay of Plenty through Taupo and Taranaki, Marlborough, the West Coast, Canterbury, Otago and Southland. The TrustPower Ltd rating reflects the recent 2000 update of the NZSOLD Dam Safety Guidelines.

The age of the structures varies significantly (refer Table 1). The design standards also vary from homogenous earthfill dams with a concrete core wall, to dams with filters designed to modern criteria. The new 2000 NZSOLD Dam Safety Guidelines in conjunction with TrustPower Ltd in-house risk management system has allowed TrustPower Ltd to rate dams structures according to potential impact which in some cases altered previous ratings. Some structures straddle potential impact ratings. Where appropriate studies such as Dam Break assessments are being utilised to refine understanding of potential impact for these structures.

Scheme	Age	Height (m)	Dam Type	NZSOLD Hazard Rating 1995	NZSOLD* Hazard Rating 2000
North Island					
Matahina	1967	72	Rockfill	High	High
Patea	1984	82	Earthfill	High	High
Mangamahoe	1931	25	Earthfill	High	High
Ratapiko	1927	11	Earthfill	Significant	Low
Hinemaia A,B,C	1952	12-27	Arch/Gravity x 3	High to Low	Low/Significant
Mangaonui	1972	29	Earthfill	High	Significant
Dry Gully	1972	20	Earthfill	Significant	Low
Matariki	1979	26	Arch	High	Significant
McLarens Falls	1925	27	Arch / Buttress	High	Significant
Flaxy (Wheao)	1980	11	Earthfill	Significant	Low

Scheme	Age	Height (m)	Dam Type	NZSOLD Hazard Rating 1995	NZSOLD* Hazard Rating 2000
South Island					
Waihopai	1925	30	Arch	High	Significant
Arnold	1932	12	Earth, Gravity	Significant	Significant
Dillmans	1928	14-16	Earth x 2	High, Significant	High, Significant
Waipori	1907-1931	11-35	Arch x 3, Gravity	High to Low	High to Low
Monowai	1925	<5	Earthfill	Significant	Significant
Argyle	1983	15	Earthfill	Significant	Significant

Table 1: TrustPower Dam Assets

Note: *TPL hazard rating based on NZSOLD 2000 Dam Safety Guidelines

Management Systems

As a new owner of a number of dams with no previous involvement with the purchased structures, TrustPower Ltd at short notice instigated a management structure to:

- Review the structures.
- Obtain information on the structures.
- Have a technical understanding of the structures.
- Develop Dam Safety Management procedures where none existed.
- Expand the existing monitoring and surveillance system to incorporate data received from stations nation wide.
- Interpret monitoring and surveillance information.
- Undertake regular civil safety inspections.
- Provide engineering assistance and advice where required.

Overall management of the Dam Portfolio is maintained in house and is interlinked with the TrustPower's Total Risk Management system. Physical recording of monitoring and surveillance information is typically undertaken by TrustPower Staff although this is contracted out at some more remote locations.

Potential risks identified to TrustPower Ltd are processed by means of a Total Risk Management System. Risks associated with dam ownership are no exception. The potential impact ratings of the dam structures within TrustPower's portfolio therefore have a direct impact by way of Dam Safety Management, maintenance and upgrades.

Given the level of specialist technical input required, particularly as new schemes were purchased, TrustPower Ltd elected to contract out the review and performance monitoring of Dam Safety Management to Riley Consultants Ltd. This allowed TrustPower to take a more strategic long term view of Dam Safety Management through the risk management system whilst maintaining a high level of technical input on a day to day basis.

The works required of Riley Consultants Ltd are broken into two broad categories:

- Civil safety performance monitoring.
- General engineering assistance.

Risk Profile of Structures

As ownership of each scheme transferred, TrustPower Ltd had to initially incorporate all dam assets within the risk management system to identify critical structures and areas where immediate attention may be required. Due diligence studies undertaken on the schemes during the purchase process had typically highlighted the areas of greatest uncertainty. For most schemes, site inspections and additional documentation reviews expanded on these areas and allowed an initial ranking of potential deficiencies to be undertaken. All major hydraulic structures were assigned NZSOLD (1995) and NZSOLD (2000) ratings to facilitate the processing of identified deficiencies through the risk management system.

In association with the hydraulic structures review a programme of independent annual civil inspections was instigated to review all components of the dam portfolio. Any additional deficiencies identified were also included in the risk management system.

