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WP7, Deliverable D21
User Interface for the CARE-S Wastewater Rehabilitation Manager Software

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CARE

CARE-S - Computer Aided REhabilitation of Sewer networks

COMPUTER AIDED REHABILITATION OF SEWER NETWORKS

RESEARCH AND TECHNOLOGICAL DEVELOPMENT PROJECT OF EUROPEAN COMMUNITY

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CARE – S

Computer Aided REhabilitation of Sewer networks.
Decision Support Tools for Sustainable Sewer Network Management

WP7 – Wastewater Network Rehabilitation Manager

Report D21

USER INTERFACE FOR THE CARE-S WASTEWATER REHABILITATION MANAGER SOFTWARE

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EXECUTIVE SUMMARY

The overall aim of the CARE-S project is to develop methods and software that will enable engineers to define and implement effective management of their sewer networks, rehabilitating the right pipe lengths at the right time. The CARE-S project is a large project formed from various elements which will produce specific methods and tools to assist in the decision making process. The results of these various elements will be brought together in the Wastewater Network Rehabilitation Manager, the output from WP7.

The first step in the process to integrate the CARE-S project has been to develop a procedure which can be adopted by a wastewater network manager to develop effective rehabilitation plans. The next step has been to identify and define the methods or software tools which can be used to develop these plans. These methods have then been applied to the generic planning procedure to develop the CARE-S procedure for rehabilitation planning.

The CARE-S procedure for rehabilitation planning was detailed in Report D20 "The CARE-S Procedure", and forms the blue print for the Wastewater Rehabilitation Manager software. The CARE-S Rehabilitation Manager will be a versatile and powerful application, facilitating the efficient use of the CARE-S toolkit. The successful application of the Rehabilitation Manager will depend upon the ease with which a rehabilitation engineer can interact with the software and thereby obtain relevant information and results. The user interface of the Rehabilitation Manager is therefore important to the success of the CARE-S project.

The user interface can be defined as any element of the Rehabilitation Manager with which the user will interact. This includes functions to import analysis data, methods for viewing and manipulating data, interaction with the CARE-S toolkit and reporting facilities. This report has presented the current design of the Rehabilitation Manager. It provides the reader with an overview of the architecture of the software, and how the various elements of the user interface function. The design of the software has been driven by the objective of providing a package which will fully integrate the CARE-S toolkit and allow rehabilitation plans to be developed in accordance with the CARE-S procedure. At this stage of the CARE-S project, the tools are still being developed. This will have an impact on the final design of the Rehabilitation Manager.

The next milestone for Work Package 7 is the delivery of a fully integrated version of the Rehabilitation Manager software by the end of the second year of the project. This version will be available for the extensive testing phase of the project.

1. INTRODUCTION

1.1 CARE-S Aims

The CARE-S project aims to develop methods and software that will enable sewerage engineers to define and implement an effective system of the management of their sewer networks, rehabilitating the right pipe lengths at the right time. The results will be disseminated as a Manual of Best Practice for sewer network rehabilitation.

This project is organised in the following Work Packages (WP):

- WP1 : Construction of a control panel of Performance Indicators for Rehabilitation
- WP2 : Description and validation of structural condition
- WP3 : Description and validation of hydraulic performance
- WP4 : Rehabilitation technology information system
- WP5 : Socio-economic consequences
- WP6 : Multi-criteria decision support
- WP7 : Wastewater network rehabilitation manager
- WP8 : Testing and validation
- WP9 : Result presentation and dissemination
- WP10 : Project management

WRc is the lead partner responsible for WP7. This report is the second output from WP7.

1.2 WP7 objectives

WP7 will produce the software application enabling a range of tools (identified and developed under work packages 1 to 6) to be applied methodically to the rehabilitation planning process. The specific objectives of WP7 are as follows:

- Specify the data input/output and storage requirements for the integrated CARE-S package;
- Produce a specification for software that will integrate the use of the tools defined in CARE-S;
- Deliver working Rehabilitation Manager software that will manage the information needed and results generated from the tools defined in CARE-S, enabling the integrated CARE-S package to identify optimum rehabilitation strategies.

WP7 is divided into three specific tasks, as follows:

Task 7.1 Develop the CARE-S procedure for optimising rehabilitation planning: The individual CARE-S tools will be thoroughly evaluated in terms of their benefits, data requirements and inter-relationships (there will be some overlap of functionality and differences of approach due to local application). Some rationalisation or development may take place. The application benefits will be mapped and a procedure for optimum integration developed. It will be made clear, how to utilise the toolbox most efficiently in order to address a given problem or circumstance.

The CARE-S procedure was presented in Deliverable 20 (report D20), December 2003 (Ref 1).

Task 7.2 Define the User Interface for the CARE-S suite: The CARE-S software will include the link to a standard GIS based tool to be used as the user interface. The user shall be able to map the existing wastewater system and the consequences of probable failures, as well as describe scenarios with connecting consequences. The aim of this task is to select an appropriate GIS system for the user interface of CARE-S.

Task 7.3 Create the prototype (software, manual and website): A database will be developed that will support the integration and data flows between the CARE-S component software. This will support automatic and manual data input. The database will store information (results of analysis) that can, for example, enable write-back to electronic corporate data storage systems, such as GIS (geographic information system). A manual will be developed to support the use of the software. This will be used to generate an on-line help system. A working demo of the software will be accessible via the CARE-S website.

This report (D21) is the output for task 7.2.

The aim of task 7.2 is to select the GIS system for the CARE-S Rehabilitation Manager user interface. However, the user interface of the Rehabilitation Manager consists of more than just the GIS viewer, although this does play a significant role. The user interface can be defined as any element of the Rehabilitation Manager with which the user will interact.

The CARE-S project aims to provide a sophisticated methodology for wastewater network rehabilitation planning. This is reflected in the variety of tools that constitute the CARE-S tool-kit. In order for the CARE-S project to succeed, the Rehabilitation Manager needs to integrate these tools and allow the user to interact in a straightforward and logical manner. An effective user interface will allow these objectives to be met.

1.3 Scope of this report

This report presents the proposed structure and operation of the CARE-S Rehabilitation Manager user interface.

Section 2 presents an overview of the CARE-S Rehabilitation Manager software and introduces a number of key terms which are used throughout subsequent sections. Section 3 describes how the proposed CARE-S toolkit interacts with the central software outlined in Section 2. Section 4 explains the number of ways in which the data can be manipulate within the CARE-S Rehabilitation Manager to get the desired results. Section 5 describes the many reporting facilities available for presentation and further analysis of results.

2. OVERVIEW OF THE CARE-S REHABILITATION MANAGER SOFTWARE

2.1 Scope

The Rehabilitation Manager will be a versatile and powerful application, incorporating a variety of rehabilitation planning tools. It will have the flexibility to allow the rehabilitation of networks to be planned at both strategic and tactical levels, or in other words, at various levels of complexity (network, catchment/sub-catchment, drainage area/sub-area or sewer) and timescale (short- or long-term). This flexibility is possible because of the Rehabilitation Manager software and the nature of the tools that form CARE-S. It should be noted that the CARE-S software is a tool to *help* an engineer devise annual and strategic rehabilitation plans; it will assist the engineer in developing a rehabilitation plan based on the integrated analysis of the relevant issues but **it does not, and is not intended to** produce the plan itself.

2.2 Software architecture

The Rehabilitation Manager software will consist of a central MS Access 2000 (Visual Basic 6.0) database application with the following attributes:

- It will provide a central storage area and reference point for essential CARE-S data;
- It will accept **user-validated** input data in a pre-defined format. Data source fields will be mapped to fields within the CARE-S database according to the specification of the declared input data source;
- It will provide automatic conversion of data item units to standard CARE-S convention;
- It will perform rudimentary data validation including duplication, data type and range checking;
- It will allow user interaction with a pre-determined range of tools under the CARE-S umbrella;
- It will interact with a pre-determined range of tools at the user's request by:

  (a) Creating the necessary input file(s) from the data stored in the CARE-S database to enable the tool to be run; and

  (b) Accepting and storing necessary output data on completion of tool use.

The general architecture of the CARE-S Rehabilitation Manager software is shown in Figure 2.1.

