DEVELOPMENT OF INFRASTRUCTURE ASSET MANAGEMENT SOFTWARE SOLUTIONS FOR MUNICIPALITIES IN SOUTH AFRICA

A Record of Study

by

CHRISTOPHER JAMES VON HOLDT

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF ENGINEERING

December 2006

Major Subject: Engineering
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Approved by:

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ABSTRACT

Development of Infrastructure Asset Management Software Solutions for Municipalities in South Africa. (December 2006).

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Chair of Advisory Committee: Dr. Roger E. Smith

This Record of Study presents the development of infrastructure asset management software solutions for municipalities in South Africa. The study was performed within a multidisciplinary engineering consulting company in South Africa with an interest in expanding its infrastructure asset management consultancy services in the local government market.

South Africa faces a large backlog in the delivery of basic services to communities; existing infrastructure is showing signs of advanced aging; and municipalities are inadequately staffed to effectively provide services with limited funding. The company identified the opportunity to support South African municipalities with the delivery of sustainable infrastructure services through the implementation of infrastructure asset management best practice. The provision of these services required the development of infrastructure asset management software that satisfies the needs of municipalities.

Infrastructure asset management practice around the world and in the context of municipalities in South Africa was reviewed to gain an understanding of the specific requirements of the asset management software solution. The software functionality was conceptualized and the technical requirements were identified to aid development. Finally, a business plan was prepared to assess the commercial viability of the software and to guide its introduction into the market.

To my wife, Joré, who has made this journey a memorable one.

ACKNOWLEDGMENTS

I would like to express my gratitude to my graduate advisor, Dr Roger Smith, for his continuous support and encouragement throughout the Doctor of Engineering program. I would also like to extend my appreciation to my Texas A&M committee members, Dr. Francisco Olivera, Dr. Larry Gresham, and Dr. Don Smith, who have supported my involvement in this program.

I am especially grateful to Dr. Gustav Rohde from Africon for encouraging me to attend Texas A&M, for serving on my internship committee, and for providing me with guidance during the internship. I am also grateful to my colleagues from Africon who have contributed to this project over the past year and for the long working hours they have endured. Finally, I would like to acknowledge Africon for providing financial support for my studies at Texas A&M and for their ongoing support of my involvement in this program.

TABLE OF CONTENTS

Page

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

1. INTRODUCTION

1.1 Background

South Africa currently faces many infrastructure related challenges at the local government level. The country has a large backlog in the delivery of basic services to communities, existing infrastructure is showing signs of advanced aging, and municipalities are inadequately staffed to effectively provide services with limited funding. The national government has realized the seriousness and urgency of the infrastructure situation and is taking proactive steps to remedy the situation. The field of infrastructure asset management is generally viewed by national government as a technical discipline that can be used to improve the infrastructure and service delivery situation across the country. Numerous steps have been taken by the national government to support the implementation of infrastructure asset management, including the passing of legislation, provision of funding, and the provision of technical resources and guidelines.

In South Africa, government agencies generally do not have the depth of technical skills to implement major infrastructure initiatives without the assistance of private consultancies. The current infrastructure situation in the country and the support of national government has provided an opportunity for private consultancies. Africon Engineering International (Africon) has identified this opportunity and have committed to developing the internal capacity of the company to provide infrastructure asset management services. Africon is a large multidisciplinary consultancy based in Pretoria, South Africa, has a staff complement of approximately 1,200 people, and operates in more than 20 countries worldwide.

This record of study follows the style and format of the *Journal of the Transportation Research Board.*

1.2 Internship with Africon Engineering International

Chris von Holdt worked as a permanent member of the Asset and Project Management Unit under the direct supervision of Mr. Johan Viktor who is a technical director of the company. The internship supervisor was Dr Gustav Rohde, who is the Chief Executive Officer of the company.

Chris von Holdt was involved in the development of technical asset management resources, providing consultancy services in asset management, the preparation of asset management tender proposals, and strategic planning related to asset management.

Asset management projects to which contributions were made during the internship include the development of a standardized approach to asset register compilation for the Western Cape Province, the preparation of an asset management policy for the Capricorn District Municipality, and the compilation of asset registers for the Drakenstein and Stellenbosch municipalities.

The main involvement of the internship was the development of the technical resources needed to implement infrastructure asset management practice at the local government level, including software that is capable of meeting the infrastructure asset management needs of small to medium sized municipalities in South Africa. The approach adopted to develop and ensure the sustainability of the solution provided by the software was to gain an understanding of infrastructure asset management best practice from around the world, gain an understanding of the South African environment, and to develop a technical solution that is focused on meeting the particular needs of small to medium sized municipalities in South Africa. A business plan was developed to assess the financial feasibility of the software and to guide the introduction of the software into the market.

The software development project had already begun when the internship started. The required software functionality became more apparent during the implementation of asset register compilation projects and improvement and refinements were identified along the way. The first version of the software has been completed and is functional, but additional requirements have been identified. Additional functional and technical

specifications must still be prepared to form the basis of the development of the next version of the software. Several of the technical resources require further refinement, including the data collection field guides, asset valuation models, and budget estimation models. Most of the focus has been on the technical aspects of the asset register to date. A greater focus needs to be placed on the understanding of the financial treatment of infrastructure assets in the future.

2. INFRASTRUCTURE ASSET MANAGEMENT OVERVIEW

The International Infrastructure Management Manual (IIMM) defines infrastructure asset management as the goal to meet a required level of service, in the most cost-effective manner, through the management of assets for present and future customers *(1)*. The key elements include:

- taking a life-cycle approach;
- developing cost-effective management strategies for the long term;
- providing a defined level of service and monitoring performance;
- understanding and meeting the impact of growth through demand management and infrastructure investment;
- managing risks associated with asset failures;
- sustainable use of physical resources; and
- continuous improvement in infrastructure asset management practices.

The AASHTO Transportation Asset Management Guide states that the goals of asset management are to *(2)*:

- build, preserve, and operate facilities more cost effectively with improved asset performance;
- deliver to an agency's customers the best value for the public tax dollar spent; and
- enhance the credibility and accountability of the transportation agency to its governing executive and legislative bodies.

There have been several definitions of infrastructure asset management, but most share the key principles of taking responsibility for the provision of defined levels of service to users, adopting a life-cycle management and financing approach to

infrastructure, and making decisions that get the best reward for investment. Infrastructure asset management is a combination of a management philosophy and the physical science of managing infrastructure. Appropriate management principles need to be adopted by the organization responsible for the assets. The implementation of the management principles must in turn be supported by appropriate decision support methodologies and information. Infrastructure asset management cannot be implemented without a commitment to adopt both the management principles and the physical science behind it.

The infrastructure asset management principles are applicable to all managers of infrastructure in both private enterprises and in public agencies. However, the main driving force behind the development of guidelines and methodologies has been to support public agencies with the sustainable delivery of services to their communities.

The technical principles of infrastructure asset management principles are not a new science and have been used in managing road networks since the 1960s. Given that road networks are typically the most valuable asset group, are very visible, and are relatively short-lived, it is understandable that road management practices have lead the way in the development of infrastructure asset management solutions. It is only in the past decade that infrastructure asset management principles have been adopted and implemented for other infrastructure services on a wide scale.

2.1 International Context

The IIMM provides an overview of infrastructure asset management in countries, including the United States, Australia, New Zealand, South Africa, and the United Kingdom. Brief summaries of the key points related to infrastructure asset management software are provided below.

2.1.1 United States

The United States heavily invested in infrastructure after World War II. This infrastructure is starting to reach its terminal age and needs renewal. The maintenance and renewal of the existing infrastructure presents a major infrastructure management

challenge in the USA. The management of infrastructure is primarily the responsibility of the individual states and local municipalities, although the Federal Government does have considerable financial influence over decision making.

Infrastructure asset management has been driven to some extent by the introduction of new accounting standards for state and local government bodies in 1999. The Government Accounting Standards Board (GASB) promulgated Statement 34, which requires the adoption of accrual accounting for infrastructure assets. The statement allows for the adoption of a depreciation or a modified method of accounting for infrastructure assets. The depreciation method is the simpler method and requires the depreciation of the historic cost of the asset over the useful life of the asset. The use of the modified approach is conditional on utilizing an infrastructure management system and demonstrating that the assets are being managed at an appropriate level. The concept underlying this approach is that many infrastructure assets have indefinite lives if managed effectively over time and depreciation is not reflective of the consumption of the asset. There is no depreciation expense when using the modified approach, but all preservation costs are expensed. The actual expenditure is compared to the required expenditure from the infrastructure management system to assess performance *(3)*.

Sophisticated infrastructure management software are widespread in the United States. The modified approach to accounting for infrastructure assets lends itself to the use of existing infrastructure management systems, such as pavement management systems and bridge management systems.

2.1.2 Australia

The adoption of infrastructure asset management by local government bodies in Australia is fairly widespread and growing with the support of national and state support programs. The Institute of Public Works Engineering (IPWEA) established a national asset management committee in 1993, who published the IMEA national asset management manual in 1994 and partnered with the National Asset Management Steering (NAMS) group of New Zealand to publish the IIMM in 2000.

The principal driver of infrastructure asset management implementation was the introduction of new accounting standards that supported accrual accounting principles in 1993. Councils were required to report service potential and consumption of infrastructure. State-based regulators, e.g. electricity, gas and water supply, were required to produce infrastructure asset management plans.

States have different levels of infrastructure asset management adoption. The state of Victoria provides assistance with a program (STEP) to assist implementation and the IIMM is used as the basis of infrastructure asset management practice. A variety of software solutions are used in Australia, ranging from simple systems through to enterprise solutions *(1)*.

2.1.3 New Zealand

Infrastructure asset management is very widely practiced in New Zealand with widespread adoption by local government and strong support from national government. The NAMS group produced the New Zealand Infrastructure Asset Management Manual in 1996 and has provided a series of workshops to support the implementation of infrastructure asset management. NAMS strongly supported the development of the IIMM in 2000 and this manual has become the standard for infrastructure asset management practice.

The Office of the Auditor General has been the principal driver of infrastructure asset management implementation since the publishing of a special report to parliament over the lack of procedures for infrastructure asset accounting in 1993. A local government Act in 1996 required local authorities to produce financial statements that take into account asset creation and service potential. A further Act in 2002 required infrastructure asset management plans to be produced. In 2003 the Attorney General reviewed infrastructure asset management practice and concluded that authorities needed to move from core infrastructure asset management planning to advanced systems including optimized decision making and risk analysis.

Since the 1990s, local authorities were required to use a computerized maintenance management system. The NAMS group introduced infrastructure asset

management information systems including Hansen[1] and Confirm[2] and predictive modeling systems (dTIMS[3]) and supported the use of these systems. These systems have not been used by all authorities, with some choosing self developed systems, alternative software such as BizeAsset[4] and Maximo[5], and GIS systems to present and manage data. A software trend noticed in New Zealand is the movement to enterprise software that provides a wide range of client solutions, including billing, administration, licensing, customer service, etc *(1)*.

2.1.4 United Kingdom

In the United Kingdom the practice of infrastructure asset management is largely driven by regulations and sector specific regulating bodies that are striving for more effective management practices, competition, risk reduction, and performance measurement. National Government provides a general framework for the management of assets, but do not prescribe how the assets are to be managed. As a result, some sectors have been more successful in adopting infrastructure asset management than others.

The UK Government Treasury has recently introduced accrual based accounting to cover all expenditure from 2001/2002. This method covers the entire public sector and will allow consistent evaluation and comparison across all sectors. The target date for total implementation is 2005/2006.

Infrastructure asset management appears to be widely adopted at a high level of sophistication in the UK. Numerous software systems are available in the UK market, with an abundance of enterprise software solutions *(1)*.

2.1.5 World Bank Advisory Note on Strategic Municipal Asset Management

A report was prepared by Worley International Limited on behalf of the World Bank that suggests an infrastructure asset management approach for developing countries *(4)*.The approach is consistent with the World Bank's Urban and Local Government Strategy

[1] www.Hansen.com
[2] www.MapInfo.com
[3] www.deighton.com
[4] bizeasset.com
[5] www.mro.com

that is based on a vision of sustainable cities that are livable, competitive, well governed, and bankable. The report highlights the need for legislative reforms, support systems, and performance monitoring as key conditions for the adoption of infrastructure asset management.

The report defines a schedule of stages in the development of municipal infrastructure asset management, which are useful to map current practice and develop improvement plans. The stages also provide insight into the decision support needs of municipalities at the different stages of infrastructure asset management development. The stages are shown in Table 1 below.

TABLE 1 Stages in the Development of Municipal Asset Management

Stage	Requirements
Stage 1	
Improvement Strategy Development	Needs analysis/status assessment Setting base strategy/asset management objectives Asset data classification Collection priorities confirmed Asset management improvement program adopted
Stage 2	
Basic Asset Register	Set up basic asset register Asset management information system Identification of all assets Basic data captured Asset replacement cost determined Asset replacement timetable determined Initial asset management plans Current levels of service identified Basic valuations prepared
Stage 3	
Basic Asset Management	Improve attribute data Introduce basic condition assessment Valuation based on condition Optimize data collection for critical assets Maintenance history data identified Second generation (basic) asset management plans prepared Renewal decision-making processes documented Determine target levels of service based on stakeholder consultation Costs captured against assets

Table 1 Continued

Stage	Requirements
Stage 4	
Improved Maintenance Management	Review maintenance procedures Apply improved procedures to assets Schedule procedure intervals Review maintenance plans for key assets Begin to introduce asset criticality analysis and risk management
Stage 5	
Introduce Advanced Asset Management Techniques	Complete failure analysis on all key asset groups and critical facilities Complete consequence of failure (risk management) analysis on all assets Apply these findings to the life-cycle strategy and maintenance plans for assets Valuations based on true economic lives
Stage 6	
System Optimization	Optimized life-cycle and economic decision making used for planning levels of service, based on ongoing stakeholder consultation All options for overcoming failures analyzed Benefits for each option quantified Costs for each option quantified Most appropriate strategy for each asset, facility or system identified Advanced asset management plans developed

2.2 Infrastructure Asset Management in South Africa

2.2.1 Overview

Major legislative reform since the adoption of a new constitution in 1993 led to the introduction of a new system of local government in 2000. In this time, 700 local authorities have been amalgamated into 284 municipalities and numerous powers and functions have been passed from national and provincial level to the local government level. Local government authorities are being held more and more responsible for service delivery. The 9 provinces are divided into 47 districts, which are managed by district municipalities. The districts are divided into 231 local municipal areas managed by local municipalities. A map of the provinces and local municipalities is provided in Figure 1.

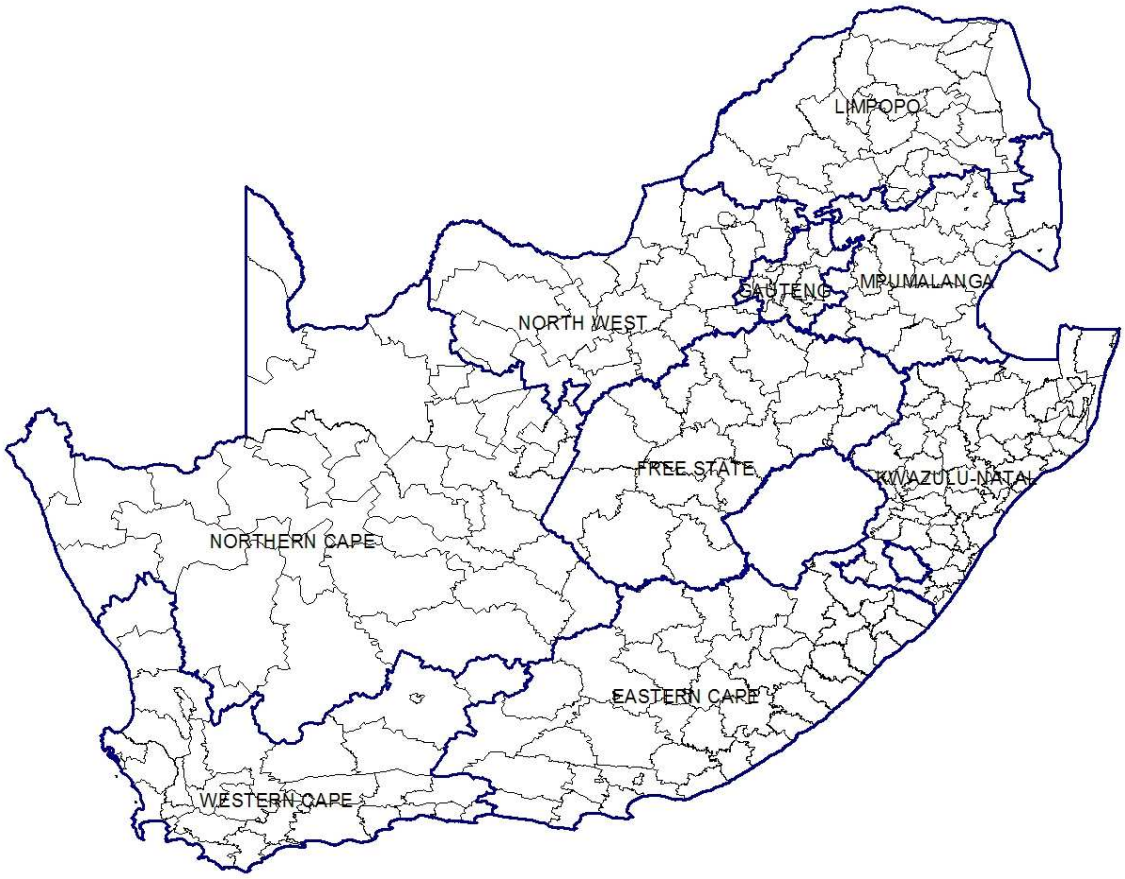

FIGURE 1 South African provinces and local municipalities.

The responsibility for service delivery is divided between the district and the local municipalities, based on the capacity to perform specific functions. The responsibilities of the different tiers of government are as follows:

- National: Assist and support municipalities by providing financial and technical assistance, including guides, manuals, and regulations.
- Provincial: Play a coordinating role in roll-out of the Municipal Finance Management Act (MFMA) and intervene when financial problems become evident at municipalities.

- Local: Provide financial and service-delivery information to the higher levels of government and liaise with other municipalities and districts on budget issues.

The delivery of infrastructure services in South Africa poses somewhat different challenges from many other countries. A large proportion of the South African population has inadequate access to even the most basic levels of municipal services. Basic services include piped water, sanitation facilities better than bucket latrines, and access to electricity. Approximately 18% of households have inadequate access to water, 32% of households have inadequate access to sanitation facilities, and 26% of households have inadequate access to electricity *(5)*. This large backlog in service provision poses a major challenge for municipalities as the areas with service delivery backlogs have populations that are unable to pay for the services. A relatively small proportion of the population with existing infrastructure provides the only revenue from the provision of services. Balancing the infrastructure maintenance needs of existing paying customers with the needs of those who have no services is a major challenge.

Municipalities have been tasked with meeting this challenge. This responsibility has been supported by recent legislation, including the MFMA and the Municipal Systems Act that makes municipal managers responsible for service delivery and the evaluation of performance. The municipalities are supported by national grant programs, which provide grant funding for capital expenditure with the aim to eradicate basic service backlogs by 2013. The grant programs, including the Municipal Infrastructure Grant (MIG), currently do not provide financial support for the maintenance and renewal of existing infrastructure.

The changes in the country since democracy in 1994 have not left municipalities untouched. A study by Alison Lawless *(6)* on the state of civil engineering in South Africa has revealed that the demand for engineers in the municipal environment far outstrips supply and the technical capacity and skills of municipalities have eroded in the past decade. The number of engineers in municipal bodies has declined while the new municipal demarcations and the acceleration of service delivery have increased the

demand for engineers. Senior technical positions have been filled by non-technical managers. This has resulted in frustrated technical managers who have entered early retirement or left the sector out of frustration. As a result, technical departments have become strategic and largely only initiate projects that are executed by the private sector.

Research findings in Lawless' study from a survey of 284 district and local municipalities revealed high levels of vacancies for technical civil staff. The findings found that 80% of local municipalities have no civil engineers and 34% have no qualified civil technical staff in the form of civil engineers, technicians or technologists. In district municipalities, 47% have no civil engineers and 9% have no qualified civil technical staff in the form of civil engineers, technicians or technologists.

These results show the enormous shortage of skills required for the implementation of infrastructure asset management in municipalities. In the cases where technical staff are available, these staff are generally overworked and have little capacity to start implementing new programs that place an additional burden on them.

In the past few years South African communities have become more demanding for the delivery of service by municipalities. The demands have turned into demonstrations, riots, and on occasion public violence, which has increased the media coverage and exposure of the demands. Some recent incidents include:

- Residents of Bothaville's Kgotsong township in the Free State ran riot in a protest over lack of service delivery, burning shops, disrupting schools and damaging property *(7)*.
- Demonstrations by residents of Frankfort and Namahadi in the Free State turned violent and municipal offices were also set alight, a stadium was vandalized, and various shops inside the township were looted *(8)*.
- Residents of Soshanguve demonstrated against poor service delivery and blocked roads and burnt tires in the streets *(9)*.

Municipalities in South Africa currently find themselves in a difficult position. They have demanding communities to satisfy, legislation demanding compliance, increased funding to spend, and very little technical capacity to do it with. The implementation of infrastructure asset management is expected to be a major challenge to most municipalities, and it is expected that consultants will supply supportive technical skills to provide infrastructure solutions.

Infrastructure asset management practice in South Africa is still in the early days of development. The Institute of Municipal Engineers of South Africa (IMESA) has launched the IIMM in South Africa, which is considered a manual of best practice. The public and private sector are gearing up to implement infrastructure asset management in the country with technical resources being developed, infrastructure asset management forums being created, and training programs being initiated.

2.2.2 Legislation

Several Acts of legislation have been introduced that support infrastructure asset management, with the MFMA being the principal driver of infrastructure asset management implementation. Section 63 of the Act places very specific responsibilities on the municipal accounting officer *(10)*. The Act states that:

> The accounting officer of a municipality is responsible for the management of –
>
> i) the assets of the municipality, including the safeguarding and the maintenance of those assets; and
> ii) the liabilities of the municipality.
>
> The accounting officer must for the purposes of subsection (1) take all reasonable steps to ensure –
>
> i) that the municipality has and maintains a management, accounting and information system that accounts for the assets and liabilities of the municipality;

ii) that the municipality's assets and liabilities are valued in accordance with standards of generally recognized accounting practice; and
iii) that the municipality has and maintains a system of internal control of assets and liabilities, including an asset and liabilities register, as may be prescribed.