TrustPower's Risk Management System

TrustPower Ltd developed an in-house total risk management system to categorise all identified critical risks to the company. All potential risks are processed via this system to allow a targeted response to risks. Risks associated with dam structures are processed and subsequently fed in to TrustPower's Asset Management Plan.

The risk management system ranks risks by four criteria:

- Financial (including loss of earnings)
- Environmental (including resource consent issues)
- Health and Safety (staff and public)
- Company Image

TrustPower Ltd risk management procedure has been designed to provide a common framework for the identification of risk, analysis of risk, magnitude of risk, and an assessment of risk. This is intended to achieve an appropriate balance between the cost of risk occurrences, and the cost of prevention. The overall framework is based on the Australian and New Zealand Standard AS/NZS: 4360 – Risk Management.

It may be noted that there is no direct reference to an “engineering” risk or consequence. This is because any civil or asset based risks are considered an integral part of 1 or more of the 4 categories mentioned previously. In most cases (for dams and associated structures) the “engineering” risk is also included in the qualitative assessment of the risk. The outcome of the risk assessment and subsequent asset management plan is a prioritised list of projects based on a standardised risk assessment programme that can be budgeted for in an economic manner.

DAM SAFETY MANAGEMENT

TrustPower Approach

TrustPower Ltd's approach to dam management has been to contract out the day to day dam performance monitoring services to Riley Consultants Ltd, but retain overall management in-house. Contracting out has provided a number of advantages. These include:

- Rapid assimilation of each scheme purchased.
- Access to specialist engineers familiar with national and international best practice.
- Access to existing independent knowledge of many of the schemes

This approach improved the rate at which new purchases were “bought on line” without the need to retain large staff numbers in-house.

The approach has allowed the company to create a new streamlined economic dam management program unencumbered by historical practices and in line with the competitive nature of the energy industry in New Zealand. The use of independent specialists familiar with industry standards such as the NZSOLD guidelines ensures methodologies are benchmarked against industry expectations.

All critical scheme components and procedures are assessed against two risk scenarios, inherent and residual risk. The inherent risk identifies the scale of risk if no controls were in place, or existing controls failed (eg spillway gate doesn't open during a flood event). The residual risk defines the level of risk existing given the existing control measures. This provides a measure of the value of control and defines the level of management responsibility required. The residual risk values for all critical dam and associated structures were compared against what could be reasonably expected for the structure (as per NZSOLD guidelines).

The process identified several situations where procedures or systems existed which were based on the “its always been done that way” concept rather than sound appropriate measures. Often these “its always been done that way” concepts had in fact “drifted” a long way from original design and/or operational expectations. The adoption of the “inherent” risk concept is intended to provide a level of internal “reality check” to reduce the possibility of drift in control. External reviews or audits are still considered necessary as a cross-check.

Where an inappropriate level of residual risk is identified (ie deficiency exists) potential improvements to the component are tested to provided a “projected residual risk” score. The improvement that gains the greatest reduction in residual risk, within economic constraints, for the component in question is fed in to the Asset Management Plan.

In many cases perceived deficiencies are more appropriately addressed by means of procedures. With the varied previous ownership structure of the TrustPower Ltd dam portfolio, several accepted key dam management tools and procedures were outdated, insufficient or non existent when purchased. The inconsistencies between schemes have required reformatting into a company standard and in line with NZSOLD guidelines. These documents include:

- Emergency action plans
- Data books
- Monitoring and surveillance manuals

TrustPower is currently undertaking a review updating or preparing these documents as key management documents and procedures.

Relationship with Commercial Objectives

In the past Dam Safety Management has been inclined to focus on the hazard posed by a dam and the level of control offered, in relative isolation to the wider economic viability of the scheme. Programs such as the SEED system have tended to reinforce this approach.

In a more commercially realistic approach all risks to a company need to be assessed by and referenced to a set of standard criteria. Considering the scheme, the portfolio of schemes and wider company issues in a holistic manner is required to achieve this. This avoids the potential for funds to be diverted from more deserving areas to fulfill an unrealistic desire to provide an excessive level of control elsewhere, which can inevitably lead to a distortion in the way risk is addressed.

Care however needs to be exercised to ensure that risks that may have very low probabilities of occurrence but high consequence are not “down played” given a commercial concept of “economic life” which could be only a fraction of the “physical life” of the component. This is particularly relevant to dams and their associated structures. The utilisation of independent advice / inspections is seen by TrustPower as one component of the process that ensures that an appropriate emphasis is given to risks associated with dam structures.