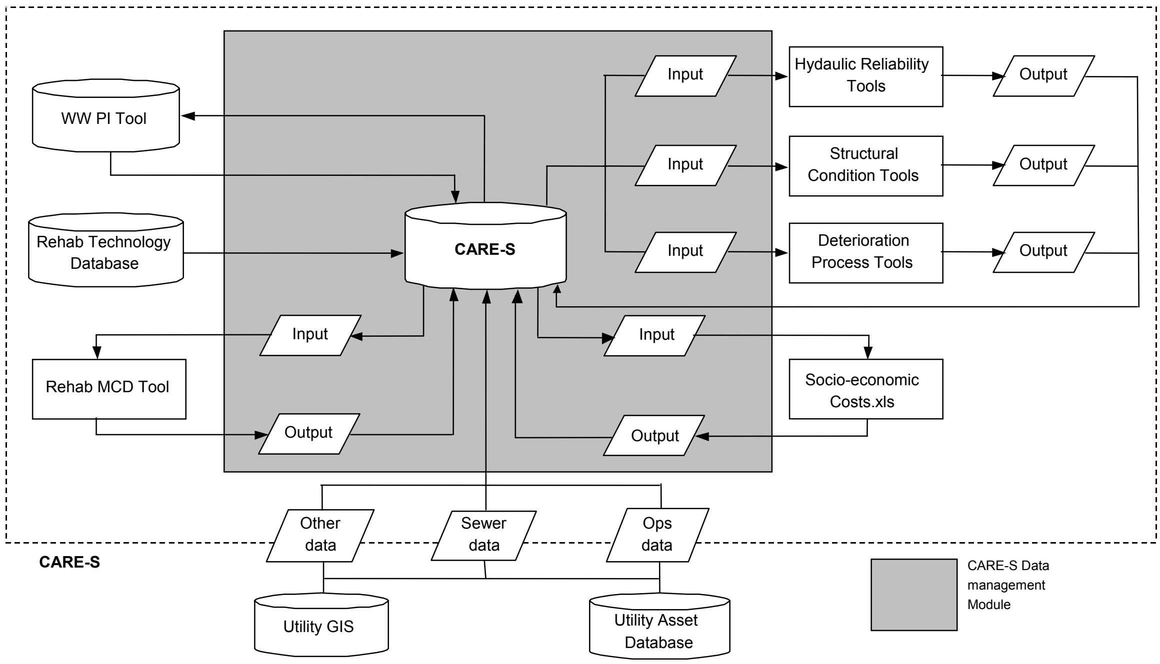


Figure 2.1 Overview of the CARE-S software architecture

2.3 Definition of key terms

2.3.1 Project

The CARE-S "project" will be a collection of data items, analyses and results pertaining to an area or areas of interest to the CARE-S user. The area of interest may be geographic (such as a city network) or thematic (e.g. flooding or environmental issues). The notion of a project provides a means to work with, and maintain, multiple CARE-S model simulations.

In practical terms, a new project means the creation of a new CARE-S database based on a pre-defined template. The new project database should then be saved with a memorable and recognisable name. The user may wish to make modifications to the standard template and provision for editing and saving templates through the interface may be provided at a later date. In all cases, if a number of CARE-S tools are to be used , the data must first be imported into an open CARE-S project database. More information on importing data to a project is given in Section 4.3.

2.3.2 Dataset

At its most fundamental level, the "dataset" will be a user-specified collection of pipes. All analysis within CARE-S will be carried out on an *input* dataset and, for each simulation, results produced. Clearly, the link between pipe attribute information and the results from analysis carried out on these pipes must be maintained. A results dataset will be associated with a future year and when results are returned to the project they must be assigned to a specific year (*results* dataset). An electronic audit trail of the analysis will be kept, and results datasets should be named such that they identify the analysis tool and input dataset used.

The creation of a dataset allows the user to filter out unwanted information and focus on the areas of interest. The dataset is therefore a convenient mechanism to identify pipe selections and manage the results of the analysis.

The majority of data used in CARE-S will be one of three types:

(1) hydraulic model data, drawn from one of the three supported hydraulic modelling software packages

(2) asset data, drawn from the asset inventory of a wastewater service provider (a company or municipality)

(3) CARE-S tool results data, generated by using one of the CARE-S tools e.g. link structural failure probability tools.

Types (1) and (2) are discussed in section 4.3 ('Importing data'). Type (3) data is discussed in chapter 3, 'Tools interaction'.

As stated previously, all data will be managed in CARE-S projects and these projects will consist of one or more datasets. These datasets may be one of six types depending on the information they hold and their relationship with other datasets. A description of each dataset type is given in Table 2.1.

Table 2.1 Description of dataset types

Dataset type	Description	Relationships with other datasets
Asset	Asset inventory data extracted directly from database systems including GIS	None
Model	Hydraulic model drainage system data	May or may not be related to the Asset dataset for the same catchment – no relationship maintained in CARE-S
Upgraded Model	Data from a hydraulic model which has resolved an identified hydraulic and/or structural problem evident in an earlier model	Related to an existing Model dataset
Future Model	Data from a hydraulic model which has used predictive analysis results from CARE-S tools to form a hydraulic picture of the catchment for some future time	Related to an existing Model or Upgraded Model dataset
Upgraded Future Model	Data from a future hydraulic model which has resolved an identified hydraulic and/or structural problem evident in an earlier model	Related to an existing Future Model dataset
Results	A collection of results relating to one or more individual assets in a project for a single time. Information in a results dataset may include one or more result types, e.g. • hydraulic simulation results and predictive analysis • structural failure probability • priority of rehabilitation • best rehab method	Related to any existing Model, Future Model, Upgraded Model or Upgraded Future Model dataset

2.4 The central database

2.4.1 General description

The heart of the CARE-S Rehabilitation Manager software is its central database. This database consists of a series of tables which are used to store information from a number of different input sources. Each table contains specific types of information, such as pipe based data, zonal, geospatial or hydraulic information. Other tables will hold information specific to a *project* or a *dataset*, including analysis results. The necessary links between input and results data will be maintained to allow proper reporting of analysis history and results to the user.

Each database table contains fields which relate to the various parameters or data items used by each tool. Many of these fields, such as pipe diameter, length and material, are used by a number of different tools. Others will be unique to a specific tool. It has been necessary to adopt a standardised set of parameter properties in order that CARE-S can communicate with all analysis tools. The structure of the database is shown in the data model (see Appendix A). Note that this data model is subject to change as more information becomes available from CARE-S tool developers.

At the request of the user, the Rehabilitation Manager will create the necessary input file(s) for an analysis tool according to a pre-defined specification held internally. These files may then be used to run the analysis tool within (or outside) the CARE-S framework. Similarly, the Rehabilitation Manager will enable the results of the analysis to be exported back to CARE-S and stored as necessary on completion of the analysis task.

2.5 User interface

2.5.1 Menu structure

Figure 2.2 shows the menu options and toolbar of the CARE-S Rehabilitation Manager software. The title bar details the name of the project that is currently open (in this example, ‘Demo’), the active dataset name (i.e. ‘V984-01’) and the active dataset description (in this case, ‘No 1’).

Figure 2.2 CARE-S menu options and toolbar

The menu bar provides access to the range of functionality available in CARE-S. The **Project** menu allows the user to open, close and save projects, with or without new names, and give access to the Project Properties dialog, a summary of the key features of the current (open) project. The **Dataset** menu allows the dataset properties to be modified, including the selection of assets which form the active dataset. This requires the user to make a selection of assets first by using the GIS selection features or “find” facility (see section 4.4 for more details). The **Tools** menu gives access to all the functions required to interact with the various

CARE-S tools, including importing and exporting data, modifying input files, and invoking the tool application. These are described in more detail in section 3.3.1. The **Options** menu allows the user to define a number of personal preferences on display of CARE-S project information, as well as providing access to a number of miscellaneous functions (see section 4.7). The **Reports** menu gives access to a range of tabular and geo-spatial report facilities allowing representation of results from all CARE-S tools. More information on reporting can be found in section 5. The **Window** and **Help** menus complete the menu bar, providing a number of standard functions similar to those in other Windows applications, including access to CARE-S help facilities and registration/licence details for the software installation.

2.5.2 The GIS viewer

The GIS viewer is the principal feature of the CARE-S Rehabilitation Manager's user interface.

It allows the:

- Geographical display and interpretation of asset data
- Selection and manipulation of geographic elements in datasets
- Representation of thematic maps including reporting of CARE-S analysis results

An example of the use of the viewer is shown in Figure 2.3.