Guidelines for the implementation of the MFMA have been provided by the Department of National Treasury (National Treasury) to assist practitioners. Key concepts include the following *(11)*:

i) The Act recognizes that local government is distinctive and independent, with the power to determine its own budget and policies.
ii) The Act makes the executive mayor or committee responsible for policy and outcomes, and the municipal manager responsible for implementation and outputs.
iii) The Act states that the municipal manager is responsible for the management of the municipality's assets and liabilities and should ensure that appropriate systems and policies are in place to adequately safeguard and maintain the municipality's assets.
iv) The Act replaces the rules and procedures based finance system with an outcomes focused system. The Act does not provide prescribed rules and procedures, but sets local government national norms and standards.
v) Financial planning has shifted from addressing immediate demands to the consideration of future financial needs.
vi) Municipalities are required to pass budgets that are fully funded and borrow only for current and capital expenditure. Budgets must accommodate all operational and maintenance costs. This places a greater emphasis on achieving a balance between revenue generation and expenditure on existing infrastructure.

There is strong alignment between the MFMA and the Municipal Systems Act. The Acts are complementary in their requirement for the adoption of performance-based municipal management. The MFMA focuses on financial performance, while the MSA focuses on non-financial performance.

The Municipal Systems Act states that the council of a municipality has the right and duty to ensure that municipal services are provided to the local community in a financially and environmentally sustainable manner *(12)*. The financial sustainability requirement includes provision for capital costs, operations costs, and the maintenance, repair, and replacement of physical assets. This implies that the financial needs of the infrastructure must be known to the municipal council.

The constitution of the Republic of South Africa states that one of the objectives of local government is "to ensure the provision of services to the community in a sustainable manner" *(13)*. This implies that local government must not only provide infrastructure in the short term, but maintain it in the future in a sustainable manner.

The Municipal Structures Act provides for the division of functions and powers between district and local municipalities *(14)*. The responsibilities are managed by the Municipal Demarcation Board, who perform annual reviews of the capacity and capability of municipalities and make recommendations to the minister on how the roles and functions should be divided.

The annual Division of Revenue Act (DORA) that is applicable to a particular financial year provides for an equitable distribution of revenue between the different tiers of government *(15)*. District municipalities are responsible for the distribution of resources among the local municipalities.

The Water Services Act (WSA) provides for access to basic water and sanitation services and the preparation of Water Services Development Plans, which must have a 5 year time frame and contain details on the required infrastructure and the operations, maintenance, repair and replacement of the existing infrastructure *(16)*.

The Government Immovable Asset Management Bill (GIAMA) requires national and provincial government asset custodians to prepare immovable asset management

plans *(17)*. Although much legislation is supportive of infrastructure asset management planning at the local government level, no legislation currently requires municipalities to develop infrastructure asset management plans.

2.2.3 Infrastructure Asset Management Guidelines

Several national departments have been involved in the development of asset management guidelines for practitioners. National Treasury has provided several guidelines including an Asset Management guideline, which introduces asset management and provides basic asset management guidelines to the public sector *(18)*. A section on asset register software states that a variety of software systems are available in the market place to assist in the effective management of assets and that any software system may be used for the capturing of assets provided it will give the information required for disclosure purposes and has been approved by the National Treasury. It also states that the asset register year-end reports should be used to support the asset amounts reflected in the Annual Financial Statements for disclosure purposes. National Treasury have provided guidelines *(19)* on the implementation of accounting standards, and circulated a letter *(20)* stipulating the minimum requirements for an asset register.

The Institute of Municipal Financial Officers (IMFO), South African Local Government Association (SALGA), LG Consultants, and Ernst and Young developed a Local Government Financial Best Practice Manual in 2004, which includes a fixed asset illustrative policy and procedures to deal with municipal assets. This manual is made available online on the IMFO website *(21)*.

2.2.4 Accounting Standards

In South Africa the Accounting Standards Board (ASB) is required in terms of the Public Finance Management Act (PFMA) to determine generally recognized accounting practice, referred to as Standards of Generally Recognized Accounting Practice (GRAP), that is applicable to government agencies *(22)*. The accounting standards are controlled by three parties, including the ASB, National Treasury, and the Auditor-General's office. The ASB is responsible for developing and issuing accounting standards. National Treasury is responsible for developing implementation guidelines and issuing Specimen

Annual Financial Statements in accordance with the accounting standards issued by the ASB. The Auditor-General is responsible for auditing financial statements in line with these accounting standards and the formats *(19)*.

In July 1997, National Treasury commissioned a study to develop statements of generally recognized accounting practices for local government. These statements, known as "old GAMAP", were largely based on the Statements of Generally Accepted Accounting Practice (SA GAAP) that were applicable at the time. In 2003, the MFMA stipulated that municipalities must comply with the accounting practice prescribed in the Standards of Generally Recognized Accounting Practice (GRAP). The old GAMAP was reviewed to be more consistent with International Public Sector Accounting Standards (IPSASs) and in 2004, the revised standards, known as Standards of Generally Accepted Municipal Accounting Practice, and referred to as the "new GAMAP", were introduced by the ASB *(23)*.

The new GAMAP is applicable to municipalities until such time that it is replaced with a relevant GRAP. Compliance will be required in the financial year after the issuance of the GRAP. The current effective date to comply with the Standards of GAMAP varies with the assessed capacity of the municipalities by the Municipal Demarcation Board. The dates of compliance are:

- high capacity by year ended 30 June 2006;
- medium capacity by year ended 30 June 2007; and
- low capacity by year ended 30 June 2008.

The standards of GRAP that were issued prior to the new GAMAP with which municipalities need to comply are the:

- Preface to the Standards of GRAP;
- GRAP 1 – Presentation of Financial Statements;
- GRAP 2 – Cash Flow Statements; and

- GRAP 3 – Accounting Policies, Changes in Accounting Estimates and Errors.

The standards of GAMAP with which municipalities need to comply are the:

- Preface to the Standards of GAMAP;
- GAMAP 4 – The Effects of Changes in Foreign Exchange Rates;
- GAMAP 6 – Consolidated Financial Statements and Accounting for Controlled Entities;
- GAMAP 7 – Accounting for Investments in Associates;
- GAMAP 8 – Financial Reporting of Interests in Joint Ventures;
- GAMAP 9 – Revenue;
- GAMAP 12 – Inventories;
- GAMAP 17 – Property, Plant and Equipment; and
- GAMAP 19 – Provisions, Contingent Liabilities and Contingent Assets.

Municipal assets have been classified into several different classes, with infrastructure assets falling into the class of property, plant, and equipment. The classification of assets is shown in Figure 2

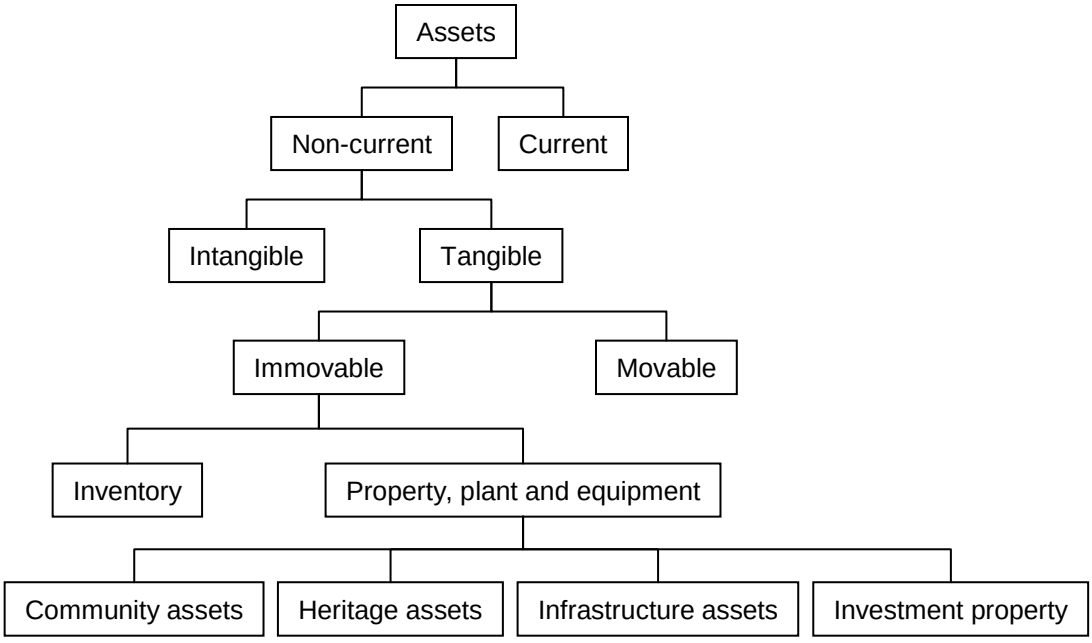

FIGURE 2 Asset classification.

Examples given of infrastructure assets include roads, water reticulation schemes, sewerage purification works, and water mains. Infrastructure assets are defined as assets that *(23)*:

- are part of a network of similar assets;
- are specialized in nature and have no alternative uses;
- are immovable; and
- are subject to constraints on disposal.

2.2.5 Infrastructure Asset Management Systems

Infrastructure asset management covers a wide range of activities related to infrastructure assets and numerous systems have been developed to address these needs. Infrastructure asset management is concerned more with the life-cycle management of infrastructure than design, so design systems are not considered.

Geographic Information Systems (GIS) have been very widely adopted by government agencies at the national and provincial levels of government to manage and store infrastructure information. Many of the high capacity local government agencies do have a GIS, but there are still many of the smaller agencies that do not.

Infrastructure asset management systems that deal with the life-cycle maintenance needs of the infrastructure include mainly pavement management systems and bridge management systems. Sophisticated pavement and bridge management systems are widely use by the national and provincial departments and metropolitan municipalities. These systems are generally capable of performing optimized decision making and producing maintenance and rehabilitation plans. The operation of these systems is predominantly contracted out to consultants, although some are managed in-house. Some of the smaller municipalities have less complex pavement management systems that are typically contracted out to consultants.

Maintenance and facilities management systems are widely used by national and provincial departments, and metropolitan municipalities. Some of the smaller municipalities have these systems, but normally with limited functionality.

Other relevant infrastructure management systems include network demand prediction and design systems for networked infrastructure such as water supply, sanitation, and road networks. These systems are also widely used by the national and provincial departments, and metropolitan municipalities, with some smaller municipalities contracting out this function to consultants.

2.3 Infrastructure Asset Management Practice in Developed and Developing Countries

The infrastructure asset management needs of developing countries, including South Africa, are somewhat different from those of the developed countries reviewed in this study. Both developed and developing countries share the challenge of eradicating maintenance backlogs from inadequate maintenance expenditure in the past. However, developing countries face the additional burden of eradicating large infrastructure

provision backlogs. Large proportions of the populations of developing countries do not have access to basic services, such as clean running water, sanitation facilities, and engineered roads.

The provision of basic services is often viewed as a greater priority by decision makers than the maintenance of existing infrastructure. This priority is more pronounced when short-term objectives dominate decision making and an understanding of the life-cycle needs of infrastructure are not entrenched. The development of new infrastructure is expensive and limited infrastructure funds are often quickly exhausted with little funding being allocated to maintenance. The inadequate expenditure on maintenance results in inefficiencies and the wastage of financial resources in the long run.

A major challenge facing developing countries is therefore to develop a decision making process to optimize expenditure between the provision of new infrastructure and the maintenance of existing infrastructure. Although this problem is addressed conceptually in some manuals and guides, the resolution of this problem in South Africa requires much attention. This Record of Study is based on the development of software that addresses the infrastructure maintenance component of the problem.

3. INFRASTRUCTURE ASSET MANAGEMENT NEEDS OF MUNICIPALITIES

3.1 Primary Infrastructure Asset Management Needs

The primary infrastructure asset management needs have been identified by means of a review of the current situational context in South Africa, discussions with municipal officials, the review of tender calls, and the opinions of experienced practitioners. The underlying concept that has emanated is the need for simplicity to ensure sustainability in an environment with limited technical capacity. The core needs have been identified as:

- the compilation of a GAMAP compliant asset register for all municipal assets to comply with legislation;
- the means to manage and maintain the asset register data; and
- the implementation of infrastructure asset management practices within the municipality.

Municipalities are required by the MFMA to compile GAMAP compliant asset registers for movable, property, and infrastructure assets. The assets must be represented in the financial statements of the municipality under non-current assets. The municipalities then have to maintain the asset register. This entails maintaining the data relevant to every asset through the asset lifecycle of acquisition, maintenance, and disposal. Expenses, impairments, and depreciation of the asset must be recorded. The means are needed to capture changes, manage the data in the register, and communicate the results to the financial statements.

Much awareness has been raised in South Africa about infrastructure asset management and the need to implement it in municipalities. The theory of infrastructure

asset management is convincing, but municipalities need the tools and methodology to implement the infrastructure asset management practices.

3.2 Satisfying the Primary Needs with a Software Tool

The primary needs can be partly addressed by a well designed software. The software acts as a tool used to simplify computational problems and manage information. The following software requirements have been identified from the primary needs.

3.2.1 The Compilation of a GAMAP Compliant Asset Register for all Municipal Assets to Comply with Legislation

Software is required to capture data into an asset register. A GAMAP compliant data structure is required in the software so that it can be populated with asset register data. The data structure must be complete and accommodate all asset types. The data structure should follow the concept of a defined inventory with associated attribute data to enable integration with other systems.

3.2.2 The Means to Manage and Maintain the Asset Register Data

Software functionality is required to update and maintain the asset register data and to integrate with other existing systems. The maintenance of the asset register should be easy for the organization. Municipalities do not want to appoint additional personnel to operate software and do not want software systems that integrate poorly with existing systems.

3.2.3 The Implementation of Infrastructure Asset Management Practices within the Municipality

Software is required to support the implementation of infrastructure asset management planning. The IIMM refers to core infrastructure asset management information systems and advanced infrastructure asset management information systems to support the implementation of infrastructure asset management practices. Core infrastructure asset management information systems include an asset register to store asset data, including asset attributes, condition, performance, criticality, and maintenance records. An advanced infrastructure asset management information system will expand the core

functionality to include risk management, predictive modeling, optimized decision-making, financial modeling, and works management *(1).*

The software needs of small to medium municipalities are expected to be primarily that of a core infrastructure asset management information system in the short term. Once infrastructure asset management practices are implemented, the software needs may expand to more advanced infrastructure asset management functionality, especially the financial modeling and works management functionalities. The need for risk management, predictive modeling, and optimized decision making software functionality are expected only in the medium and high capacity municipalities that are fairly advanced in the implementation of infrastructure asset management practices.

3.2.4 Summary of Software Requirements

The summary of the software requirements to satisfy the needs of medium to small municipalities is a software that contains a GAMAP compliant asset register, can be managed and maintained easily in the municipality, and has core infrastructure asset management information functionality. The software should have the ability to be expanded to include advanced infrastructure asset management functionality, either by means of additional modules or by means of integration with other systems.

3.3 Specific Contextual Requirements of the Software

The environment in which the product will be marketed and implemented provides the context for the design of the software. Several contextual requirements of the infrastructure asset management software have been identified and are discussed below.

i) Given the low technical capacity of municipalities in South Africa, the software needs to be simple in its design and in its operation. The software design must allow the external maintenance thereof by consultants, but allow the municipalities access to the information.
ii) Given the fact that most municipalities are cash-strapped, the software should be affordable to implement and maintain. The purchase cost of the software and

maintenance fees should be kept as low as possible. The software must be capable of minimizing data collection costs by being data efficient, and by operating with different levels of data accuracy.

iii) Given that several municipalities may have existing software systems and IT architectures in place, the software should be able to be integrated with other systems. In particular, the software should be able to be integrated with existing GIS systems, and common database systems that may form the basis of other software such as maintenance management systems, land use management systems, financial systems, etc.

iv) Given the great number of municipalities and their wide distribution across the country, the software design should allow the support and updating of the software from a remote location.

v) Given the different sizes of municipalities, the software should be scalable to fit in with the nature and size of the organization, from single users to multiple users in different departments and locations.

4. CONCEPTUAL MODEL OF THE SOFTWARE

Conceptual models of the software are provided to conceptualize the function of the software and to guide the development thereof in the future. The software under development has been termed “Asset Manager” and will be referred to as such throughout the remainder of the document.

4.1 Conceptual Models

4.1.1 Relation of the Asset Manager Software to Infrastructure Asset Management Planning

The Asset Manager software should be a simplified infrastructure management system, capable of operating with macro information. The software should be compatible with more sophisticated infrastructure systems, such as demand modeling, condition modeling, and maintenance management systems. The common base of the infrastructure systems should be asset inventory, which should preferably be managed in a GIS environment. The software should provide the financial system with the required financial information for municipal accounting purposes. The software should also inform the infrastructure asset management planning process, along with the other systems and external information. The relation of the Asset Manager software to infrastructure asset management planning is shown in Figure 3.

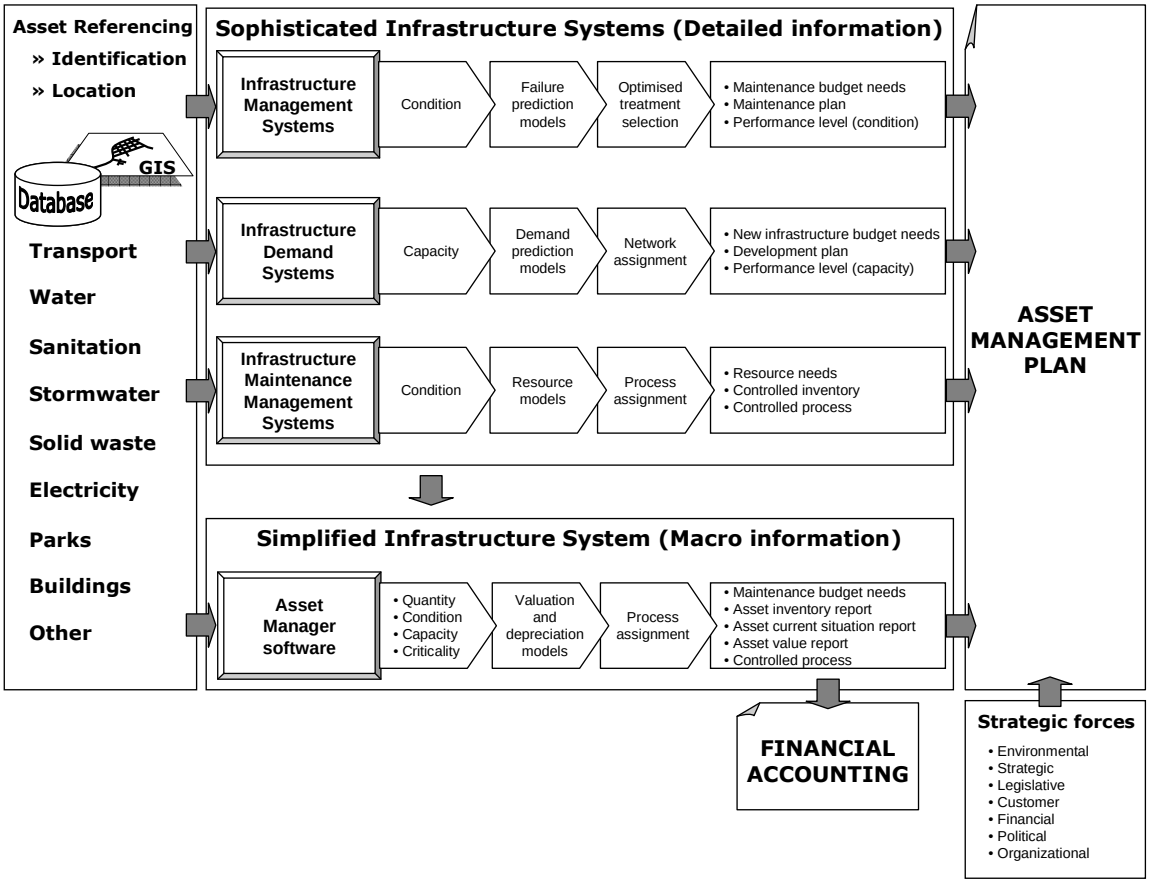

FIGURE 3 Relation of the software to infrastructure asset management planning.

4.1.2 Relation of the Asset Manager Software to other Infrastructure Modeling Systems

The Asset Manager software should be a simple data capture, maintenance, and reporting software that is capable of interfacing with more advanced infrastructure modeling systems. The compatibility between the systems lies in the development of a common inventory. The inventory should preferably be managed by either the GIS interface of the Asset Manager software or by an existing GIS in the municipality. If additional specialized functionality is added to the Asset Manager software, it should be added as an additional external module. This will maintain the ability of the software to integrate with other specialized systems, rather than becoming dependent on its own

internal systems. The interaction between the Asset Manager software and other software is shown in Figure 4.

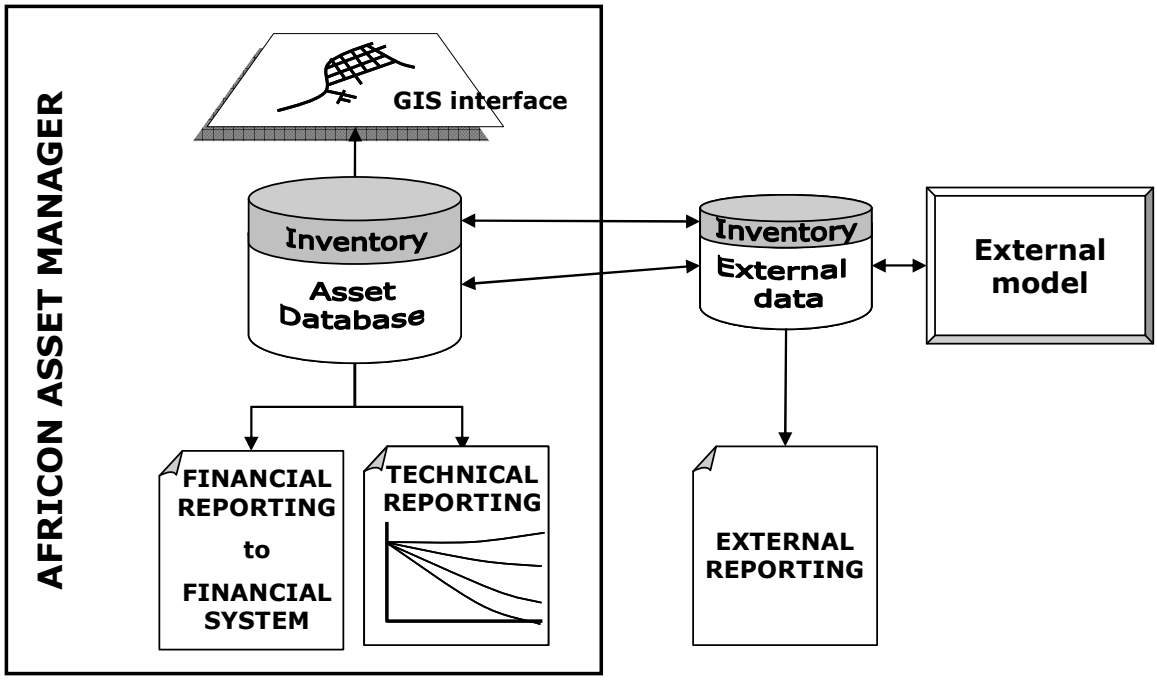

FIGURE 4 Relation of the software to other infrastructure modeling systems.