Of critical importance is ensuring the risk assessment system utilised provides an appropriate level of weighting between frequency, consequence and exposure to the risk. There is no standard answer for this as it is a function of the particular industry, commercial environment, legislative controls and the companies risk appetite.

Consent Conditions and RMA Requirements

It is becoming more and more common to find aspects of Dam Safety Management defined and/or controlled in resource consent conditions. Within the range of schemes purchased by TrustPower several are currently undergoing resource consent renewals. Several other schemes required amendments to consents where inconsistencies were identified during the due diligence process and subsequent internal procedures.

For many of the older schemes undergoing consenting Regional Councils and/or interested parties that are ongoing or frequently requesting proof that the components within the scheme that may pose a hazard to people and/or the environment are being monitored and maintained to an acceptable level. The ability to show interested parties that a ongoing comprehensive dam safety management system is being employed which includes independent external review is usually sufficient to satisfy most "realistic" concerns.

Care needs to be exercised to ensure that consent restrictions derived from today's enhanced environmental expectations do not compromise dam safety. For example the desire to have spill discharges from dams mirror "natural" river processes can compromise the ability for reservoirs to regulate flood events. This inevitably increases risk.

Potential restrictions on the safe operation of dam structures, intimated during the resource consent process, are assessed through the risk management system.

Monitoring and Surveillance Systems

A key component of the TrustPower Ltd dam management programme is a monitoring and surveillance recording and reporting system developed by Riley Consultants Ltd to review dam safety instrumentation. This programme was initially devised to replace the old Apple IIe based system used at the Kaimai HEPS. As new schemes were purchased they were included in to the system.

Riley Consultants Ltd are contracted to TrustPower Ltd to undertake the review and interpretation of all monitoring information collected by TrustPower Ltd staff, and advise of deficiencies or potential deficiencies in existing hydraulic structures. A broad outline of individual responsibilities of the TrustPower Ltd and Riley

Consultants Ltd staff is presented in figure 2, and an outline of the monitoring and surveillance reporting procedures presented in figure 3. The monitoring and surveillance system is a Paradox based data collection, transfer, storage, data manipulation and data presentation programme specifically designed for TrustPower Ltd.

The database system is currently being enhanced by TrustPower to include other components of civil safety monitoring such as the recording of periodic inspections (eg tunnels), performance testing of critical protection equipment and the programming of procedural updates. These items fall under the large umbrella of civil safety compliance. The intent is that the system will provide both a historical record of dam compliance monitoring and processes as well as a future checklist of requirements.