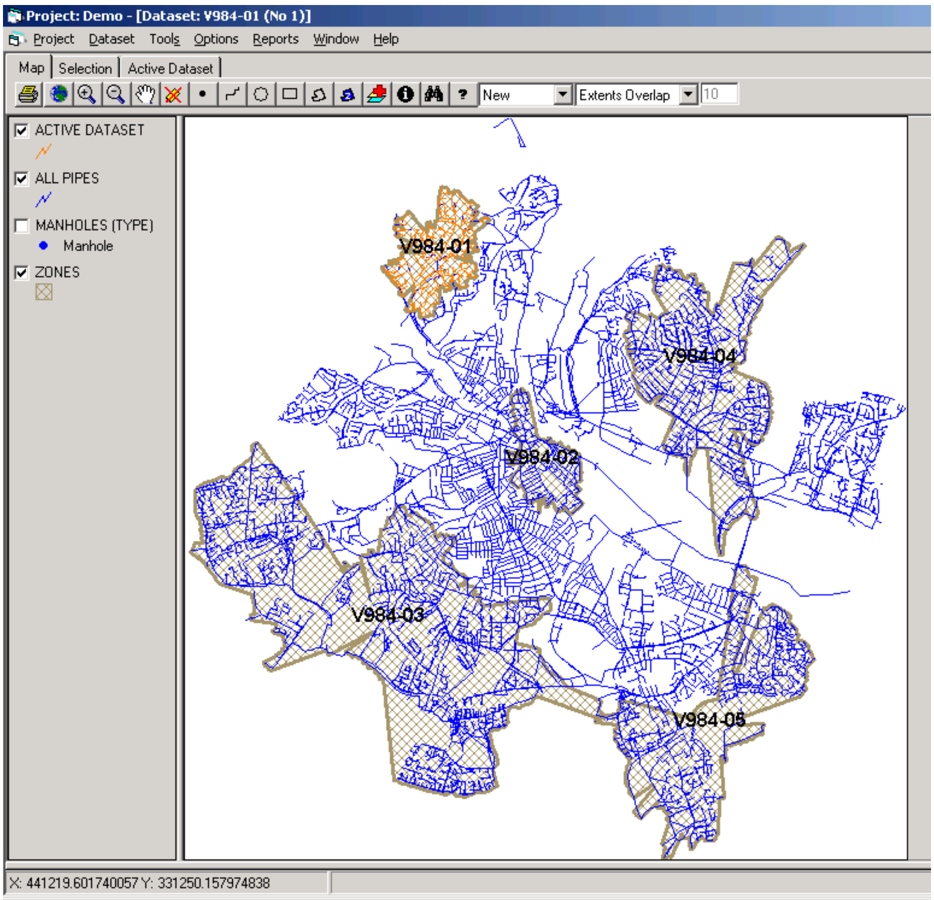


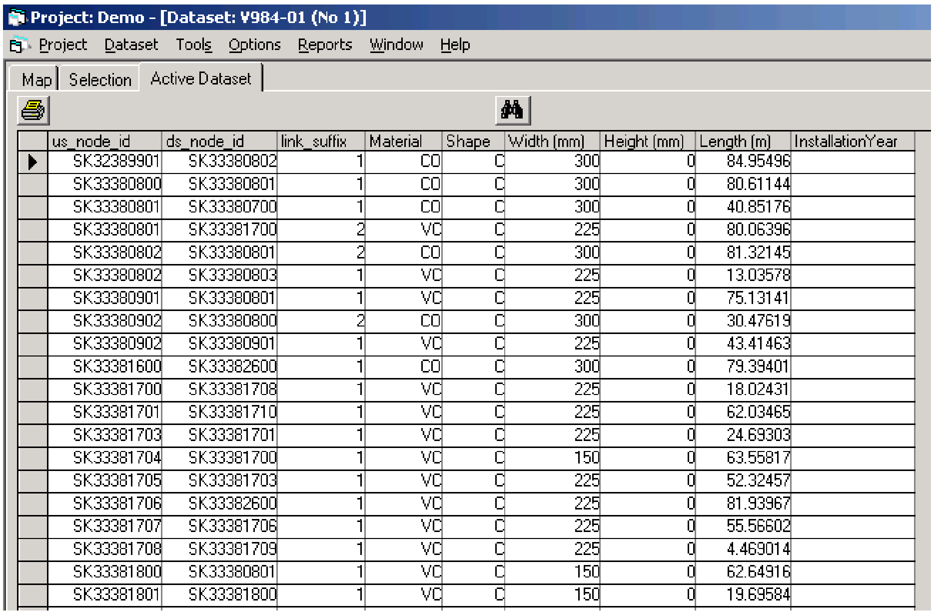
Figure 2.3 The CARE-S GIS Viewer

As with other standard GIS applications, information is structured in layers, each of which may be viewed or 'switched off' by means of the check boxes in the left-hand pane of the GIS window. When data are imported, a standard colour scheme, line style and/or object are used to display different assets. Note that in Figure 2.3 the manhole positional data (represented by small filled blue circles) has been switched off for reasons of clarity. In CARE-S, the active dataset (that which is of interest to the user at the current time) is highlighted in a different colour (in this case orange). Datasets are denoted by polygon boundaries filled by hatching of the same colour. These boundaries may be constructed manually or automatically (see section 4.4.3). The name of the dataset is printed at the centroid of the polygon. It can be seen in Figure 2.3 that the asset data imported consists of a number of user-defined non-contiguous datasets, all of which may be analysed individually by CARE-S tools.

Further information of working with data and datasets is given in section 4.4.

2.5.3 Tabular views

In addition to the spatial representation of data and results, there are tabular views for users of datasets without geospatial referencing. Although the functionality is necessarily more limited than with the GIS viewer, these views contain the essential asset information and provide the means for manual inspection before proceeding with making a selection of assets for further analysis or reporting. An example of one such view is given in Figure 2.4. Each record denotes a sewer, with details such as upstream and downstream node names, length of section, construction material, and so on.



us_node_id	ds_node_id	link_suffix	Material	Shape	Width (mm)	Height (mm)	Length (m)	InstallationYear
SK32389901	SK33380802	1	CO	C	300	0	84.95496	
SK33380800	SK33380801	1	CO	C	300	0	80.61144	
SK33380801	SK33380700	1	CO	C	300	0	40.85176	
SK33380801	SK33381700	2	VC	C	225	0	80.06396	
SK33380802	SK33380801	2	CO	C	300	0	81.32145	
SK33380802	SK33380803	1	VC	C	225	0	13.03578	
SK33380901	SK33380801	1	VC	C	225	0	75.13141	
SK33380902	SK33380800	2	CO	C	300	0	30.47619	
SK33380902	SK33380901	1	VC	C	225	0	43.41463	
SK33381600	SK33382600	1	CO	C	300	0	79.39401	
SK33381700	SK33381708	1	VC	C	225	0	18.02431	
SK33381701	SK33381710	1	VC	C	225	0	62.03465	
SK33381703	SK33381701	1	VC	C	225	0	24.69303	
SK33381704	SK33381700	1	VC	C	150	0	63.55817	
SK33381705	SK33381703	1	VC	C	225	0	52.32457	
SK33381706	SK33382600	1	VC	C	225	0	81.93967	
SK33381707	SK33381706	1	VC	C	225	0	55.56602	
SK33381708	SK33381709	1	VC	C	225	0	4.469014	
SK33381800	SK33380801	1	VC	C	150	0	62.64916	
SK33381801	SK33381800	1	VC	C	150	0	19.69584	

Figure 2.4 Tabular view example

3. TOOLS INTERACTION

3.1 Introduction

A principal feature of the Rehabilitation Manager software is the facility to interact with a pre-determined range of tools. This interaction will be initiated by the user as described below.

Once the user has selected a tool to use for his analysis, the Rehabilitation Manager will create data files which will provide the necessary data to be used by the tool.

The Rehabilitation Manager will allow the user to view and edit the import files before they are presented to the tools for use. This will allow the user to check the integrity of their contents and to ensure successful file creation.

Where appropriate the Rehabilitation Manager will receive and store results from the analysis undertaken by the CARE-S tools. When prompted by the user, the Rehabilitation Manager will return these data to the appropriate tables in the project database ready for subsequent reporting. The results returned will be values required for use by other CARE-S tools and/or values which must be reported directly to the user.

3.2 The CARE-S Tool Manager

As the name suggests, the CARE-S Tool Manager manages the interaction of the tools with the Rehabilitation Manager by using stored configuration data relating to each of the applications. The user must complete this configuration data by specifying the filename(s) and locations of the CARE-S applications such as the PI-S tool. This need only be done once per installation, and updated if any of the CARE-S tools are removed and/or re-installed.

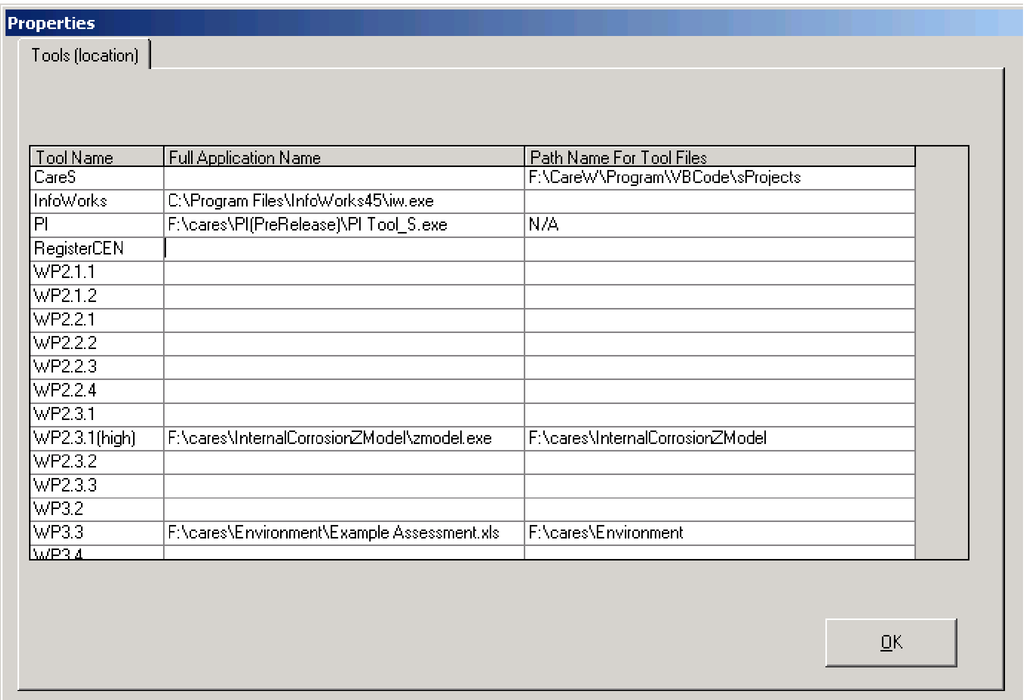


Figure 3.1 The CARE-S Tool Manager (first release)

To improve the seamless interaction between the Rehabilitation Manager and other CARE-S tools, the PI-S tool has been developed such that it is fully integrated with the Rehabilitation Manager. In addition, the rehab technology and contractor databases are linked to the Manager's central database.