4.1.3 Core Functionality of the Asset Manager Software

The functionality that is essential to meet the primary needs of municipalities and that is central to the Asset Manager software is:

i) A GAMAP compliant asset register.
ii) A register of financial transactions, including acquisition, revaluation, depreciation, impairment, and disposal.
iii) A register of technical data, including condition, performance, and criticality;
iv) A register of historical maintenance expenses and activities.

v) A financial model to produce valuations and financial outputs.

vi) A budget estimation model to estimate budget needs for renewals and maintenance.

The inputs and outputs of the core functionality are in Figure 5.

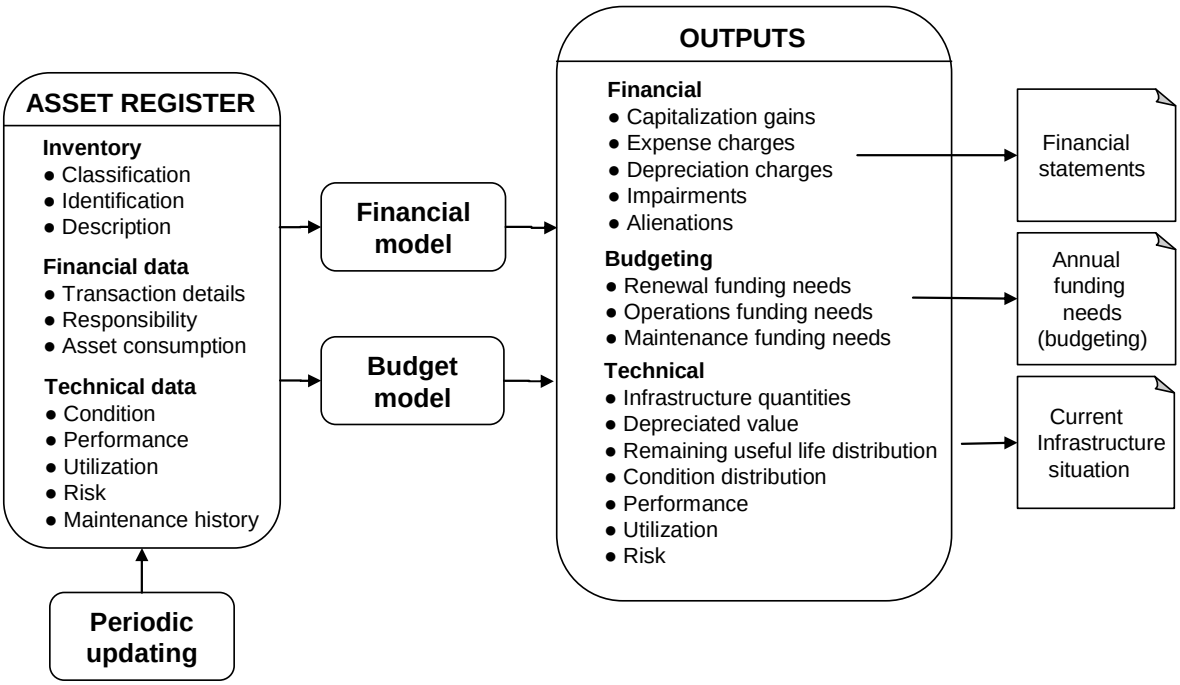

FIGURE 5 Core functionality of the Asset Manager software.

4.2 Software Selection

The Africon System Unit undertook a review of current software available in the market to determine the suitability of the software for providing the desired functionality. The study revealed that the GIS based systems that are affordable to local municipalities did not have the required database functionality, and the existing specialized asset systems lacked the ability to deal with different levels of data in a structured data hierarchy. This

prompted the initiative to develop a new software tool suited to South African conditions and requirements.

5. BUSINESS PLAN

5.1 The Business

5.1.1 The Opportunity

There is a need for sustainable infrastructure service delivery in South Africa, which requires more effective management of municipal assets by local government officials. Communities demand service delivery from municipalities and national government have placed municipalities at the forefront of meeting community needs. Many municipalities are poorly staffed and lack the skills and tools to deliver on their service delivery responsibilities. The principles of infrastructure asset management are being actively promoted in South Africa as best practice to manage municipal infrastructure assets in a sustainable manner. Legislation has been introduced that requires municipalities to compile asset registers and account for their infrastructure assets in their financial statements. Africon has identified this opportunity and plan to pursue the opportunity by investing in personnel skills, software, technical resources, and strategic partners. This business plan is focused on the development of Africon's Asset Manager software and related services that will service the need to compile asset registers, account for the assets in financial statements, and implement infrastructure asset management best practice.

5.1.2 The Description of the Business

Africon will offer municipalities software to prepare GAMAP compliant asset registers, support the implementation of infrastructure asset management, and manage the data relevant to infrastructure asset management. Africon will provide the technical resources and methodology to support the implementation of the software at municipalities. The service will in all cases include the installation of the software, training of the operators, and the initial upload of mass existing data. Upkeep of the system can be performed internally by the municipality using a desktop software version or by Africon as a bureau service using a web-based software version.

5.1.3 History of the Business

The first version of the software was developed to support the preparation of infrastructure asset management plans at several municipalities in the Limpopo and Mpumalanga Provinces. The first version provided data capture, management and reporting functionality, but provided no spatial view of the data. It was decided to expand the first version into a spatially enabled software to simplify the management of infrastructure data and improve the presentation of data. The Systems Unit of Africon was granted a risk budget of R250,000 from Africon to develop the spatially enabled version of the software. The development of this version has been completed.

During the course of the last 6 months, additional functionality has been identified that is required to support infrastructure asset management and improve user-friendliness. Specifications for the additional functionality are currently being prepared. The funding of the further development will come from sales of the software. The Department of Local Government and Housing in the Western Cape Province have committed to purchasing 10 software licenses and supporting their installation for a total revenue of R500,000.

The infrastructure asset management software and service is being coordinated and promoted by the Asset and Project Management Unit in Africon. The other technical units within Africon have an interest in the software as a means to compile asset registers and support infrastructure asset management practices in their particular sectors.

The objective of the Asset and Project Management Unit is to market the software to municipalities, support the implementation of the software, pursue appointments to compile asset registers, and pursue infrastructure asset management planning services on the basis of the software. The implementation and ongoing support of a software that deals with the planning and management of all infrastructure types provides Africon with excellent exposure in the local government sector.

The infrastructure asset management software initiative is consistent with Africon's vision "to be a preferred and globally recognized professional services provider offering sustainable infrastructure life cycle solutions." It is also consistent with

Africon's mission "to provide sustainable solutions through our integrated professional services in the development and management of infrastructure, make a positive social and environment impact, fulfill our potential, and create value for all our stakeholders."

5.1.4 Competitive Advantage

The mission of the Asset and Project Management Unit, as related to infrastructure asset management, is to provide municipalities with the best available support in South Africa for the implementation of infrastructure asset management practices. Africon will develop technical resources based on international best practice and tailor them for South African municipalities to ensure that Africon is the preferred service provider of infrastructure asset management consultancy services in South Africa.

Compiling infrastructure asset registers will for many municipalities be the first step towards implementing infrastructure asset management and sustainable infrastructure service delivery. Africon will support municipalities with the compilation of asset registers with the view to expand the services to a wider adoption of infrastructure asset management.

Africon has several core competencies that give it an advantage in the infrastructure asset management market. Africon is a large consultancy with 1,200 full-time employees and with access to technical experts in all sectors of municipal infrastructure. It also has an internal software development group that can respond quickly to development needs. Organizationally, Africon has strengthened its infrastructure asset management initiative by incorporating its road management group into the asset management unit. The technical skills, tools and competencies used for managing road networks are very similar to those needed for infrastructure asset management. Africon is able to leverage these competencies in developing infrastructure asset management technical resources and solutions. In particular, Africon can utilize its dTIMS software[6] and competencies for implementing advanced infrastructure asset

[6] Africon are authorized dTIMS distributors for Southern Africa and authorized dTIMS consultants.

management decision support. Africon is also widely represented in South Africa by a local office network of 18 offices, which provides good access to the municipal market.

Africon intends to pursue a business partnership with i@Consulting as a means to strengthen its competitive position in the market. i@Consulting is a small company specializing in infrastructure asset management. The companies have worked together to develop the infrastructure asset management market in South Africa, have a joint infrastructure asset management training program, have jointly marketed infrastructure asset management services, and have jointly executed projects. i@Consulting has a strong marketing base. They have two senior staff, namely Louis Boshoff and Rob Childs, who have been very involved at a strategic level with the introduction of infrastructure asset management into South Africa. Rob Childs is an ex-Africon employee.

The current skill set of the companies are complementary with Africon providing the technical resources and i@Consulting providing the strategic skills to implement infrastructure asset management effectively. The combined skill set gives both companies a competitive advantage in the market. Infrastructure asset management is in a growth stage in South Africa. The joint research and development effort of both companies should enable the companies to maintain a competitive advantage, survive the shakeout period that will come in the future, and maintain a mature infrastructure asset management service line in the long-term.

Africon is further seeking to develop a business relationship with Ducharme Consulting to cover the financial accounting requirements of infrastructure asset management. Ducharme Consulting is a small company specializing in the financial accounting of municipalities and the preparation of financial statements that are compliant with accounting standards. Ducharme Consulting has two shareholders, namely George Ducharme CA (SA) and Francois Conradie CA (SA). George Ducharme was until recently an Associate Professor in accounting in the department of accounting of the University of the Western Cape. He is highly qualified and experienced in providing accounting services to municipalities, especially in the Western Cape. Africon

currently lacks the financial accounting expertise to deal with the financial aspects of asset register compilations and infrastructure asset management planning. It is expected that Ducharme Consulting can provide this skill and the companies are currently looking for opportunities to secure projects together. Access to a partner in the municipal finance sector provides Africon with a competitive advantage, especially in pursuing asset register compilation projects.

5.1.5 Current Status and Requirements

Africon has developed the first spatially enabled version of its asset register software, called Asset Manager. The Department of Local Government and Housing in the Western Cape has committed to the implementation of 10 licenses, although the implementation of the software has not started. An upgraded version of the software is planned for development with the preparation of specifications currently underway. The newer version will have similar structure and design, but increased functionality and user-friendliness. The newer version will also be web-based to allow the servicing of customers on a bureau basis.

Africon has developed several technical resources to support the asset register software, including field guides for roads, water, and sanitation. Some field guides still have to be developed, including resources for electricity, buildings, parks, and stormwater.

In order to move forward with the development of asset register technical resources, the following is needed:

i) Finalization of the specifications for the newer version of the software, and development of the software.
ii) Projects for the compilation of asset registers to refine the data collection methodology in practice.
iii) Projects to update financial statements using asset register data with accounting partners to develop a better understanding of the linkage between the technical requirements and the financial requirements of asset registers.

iv) Projects to implement infrastructure asset management at municipalities to gain a better understanding between the linkage between the asset register and the infrastructure asset management data requirements. Africon has been awarded for a project of this nature by the Msunduzi Local Municipality.

5.2 Management Team

The Asset Manager software initiative is being coordinated by the Asset and Project Management Unit, the Systems Unit is developing the software, and the other units are involved in the preparation of the specifications of the software on a sectoral basis. The unit leaders and technical directors responsible for the software development initiative are Ottie Ncube and Johan Viktor from the Asset and Project Management Unit and Dr Danie Wium and Hentie Viviers from the Systems Unit. The people responsible for the software development and distribution are Chris von Holdt who is responsible for specifications, marketing, distribution, and technical support and Hentie Viviers who is responsible for software development and maintenance.

5.3 Structure, Ownership, and Intellectual Property

5.3.1 Organizational Structure

The Asset and Project Management Unit is leading the initiative to compile asset registers and implement the software at municipalities. The unit is responsible for marketing the software, developing the municipal market, and providing technical support for the software. The Systems Unit is responsible for developing the software and proving software maintenance support. The sectoral units will have access to the software and are free to use and market the software to clients in the individual sectors.

5.3.2 Ownership

The software is jointly owned by the Asset and Project Management Unit and the Systems Unit with equal shareholding. The software related income and expenses will be managed under an individual project with joint entitlement between the two units.

5.3.3 Intellectual Property

Africon and i@Consulting have undertaken to jointly develop technical resources in the field of infrastructure asset management. This agreement has not yet been formalized, but the undertaking is to provide each partner with access to the developed technical resources. This implies that i@Consulting will have access to the Asset Manager software for pursuing the infrastructure asset management market. Other technical resources that will be shared include field guides and data collection forms that supplement the software. The granting of rights to the software will be conditional, but these details still have to be agreed upon. The parties intend drafting a formal cooperation agreement that outlines the extent of shared use of intellectual property.

5.4 Industry Analysis

5.4.1 Industry Trends

The role of local government in the delivery of service and management of infrastructure is increasing. The National Government's commitment to local government is highlighted by the President's statement that "*to meet our developmental objectives, which must respond to the high expectations of our people, we will pay special attention to the critical task of strengthening local government*" *(24).* It is evident that municipalities are currently not providing adequate service to their communities and maintaining their infrastructure effectively. The poor service delivery has resulted in increased action by National Government. In his Freedom Day speech the President stated that *"we have to attend seriously and systematically to this matter because it cannot be that after 12 years of democracy we still have municipalities that cannot deliver basic services" (25).* These trends indicate an increase in emphasis and support for municipal programs by the higher levels of government.

Communities have become more demanding of service delivery by their municipalities. Communities have become more vocal and demanding of service delivery, with several demonstrations and riots across the country in the past year. Some demonstrations turned violent and have resulted in extensive media coverage on service delivery. This trend suggests that municipal managers will become more responsive to

community needs and will place a greater urgency on service delivery and the management of infrastructure.

Municipalities have become less able to attend to their infrastructure management needs. The number of engineers in municipal bodies has declined in the past decade and senior technical positions have been filled by non-technical managers *(6)*. Municipalities have a shortage of skills for the implementation of new programs within their organizations, including infrastructure asset management. This trend increases the likelihood that infrastructure asset management services will be contracted out to consultants.

Government spending on infrastructure has increased in the past few years and continues to increase. The South African Government was mandated in 2004 to halve poverty and unemployment by 2014. The Government has implemented the Accelerated and Shared Growth Initiative for South Africa (AsgiSA) to implement this vision of growth. The program includes large investment in infrastructure to meet service delivery needs *(26).* The financing for municipal infrastructure comes primarily from infrastructure grant programs, including the Municipal Infrastructure Grant. R372 billion will be provided for these programs over the next three years *(24).* This trend indicates that funding will be made available for infrastructure spending, although these initiatives are focused more on capital expenditure than maintenance expenditure and the management of assets.

Legislation was introduced in 2003 that requires municipal managers to take responsibility for the management of their infrastructure assets. The MFMA specifically requires municipal managers to compile asset registers and manage information on their assets, including infrastructure assets. The introduction of legislation related to municipal management is indicative of the greater emphasis on accountability and responsibility at the local government level. This suggests that products related to the management of infrastructure will be in greater demand from municipal officials.

The MFMA calls for the compilation of registers and effective management of all municipal assets. This includes movable assets, property, and infrastructure. The

familiarity of movable assets with financial staff has prompted many municipalities to focus compliance on the movable and property assets. Infrastructure assets have been neglected to date, but audit qualifications will be raised if the infrastructure is not valued.

The MFMA requires each municipality to implement a Supply Chain Management Policy that complies with regulatory framework. A regulatory framework was prescribed in 2005 in the Government Gazette, which requires formal written price quotations for procurement less than R200,000 (VAT included) and competitive bidding for procurements greater than R200,000 *(27)*. Since competitive bidding in an environment with many competitors is undesirable, this new approach to municipal procurement suggests that two service provision options should be investigated. The first option is to offer unique services for which there are few competitors. The second option is to offer services valued at less than R200,000.

5.4.2 Industry Size

A total of 284 municipalities have been demarcated by the Municipal Demarcation Board. They consist of 6 metropolitan municipalities, 47 district municipalities, and 231 local municipalities. The municipalities have been classified according to their capacity to deliver services. The classifications include high, medium, and low capacity. Each class has different deadlines for compliance with the MFMA. The municipal classes and deadlines for compliance are shown in Table 2.

TABLE 2 Municipality Type, Capacity Class, and MFMA Compliance Date

	Capacity		
Municipality type	**High**	**Medium**	**Low**
Metropolitan	6	0	0
Local	35	84	112
District	9	23	15
MFMA compliance date	30 June 2006	30 June 2007	30 June 2008

5.4.3 Industry Attractiveness

With the emphasis on local government to deliver service to communities and the increase of funding support, local government expenditure has increased and is expected to continue to do so in the short term. This sector is showing a high growth rate, making it very attractive for the provision of consultancy services.

5.4.4 Profit Potential

Profit potential is related to the number of competitors in the market and the demand for consultancy services. It is evident that there is a large demand for services in the medium term and relatively few competitors in the market. The potential for profitability is therefore high.

5.4.5 Target Market

The metropolitans generally have the information management systems, data and the technical capacity in place to comply with the immediate legislative requirements and future infrastructure asset management needs. Some of the district and local municipalities do have GIS and other specialist systems to support the management of their infrastructure, but due to lack of capacity, they are expected to require technical assistance to comply with the legislative requirements and to implement infrastructure asset management practices. There is an attractive opportunity to penetrate the sector using the Asset Manager software on the basis of the need to comply with legislation and address service delivery demands. The target market for the Asset Manager software is therefore local and district municipalities. The different capacity municipalities can be targeted based on their required date of compliance with legislation.

5.4.6 Competitive Position within Target Market

Africon has a relatively strong position within the target market. Africon is over 50 years old and have 18 offices distributed throughout South Africa that service all 9 provinces. This provides good access to municipalities across the country and good potential for market penetration with new products. However, there are currently several asset register

software competitors in the target market, and competition is expected to increase rapidly.

The compilation of asset registers is not complex, and a GAMAP compliant asset register can be compiled on a spreadsheet. In order to differentiate the Asset Manager software from the competition, the software is designed to support infrastructure asset management decision making and not only to comply with financial legislation. The data structure, valuation method, spatial GIS interface, and software architecture provide the basis of differentiation from competitor's products.

5.4.7 Competitor Analysis

The low level of complexity of asset register software has enabled several competitors to enter the target market. Competitor software range from modified GIS systems, inventory management systems, infrastructure modeling systems, and customized databases, such as Microsoft Access and Excel. Several key competitors have been identified and are discussed below.

IMQS Software Provided by GLS IMQS software is expected to be the greatest competitor to the Africon Asset Manager software. IMQS is an acronym for Infrastructure Management Query Station. The software is maintained by the IMQS company, with joint interests from V&V consulting engineers and GLS consulting. The software has a spatially enabled GIS front-end linked to a database. The software is designed as an information management system for all infrastructure data. The software has several specialist systems associated with it, including water network modeling, sanitation modeling, stormwater modeling, and a pavement management system. The business concept is to provide users the ability to view their infrastructure data using the database and GIS viewer. The water and sewer modules in the IMQS platform is developed and maintained by GLS, based in Stellenbosch.

One of the main strengths of IMQS lies in its modeling modules. These include the Wadiso and Sewsan modules. Wadiso is a module for the analysis and design of water distribution systems, including steady state analysis, time simulation, optimization

and water quality analysis. Sewsan is a module for the analysis and design of sewer systems. The software has additional modules including Swift, which is a module that performs statistical analysis of municipal billing data and provides a link between the water distribution and sewer systems. The GLS software development team is technically proficient and the software modeling capability is of a high quality.

Clients are provided with the IMQS viewer and query station, which gets installed at the client workstation and provides the links to data displays and modeling outputs. The client has to purchase a license for the IMQS viewer software module as well as the a license for the specialist modeling module. For example, a license for the Wadiso IMQS viewer module must be purchased along with a license for the Wadiso modeling module. The IMQS modules cost approximately R30,000 for 4 installations and the specialist modeling modules cost approximately R40,000 for each module for the medium to small municipalities. These prices are scaled up with network size. Software annual maintenance fees are 12.5% of the purchase value for both the viewer and the specialist modeling license.

GLS also offer software analysis and information updating on a bureau basis, where the viewer is updated quarterly. If the specialist modeling is performed on a bureau service basis, the client must purchase the viewer license at full price and the modeling license at 40% of the full price. Annual maintenance fees are still payable on the full price. The bureau service entails quarterly analyses and information updating at a cost of approximately R50,000 per year for each specialist modeling module.

IMQS is used by the cities of Tshwane (Pretoria), Johannesburg, Cape Town, and Ekurhuleni. It is estimated that the IMQS software is used by approximately 50 municipalities in South Africa, including all the municipalities in the Western Cape Province. The IMQS system has been developed over the past 10 years, with a specialist IT company leading the development since 2000. GLS have an IMQS training program, operate an IMQS call centre, and hold annual user groups across the country.

The software functionality has recently been expanded to include the GAMAP data requirements for an asset register in an infrastructure asset management module.

Additional fields have been added to the existing database of assets stored in the database. While the data structure complies with the GAMAP requirements for the data already in the IMQS database, it does not include all asset types yet. The data structure also does not yet support infrastructure asset management planning.

Intermap Intermap is expected to be another strong competitor software. Intermap software is based on the provision of web-based information visualization (GIS) and business process management tools. The primary function of the software is online business process management established on workflow principles with a GIS based visualization functionality. Although the business process functionality has resulted in most of their business to date, they have recently expanded into the local government market.

Intermap was founded in 1999 by a consulting engineer who is the sole owner. Intermap currently has more than 50 clients in the private and public sector, a staff complement of 20 people, and an expected turnover in 2006 of approximately R10 million to R15 million. Intermap is based in Pietermaritzburg with offices in Johannesburg, Vryheid, and Perth, Australia. Intermap appear to have adopted an expansion strategy and plan to establish offices in Cape Town, Richards Bay, and London.