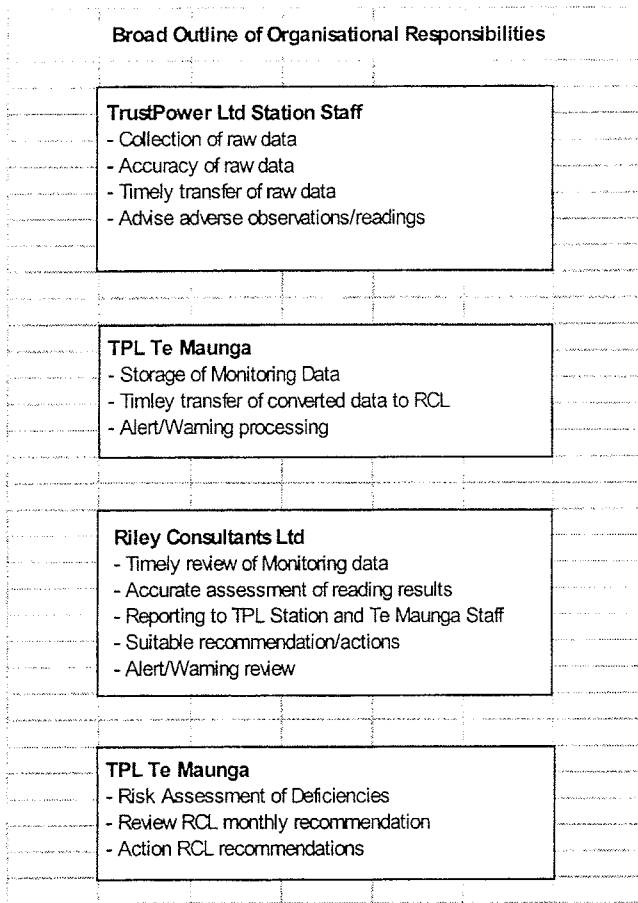


Figure 2: Outline of Organisational Responsibilities

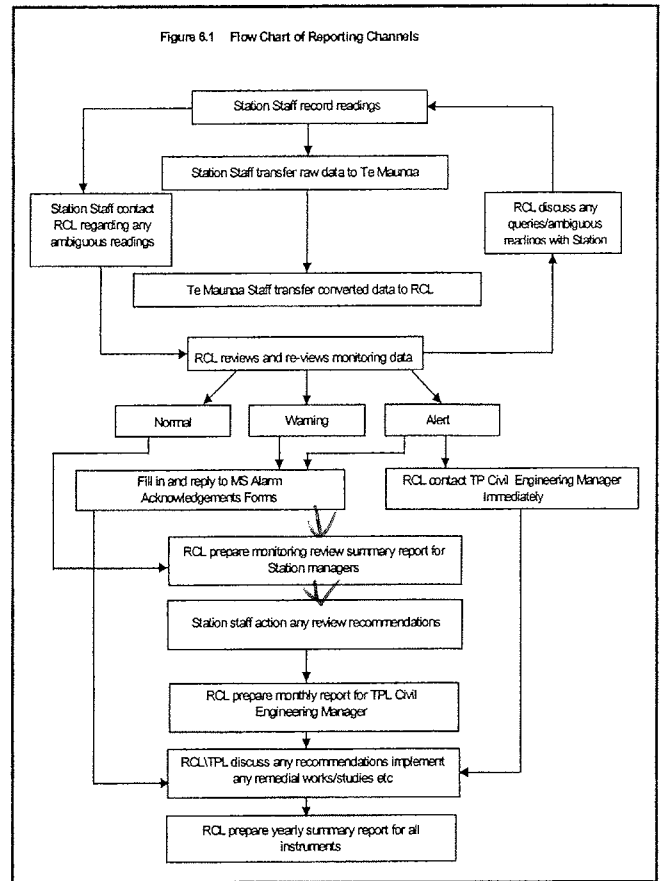


Figure 3: Outline of reporting channels

Review of monitoring information including deformation surveys is critical to the ongoing safety evaluation of the dam structures portfolio wide. To unify the monitoring and surveillance data collection process two data collection systems were developed (Figure 2, Figure 3) to collect and transfer data to the Paradox database, namely:

- PSION handheld computers for large schemes
- Excel visual basic data books for smaller schemes

The PSION system was developed so that station staff can input, store and review data onsite. The main advantage with the system is that it is two way.

Updated statistics and alarm levels for each instrument are uploaded automatically each time the units are used. This means that site staff are warned immediately, within the field, of possible inconsistent or unusual readings.

The Excel system was developed for schemes where the PSION system was not economic due to the small number of monitoring locations. This also has key statistics embedded in the system but relies on periodic upgrades. The PSION and Excel data storage programmes are designed to transfer monitoring data automatically to TrustPower Ltd head office in Tauranga where raw data is collected in the principal paradox based monitoring and surveillance system processed and reported on. Data is transferred to a mirror system at Riley Consultants Ltd for review and response to alarms, inconsistent readings or any other issues.

CONCLUSIONS

Purchasing a large number of dam structures in a short time period by a company not historically a large dam owner has provided TrustPower Ltd with some unique challenges in establishing a dam management programme to provide security to shareholders. To assist in the task TrustPower Ltd engaged an independent engineering consultancy, Riley Consultants Ltd, to provide technical support and an ongoing review role to the dam management program. The geographic spread and the number of inherited management systems required a unified approach to dam management, and understanding the history and engineering peculiarities of each dam. A fully integrated company wide risk management system in to which perceived deficiencies were fed, was crucial in this process. Utilisation of dam potential impact ratings facilitated prioritisation of risks. In association a robust monitoring and surveillance system was developed and is still being enhanced.

The lessons to date have proven that establishing a dam management program from scratch is a large task and takes several years to complete. The purchase of dams from a number of organisations has shown that there is significant variation in approaches to dam safety management. Unifying several systems in an economical manner requires a risk assessment approach to identify key issues and actions to be undertaken to improve the safety or knowledge of potential hazards and consequences.