3.3 Using CARE-S tools

3.3.1 The Tools menu

The CARE-S Rehabilitation Manager software has a menu dedicated to the interaction with other CARE-S tools.

The actions listed in Table 3.1 are available for most tools. They are explained in the sections that follow.

Table 3.1 Tools menu

Menu item	*Description*
Help about…	Accesses brief help guide about the operation of a particular tool.
Create input file(s)	Initiates creation of necessary input file(s) for use by that tool. See section 3.3.2
Edit input file(s)	Accesses the relevant file editor to edit tool input file(s). See section 3.3.2.
Run	Runs the relevant software tool for use alongside CARE-S. See section 3.3.3.
Return results	Prompts the Rehabilitation Manager to search for and save a particular set of analysis results into the active project database. See section 3.3.4.

3.3.2 Creating and editing files for CARE-S tool use

The Rehabilitation Manager will be able to create the input file(s) for each of the tools developed in the CARE-S project. These files will be created using data previously imported to the relevant project database and formatted according to pre-defined specifications held internally.

Figure 3.2 shows the process of data transfer from asset inventory and/or hydraulic model, through to the CARE-S project database (left side of diagram), and the interaction of the project database with other CARE-S tools (e.g. those produced as part of Work Packages 2, 3 and 6) on the right side of the diagram. Note that CARE-S will support the export of data held in a project database to the user's hydraulic modelling software, with or without any results obtained from analysis using CARE-S tools.

The Rehabilitation Manager will use the standard editing application, relevant to each file format, to allow editing of input files produced by the Rehabilitation Manager for CARE-S tool use. For instance, *.xls files will be edited in Excel, *.mdb files in Access, etc.

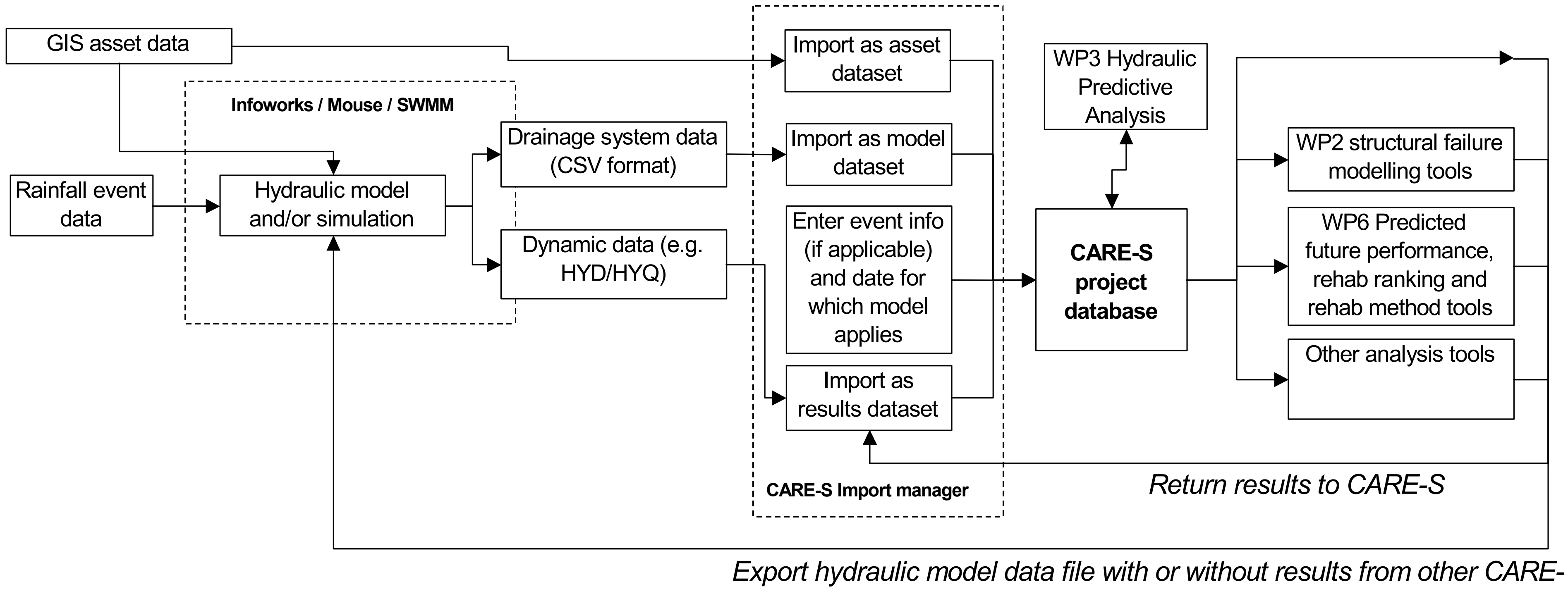


Figure 3.2 Tools interaction with CARE-S project database

3.3.3 Starting a CARE-S tool from CARE-S

Running a CARE-S tool from the CARE-S Rehabilitation Manager is straightforward: simply choose the relevant subject area and tool from the Tools menu, then, having created and (if necessary) edited the input file(s) for that tool, choose *Run* from the sub-menu. An example is shown in Figure 3.3.

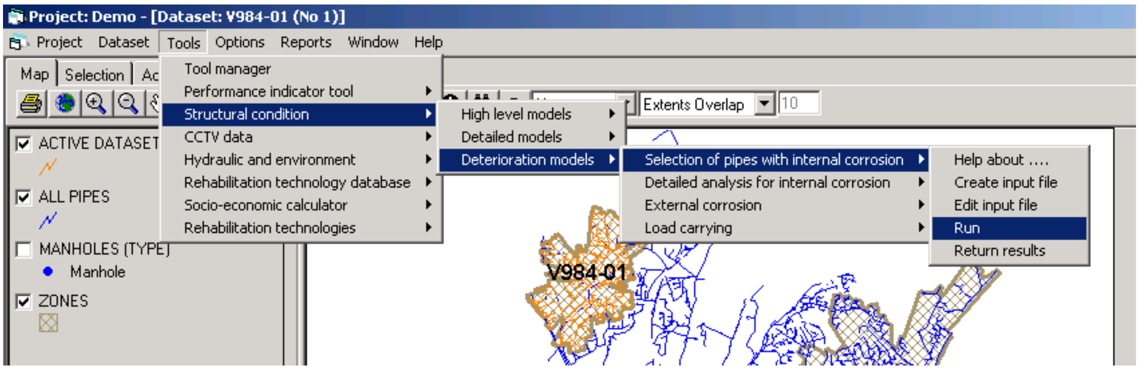


Figure 3.3 Invoking a CARE-S software tool

3.3.4 Returning CARE-S tool results to a project database

As might be expected, the CARE-S Import Manager (described in Figure 3.2) also supports the return of analysis results from CARE-S tools into a CARE-S project database.

CARE-S tool results will be returned to the relevant tables in the **active** project database when the user chooses the *Return results* option under the relevant tool's sub-menu. The software will then check for any available results associated with the current model (i.e. **active** dataset) and prompt the user if none are available.

N.B. It is important that the data transfer folder location is correctly specified in the Tool Manager otherwise CARE-S will not find any results produced by that tool. See section 3.2 for more information on the Tool Manager.

4. WORKING WITH DATA

4.1 Introduction

Section 2.4 discussed the structure of the CARE-S database, which forms the core of the CARE-S software. It is a cornerstone in the integration of a number of tools, which in turn provide users with alternative routes to prepare their rehabilitation strategies and plans for the years ahead. This is not possible, however, without a facility to move data between the central database and the tools and vice versa. The main benefit of the CARE-S Rehabilitation Manager software to the rehabilitation planner is the power and flexibility of data handling and analysis. *The Rehabilitation Manager software must allow the option of using different tools to ensure the complete analysis and preparation of their rehabilitation plans*. A rehabilitation planning procedure, and how CARE-S can help in this process, was described in the earlier CARE-S report for Task 7.1. (Ref. 1).

This chapter describes how data are managed in the Rehabilitation Manager software. It discusses the procedure for importing data into the central database, exporting data to the various tools and getting results from use of the GIS viewer and tabular views.

4.2 General data handling requirements

The Rehabilitation Manager will have a powerful facility for storing and processing data, the details of which are discussed in this chapter. However, any analysis undertaken using the Rehabilitation Manager will only be as good as the data used for that analysis. It should be emphasised that it is the user's responsibility to ensure that valid data are available for importing into the Rehabilitation Manager, i.e. the data are arranged in a consistent and definable manner, data types are correct and data values are meaningful.