Intermap has developed a web-based information management system called District Information Management Systems (DIMS) for municipalities after working with the Uthungulu District Municipality in Richards Bay. The product contains several modules to assist municipalities with service delivery. The primary modules include an Integrated Development Plan, project management, performance management, asset management, finance, procurement, human resources and office management. The asset management module contains an infrastructure asset register, the ability to maintain and report on movable assets, and the ability to link between the project management module and the asset register to record assets as they are completed as projects.

Intermap has an assets module that specifically supports infrastructure asset management. It allows the management of asset data from acquisition, maintenance through to disposal. It apparently has the functionality to incorporate planned maintenance schedules, record maintenance history, support simple budgeting, depreciate and value assets, and to integrate with financial systems. Intermap's primary business appears to be the development of IT solutions and not the provision of engineering consultancy services related to the IT solutions.

Pragma Pragma software was developed from an inventory, maintenance, and operations management software. Clients have consisted primarily of manufacturers, but Pragma have shown a strong interest in the local government market. GLS have included a Pragma maintenance management module into the asset module of the IMQS software. The Pragma software also has an asset register module that allows the management of asset data and the valuation and depreciation of assets. Pragma was founded in 1990 and has offices in Cape Town, Port Elizabeth, Durban, and Johannesburg.

Municipal Enterprise Software Enterprise software systems, such as Hansen and Confirm, offer a comprehensive solution to municipalities. These systems include asset registers as modules of the system. While they are more comprehensive, they are more complex and expensive and most probably only feasible for the high capacity municipalities, which are not the target market for the Africon Asset Manager software.

Movable Asset Software Several software packages are available for the compilation of movable asset registers, with most municipal accounting software able to manage asset registers. Some specialized systems for large agencies are available, such as Hardcat supported by Ngubane and Associates.

Potential Future Competitors The needs of municipalities in South Africa are extensive and many different types of support software are expected to be developed and

marketed to satisfy those needs. The immediate need for GAMAP compliant asset registers is relatively easy to satisfy by enhancing existing software, as was done by GLS, Intermap and Pragma. It is expected that several similar software types will emerge on the market in the short term.

Summary of Competitor Analysis It is evident that there is already significant competition for asset register software that can assist municipalities in becoming GAMAP compliant. Due to the low level of complexity of asset registers, the entry barriers are low and the competition is expected to increase. Due to the high level of competition, Africon cannot expect to gain and maintain significant market share or high profitability with the sale of asset register software for infrastructure. Although Africon has been the first mover into the infrastructure asset management field and has developed guidelines and standards for the data requirements of asset registers, this lead is expected to be very short lived.

The systems that are currently available have been developed as GAMAP compliance tools, rather than tools to support infrastructure asset management planning. Africon has as its interest the use for the software to compile GAMAP compliant asset registers and to provide infrastructure asset management planning services. These services can be equally profitable, but the likelihood of securing infrastructure asset management services increases if the software was used to develop the asset register. Africon must therefore aggressively pursue market share with the Asset Manager software.

5.5 Marketing Plan

5.5.1 Product Description

The product is a software package, named Asset Manager, that supports a GAMAP compliant asset register and contains the data structures and functionality to support infrastructure asset management planning. The software consists of a spatially enabled (GIS) user interface running off a relational database. The user interface is developed in the .Net environment, the spatial component is developed using MapInfo, the database is

a MSSql database, the reporting function is developed using Crystal Reports, and the product runs in the Windows environment. The product is currently a desktop version, but there are plans to develop a web-based version. The web-based application will allow data management and maintenance to be outsourced and also allow easier software maintenance.

The product will not be sold as an off-the-shelf software product. The product purchase will at a minimum require Africon to install the software, train the operators, and upload existing mass infrastructure data. The operators will have sufficient proficiency after training to manage and maintain the data, including the addition of new infrastructure assets. The initial upload of infrastructure data from other systems is a complex process that requires specialized knowledge of the software product.

Africon has not conducted any product testing for the new product. However, an earlier version of the software, that was not spatially enabled, was used to capture and manage data for the preparation of infrastructure asset management plans for numerous municipalities. The users of the software were Africon and i@Consulting personnel. These users realized the value of the software and prepared the initial specifications for the spatially enabled version of the software. The concept has therefore been tested internally, but the software has not yet been used by clients.

5.5.2 Product Strategy

The immediate opportunity for software distribution is the current need for municipalities to prepare GAMAP compliant asset registers. The asset register functionality of the software is capable of satisfying this need, but the data and software also forms the basis of infrastructure asset management planning. The compilation of a GAMAP compliant asset register using the Asset Manager software provides an entry for the provision of infrastructure asset management services. It is not the intention to achieve high sales and profitability from the sale of the software product, but to use it for market penetration to grow market share.

Given the strong asset register software competition, Africon cannot expect to gain the market share and exposure it desires without actively managing the competition,

particularly in areas where the competition has a strong presence. In the Western Cape, both GLS and Pragma are well positioned. GLS have developed an asset register module and have colluded with Pragma, who is another strong competitor, to provide a maintenance management module. Africon, in turn, has been very involved with the development of the infrastructure asset management guidelines for the Western Cape, which includes the compilation of asset registers according to the guidelines developed by Africon.

GLS have an established presence in the province with the IMQS software, but may not be that interested in expanding their specialist water modeling services to cover general infrastructure asset management consulting services. Pragma do not appear to have the civil engineering qualifications and experience to provide infrastructure asset management services and may also be primarily interested in providing IT solutions. Both of these companies appear interested in the provision of systems solutions, rather than consulting services. The greatest threat to Africon is that these companies pair up with other consulting civil engineers to provide both the systems and the infrastructure asset management consulting services.

GLS and Pragma are aware that Africon are developing infrastructure asset management software and will consider Africon direct competition to their software solutions. This increases the likelihood they will pair with another civil engineering consultancy to improve their competitive position. This may be the reason that they have already colluded in the infrastructure asset management software solution.

It is recommended that this competition be managed through signaling, adopting a price penetration strategy for the software, and cost competitiveness for related services. Africon should signal to GLS that its software does not pose a threat to their existing market as it is specifically designed for infrastructure asset management purposes. A technological solution should be sought where the software can be supplementary to the IMQS software and not in direct competition. Without this signaling, GLS will consider Africon a direct threat to their market and will intensely pursue the development of a competitive infrastructure asset management module. GLS

will also seek to use its influence with existing clients to discourage them from using the Africon product. Fear of lacking capacity in the infrastructure asset management field may encourage them to seek partnerships with other consultancies.

A price penetration strategy should be used to discourage potential software developers from developing competitive products. This should have the effect of reducing the competition to civil engineering consultants who want to provide infrastructure asset management services. The need to develop software for little return may act as a barrier to entry into the infrastructure asset management consulting services and reduce the competition for those services.

Cost competitiveness should be used for tendering for asset register compilation projects in the Western Cape. The projects will be valued at greater than R200,000 and will be awarded on a competitive tender basis. Africon cannot develop a large premium of perceived value on data collection projects. It is therefore more advantageous for Africon to leverage its experience and cost competitiveness to gain market share. Africon should be able manage it data collection risk due to intimate knowledge of the data requirements.

The ability of the software to be web-based lends itself to the provision of a bureau service. Given the current personnel capacity constraints of municipalities and the reluctance of overworked officials to take on more responsibility, the bureau service is expected to be an attractive alternative for municipalities. The web-based capability of the software may also differentiate it from competitor software. This should be the preferred business model for Africon and should be strongly marketed.

5.5.3 Channels of Distribution

Africon is the developer and sole owner of the software. Africon will retail the software through its existing network of regional offices that interact directly with the client. The initial implementation of the software will be performed by the Africon Tshwane office.

Africon has a business partnership with i@Consulting, who will be given rights to retail the software directly to clients, but the initial implementation will be performed by the Africon Tshwane office. It is recommended that the following conditions be

included in an agreement with i@Consulting for the use of the software and any associated technical resources:

i) The license fees go to Africon
ii) The client enters into a support and maintenance agreement with Africon.
iii) Each client must purchase a separate license for the software.
iv) If Africon is not materially involved in the provision of services on the project, a fee surcharge of 10% is payable to Africon for services related to the use of the software. This includes fees for data capture, data management, analysis and reporting.

5.5.4 Promotion

The promotion planned during the introduction stage of the product is based on leading the target market through the product adoption process. In order to stimulate adoption, it is necessary to strongly promote the asset register benefits of the software and the ability to produce a GAMAP compliant asset register. However, in order to differentiate the software from that of competitors in areas where competitors are strong, the software should be promoted as a tool needed to support effective infrastructure asset management planning.

Africon and i@Consulting have procured a shared stand at the Institution of Municipal Engineering of Southern Africa annual conference in October 2006. This is an excellent opportunity to promote the software along with Africon and i@Consulting's consultancy services. It is critical that Africon use the two pilot projects currently underway in the Western Cape to achieve success. The two municipalities are seen as leaders, and successful implementations will facilitate the adoption of the software and services at the other municipalities. In order to achieve successful implementations, Africon will have to find a technological solution to the implementation of the software in a manner that is not in direct competition with the IMQS software. The Western Cape

pilot projects can be showcased at the IMESA conference as examples of successful implementations.

Africon can promote the software and associated services through its network of regional offices by making promotional materials available and providing the regions with information on the benefits and application of the software. Sufficient incentive should be provided to the regional offices to market the software and local staff should be used as much as possible.

The Africon and i@Consulting infrastructure asset management training program can be used as a means to stimulate demand for software that supports infrastructure asset management planning. This is accomplished by informing prospective clients of the need for such software.

5.5.5 Pricing Strategy

A penetration pricing strategy should be used to gain market share and discourage competitors from entering the market. The pricing should be comparative to similar competition products, such as the IMQS software. The IMQS software license costs approximately R30,000 for 4 installations of the viewer and query station. It is expected that clients will consider the products to be of similar quality, so the recommended price for the software is R20,000 for 4 installations.

Given that Africon prefers the bureau service model, the initial software license and maintenance should be offered for free, but costs will be recovered for the provision of the service. It is anticipated that the bureau service will recover costs for 15 days of a junior personnel time, and 3 days of senior personnel time. The total cost is expected to be in the order of R50,000 per year.

The software maintenance fee should cover the direct costs to Africon associated with the maintenance of the installed software, which is in the order of R4,000, as well as premium to cover time for a software developer to attend to maintenance issues. It is recommended that sufficient revenue be accrued from maintenance fees that will allow one developer to spend approximately 1 month per year on software maintenance. This is equivalent to 0.5 days per municipality for 40 municipalities. This results in a total

maintenance fee of approximately R6,000 per annum. The annual maintenance fees for the IMQS software are 12.5% of the purchase value, which is R3,750.

The cost of providing technical support should be recovered from additional fees based on a contractual agreement with the client that addresses the nature of the support. The recommended pricing structure is for the client to purchase a set number of support units per year. The units can be used at any time during the year. Different types of support result in a different rate of unit consumption. A typical offering would be the purchase of 100 units of support per year for a fee of R4,000. The suggested unit consumption rate is 8 units per hour for senior management and developers, 6 units per hour for software programmers, and 4 units per hour for general support staff and trainers. Additional support and direct expenses, such as travel, will be claimed on a time and cost basis. The support fees are not transferable to the next year.

5.6 Operations Plan

5.6.1 Software Development

Software development will be conducted by the Systems Unit under the supervision of Hentie Viviers. The functional specification for the software will be coordinated and compiled by the Asset and Project Management Unit under the supervision of Chris von Holdt who will pass it to the developers. The technical specialist team will be kept informed of the software development proposals and progress.

5.6.2 Software Support

A software support service will be established to deal with maintenance and technical support problems. The support service will be provided by a person from the Asset and Project Management Unit under the supervision of Chris von Holdt. Users will be provided with a telephone number and email address to contact support. A password protected website will be developed to support users by providing documentation, updates and case studies.

5.6.3 Implementation Support

Implementation support will consist of installation, software training, and mass data upload of existing data. These services will be required for each new client and will be provided by personnel from the Africon Tshwane office. The cost of the implementation support will depend on the specific implementation strategy for each client. These services will be charged on a time and costs basis and a quotation will be provided once the scope of work has been established.

5.6.4 Marketing Material

Marketing material will be developed jointly by the Asset and Project Management Unit, the Systems Unit, and the marketing section. The planned marketing material includes a PowerPoint slideshow, brochures, and posters. The marketing material will be distributed to the regional offices.

5.6.5 Internal Awareness and Training

Internal awareness and training on the software will be provided to sectoral specialists during lunch sessions to familiarize them with the software functionality and application to their sector.

5.7 Financial Plan

5.7.1 Capital Requirements

Capital is required for the development of the software, marketing and finalization of the pilot projects in the Western Cape. The total expected costs are shown in Table 3.

TABLE 3 Capital Requirements

Activity	Cost
Version 1 total costs	R240,000
Version 2 development	R100,000
Web-based conversion	R60,000
Marketing	R50,000
Pilot project finalization	R50,000
Total development cost	**R500,000**

5.7.2 Financial Projections

South Africa has 278 district and local municipalities, which constitute the target market for software sales. These can be separated into high, medium and low capacity as assessed by the Municipal Demarcation Board. The distribution of municipalities is shown in Table 4.

TABLE 4 Distribution of District and Local Municipalities in South Africa

Province	Capacity			Sum
	High	**Medium**	**Low**	
Eastern Cape	5	16	23	**44**
Free State	5	10	10	**25**
Gauteng	4	7	1	**12**
KwaZulu-Natal	8	16	36	**60**
Limpopo	3	8	21	**32**
Mpumalanga	6	6	8	**20**
Northern Cape	1	18	13	**32**
North West	5	8	11	**24**
Western Cape	7	18	4	**29**
Sum	**44**	**107**	**127**	

Several revenue streams are expected to result from the sale of the software product and leveraging of the software functionality. Revenue expected from the software include, software sales, annual maintenance fees, annual technical support fees, implementation support fees, asset register compilation appointments, asset register bureau service appointments, and infrastructure asset management planning appointments.

Market Share It is expected that the market size will be driven by municipalities who require assistance with the compilation of asset registers. It is expected that 70% of the target market (195 municipalities) will put the compilation of asset registers out to tender over then next 5 years. Of the municipalities that are expected to put the compilation of asset registers out to tender, 70% are expected to be initially receptive to new asset

register software. Of these municipalities, it is expected that Africon will maintain a share of 25% of the software market and 15% of the asset register compilation market.

Of the municipalities that are not initially receptive to new software, it is expected that Africon will gain a share of 2% of the software market and 10% of the asset register compilation market. These estimates result in a total expected software sales of 35 software licenses and 26 asset register compilation projects. It is further expected that 25% of the software clients will engage into a bureau service contract, which results in 9 bureau service contracts.

Software Sales Revenue Of the R20,000 sales price, R8,000 represents a direct costs to Africon for software development license fees.

Annual Maintenance Fee Maintenance fees are priced at R5,000 per license per year to cover the costs of a software developer to maintain the software.

Annual Technical Support Fee Annual technical support fees are priced at R4,000 per license per year. These fees are expected to cover the professional time needed to provide technical support.

Implementation Support Fee Implementation support fees will be handled on a case by case basis, based on the needs of the client. It is estimated that the typical medium to small municipalities will require implementation support worth approximately R20,000.

Asset Register Compilation Appointments Asset register compilation appointments entail the collection, capture and processing of data into the format required to import the data into the Asset Manager software. Data collection costs for a small to medium municipality is expected to be in the order of R250,000.

Asset Register Bureau Service Appointments Asset register bureau appointments entail the management of the asset register and asset register data on an ongoing basis on behalf of a municipality. If new information becomes available, the data will be captured into the software and the asset register updated. It is expected that these appointments will be valued at approximately R50,000 per year.

Infrastructure Asset Management Planning Appointments Infrastructure asset management planning appointments entail the compilation and implementation of infrastructure asset management plans for the different infrastructure sectors within municipalities. The main sectors are water, sanitation, and roads. It is estimated that infrastructure asset management plan projects for all sectors will be in the order of R500,000 after the data has been collected for a complete asset register. Although it is expected that the Asset Manager software will provide Africon with a competitive advantage in securing infrastructure asset management planning appointments from software clients, this potential revenue stream is left out of the financial analysis. The revenue from infrastructure asset management appointments is too far removed from the software and Africon will be able to secure infrastructure asset management appointments, even if the Asset Manager software is not used.

Timing of Appointments The timing of appointments is influenced by the compliance date for the different capacity municipalities. The compliance is expected to be lagged over the next 5 years. The expected distribution of contracts for consultancy services and the compliance dates for the different capacity municipalities are shown in Table 5.

TABLE 5 Expected Distribution of Contracts for Related Consultancy Services

			Year				
	Number	**Compliance year**	**06/07**	**07/08**	**08/09**	**09/10**	**10/11**
High	44	2006/07	20%	40%	40%		
Medium	107	2007/08	10%	30%	40%	20%	
Low	127	2008/09			40%	40%	20%
Overall	**278**		**5%**	**21%**	**35%**	**28%**	**11%**

5.7.3 Financial Model and Sensitivity Analysis

A financial model was developed to assess the financial feasibility of the software development initiative. The expected after-tax net cash flows resulting from the revenue and cost streams of providing the services were estimated. The cost of providing services was calculated using both the cost of the employees to perform the activities and the direct costs related to the activity. The financial unit revenue and unit cost inputs that were incorporated into the financial model are shown in Table 6.

TABLE 6 Financial Model Unit Revenue and Unit Cost Inputs

Activity	Revenue	Employee cost	Direct cost	Total cost
Software license fee (per license)	20,000	-	(8,000)	(8,000)
Software implementation fee (per license)	20,000	(6,000)	(2,500)	(8,500)
Software maintenance (per license)	5,000	(640)		(640)
Continuous software enhancement (per annum)	-	(86,400)	-	(86,400)
Software technical support (per license)	4,000	(1,493)	-	(1,493)
AR compilations (per contract)	250,000	(72,500)	(30,000)	(102,500)
Bureau service appointments (per contract)	50,000	(11,000)	(5,000)	(16,000)

Uncertainties were incorporated into the financial model using triangular distributions. A simulation was performed using Palisade @Risk software to generate a net present value profile generated by the activities related to the Asset Manager software. The uncertainties that were included in the model are shown in Table 7.

TABLE 7 Estimates of Uncertainties in the Financial Model

Uncertainty	Low	Medium	High
Percentage of target market who put tenders out for asset register compilations	50%	70%	85%
Percentage of municipalities who have asset registers compiled by consultants who are receptive to new software	50%	70%	85%
Software sales success rate at municipalities who are receptive to new software	15%	25%	40%
Software sales success rate at municipalities who are NOT receptive to new software	0%	2%	5%
Asset register compilation success rate at municipalities who are receptive to new software	10%	15%	25%
Asset register compilation success rate at municipalities who are NOT receptive to new software	5%	10%	15%
Bureau service provision success rate at existing software clients	5%	10%	20%
Annual software development/enhancement personnel days	40	80	150
Annual software maintenance personnel days per municipality	0.3	0.5	2.0
Annual technical support personnel days per municipality	1	2	4

In the financial model, the net cash flow streams were calculated using the estimated distribution of contracts over the next 5 years. Annual fees were incorporated into the analysis over the 5 years and then into the future as a perpetuities. The net cash flow streams were discounted to net present value at a discount rate equivalent to the expected return on capital for the company. The financial assumptions used in the model are an expected return on investment of 30% and an inflation rate of 5%.

The simulation settings that were used in the analysis model are 5,000 iterations and latin hypercube random sampling. The expected value distribution from the financial model simulation is shown in Figures 6 and the tornado diagram that illustrates the sensitivity of the uncertain inputs is shown in Figure 7.

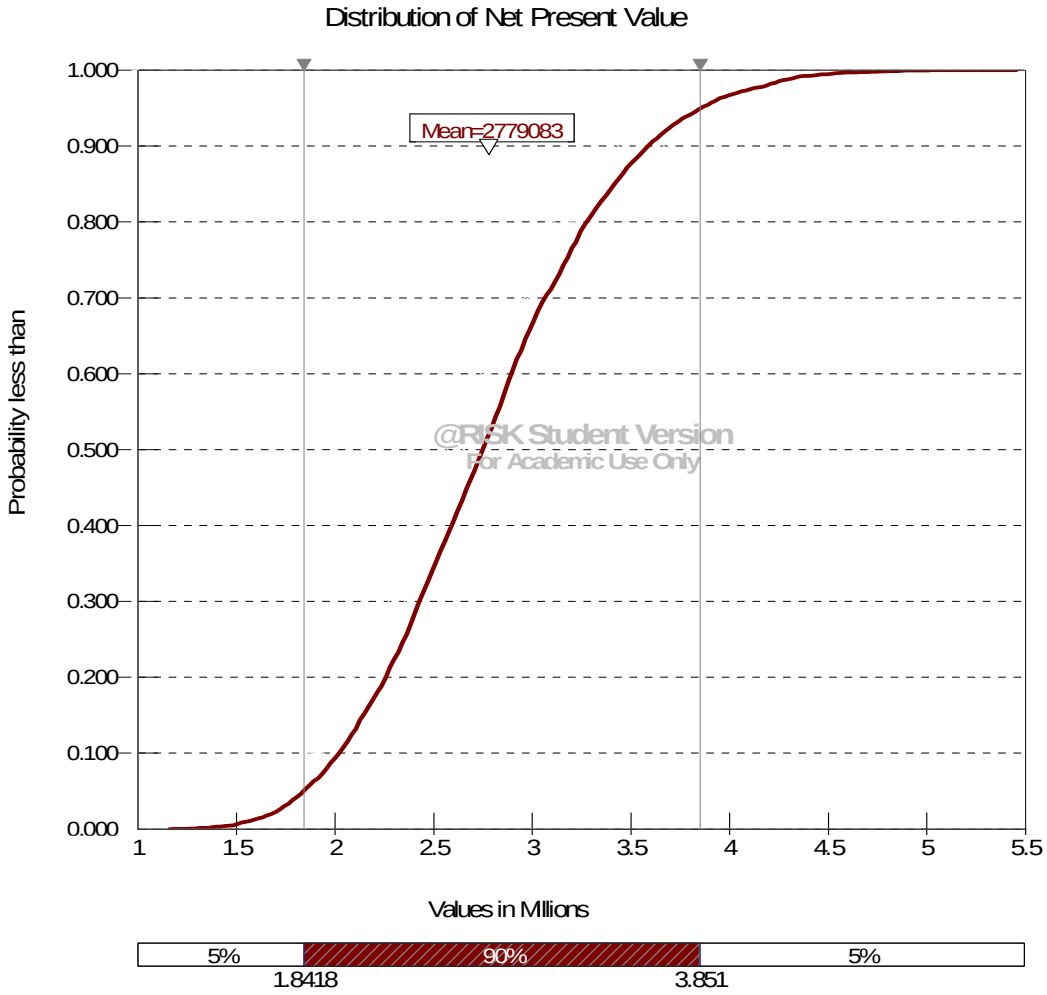

FIGURE 6 Cumulative distribution of net present value of revenue.