4.3 Importing data

The process of importing data into a CARE-S project is summarised in Figure 4.1.

The first decision the user will have to make is the nature of the import. Are the data from an asset inventory or from a hydraulic model? If it is the former, it is assumed that the data are unverified and, provided that a specification for data import has been defined, these data will be imported to the CARE-S project database as an unverified dataset. In the case of hydraulic model data, the user must specify whether the data to be imported are fundamental model data or simulation results, and confirm any relationship with existing model data already held in that CARE-S project from an earlier import. (Note that asset data and hydraulic model data are the only types of data that the user will be expected to import using the Import menu. Other data e.g. PI values, structural performance, socio-economic factors etc. will be imported from the relevant tools by the Rehabilitation Manager on user request using the Tools menu. See section 3.3.4 for more details.)

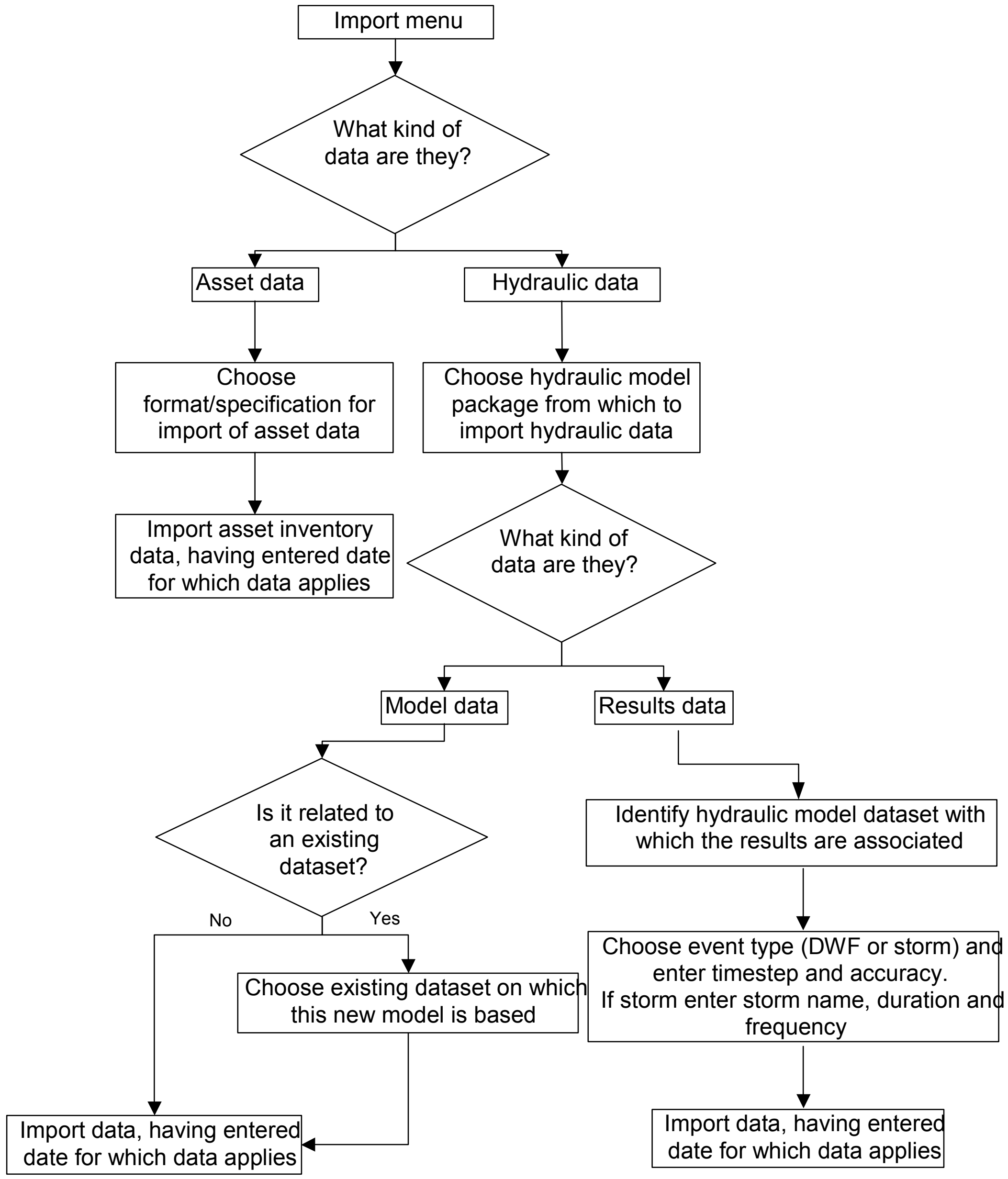


Figure 4.1 Process chart for data import

In all imports, the date for which the data are applicable must be specified. This is particularly relevant where predictive modelling has been carried out and these predictions are to be stored separately from current values (i.e. pertaining to the present time) in the CARE-S project.

Figure 4.2 shows the import dialog for hydraulic model data from Infoworks.

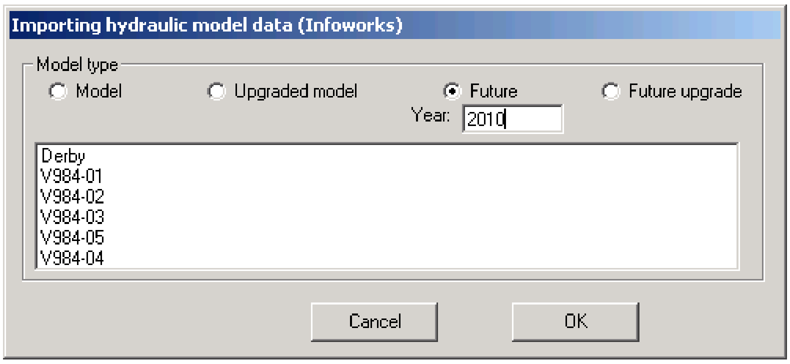


Figure 4.2 Import hydraulic model data dialog

As illustrated in the flow chart of Figure 4.1, the user must also identify which kind of results data he is importing, be it from a dry weather flow or storm event simulation (see Figure 4.3):

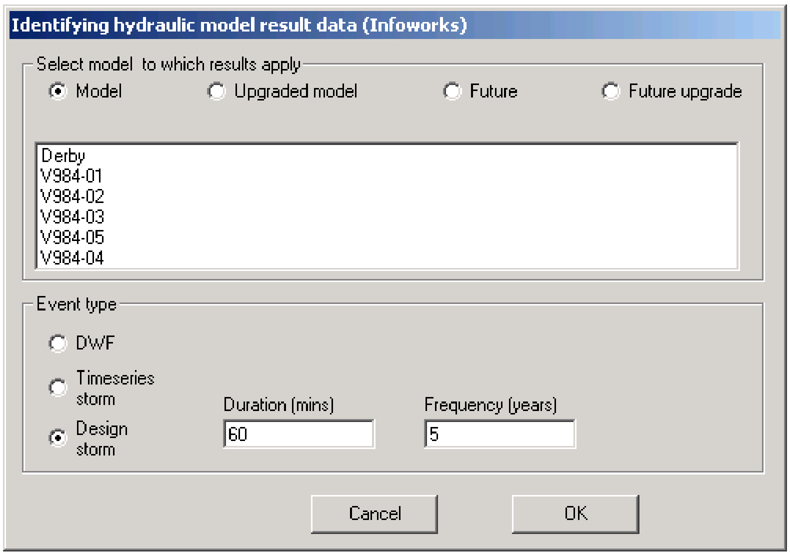


Figure 4.3 Import hydraulic model results data dialog

Examples of acceptable dataset entries are shown in Table 4.1. Such entries are shown in *Project Properties*, available from the Project menu.

Table 4.1 Examples of dataset entries in Project Properties dialog

New dataset name, e.g.	Type	Year	Related to (dataset name)	Type	Year	Comment
Model1S	Model	2004	-	-	-	Imported hydraulic model system data
Model1D	Results	2004	Model1S	Model	2004	Imported hydraulic model simulation results
Model1U1	Upgraded Model	2004	Model1S	Model	2004	Revised system data as a result of CARE-S analysis (WP3) and hydraulic modelling
WP2_Model1	Results	2004	Model1U1	Upgraded Model	2004	Structural failure probability results
Model1U1F2010	Future Upgraded Model	2010	Model1U1	Upgraded Model	2004	Now includes predictive analysis results and hydraulic data for 2010

4.4 <u>Getting results: using the GIS toolbar</u>

4.4.1 Introduction

Importing data for use by CARE-S tools is practically worthless if there are no facilities to find, select, manipulate and update these data in the CARE-S Rehabilitation Manager. Fortunately, CARE-S comes with a range of features to support these requirements, many of which are directly accessible from the GIS toolbar (Figure 4.4).

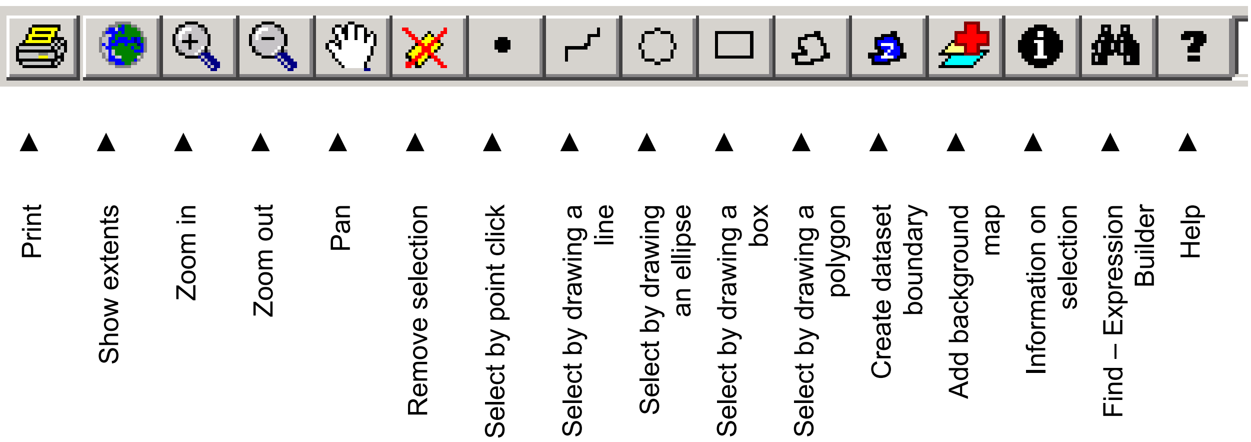


Figure 4.4 GIS toolbar

The GIS toolbar offers a number of standard GIS selection functions which, as they are common to many GIS applications and self-explanatory from Figure 4.4, will not be described further here. However there are some non-standard or modified features, which are described below. The principal non-standard component is the CARE-S find/selection facility, the Expression Builder.

4.4.2 The Find facility: the Expression Builder

This multi-purpose search and selection facility will find and select assets in the active map layer (the layer whose name appears raised in the left-hand pane of the GIS window) according to user-specified criteria. The Expression Builder operates in one of three modes:

1. Use pre-defined query
2. Make new selection (default mode)
3. Use existing GIS selection for update

Mode 1 allows the user to select one of a number of pre-defined data queries for reliable and repeatable selection of data and/or analysis results. Figure 4.5 shows the user choosing a custom query which finds and selects all those assets in the active dataset which are

(a) in condition grade 4 or poorer, **and**

(b) flood in a 1 in 5 year storm.

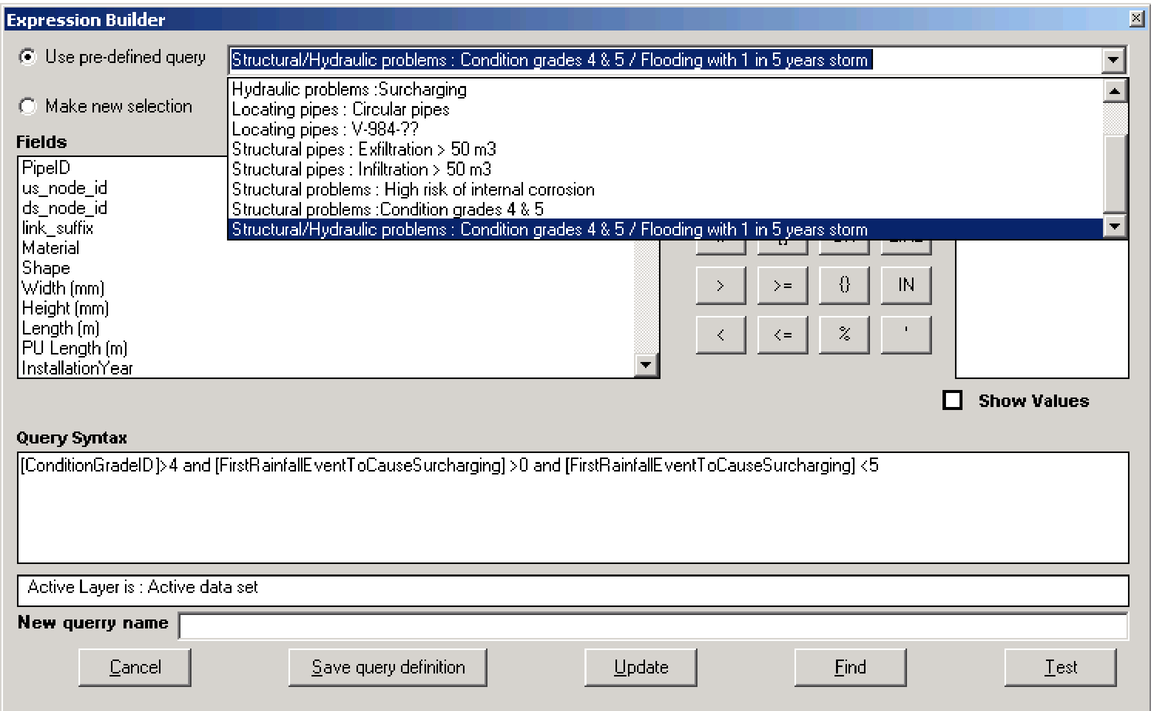


Figure 4.5 Finding assets using the Expression builder

The user may amend existing pre-defined queries or add his own custom query by inserting a name in the *New query name* text box and clicking the *Save query definition* button.

Mode 2 assumes that the user wishes to make a new selection by writing his own query in the Query Syntax text box. To help him, the available fields (e.g. Shape, Width, etc.) to build the search/selection criteria are provided on the left-hand side of the Expression Builder form. A range of operator buttons is provided to build a query such as that shown in Figure 4.5. The range of values held in the active layer for any field is displayed by clicking on the "Show values" check box, then clicking on the field of interest.

In Mode 3, the selection of assets made using the GIS selection tools (from the GIS toolbar) is retained and used with the "Update" facility (see section 4.5).

The buttons on the Expression Builder dialog and their associated functions are summarised in Table 4.2:

Table 4.2 Command button functions on Expression Builder dialog

Button	Function
Test	Tests the criteria you entered in the Query syntax text box without selecting the pipes. Returns the number of records which match the criterion/criteria you entered.
Find	Searches the project database and selects those elements which match your search criteria. Highlights selection in GIS window ("Map" tab) in a different colour.
Update	Allows updating of a specified data field using the Query Syntax text box contents as a filter. If one or more criteria are specified in the Query Syntax text box, the data which may be edited is restricted to those which match the specified criteria. See section 4.5.
Save query definition	Saves current syntax in Query Syntax text box as a new query. This query will then be available by choosing the 'Use pre-defined query' option (Mode 1) on subsequent uses of the Expression Builder. See also Mode 1 paragraph, above.
Cancel	Returns user to GIS window or Selection tab (where no map exists) without making a selection.

When the user clicks the "Find" button, the assets found are selected and coloured differently on the Map tab to indicate that they have been selected. Where geospatial information is not available, the assets found and selected are listed with their essential attributes in the Selection tab (see also section 2.5.3, Tabular views).

4.4.3 Storing a selection and displaying datasets

Once data have been selected by using the GIS toolbar facilities or using the Expression Builder, it may be useful to store this selection for future use. This is done easily by selecting one of three options from the Dataset menu. The user can:

- create a new dataset which includes the assets currently selected ('*Create new dataset from selection*'), or

- add or remove the selected assets from the current (active) dataset ('*Add selection to active dataset*' / '*Remove selection from active dataset*').

To facilitate the reporting of results pertaining to whole datasets (see section 5) and to allow geospatial representation of catchments or sub-catchments, CARE-S provides a tool to draw a polygon boundary around datasets. To run this tool on the active dataset, the user must choose *Automatically generate polygon* from the Dataset menu. A solid line polygon with hatched fill will appear in a new "Zones" layer together with the name of the dataset at its centroid (Figure 4.6).

The creation of a new layer for these boundaries means that they may be switched off easily if not desired (for example, when reporting results for individual sewers). For permanent removal of individual dataset boundaries, the user should choose the *Delete polygon for active dataset* option.

Other properties specific to the active dataset may be viewed by choosing *Dataset properties* from the Dataset menu.