The simulation result shows that the net present value of the net cash flow stream that results from the software initiative are positive. The 5th percentile is approximately R1.8 million and the 95th percentile is R3.8 million. The mean is in the order of R2.8 million. The downside risk of the software initiative is expected to be very small. This analysis illustrates the low risk and profit potential of the software and highlights the need to develop the software and take it to market quickly and effectively.

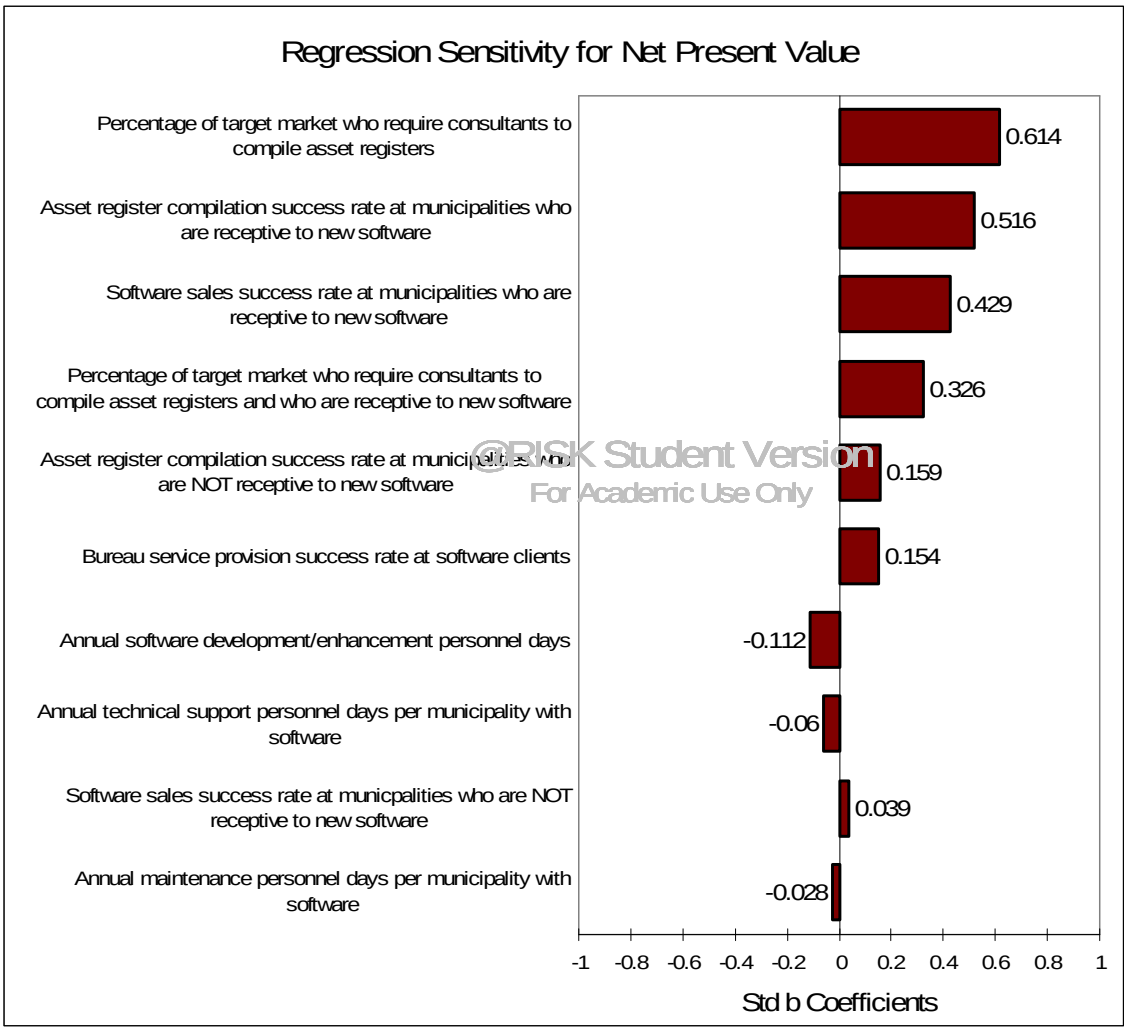

FIGURE 7 Sensitivity of the net present value to model inputs.

The sensitivity in the financial model is demonstrated using the tornado diagram. The beta coefficients show the sensitivity of net present value to the model inputs. The inputs with the greatest sensitivity should be given the greatest attention to maximize profit and minimize risk. The two factors with the greatest sensitivity are the percentage of the target market that require consultants to compile asset registers and the success rate for tendering for asset register compilation projects for clients who are receptive to new software. The two most sensitive factors are related to asset register compilation and not software sales. This indicates that Africon should aggressively develop and

market its asset register compilation expertise. The third most sensitive factor is software sales success rate at municipalities who are receptive to new software. This indicates that the sale of software is significant in the profitability of the initiative and not just asset register compilation expertise.

The most sensitive negative factor is the annual software development and enhancement personnel days that are required to keep the software current and competitive. The sensitivity of the net present value to this factor is masked by the use of internal programming personnel resources at cost rates. If external programmers were used, it is expected that the sensitivity of the net present value to this factor would be much greater. Although the model does not highlight the downside risk of this factor, experience shows that it does represent a considerable risk.

An indicator termed the effective recovery rate is used to provide a basis of comparison for the project against other consultancy projects undertaken by the company. As a provider of consultancy services, the company strives to employ its personnel resources as effectively as possibly. The effective recovery rate is the ratio of the net cash flow of the project to the personnel cost, with one added to the ratio to get the performance indicator. Typical values are in the order of 2.5. The distribution of the effective recovery rate was determined using the financial model and is shown in Figure 8 below.

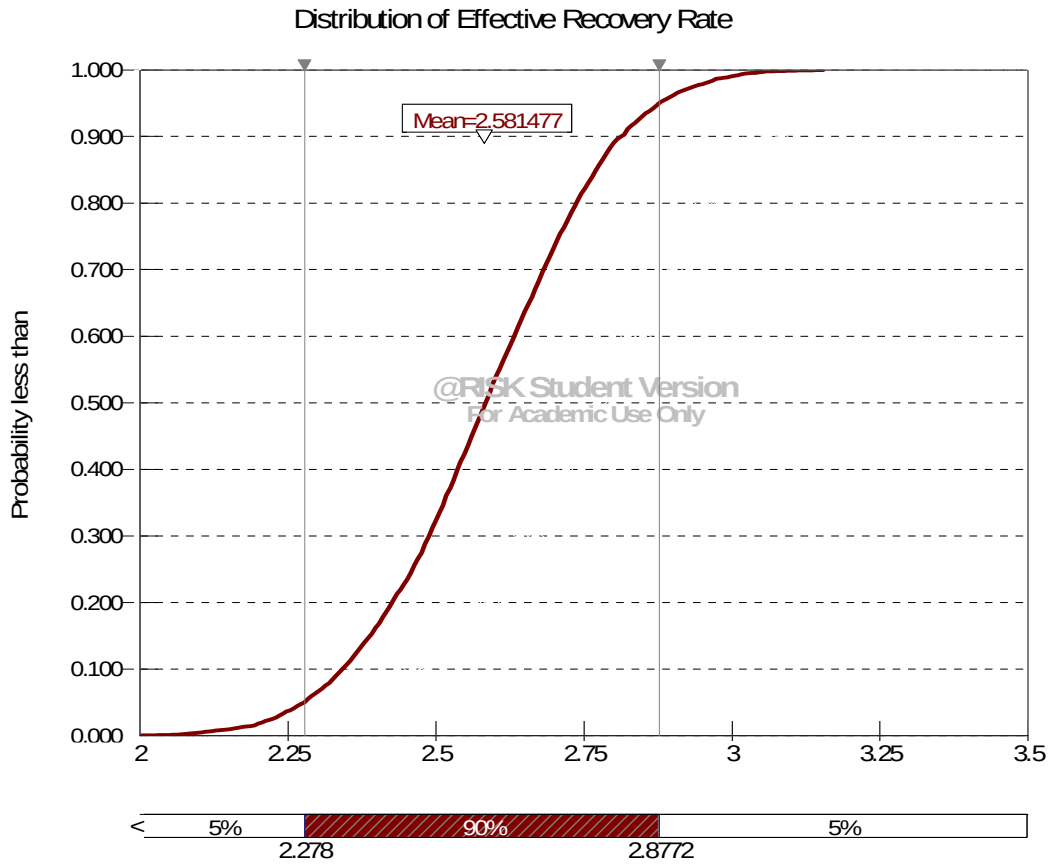

FIGURE 8 Cumulative distribution of effective recovery rate.

The distribution of the effective recovery rate indicates that the project compares favorably with other consulting projects. The 5th percentile is approximately 2.3 and the 95th percentile is approximately 2.9. The mean is in the order of 2.6, which is better than the expected effective recovery rate of 2.5.

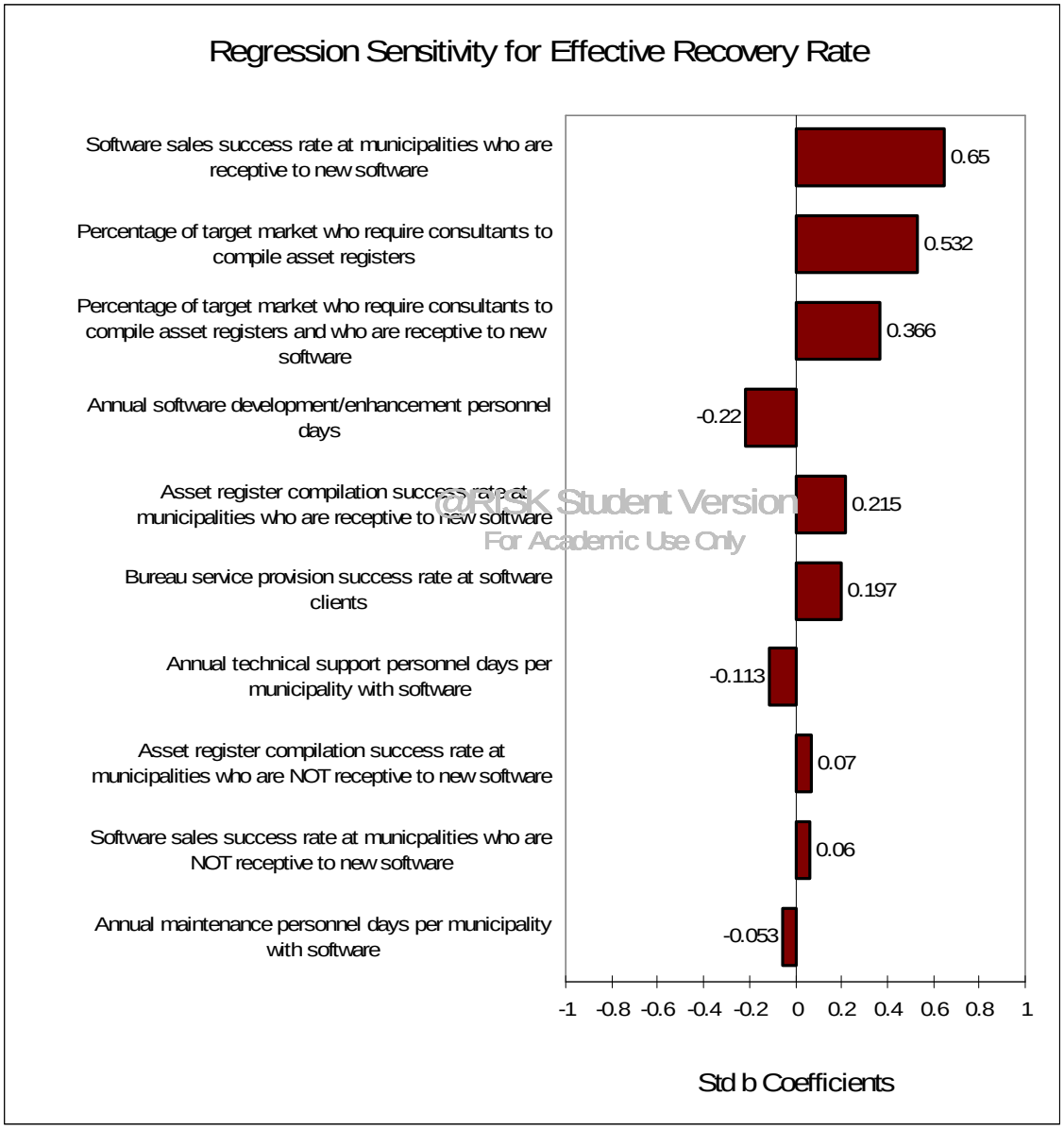

FIGURE 9 Sensitivity of the effective recovery rate to model inputs.

The effective recovery rate is sensitive to similar model inputs as the net present value, but with greater sensitivity to software based factors. The effective recovery rate is the most sensitive to the software sales success rate and is more sensitive to the annual software development and enhancement personnel days.

5.7.4 Exit Strategy

The software is consistent with Africon's core business, and will be used to leverage related consultancy appointments from the client base. It is therefore not the intention to sell the software or services to another party as an exit strategy. If the venture shows poor profitability, it is most probable that a harvest strategy *(28)* will be followed to stop further investment and to recoup as much profit as possible from existing clients. This decision will be taken at a time in the future based on the available information, alternatives, and preferences at the time.

5.8 Critical Risk Factors

5.8.1 Management Risks

Although personnel resources are currently in short supply, the joint ownership of the software between the Asset and Project Management Unit and the System Unit reduces the risk of lack of responsibility for the software. The equal ownership does, however, increase the risk of management pursuing dissimilar goals and leading to an internal struggle over the development and marketing of the software.

5.8.2 Marketing Risks

The adoption of the product will be dependent on successful implementations and word of mouth communication between municipalities. There is a risk of unsuccessful adoption in the Western Cape. The Western Cape pilot projects have taken long to complete due to poor data collection and the time needed for software development. The software has not yet been implemented at the pilot municipalities and competitors have started developing alternative solutions. Successful implementation of the software at the pilot municipalities is critical to success in the Western Cape and elsewhere.

The software has been marketed in the past as asset register software and not software to support sustainable infrastructure service delivery. This positions the software in the market with many other competitors. The marketing emphasis needs to shift from asset register software only to software that assists municipalities with the implementation of infrastructure asset management. This may form the basis of some differentiation from other products.

A risk exists that the software will appear to be in direct competition and directly comparable to other software that is already well established, such as IMQS. The product should be differentiated from its competitors and framed as supplementary to existing products, rather than in direct competition.

5.8.3 Operating Risks

The current high demand and low supply of personnel resources increases the risk that the software implementation and support cannot be adequately staffed and serviced. Inadequate capacity has already hampered progress on development and implementation of the pilot studies in the Western Cape. The Africon sectoral specialists and their units currently have a large workload and many are overextended on their own projects. The risk exists that it may not be easy to gain technical support and commitment from these units for projects that may be considered a low priority to them. This risk should be considered when tendering to secure infrastructure asset management work.

5.8.4 Financial Risks

A financial risk is not receiving sufficient sales revenue from the software to cover the development costs, although the purchase of 10 licenses and installations by the Western Cape Department of Local Government has reduced this risk. Another risk is landing into the trap of continuously needing to update the software over time to satisfy evolving client needs and meeting new technology requirements. This should be reduced by keeping the software functionality simple and not adopting an expansive software development view to satisfy numerous needs with the one software. A modular design using mainstream software development tools may limit this risk. Decisions on further development should be based on a forward looking decision process that disregards the sunk cost to date.

5.8.5 Intellectual Property

Given the fairly straight forward methodology of asset register compilation, intellectual property is expected to have a short life. The Asset Manager intellectual property lies primarily in the software source code, data structure, and valuation method. The data

structure and valuation method are expected to have short lives, and Africon will have to remain innovative to stay ahead in the field. It is expected that the software will not be replicated in its current form, but competitors will seize opportunities brought about by new technology. This risk has been managed to a certain extent by designing the software with mainstream software tools that are less likely to become obsolete in the near future.

Africon has a business relationship with i@Consulting and has undertaken to share technical resources for the provision of infrastructure asset management services. The risk exists that the strategic partnership will dissolve and i@Consulting will develop its own technical tools similar to that provided by Africon. Alternatively, if there are perceived to be greater benefits, i@Consulting may approach another large engineering competitor as a partner to provide infrastructure asset management services. This risk should be minimized by engaging in a mutually beneficial partnership with i@Consulting. Their fear of not having access to technical tools should be assuaged by means of a contractual agreement that specifies their rights to use the Africon software and other technical resources. The perspective that Africon does not need i@Consulting should be tempered by the fact that potential competition is never far behind, Africon staff resources are currently under enormous pressure, there is a high growth in demand for infrastructure asset management services, and the mutual benefit of cooperation far exceeds the individual benefit that can be obtained from pursuing the market alone in the short term.

6. TECHNICAL COMPONENTS OF THE SOFTWARE

The technical components of the software are designed to support the development of the core functionality of the software. These descriptions are used as the basis of developing software specifications.

6.1 Interpretation of Accounting Standards

For infrastructure management, GAMAP 17, which deals with property, plant and equipment is the most relevant standard. The GAMAP 17 standard supports the depreciation method of accounting for infrastructure assets and does not make provision for other methods, such as the preservation approach used in the United States. The principle issues addressed by the standard are the timing of recognition of the assets, and the determination and accounting treatment of the carrying amount, depreciation, and impairment of assets. Several interpretations of the standard that are relevant to the development of infrastructure asset management systems are highlighted below.

6.1.1 Recognition of Assets

Guidelines by National Treasury define assets as resources controlled by an entity as a result of past events and from which future economic benefits or service potential is expected to flow to the entity *(19)*. The definition allows for the management of assets over which the entity has control and does not necessarily require ownership.

Two conditions are required for the recognition of assets. Firstly, it must be probable that future economic benefits or service potential associated with the asset will flow to the entity, and secondly, the cost or fair value of the asset to the entity must be able to be measured reliably *(23)*. It is expected that these conditions will be readily satisfied by most infrastructure assets. Interpretation is required when separating assets and breaking them down into components and accounting for them separately.

The separation of assets results in the width of an asset hierarchy. The underlying principle guiding the separation of assets is to not separate assets that are highly dependent on each other for the provision of a service. For example, the mechanical plant and the civil structures at a water treatment works should not be separated in an

asset hierarchy. In this case, the water treatment works should be treated as an asset with components.

The breaking down of assets into components provides the depth of an asset hierarchy. The underlying principal guiding the breaking down of asset into components is to only break an asset down if the components are material, the components have different useful lives or accrue benefits in different manners, and the fair value of the components can be measured reliably. The Local Government Financial Best Practice Manual recommends that no assets with a value less than R5000 be recognized on the basis of a materiality criterion *(21)*. This threshold value is supported by National Treasury guidelines *(18)*. The level to which assets are broken down into components should be in balance with the ability of the particular agency to collect and maintain the data needed to manage the assets at that level.

There has been much debate over the accounting treatment of a road asset. Using the depreciation method of accounting for infrastructure assets, it is recommended that a road asset be broken down into road surfacing and road structure components. The components have very different useful lives under normal maintenance regimes, even though there is some dependency between the lives of the two components. Given that road infrastructure assets normally account for a large proportion of municipal asset value and expenditure, it is recommended that municipalities make every effort to collect and maintain data for the two components.

6.1.2 Carrying Amount

The initial measurement of infrastructure assets should be at cost or fair value, if cost is not appropriate. The cost of an asset comprises its purchase price, including non-refundable duties and taxes, and any costs to bring the asset into working order. This would typically include the costs for site preparation, delivery, installation, and professional fees. The GAMAP 17 standards do not specify the means of determining fair value and it is recommended that the depreciated replacement cost method be used for infrastructure. The carrying amount of an asset subsequent to recognition is its cost less accumulated depreciation and impairment.

The GAMAP 17 standard allows for a historic cost measurement basis for infrastructure assets. This method has a considerable impact on the accounting for infrastructure assets, which have very long lives often over 30 years. The historic cost measurement basis underestimates the depreciation charge in the future years of infrastructure assets due to the effects of inflation. The consumption of assets in future years is therefore understated and the carrying value deviates grossly from the fair value of the asset.

The GAMAP 17 standards require that subsequent expenditure on an asset be added to the carrying amount of the asset if additional economic benefits or service potential will flow to the entity. All other subsequent expenditure is treated as an expense *(23)*. Cases where subsequent expenditure should be added to the carrying value of the asset are interpreted as being the following:

i) If the expenditure increases the capacity of an asset. Examples include increasing the size of a water treatment plant, and widening a road.
ii) If the expenditure increases the expected useful life of the asset substantially beyond the useful life extension expected from normal maintenance. An example includes the rehabilitation of a road.
iii) If the expenditure increases the performance of the asset beyond the expected performance of the asset. An example includes installing a laboratory at a water treatment works.

There has been much debate over the classification of expenditure. A particular case that has received attention is the classification of expenditure for road assets. The option to classify the road into either road surface and road structure components or to consider it as one asset adds complexity to this problem. The issue is whether a subsequent treatment is considered the same in both cases. For example, if the road is not broken down into components, its overall service life may be as long as 40 years and a resurfacing may be viewed as a maintenance expense. If the asset is broken down into

components, the resurfacing may be interpreted as a disposal and replacement of the surfacing component. Road treatments often consist of a surface replacement with some base repair and the question has been raised whether this should be treated as a surface replacement, which can be capitalized and base maintenance treatment, which can be expensed. The underlying principle is that cost should be distributed over a period for which it provides benefit. Maintenance benefit lasts less than a year and should therefore be expensed in the first year. Improved standards and guidelines are needed to provide clarity on these issues.

To find a practical solution to the handling of expenditure on infrastructure assets, one must consider the intention of infrastructure asset management to align technical practice with financial accounting. The depreciation of assets or components indicates the rate and extent to which the assets are being consumed. The rate of consumption should be indicative of the rate of expenditure required by the agency to periodically renew the assets under its control. This expenditure is in excess of the maintenance expenditure that is required on an ongoing basis for assets to reach their expected useful lives. The definition and classification of assets should therefore be aligned with the classification of expenditure during the infrastructure asset management planning process. For the purposes of managing infrastructure assets, it is recommended that expenditure be classified as:

- capital expenditure for funds spent on increasing the capacity and performance of assets beyond their original design;
- renewal expenditure for funds spent on renewing or partially renewing the asset by increasing the expected service life of the asset beyond the initial expected service life; and
- maintenance expenditure for funds spent on ensuring that assets meet their expected useful lives.