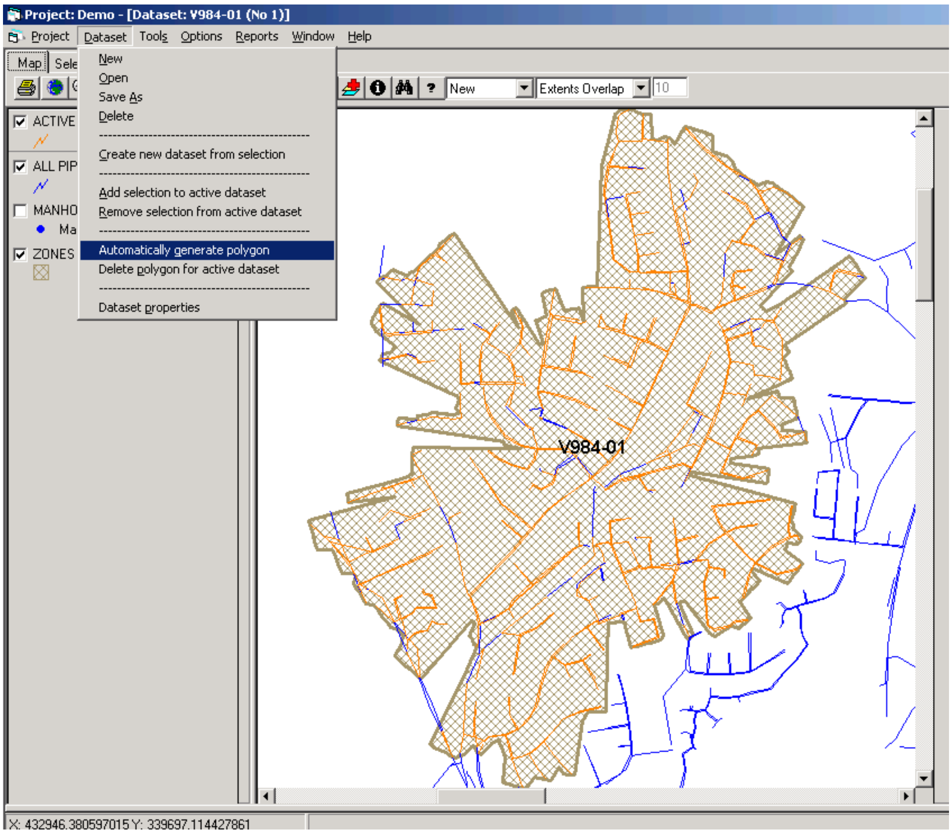


Figure 4.6 Automatic dataset polygon generation

Properties specific to individual assets may be accessed by clicking on the information button on the GIS toolbar () then clicking on the asset of interest.

4.5 Updating data in a project

Updating specific data items in the CARE-S project database is made considerably easier with the update facility provided by the Expression Builder (see also section 4.4.2). The user may select the assets whose data are to be updated using the GIS selection tools on the GIS toolbar or by writing a query using the Expression Builder. If a query is written, the user must click the "Update" button on the Expression Builder dialog (Figure 4.5) to access the update dialog (Figure 4.7). Alternatively, if a selection has been made using the GIS map window and the selection tools on the GIS toolbar, the user can access the update facility directly by choosing the *Use existing GIS selection for update* option near the top of the Expression Builder form.

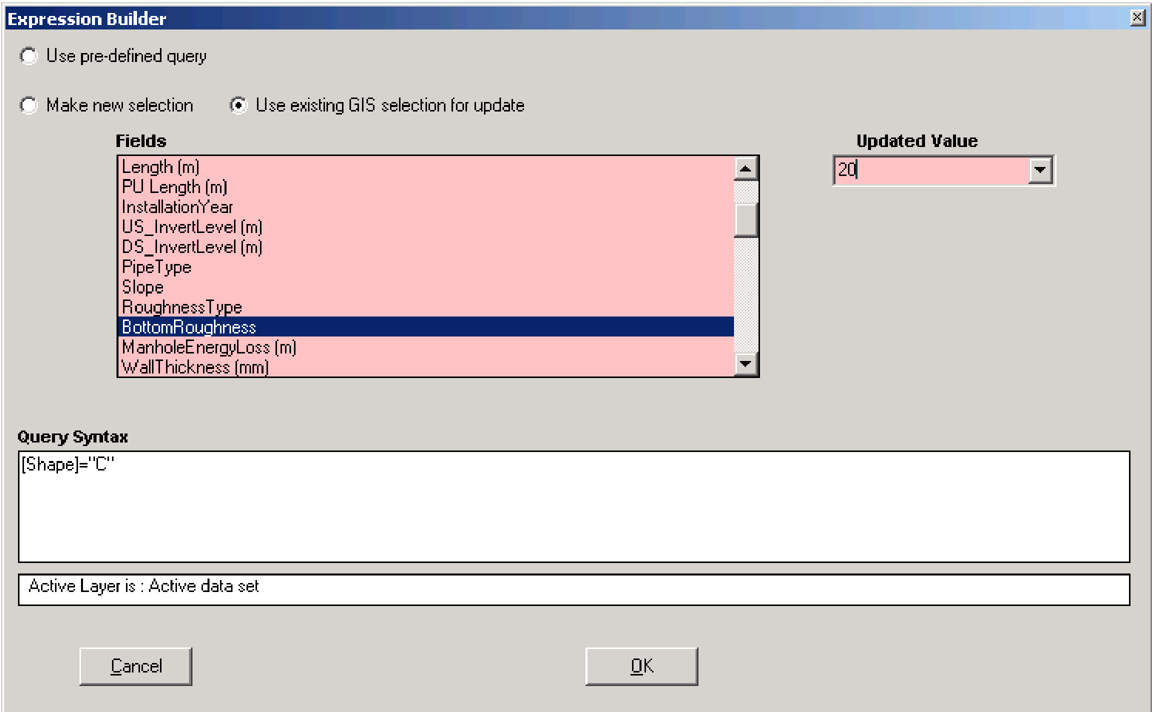


Figure 4.7 Update facility dialog

Figure 4.7 shows how the user would update the "bottom roughness" value to 20 for all assets in the active dataset which have an entry in their "Shape" field equal to "C" (circular).

4.6 Using map layers

Additional background layers which display other information of interest to the rehabilitation planner or engineer may be added and removed using the  button on the GIS toolbar[1]. Attributes of these layers may be displayed by clicking the  button on the GIS toolbar, and then the map area of interest. It should be noted that this information is not stored in the

[1] Supported formats only.

CARE-S project database, but is an attribute of the map layer. The information that can be viewed will therefore depend upon the data associated with a particular map layer.

Figure 4.8 shows soil data applied as an additional map layer. The selected area (in green) is of a particular soil type whose information is presented in the *Feature info* pop-up form.

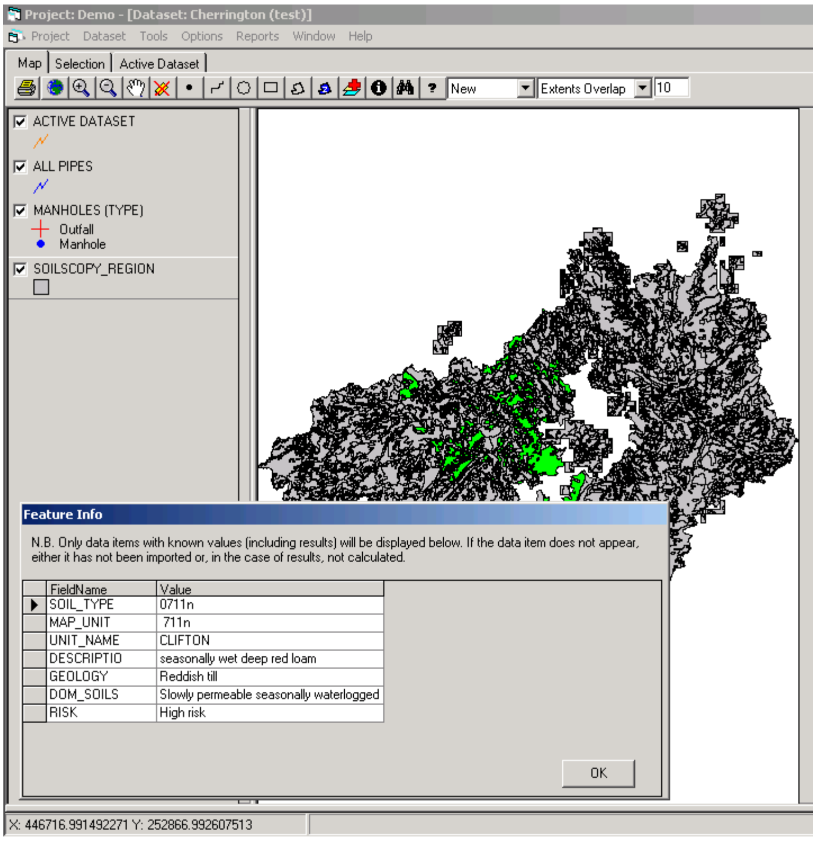


Figure 4.8 Using background map data

4.7 <u>User options</u>

A number of user options and miscellaneous functions will be available from the Options menu. The contents of this menu have not been fully specified at this stage, however it is likely that the following options will be included.

(a) user display preferences

(b) defining data transfer options (import options)

(c) working with map layers.

Option (b) allows the user to modify the number of optional data items that are exported when the Rehabilitation Manager creates input file(s) for the CARE-S tools. Pre-defined specifications for data transfer include the minimum data requirements for the input file and, if different, the maximum number of data items.

Option (c) allows the user to reinstate background map layers that have been previously associated with that project. Background maps allow improved understanding and interaction between asset data and other geospatial information of interest, for example the geography and geology of the local area. See also section 4.6.