The infrastructure asset management plan should make provision for the financial accounting of projects that include elements of both capital and renewal expenditure and projects that influence adjacent components, such as road surfacing and road structure.

6.1.3 Revaluations

The GAMAP 17 standards are not specific on the method of revaluation of infrastructure assets, but do recommend changing the carrying value by restating or eliminating the accumulated depreciation so that the carrying value reflects the revaluation amount. Increases in value should be credited to non-distributable reserve named revaluation surplus, and decreases should be recognized as expenses *(23)*.

The GAMAP 17 standards recommend that when revaluations are performed, they should be performed across all assets in the class. Revaluation frequencies of 3 to 5 years are recommended for land and buildings, but no guidelines are given for infrastructure *(23)*. National Treasury guidelines on infrastructure assets stipulate that revaluations be conducted regularly and that assets be separately identifiable in the fixed asset register. The guidelines suggest the adoption of an improvement plan for the accumulation of detailed information over several years *(19)*. It is recommended that the revaluation frequency of infrastructure assets be related to the expected useful life of the asset. Assets with lives in the order of 10 to 15 years should be revalued every 3 years.

6.1.4 Depreciation

Depreciation is used to represent the pattern of consumption of economic benefits and service life over the life of the asset. Although the GAMAP 17 standards make provision for several methods of depreciation, straight line depreciation is recommended by the National Treasury guidelines. The GAMAP 17 standards recommend the review of useful lives periodically and the change in depreciation charges in the future to reflect the changes in useful lives.

6.1.5 Impairment

Asset impairments are the result of damage or economic obsolescence. Impairments can be used to reflect underperformance of an asset relative to its expected useful life.

6.1.6 Disposals

Disposals result when the asset is withdrawn from use when no further economic benefits or service potential are expected to be derived from the asset.

6.1.7 Financial Disclosure

For the purposes of financial disclosure, a class of assets must be disclosed as a single item in the financial statements. A class of assets is defined in the standard as a grouping of assets of similar nature or function. It is interpreted that examples of classes would include pump stations, reticulation, water treatment works, etc.

6.2 Asset Register Hierarchical Design

The asset register is the data source that is used to provide information to decision makers. The data source must be comprehensive and well defined to ensure that the information can be collated into useful information. The asset register must be designed to provide the most information with the least data to minimize data collection and maintenance costs.

6.2.1 Asset Hierarchy

The asset hierarchy provides the structure of the asset register. The asset hierarchy has been developed to allow the logical grouping of infrastructure assets. The two highest levels of the hierarchy are used for grouping and the lower levels are used for data capture. The hierarchy has been specifically designed to allow the capture of data at different levels of the hierarchy. This functionality reduces the data dependency of the asset register and allows users to improve the resolution of the data and the accuracy of the asset register over time. The asset hierarchy structure and some examples of data at the different levels of the hierarchy are shown in Figure 10.

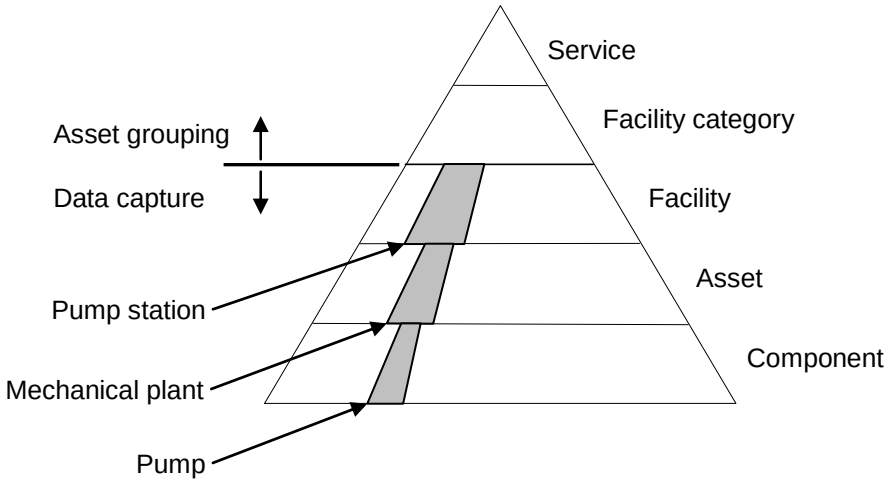

FIGURE 10 Asset hierarchy.

The definitions of the different levels of the hierarchy are provided below.

- **Service:** Service type provided by the agency. An example is Water Supply.
- **Facility category:** A function provided by a service. Each function may require more than one facility type to perform the function. An example for the Water Supply service is Bulk Supply, Bulk Distribution, and Reticulation.
- **Facility:** A grouping of assets that together provide a particular function and have a defined location that can be located in the field. It can either be a site-based facility, such as a Water Treatment Works that consists of many different assets, or a network-based facility such as a Reticulation Area that consists of many similar assets. Facility data is typically useful for planning and high-level valuations and does not contain detailed data such as material type. Facilities of the same type will always be expected to consist of a similar grouping of assets.
- **Asset:** A grouping of similar components in a facility that operate together as one system. Assets normally have one dominant component. Asset data is typically used for works planning and detailed valuations and may contain

detailed data such as material type of the dominant component. An example for water treatment work is Mechanical Plant.

- **Component:** An individual physical entity that typically requires individual maintenance attention. Component data is typically used for maintenance management purposes and contains detailed data about the component. An example of a component is Pump.

A standardized asset hierarchy was developed for municipalities in the Western Cape Province. The hierarchy is shown in Appendix A and included several services including:

- water supply;
- sanitation;
- road transport;
- stormwater;
- solid waste;
- electricity supply;
- parks; and
- buildings.

6.2.2 Geographic Hierarchy

South Africa has been subdivided geographically into a series of mutually exclusive and collectively exhaustive sub-areas with increasing levels of division. This subdivision forms a hierarchy of geographic areas that are useful for the reporting of information. The country is divided into 9 provinces, which are divided into 47 district municipalities, which are divided into 231 local municipalities, which are in turn divided into census sub-areas.

Assets can be referenced spatially in GIS as either a point, line, or a polygon. The spatial referencing enables information reporting by spatial locations such as census sub-

areas, wards, and technical service areas. The principal spatial reference is census sub-areas, which follow suburb boundaries. The suburbs seldom change boundaries and useful census data is available on the census sub-areas. Ward boundaries are political boundaries that change frequently. Service area boundaries make sense to engineers in a specific field, but are not readily recognized by others.

To enable reporting at a specific level of spatial detail, data must be captured at that level of detail. For example, if data is collected for an area representing the town, the data representing the suburbs cannot be accurately reflected. A challenge exists in that the boundaries of suburbs, wards, and service areas do not always overlap. The recommended method of capturing data, if detailed spatial reporting is desired, is therefore to capture it according to the smallest common denominator of suburbs, wards, and service areas. GIS spatial data should be assigned to the data capture areas using the centroid of the GIS shape.

6.3 Asset Register Data Requirements

Guidelines for the data requirements of asset registers have been given in various guidelines by National Treasury, but these have been focused primarily on movable assets and land and building immovable assets. No clear guidelines have been given on infrastructure. The IIMM does provide some guidance on asset registers for infrastructure assets, but these place greater emphasis on the technical data needs. The GAMAP 17 standards require the disclosure of the following information for each class of asset *(23)*:

i) Measurement basis for determining gross carrying amount.
ii) Depreciation method used.
iii) Useful lives or depreciation rates used. It is recommended that the expected useful life, age, remaining useful life, and current rate of depreciation be reported.
iv) Beginning period gross carrying amount and accumulated depreciation with impairment.

v) Period depreciation, impairments, and other movements.
vi) Period reconciliation including additions, disposals, acquisitions, increases or decreases from revaluations, increases or decreases from impairments.
vii) End period gross carrying amount and accumulated depreciation with impairment.

The GAMAP 17 standard reporting requirements refer to financial movements due to financial transactions and due to asset performance. The relevant data from financial transactions need to be captured. The transactions that should be recorded on an ongoing basis include capital expenses for new acquisitions, capital expenses for improvements to current assets, renewal expenses, maintenance expenses, impairments, and asset disposals. This transaction data is used to update the financial statements for additions and deletions. Revaluations are conducted periodically for all assets in the asset class and should therefore not be recorded on an ongoing basis. However, when revaluations are conducted, the revaluation data needs to be captured against the assets in the asset register.

The level of detail to which the transactions are recorded against assets is dependent on the agency needs. Agencies that manage their assets on a very detailed level may record the transactions against individual assets or components. Agencies with limited data, who manage their assets at a lower level of detail, may record their transactions against asset groups or asset classes. In both cases the same quantities are defined and recorded and the financial statements are affected in the same way. However, agencies that record the transactions against individual assets will have more detailed data to evaluate the performance of individual components and support decision making at that level. The level of detail used for recording financial transactions should be consistent with the level of detail used for the recording of the technical data. It is recommended that agencies establish asset inventories for their asset registers at a level of detail that they can manage, and then record the transaction data against the defined

assets. This will ensure that the financial reporting is consistent with the technical infrastructure asset management practice of the agency.

To simplify data management, it is recommended that historic data not be maintained in the asset register. The asset register will therefore provide a basis for capturing the financial transactions in the financial year and provide a snapshot of the financial situation at year end. Technical data will also not be modeled forward from previous years to the current year. The technical data will therefore only provide a snapshot of the technical situation at the data of assessment. Analysis sets should be saved on an annual basis to perform trend analysis over time.

The multilevel asset hierarchy allows data to be captured at different levels of the hierarchy. For example, if data is captured for an asset at the asset level, additional data may be captured at the facility level. The hierarchical structure also allows data to be aggregated or ‘rolled up’ to the higher level from the assets of the lower level. For example, the current value of a facility may be calculated as the sum of the current values of all the assets that are associated with that facility.

The recommended data requirements for the management of data at the asset level are provided in Table 8. The data requirements for the management of data at higher levels in the hierarchy are provided in Table 9. The financial importance indicates the importance of the data for the financial management of assets. The technical importance indicates the importance of the data for the technical management of assets. The priority rating scale has a minimum of 1 tick mark and maximum of 3 tick marks.

TABLE 8 Recommended Asset Register Data Requirements

Description	Financial importance	Technical importance
Acquisition		
Acquisition date	✓✓✓	
Supplier	✓✓✓	
Payment reference	✓✓✓	
Acquisition cost	✓✓✓	
Acquisition take-on value	✓✓✓	
Acquisition type (purchase/self construct/3rd party construct/donation)	✓✓✓	
Funding source	✓✓✓	
Date captured	✓✓✓	
Identity and position in hierarchy		
Parent reference number	✓✓✓	✓✓✓
Asset type	✓✓✓	✓✓✓
Unique number	✓✓✓	✓✓✓
Name	✓✓✓	✓✓✓
Alternative number used for asset in other systems	✓✓✓	✓✓✓
Location		
Service area		✓
Suburb		✓✓✓
Ward		✓
GIS reference number	✓	✓✓✓
Location description	✓✓	✓✓
Land parcel number	✓✓	✓✓
Description		
General description	✓✓✓	✓✓
Descriptor 1 (user defined physical descriptor)		✓✓
Descriptor 2 (user defined physical descriptor)		✓✓
Descriptor 3 (user defined physical descriptor)		✓✓
Descriptor 4 (user defined physical descriptor)		✓✓
Size 1 (user defined size)	✓✓✓	✓✓✓
Size 2 (user defined size)	✓✓✓	✓✓✓
Size 3 (user defined size)	✓✓✓	✓✓✓
Number (some of similar items)	✓✓✓	✓✓✓
Quantity (product of sizes and number)	✓✓✓	✓✓✓
Condition		
Latest assessed condition grade		✓✓✓
Date of latest assessment		✓✓✓
Assessor		✓✓✓

Table 8 Continued

Description	Financial importance	Technical importance
Utilization		
Capacity		✓✓
Utilization (% of capacity)		✓✓
Usage (abandoned/infrequent usage/regular usage)		✓✓✓
Risk		
Failure mode		✓✓
Probability of failure (low/medium/high) (computed on condition)		✓✓
Criticality – health & safety		✓✓
Criticality – Cost		✓✓
Criticality – Performance		✓✓
Criticality – Environment		✓✓
Criticality grade (computed)		✓✓
Management responsibility		
Owner	✓✓✓	
User department	✓✓✓	
Custodian	✓✓✓	✓✓✓
Cost centre	✓✓✓	
Convertants or restrictions	✓✓✓	
Warrantees and guarentees	✓✓✓	
Measures	✓✓✓	
Performance		
Performance indicator		✓✓
Target performance		✓✓
Performance grade		✓✓
Date of last assessment		✓✓
Assessor		✓✓
Lifecycle costing data		
Annual operations cost (default from budget estimation model)		✓✓✓
Annual routine maintenance cost (default from budget estimation		✓✓✓
Annual periodic maintenance cost (default from budget estimation		✓✓✓
Valuation data		
Construction date		✓✓✓
Last renewal date		✓✓✓
Asset age (since last renewal)	✓✓	✓✓✓
CRC (default from valuation model)		✓✓✓
EUL (default from valuation model)	✓✓	✓✓✓
Residual value (% of CRC, default from valuation model)		✓✓✓

Table 8 Continued

Description	Financial importance	Technical importance
Latest assessed RUL	✓✓	✓✓✓
Assessor		✓✓✓
Current value (default is DRC from valuation model)		✓✓✓
Accounting data		
Begin period carrying amount	✓✓✓	
Begin period accumulated depreciation and impairment	✓✓✓	
Period depreciation	✓✓✓	✓✓✓
Period impairment	✓✓✓	
Period revaluation amount	✓✓✓	
Period revaluation movement	✓✓✓	
Period capital expense	✓✓✓	
Period renewal expense	✓✓✓	
Period maintenance expense	✓✓✓	
End period carrying amount	✓✓✓	
End period accumulated depreciation and impairment	✓✓✓	
Disposal		
Date	✓✓✓	
Income or cost	✓✓✓	
Condition at disposal	✓✓✓	✓
Remaining useful life at disposal	✓✓✓	
Value at disposal	✓✓✓	

TABLE 9 Recommended Asset Register Data Requirements for Higher Hierarchical Levels

Description	Financial importance	Technical importance
Identity and position in hierarchy		
Service type	✓✓✓	✓✓✓
Facility category type	✓✓✓	✓✓✓
Facility type	✓✓✓	✓✓✓
Facility unique number	✓✓✓	✓✓✓
Facility name	✓✓✓	✓✓✓
Location		
Service area		✓✓✓
Suburb		✓✓✓
Ward		✓✓✓
Facility GIS reference number		✓✓✓
Facility location description		✓✓
Facility land parcel number, list all erven		✓✓

Table 9 Continued

Description		
General description		✓
Descriptor 1 (user defined physical descriptor)		✓
Descriptor 2 (user defined physical descriptor)		✓
Descriptor 3 (user defined physical descriptor)		✓
Descriptor 4 (user defined physical descriptor)		✓
Size 1 (user defined size)		✓
Size 2 (user defined size)		✓
Size 3 (user defined size)		✓
Number (some of similar items)		✓
Quantity (product of sizes and number)		✓
Condition		
Condition distribution (rolled up)		
RUL distribution (rolled up)		
Utilization		
Facility capacity		✓✓
Facility utilization (% of capacity)		✓✓
Facility usage (abandoned/infrequent usage/regular usage)		✓✓
Risk		
Criticality grade distribution (rolled up)		✓✓
Performance		
Performance grade (rolled up)		✓✓
Life cycle costing data		
Annual operations cost (rolled up)		✓✓
Annual routine maintenance cost (rolled up)		✓✓
Annual periodic maintenance cost (rolled up)		✓✓
Valuation data		
CRC (rolled up)		✓✓
Current value (rolled up)		✓✓
Accounting data		
Period depreciation (rolled up)		✓✓
Period capital expense (rolled up)		✓✓
Period renewal expense (rolled up)		✓✓
Period maintenance expense (rolled up)		✓✓

6.4 Record of Maintenance Activities

A record of maintenance activities is useful for recording expenses and identifying assets requiring high levels of maintenance. Maintenance data is not collected en masse so the capture of historic data is less troublesome for data management. The software is not intended to function as a maintenance management system, but it should be able to integrate with a maintenance management system, if one exists. The following data should be recorded:

- maintenance activity type;
- cost;
- comment;
- responsible person; and
- date.

6.5 Financial Model

The financial model should be used to perform asset valuations and the financial calculations needed to update the asset register data.

6.5.1 Asset Valuation Model

The recommended approach for infrastructure asset valuation is the depreciated replacement cost method. The method of valuation entails the assessment of the remaining useful life of assets. The proportion of value reduction of the depreciable part of an asset is equal to the proportion of the remaining useful life and expected useful life. The calculation is shown in Figure 11.

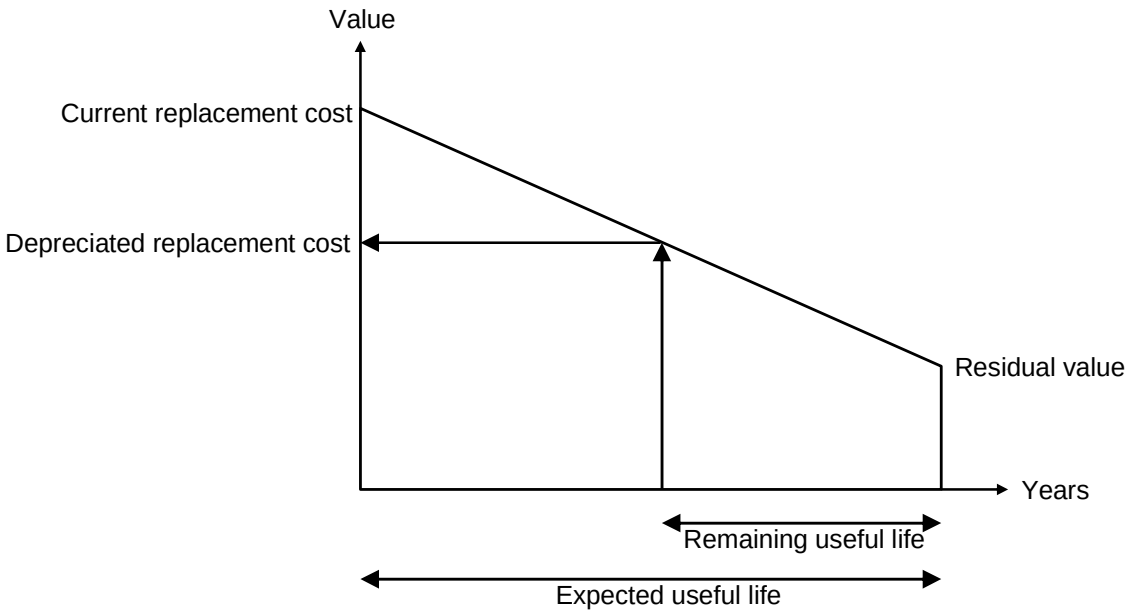

FIGURE 11 Depreciated replacement cost valuation method.

The inputs to this valuation method are the current replacement cost, residual value, expected useful life, and remaining useful life. The remaining useful life is estimated during the valuation. It is recommend that standardized current replacement costs, residual values, and expected useful lives be used for the valuation on infrastructure assets.

The recommended method of determining the current replacement cost is the used of standardized unit rates for infrastructure, which can be multiplied by the asset quantity to obtain a current replacement cost. For example, a standard rate of R250 per meter can be used for 100mm asbestos cement (AC) pipes. The length of the pipe is then multiplied by the unit rate to determine the current replacement cost. The use of standardized unit rates allows benchmarking and increases consistency and credibility in the results. It is recommended that the robustness of valuations and the consistency of valuations be given greater priority than the accuracy of the valuations. Infrastructure assets are very difficult to value and the added benefits from conducting highly accurate

valuations are not worth the cost of performing the valuations. An example of data needed for valuation and the valuation method is provided in Appendix B.

6.5.2 Financial Data Management

The GAMAP 17 accounting standards stipulate that assets should be carried at cost less accumulated depreciation and impairments. There are three practical options for the performing of financial calculations by municipalities. The first method is a revaluation method, where the values of the asset classes are initially determined. The asset classes are then depreciated over time and financial transactions are recorded against the asset classes, rather than the individual assets. The depreciated financial values are updated periodically after revaluations, where the entire asset class gets revalued. This method is practical for agencies with limited asset data and limited capacity to maintain the asset data accurately over time.

The second method is to record financial transactions against individual assets or asset groups and to perform the financial calculations against each asset on an ongoing basis. This method is the most accurate, but requires more active data management. Given the difficulty of maintaining detailed infrastructure data without a spatial viewer and the large number of assets, the data should be managed in the technical software.

The third option is to establish an asset register with a common inventory to the financial software. The financial data and technical data are then maintained using a GIS product and the relevant data is passed to the financial system on an annual basis. This may create data management problems between the two systems.

Given the simplicity of the financial calculations and the emphasis of maintaining data both accurately and easily, it is recommended that the financial calculations be performed in the technical software and the relevant financial data be passed on to the financial system for incorporation into the financial statements.

6.5.3 Financial calculations

For financial reporting, the most important financial metrics to report are beginning and ending period carrying amounts and beginning and ending accumulated depreciation. The movements from impairments, revaluations, and period depreciation should also be

reported. These movements should be captured for each infrastructure asset and then passed as outputs to the financial system in aggregated form. The data does not have to be kept from previous years. The historic cost, expected useful life, age, carrying value and accumulated depreciation get passed from one year to the next.

It is recommended that the revaluations be based on the beginning of the reporting year. Impairments and capitalization movements should then be applied to the revalued amount to get the carrying amount prior to depreciation. The depreciation calculation should be performed at the end of the reporting period on the carrying amount that includes all movements during the period.

The allocation of financial movements to the appropriate accounts in the financial statements should be performed by the financial accounting system based on the inputs received from the technical software.

6.6 Budget Estimation Model

An important component of infrastructure asset management is the determination of the financial commitment required to maintain the assets in servable condition and to operate them over time. The financial requirements for maintenance and operations should be defined in detail in infrastructure maintenance plans that are a part of the infrastructure asset management planning process. It is recommended that the financial requirements for routine (reactive) maintenance and periodic (planned) maintenance be determined individually.

A practical approach for estimating the budget requirements to maintain infrastructure is to estimate annualized budgets instead of trying to model the sequence of maintenance events over time. The sequencing of maintenance events can be complex with several different types of maintenance activities required over time. Given that an agency owns numerous assets of the same type, the sequenced activities should smooth out over time.

The budget estimation model that is used to estimate the annual maintenance budget requirements defines the budget requirements as a percentage of the current replacement cost of the asset for each different asset type. Assets of the same type that

are of a greater value therefore have proportionately greater maintenance requirements. The model has the advantage of being simple, but has the disadvantage of not being able to model the increase of the maintenance needs of an asset as it increases in age. An example of data needed for budget estimation and the budget estimation method is provided in Appendix B.

6.7 Reporting Requirements

The reporting requirements of the Asset Manager software have been identified as technical reports, budgeting reports, and financial reports. These reports support infrastructure asset management, by providing information on the current infrastructure situation and funding needs. The financial reports ensure compliance with financial reporting requirements of the MFMA. It should be noted that the lack of predictive and decision making functionality of the software does not allow future performance to be reported, nor does it demonstrate the consequences of alternative scenarios. The asset and geographic hierarchical structures allow data sorting and reporting by these two dimensions. Reporting is practical up to the asset category level of the asset hierarchy and for all levels of the geographic hierarchy.

The software should provide standardized predefined reports for the most common reports to allow quick reporting. The software should also have a data query functionality that provides customized data queries and allows the exporting of tabular data to Microsoft Excel. The graphing of customized query data should be performed externally using the exported data in Microsoft Excel, which is widely used and available in municipalities.

6.7.1 Technical Reporting

Several standardized quick reports have been identified for incorporation in the software in an effort to convey the most important results in a standardized manner to decision makers. It is hoped that the standardized results will become a standard requirement for reporting and enable direct comparison and benchmarking in the future. Provision will also be made in the software for customized report generation by users.

Extent of Assets Table The extent of assets table should provide summaries of the facility, assets, and components that are in the asset register. The intention is to provide a quick report that can be used to gain an overview of the quantity of infrastructure assets in the municipality, without too much detail on the assets themselves. The table should be structured in the order of the asset hierarchy, with the items grouped by common technical attributes. The table should provide the number of assets and sum of quantity used for value prediction. An example of a typical table is given in Table 10.

TABLE 10 Example of Typical Extent of Assets Table

RESERVOIR		
Reservoir with facility level data		
Reservoir	**Number**	**Total Volume (kl)**
Ground	2	8,000
Elevated	3	1,200
Total for Reservoir	**5**	**9,200**
Reservoir with asset level data		
Reservoir & Pipework	**Number**	**Total Volume (kl)**
Ground	4	12,000
Elevated	2	800
Total for Reservoir & Pipework	**6**	**12,800**
Mechanical Plant	**Number**	**Total Volume (kl)**
	6	12,800
Total for Mechanical Plant	**6**	**12,800**
Site Improvement	**Number**	**Total Area (m^2)**
Access secure and landscaped	2	440
Access landscaped and not secure	3	850
Access secure and not landscaped	1	300
Total for Site Improvement	**6**	**1,590**

Facility Degree of Depreciation Graph The facility degree of depreciation graph is a histogram that illustrates the extent to which the benefits of the assets have been consumed for each facility type. This gives an indication of the overall state of the assets in the municipality. The current replacement value is shown with the current value and the residual value. An example is shown in Figure 12.

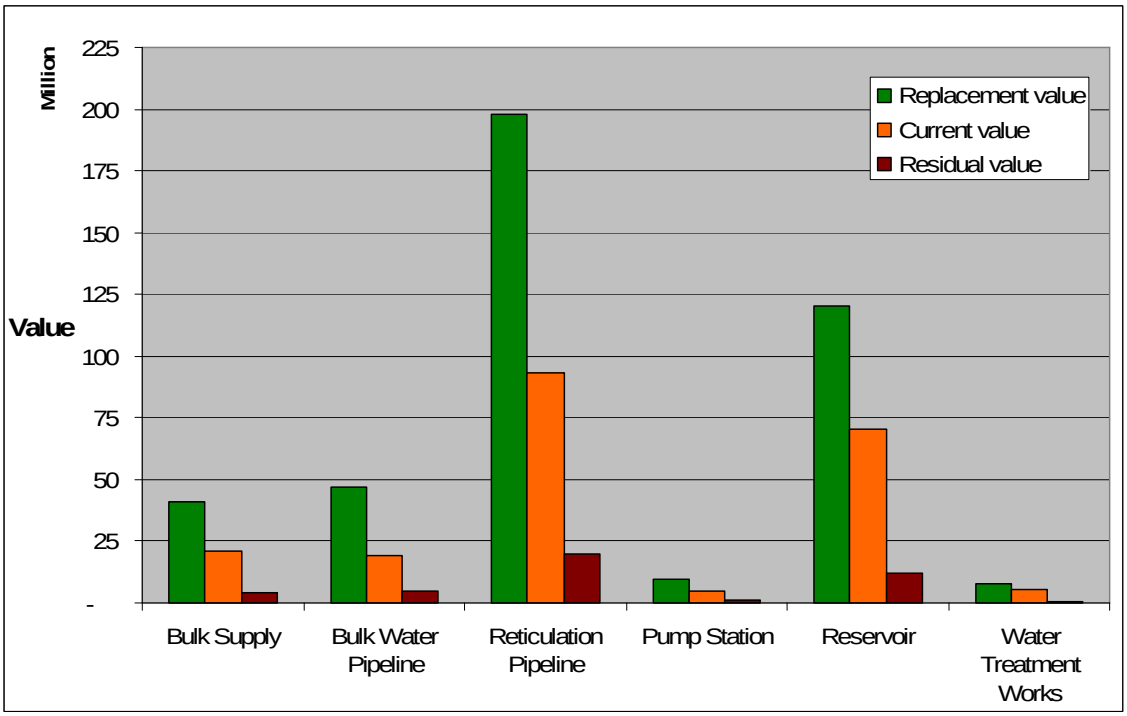

FIGURE 12 Example of a degree of depreciation graph.

Facility Condition Distribution Graph The facility condition distribution graph illustrates the condition of the different facility types in each service, aggregated by replacement value. An example is shown in Figure 13.

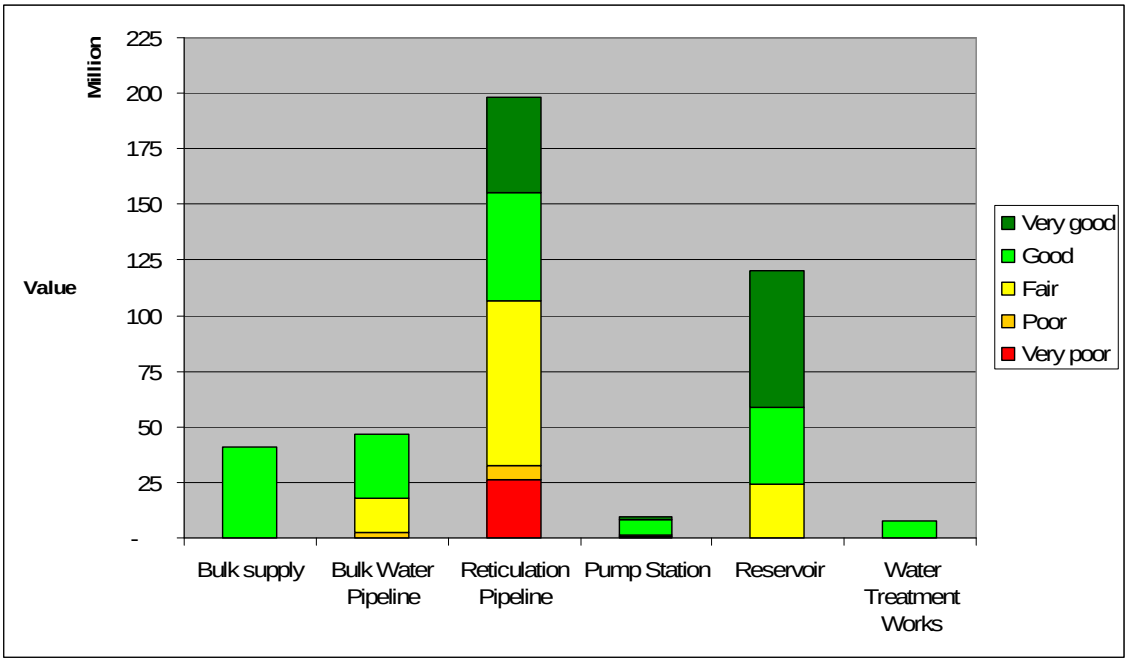

FIGURE 13 Example of a facility degree of depreciation graph.

Facility Remaining Useful Life Distribution Graph The facility remaining useful life distribution is aggregated by replacement value. The graph provides an indication of the future cost needed to replacement assets that are reaching the end of their useful lives. An example is shown in Figure 14.

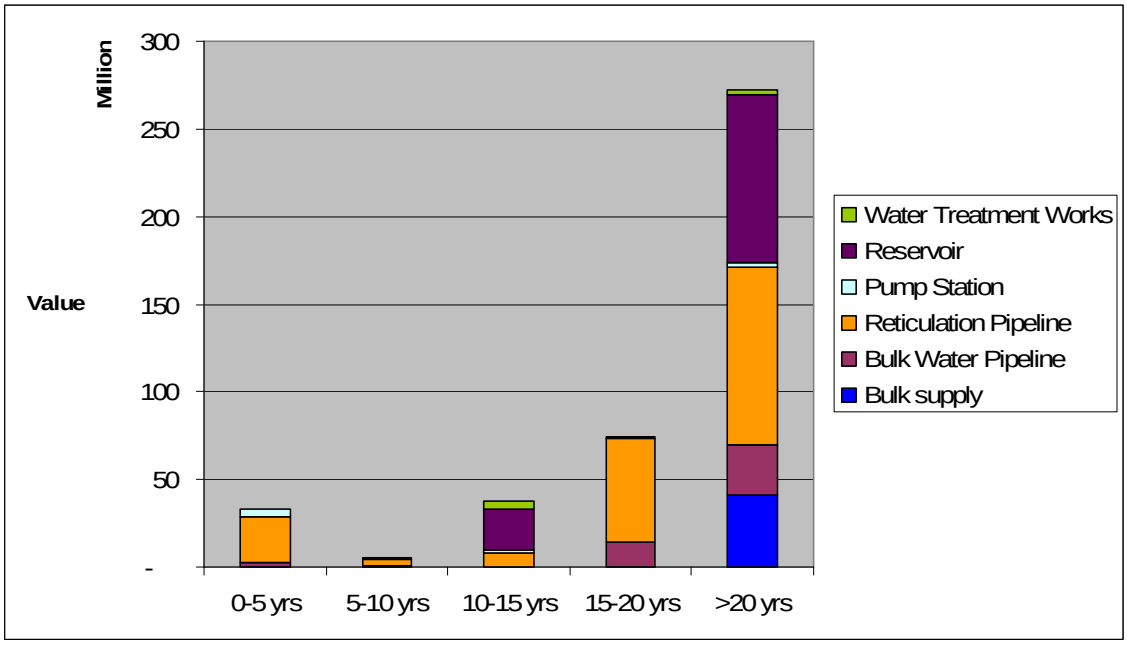

FIGURE 14 Example of a facility remaining useful life distribution graph.

6.7.2 Budgeting Reporting

The budgeting reporting should provide a basis for motivating for funding to renew and maintain assets.

Budget Needs Graph The budget needs graph shows the results from the budget estimation model. The graph includes the budgets for renewals and the budgets for operations and maintenance. An example is shown in the Figure 15.

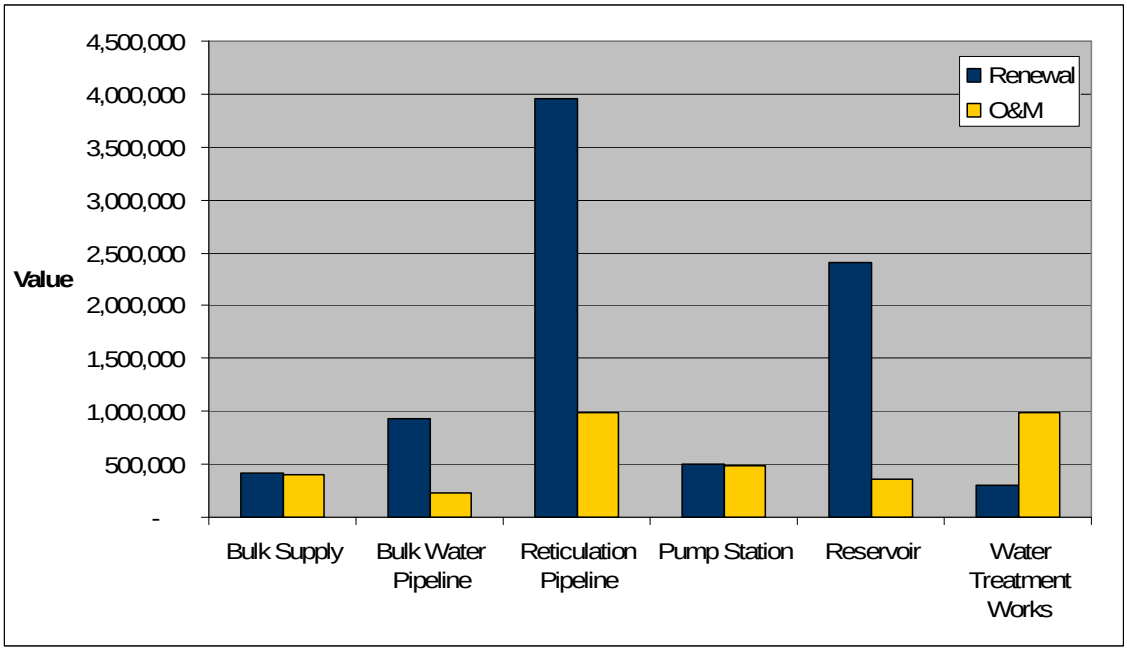

FIGURE 15 Example of a budget needs graph.

Actual Expenditure Percentage Graph The actual expenditure percentage graph shows the actual expenditure in the year as a percentage of the estimated budget needs for each facility type. An example is shown in Figure 16.

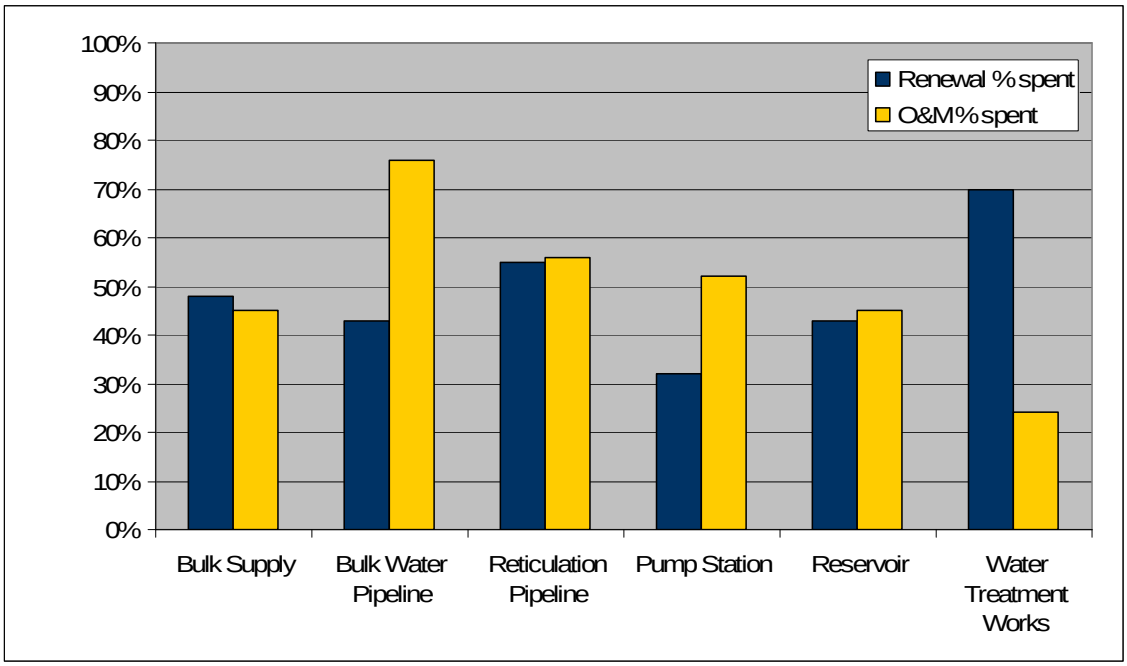

FIGURE 16 Example of an actual expenditure percentage graph.

6.7.3 Financial Reporting

Financial reporting is required to pass the required information to the financial system for incorporation in the financial statements. Guidelines from National Treasury specify the minimum reporting requirements as the following *(19)*;

i) Summary of all acquisitions.
ii) Summary of all disposals and write-offs, including cost and accumulated depreciation.
iii) Aggregate depreciation for the year.
iv) Changes in impairments during the year.
v) Opening and closing balances at cost.
vi) Opening and closing balances of accumulated depreciation.
vii) Movements in the revalued portion.

It is further required that the reporting be done by the following categories:

i) Asset class.
ii) Funding source.
iii) Department or function.
iv) Asset category.

The financial statements, and in particular the balance sheet, will contain the summary information that has been passed from the infrastructure asset register. This information may be used for the evaluation of overall municipal performance using financial ratios. Opportunities should be sought to develop benchmarks based on this data that can be used to compare the performance across municipalities.

7. PROJECT MANAGEMENT

The software development project started in November 2005. The specifications were prepared and programming commenced in January 2006. The project management of the project has changed during the course of the project. The functions and duties of Chris von Holdt were previously performed by Rob Childs. The lead programmer also changed with Louis Coetzee taking over from Marcel Hutton.

7.1 Organizational Breakdown Structure

The organizational breakdown structure (OBS) shown in Figure 17 illustrates the structure of the key project personnel who are involved in the Asset Manager software development.

7.2 Work Breakdown Structure

The work breakdown structure (WBS) shown in Figure 18 illustrates the structure of the key project tasks.

7.3 Organizational and Work Breakdown Structure Matrix

The OBS/WBS matrix in Table 11 shows the relationship between the people involved on the project and the key tasks performed on the project.

7.4 Budget

The budget for the development for the first version of the Asset Manager software was estimated at approximately R220,000. This budget is for staff expenses at cost rate. Africon normally require a recovery factor of at least 2.5 for staff time costs, but since this is an internal project, a recovery rate of 1.0 is used on the project. The budget estimate breakdown is shown in Table 12.

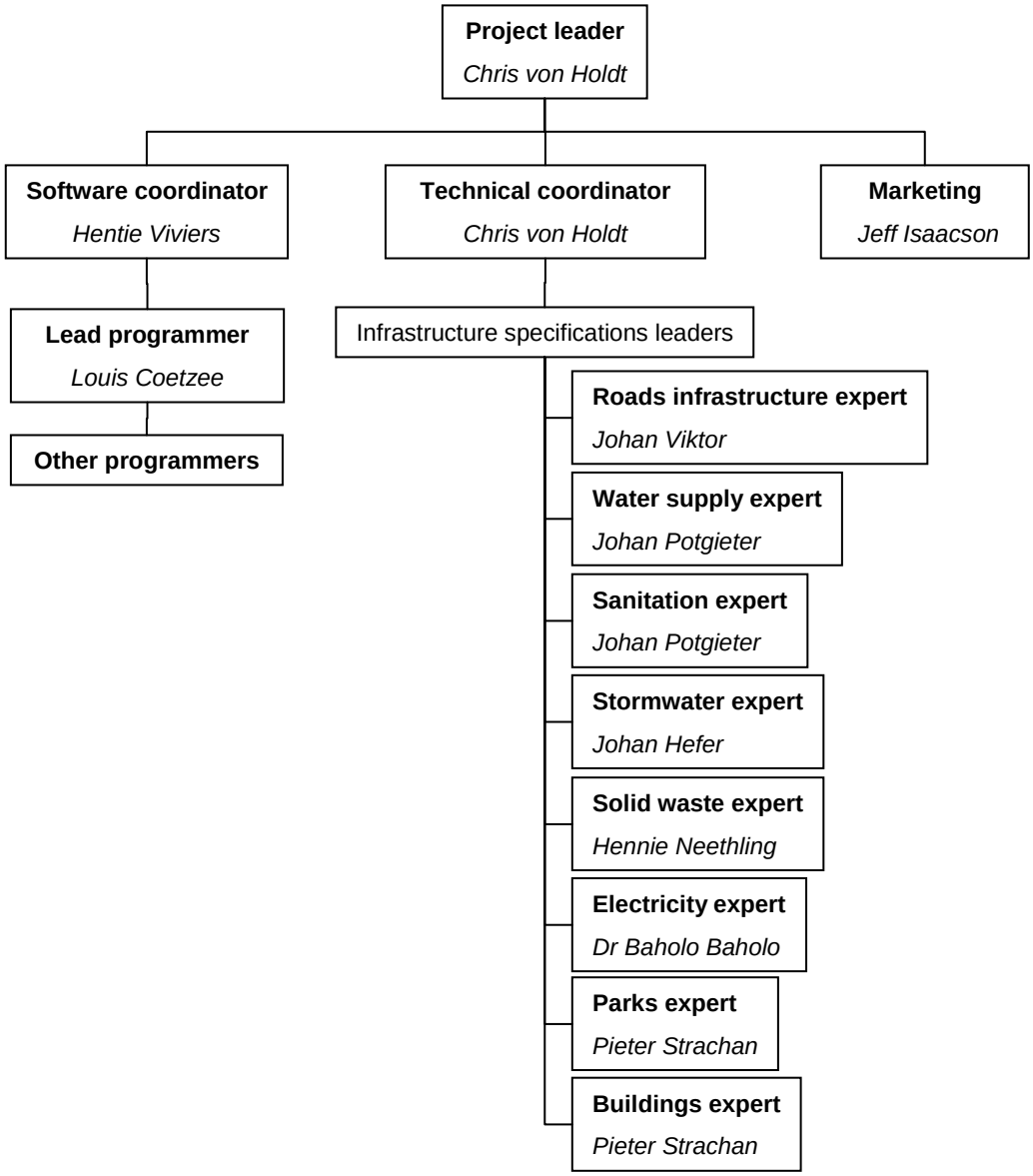

FIGURE 17 Organizational breakdown structure.

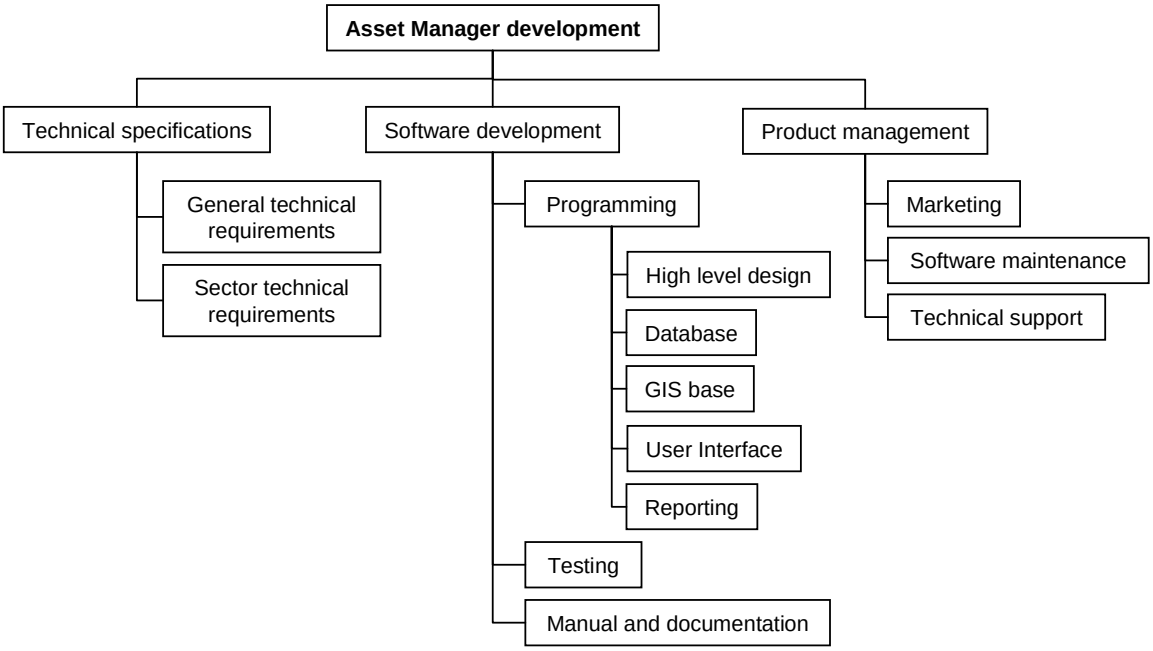

FIGURE 18 Work breakdown structure.

TABLE 11 Organizational and Work Breakdown Structure Matrix

			WBS key tasks							
			General technical requirements	Sector technical requirements	Programming	Testing	User manual	Marketing	Software maintenance	Technical support
OBS personnel	Project leader	Chris von Holdt	×	×	×	×	×	×	×	×
	• Software coordinator	Hentie Viviers			×	×	×	×	×	
	- Lead programmer	Louis Coetzee			×	×	×		×	
	- Other programmers	-			×	×	×		×	
	• Technical coordinator	Chris von Holdt	×	×		×	×			×
	- Road transport expert	Johan Viktor		×						
	- Water supply expert	Johan Potgieter		×						
	- Sanitation expert	Johan Potgieter		×						
	- Stormwater expert	Johan Hefer		×						
	- Solid waste expert	Hennie Neethling		×						
	- Electricity expert	Dr Baholo Baholo		×						
	- Parks expert	Pieter Strachan		×						
	- Buildings expert	Pieter Strachan		×						
	• Marketing	Jeff Isaacson						×		

TABLE 12 Budget Estimate for the Development of the Asset Manager Software

Phase	Budget
Planning and design	R 34,096
Development	R 100,224
Testing	R 33,318
Launch	R 9,792
Total staff cost	**R 177,430**
Contingency	R 17,743
Software	R 25,000
Total Cost	**R 220,173**

The first version of the Asset Manager was completed within budget. During the course of programming the first version, additional functionality was identified to enhance the software. The additional functionality will be programmed as version 2 of the software. Revenue from the sale of the software will be used to fund the additional development.

7.5 Project Program

The baseline project program was developed in November 2005 on the basis of the estimated time to complete key tasks. The base line program and the actual program are shown in Figure 19.

ID	Task Name
1	**AMIS Phase 1**
2	**Planning & design**
3	Detailed requirements definition
4	Workshop to finalise needs
5	Finalise URS
6	Design system
7	**Development**
8	GIS base
9	Database
10	GUI development
11	Reporting
12	Integration
13	User documentation
14	**Testing**
15	Alpha testing
16	System improvements
17	Beta testing
18	System finalization
19	ATP
20	**Launch**
21	Install at client
22	Data upload
23	Final testing at first site
24	Finalization

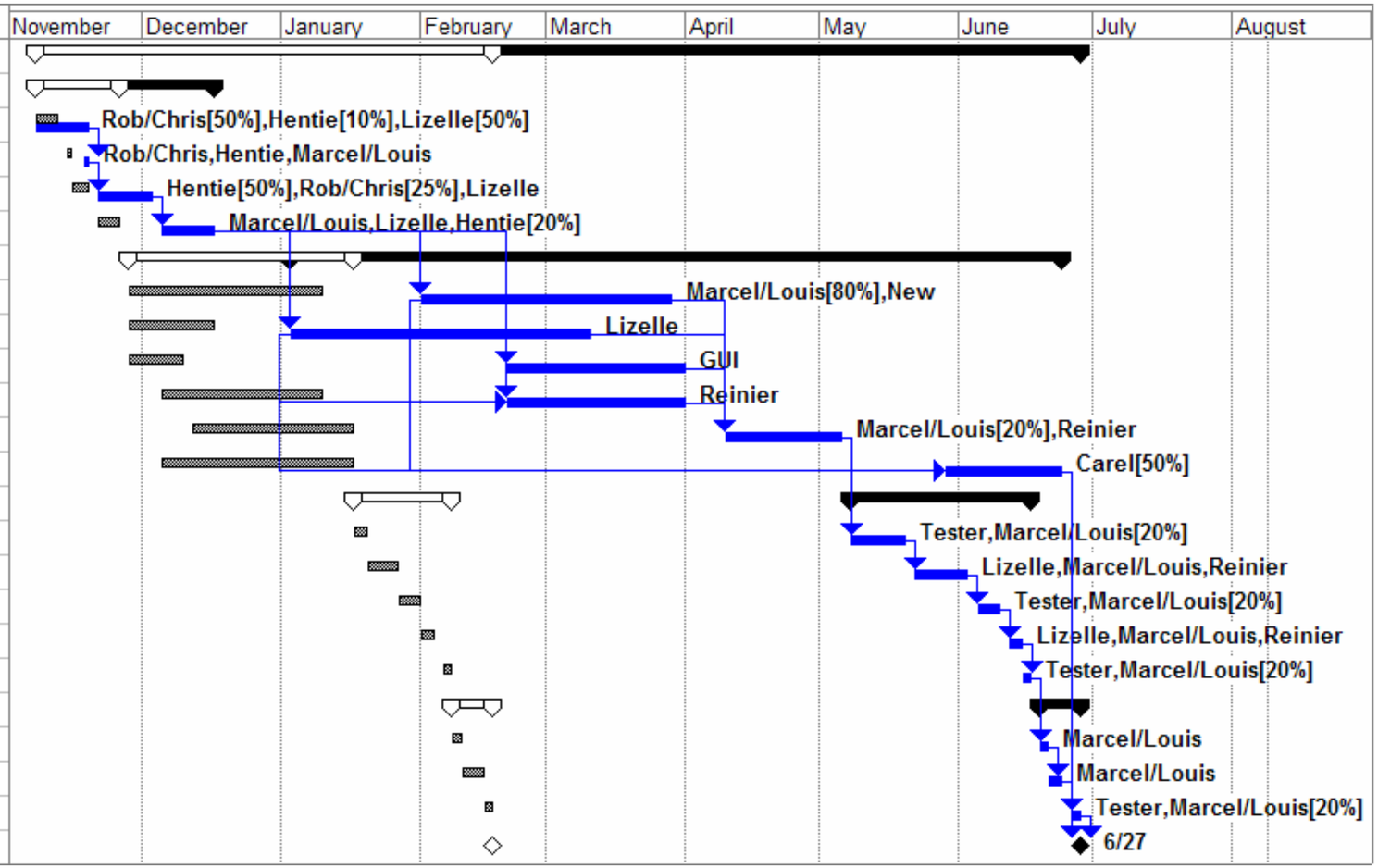

FIGURE 19 Project program.

The project ran behind schedule and the first version of the software was completed approximately 4 months behind schedule. There are several reasons for the delays on the project. The main reasons include loose specifications, replacement of the lead programmer, incomplete data collected from pilot projects, the need for the lead programmer to deal with data processing, and high workload on other projects.

8. CONCLUSION

South African municipalities are faced with major challenges to attain sustainable infrastructure service delivery. The implementation of infrastructure asset management is seen by national government as one means to improve municipal performance across the country. This presents an opportunity for Africon to provide consultancy services in this market.

Africon identified this opportunity and has commissioned a project to develop a software product to support infrastructure asset management consultancy services for the municipal market. The software has been developed over the past year and is currently in the process of being marketed in South Africa.

A business plan was developed for the commercialization of the software. The business plan indicates that the software is financially viable and should be taken to market. The strategy included in the business plan should be followed and the business plan should be updated periodically as new information becomes available to minimize risks and to maximize profits from the venture.

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APPENDIX A

EXAMPLE ASSET HIERARCHY

The standardized asset hierarchy that goes down to the asset level is used as an example. This hierarchy was used for the Western Cape Province and is in a process of continuous refinement. The hierarchy goes down to the asset level. All items identified in the asset hierarchy form part of the asset register and are used in the asset valuation model and the budget estimation model. This implies that every item identified at the facility and asset level is defined with the inputs required for the models. Municipalities are welcome to add components to the assets and allow the component information to roll up to the higher levels. The more detailed information may be useful for maintenance significant items such as individual pumps and generators.

TABLE A1 Water Supply

Facility category	Facility	Asset
Bulk Supply	Borehole	Borehole Plant
		Borehole Well
		Site Improvement
		Small Building
	Dam	Civil Structures & Pipework
		Mechanical Plant
		Electrical Plant
		Site Improvement
		Small building
	Spring Protection	Spring Protection
Bulk Distribution	Bulk Water Network	Pipeline
	Pump Station	Civil Structures & Pipework
		Mechanical Plant
		Electrical Plant
		Site Improvement
		Small Building
	Reservoir	Reservoir & Pipework
		Mechanical Plant
		Electrical plant
		Site Improvement

Facility category	Facility	Asset
Water Treatment	Water Treatment Works	Civil Structures & Pipework
		Mechanical Plant
		Electrical Plant
		Site Improvement
		Small Building
		Laboratory
Distribution	Reticulation Network	Pipeline

TABLE A2 Sanitation

Facility category	Facility	Asset
Bulk Distribution	Bulk Sewer Network	Rising Main
		Falling Main
	Pump Station	Civil Structures & Pipework
		Mechanical Plant
		Electrical Plant
		Site Improvement
		Small Building
Sewage Treatment	Sewage Treatment Works	Civil Structures & Pipework
		Mechanical Plant
		Electrical Plant
		Site Improvement
		Small Building
		Laboratory
Collection	Reticulation Network	Pipeline

TABLE A3 Road Transport

Facility category	Facility	Asset
Road	Paved Road Network	Road Surfacing
		Road Structure
	Unpaved Road Network	Road Surfacing
		Road Structure
Pedestrian Facility	Pedestrian Network	Sidewalk
Traffic Management	Signage Network	Overhead Gantry
		Street Sign
	Traffic Control Network	Signalized Intersection
	Protection Network	Guard Rail
Street Lighting	Street Lighting Network	Street Light
Public Transport	Public Transport Network	Commuter Shelter
		Public Transport Station
Structure	Bridge	Bridge
	Retaining Wall Network	Retaining Wall

TABLE A4 Stormwater

Facility category	Facility	Asset
Interception	Interception Network	Catchpit
		Grid Inlet
		Manhole
		Wing Wall
Distribution	Stormwater Network	Pipeline
	Pump Station	Civil Structures & Pipework
		Mechanical Plant
		Electrical Plant
		Site Improvement
		Small Building
	Conveyance Network	Culvert
		Open Channel
		Erosion Protection
		Hydrological Monitoring Station
Attenuation	Attenuation Pond	Earth Embankment
		Outlet
		Spillway
		Site Improvement

TABLE A5 Solid Waste

Facility category	Facility	Asset
Collection	Container Network	Container
	Vehicle Fleet	Vehicle
Processing	Processing Station	Equipment
		Weighbridge
		Site Improvement
		Small Building
Landfill	Landfill	Weighbridge
		Vehicle
		Civil Structures
		Site Improvement
		Small Building

TABLE A6 Electricity Supply

Facility category	Facility	Asset
Transmission	HV Network (> 22kV)	HV Overhead Line
		HV Underground Cable
		Site Improvement
	MV Network (< 22kV)	MV Overhead Line
		MV Underground Cable
		Site Improvement

Facility category	Facility	Asset
	LV Network	LV Overhead Line
		LV Underground Cable
		Consumer Meter
Substation	HV Substation (> 22kV)	HV Outdoor Equipment
		HV Indoor Equipment
		HV GIS Equipment
		HV Transformer
		Site Improvement
		Small Building
	MV Substation (< 22kV)	MV Outdoor Equipment
		MV Indoor Equipment
		MV Transformer
		Site Improvement
		Small Building
Network Management	Network Management	Workstation
		Software
		Telemetry
		Quality Equipment
		Load Control Equipment
Power Generation	Power Generation Plant	Generation Plant
		Small Building
		Site Improvement
		Small Building

TABLE A7 Park

Facility category	Facility	Asset
Park	Park	Ablution
		Garden Furniture
		Hardened Surface
		Irrigation
		Paved Road/Parking
		Unpaved Road/Parking
		Landscaping
		Perimeter Security
		Closed Stormwater Conduit
		Strormwater Node/Transition
		Water Reticulation
		Site Improvement
		Small Building
	Cemetery	Ablution
		Garden Furniture
		Hardened Surface
		Irrigation

Facility category	Facility	Asset
		Paved Road/Parking
		Unpaved Road/Parking
		Landscaping
		Perimeter Security
		Closed Stormwater Conduit
		Strormwater Node/Transition
		Water Reticulation
		Site Improvement
		Small Building

TABLE A8 Building

Facility category	Facility	Asset
Residential	Economic Housing (±100 m²)	Structure
		Finishing
		Plumbing
		Electrical
		Air Conditioning
		Site Improvement
	Low Cost Housing (±45 m²)	Structure
		Finishing
		Plumbing
		Electrical
		Air Conditioning
		Site Improvement
	Hostel	Structure
		Finishing
		Plumbing
		Electrical
		Air Conditioning
		Lift
		Fire Protection
		Site Improvement
Non-Residential	Centre / Hall / Chamber	Structure
		Finishing
		Plumbing
		Electrical
		Air Conditioning
		Lift
		Fire Protection
		Specialized Equipment
		Site Improvement
	Office / Shop / Library	Structure
		Finishing

Facility category	Facility	Asset
		Plumbing
		Electrical
		Air Conditioning
		Fire Protection
		Site Improvement
	Fire Station / Sport Complex	Structure
		Finishing
		Plumbing
		Electrical
		Air Conditioning
		Lift
		Fire Protection
		Site Improvement
	Clinic / Day Hospital	Structure
		Finishing
		Plumbing
		Electrical
		Air Conditioning
		Lift
		Fire Protection
		Gas Installation
		Site Improvement
	Store / Garage / Workshop / Depot	Structure
		Finishing
		Plumbing
		Electrical
		Air Conditioning
		Fire Protection
		Site Improvement
	Ablution	Structure
		Finishing
		Plumbing
		Electrical
		Site Improvement

APPENDIX B

EXAMPLE DATA SPECIFICATIONS

The asset quantification data requirements specify the inputs required to quantity the asset. The quantity is used in the valuation model as a multiplicative factor to multiple with the appropriate unit rate. It is also used to interpolate between unit rates.

TABLE B1 Example Asset Quantification Table for a Dam Facility

Facility	Asset	Size1	Size2	Size3	Quantity
Asset					
Dam	Civil Structure	Length (m)	Average width (m)	Average length (m)	Wall volume (m^3)
	Site Improvement	Area (m^2)			Area (m^2)
	Small Building	Area (m^2)			Area (m^2)

The asset description data requirements specify the standard data that must be captured for the specific asset. The data is predefined to ensure data integrity. The data is used in the valuation models to search for the applicable unit rate and is also useful descriptive data of the assets.

TABLE B2 Example Asset Description Table for a Dam Facility

Facility	Asset	Descriptor 1 name	Descriptor 1 options	Descriptor 2 name	Descriptor 2 options	Descriptor 3 name	Descriptor 3 options	Descriptor 4 name	Descriptor 4 options
Asset									
Dam	Civil Structure	Structure type	Earthfill						
			Rockfill						
			Rollcrete						
	Site Improvement	Improvement type	Access secure and landscaped						
			Access landscaped and not secure						
			Access secure and not landscaped						
	Small building	Building type	Brick/block walls & concrete roofslab						
			Brick/block walls & “other” roof						
			Precast concrete walls & “other” roof						
			Prefabricated shed						
			Traditional wattle & daub construction						

The asset valuation unit costs are used to value the assets. The asset is valued by multiplying the appropriate unit cost with the asset quantity. The unit cost is returned from the asset unit cost table using a search routine. The asset unit cost table has 4 columns to make provision for the asset descriptor data specified in the asset description table, and one column for the quantity data from the asset quantification table. The asset descriptor data are used as categorical data in the search procedure, and the asset quantity data is used as a variable that allows interpolation between unit costs. The interpolation ability is required to account for the variation of unit costs due to the economies of scale as asset size increases. The date column provides a reference for inflation adjustment. Only the first asset descriptor is used in the example below.

TABLE B3 Example Asset Unit Cost Table for a Dam Facility

	Asset descriptor data	Asset quantity data			
Civil Structure	**Structure type**	**Quantity**		**Unit Cost**	**Date**
	Earthfill	40,000		R 195	07-2004
	Earthfill	100,000		R 160	07-2004
	Earthfill	500,000		R 160	07-2004
	Earthfill	2,000,000		R 120	07-2004
	Earthfill	4,000,000		R 120	07-2004
	Earthfill	6,000,000		R 85	07-2004
	Rockfill	3,000		R 200	07-2004
	Rockfill	20,000		R 190	07-2004
	Rockfill	40,000		R 190	07-2004
	Rockfill	100,000		R 180	07-2004
	Rockfill	400,000		R 180	07-2004

Table B3 Continued

Rockfill	600,000		R 165	07-2004
Rockfill	2,000,000		R 165	07-2004
Rockfill	4,000,000		R 165	07-2004

Rollcrete	40,000		R 1,525	07-2004
Rollcrete	100,000		R 1,400	07-2004
Rollcrete	600,000		R 900	07-2004
Rollcrete	1,000,000		R 900	07-2004
Rollcrete	2,000,000		R 900	07-2004
Rollcrete	3,000,000		R 900	07-2004
Rollcrete	5,000,000		R 900	07-2004

Site Improvement

Improvement type		**Unit Cost**	**Date**
Access secure and landscaped		R 40	07-2004
Access landscaped and not secure		R 20	07-2004
Access secure and not landscaped		R 20	07-2004

Small Building

Building type		**Unit Cost**	**Date**
Brick/block walls & concrete roofslab		R 4,600	07-2004
Brick/block walls & "other" roof		R 4,000	07-2004
Precast concrete walls & "other" roof		R 4,800	07-2004
Prefabricated shed		R 3,400	07-2004
Traditional wattle & daub construction		R 2,400	07-2004

The asset useful lives and residual values are needed for the asset valuation. The data is obtained using a similar search procedure as the unit cost search routine. The default expected useful lives and residual values, expressed as a percentage of current replacement cost, are defined in a table. If the data are different for different asset descriptors or asset quantities, these data are used to search for the appropriate values. In the dam example below there is a variation in the expected useful lives for the civil structures based on the first data descriptor. The site improvement and small building asset types share the same expected useful lives and residual value, so there is no need for categorization, and therefore no data in the header or in the table.

TABLE B4 Example Asset Useful lives and Residual Values for a Dam Facility

	Asset descriptor data				Asset quantity data		EUL	Res %
Civil Structure	**Structure type**							
	Earthfill						50	0
	Rockfill						75	0
	Rollcrete						100	0
Site Improvement								
							20	0
Small Building								
							30	0

The operations, routine maintenance, and periodic maintenance estimates are needed in the budgeting model. The applicable data is obtained using a similar search procedure as the methods described for unit cost search routine. The default

budget requirements, expressed as a percentage of current replacement cost, are defined in a table. If the data are different for different asset descriptors or asset quantities, these data are used to search for the appropriate values. In the dam example below there is a variation in the expected useful lives for the civil structures and the small buildings based on the first data descriptor. The site improvement asset types share the same budgets estimation inputs, so there is no need for categorization, and therefore no data in the header or in the table for that asset.

TABLE B5 Example Asset Budget Estimation Inputs for a Dam Facility

	Asset descriptor data	Asset quantity data	Operations %	Routine maintenance %	Periodic maintenance %
Civil Structure					
	Earthfill		0.4	0.2	0.6
	Rockfill		0.4	0.2	0.38
	Rollcrete		0.4	0.3	0.38
Site Improvement					
			5	0.3	1.0
Small Building					
	Brick/block walls & concrete roofslab		0	1.5	0.3
	Brick/block walls & "other" roof		0	1.5	0.3
	Precast concrete walls & "other" roof		0	1.5	0.3
	Prefabricated shed		0	1.5	0.3
	Traditional wattle & daub construction		0	3.0	1.2

VITA

Christopher James von Holdt was born in Somerset East, South Africa on the 1st of July 1974 to Mr. Brian von Holdt and Mrs. Sophia von Holdt. He attended Gill Primary School for the first 3 years of schooling. Thereafter he attended Grey Junior School and Grey High School in Port Elizabeth as a boarder until matriculation. Following matriculation he attended Stellenbosch University and completed a B.Eng degree in civil engineering in 1997. From 1998 to 2002, he worked for Africon Engineering International (Pty) Ltd in Pretoria, South Africa as an engineer.

In the fall of 2002 he attended Texas A&M University and graduated with a M.Eng degree in civil engineering in 2003. He also received a Graduate Business Certificate from the Mays Business School in 2003. In the spring of 2004 he entered the Doctor of Engineering program. Mr. von Holdt specializes in the field infrastructure asset management.

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