5. REPORTING

5.1 Introduction

One of the main objectives of the CARE-S Rehabilitation Manager is to manage information and results, enabling the CARE-S toolkit to identify optimum rehabilitation strategies. The reporting and displaying of relevant information will allow the Rehabilitation Manager to achieve this objective.

The CARE-S Rehabilitation Manager has the facility to display both project summary information and analysis results. This information can be used to identify gaps in data, assist in the choice of tools to utilise, aid the selection of sewers to be included in a given analysis and assist in the final development of the rehabilitation plan.

The data contained in a CARE-S project can be viewed in one of two ways, either geospatially using the GIS viewer, or in tabular form. This section will discuss a number of GIS and tabular reports which could be produced by the Rehabilitation Manager. Where possible, example reports have been produced and should be used as a basis for discussion to refine the reporting requirements for future releases of the CARE-S software.

5.2 The Reports Menu

The Reports Menu (Table 5.1) allows the user to access all the functions which relate to reporting analysis results. The first menu item allows the user to access non-GIS reports. The reports will be created by querying data directly from the central database and exporting it to a spreadsheet. A series of templates have been created to accept data contained in the project database. It should be noted that these tabular reports are a supplementary feature to the GIS results display. The advantage of using these tabular reports is that a permanent record can be kept of the analysis undertaken and the results obtained by simply saving the spreadsheet with an appropriate name. All the tabular reports can be printed and saved by the user. The data within the reports can also be manipulated by the user and further analysis undertaken, e.g. use of charting options.

The next two items will display analysis results using the GIS viewer. The *GIS sector* option will display results which are not specific to individual pipes. Typically, the results of the Performance Indicator tool would be reported using this option. To allow results to be reported at the dataset level the dataset(s) must be enclosed by a boundary. The boundary can be assigned automatically by the Rehabilitation Manager using the “Automatically generate polygon” option from the “Datasets” menu or manually drawn using the GIS toolbar. See Section 4.4.3 for more information about this option.

The *GIS pipe* item will display the analysis results for each pipe. These will include results obtained from the use of asset-based analysis tools.

The final item on this menu is the “Named GIS Reports”. The user will be presented with a list of standard GIS reports available for the current dataset.

Table 5.1 Reports Menu

Level 1	Level 2	Description
Tabular		Accesses the Tabular reports dialog listing the available reports, as follows: *Asset summary* *Project summary – current performance* *Current status of condition inspection data* *Summary of current internal condition* *Summary of high level structural deterioration analysis* *Current and future structural deficiencies*
GIS	Sector	View results at less than pipe-level detail
	Pipe	View results per pipe in GIS Viewer
	Named GIS reports	Produces pre-defined GIS displays based on a list of available reports

The GIS and tabular reports have been developed from the proposals set out in the step-by-step guide contained in Report D20 (Ref. 1). This step-by-step guide details the processes required to complete a rehabilitation plan in accordance with the CARE-S procedure. This includes the flow of information between the Rehabilitation Manager and the CARE-S toolkit as well as the type of reports that would be required to assist in the development of a rehabilitation plan. Table 5.2 below lists the reports proposed in the step-by-step guide. Task references refer to specific tasks in the step-by-step guide. The remainder of this Section describes the purpose and function of these reports.

Table 5.2 Standard reports specified in the CARE-S Step-by-step guide

Task Reference	Report Title	See Section
	Asset summary report	5.3
1.3/T6	WW PI tool: project current performance (Tabular and GIS)	5.4
2.1/T3	Current status of condition inspection data (Tabular and GIS)	5.5
2.1/T7	Summary of Current Internal Condition (Tabular)	5.6
2.1/T10	Summary of High level Structural Deterioration Analysis (Tabular)	5.7
2.1/T15	Current and Future Structural Deficiencies (Tabular and GIS)	5.8
2.2/T3	Current hydraulic and structural performance (GIS)	5.9
2.2/T7	Future hydraulic and structural performance (GIS)	5.10
2.2/T10	Probability of Hydraulic Failure (GIS)	5.11
3.3/T1	Optimal short term rehabilitation solutions (GIS)	5.12
3.3/T2	Optimal long tern rehabilitation solutions (GIS)	5.12

5.3 Asset summary report

This is a straightforward report which summarises the current status of the active dataset, i.e. before any rehabilitation plan is implemented. This report would contain the length of each category of asset (i.e. pipes) grouped by material, shape, height, width and era of construction. An example of this report is shown in Figure B.1 in Appendix B.

5.4 Wastewater Project PI Report

This report summarises the calculated performance indicators for a given CARE-S project. The PIs are listed for each dataset within the project and for each analysis period selected, where these values have been calculated by the PI tool. In this context, the analysis period is the period over which the PIs have been calculated. The PIs are listed for each dataset, with separate worksheets for each analysis period and can be permanently recorded by saving the report file. An example of this report is given in Figure B.2 of Appendix B. It should be noted that the PI tool also has the facility to produce tabular reports in Excel, detailing the PI value per analysis period. The CARE-S PI Project report is complementary as it allows PIs for different datasets to be compared directly for each analysis period.

A GIS version of this report is also available and would be accessed via the *GIS sector* option from the Reports menu. This GIS report will display the results for one PI for one analysis period, for the whole project. The results of a particular PI will be displayed for each dataset for which it has been calculated. Each dataset will require a boundary for the PI results to be shown, as the area within this boundary will be coloured according to the value of the PI. An example of a PI GIS report is shown in Figure 5.1 below. This figure shows an example of the result window displayed along side the active dataset window. This allows the user to compare other zone details with the PI results obtained.

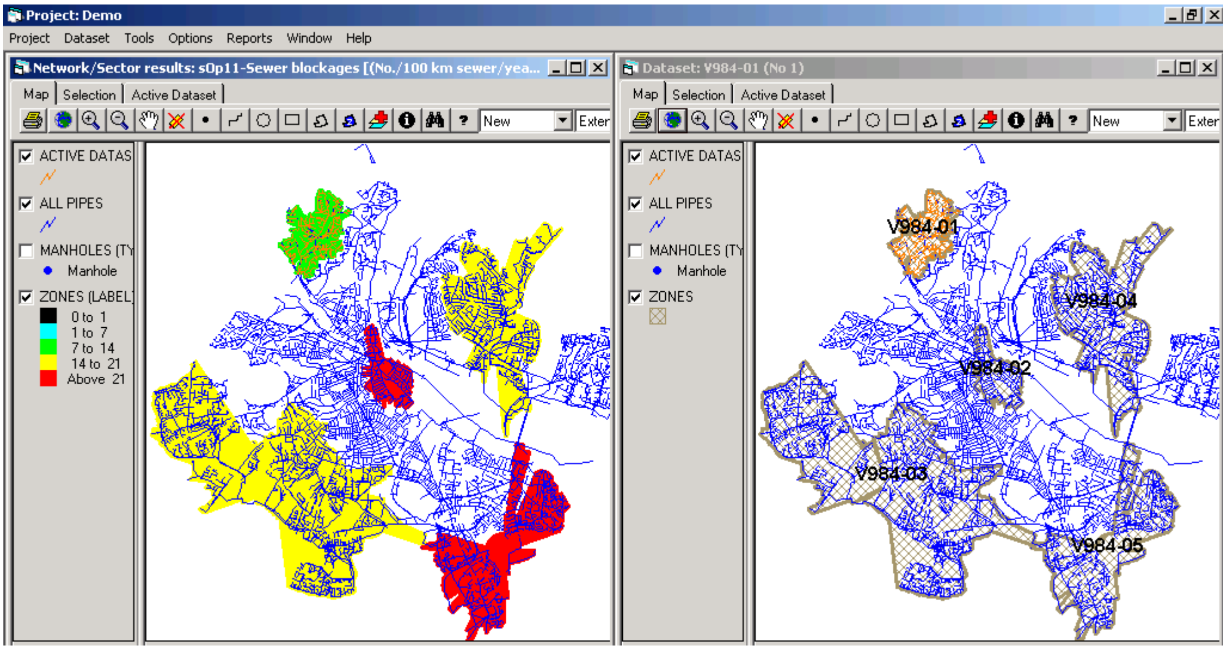


Figure 5.1 Wastewater PI GIS report

5.5 Current Status of Condition Inspection data

Many of the CARE-S tools require a measure of the condition of the sewer. At the most basic level this will consist of the defect codes as described in EN 13508-2 (Ref. 2), developed from the visual inspection of the sewers. One of the tasks of the CARE-S Rehabilitation Manager is to provide user guidance on which sewers require inspection. This guidance will be based on:

- Priority sewers for inspection (determined by the user);
- Whether inspections have already been carried out on a sewer, and;
- Where an inspection has been carried out, but is 5 or more years old[2].

There are two reports that can aid this process, one tabular and one GIS. The tabular report consists of a list of sewers with the last date of inspection detailed for each. If a particular sewer has not been surveyed then this information will be left blank. Sewers that have been surveyed 5 or more years ago will be highlighted.

The report will have two sheets, one for priority sewers only and one for non-priority sewers. The allocation of priority to a sewer will be optional. If a user has not allocated priority sewers then only one sheet will be displayed, listing all sewers. An example of this report is given in Figure B.3 of Appendix B.

A similar report can be generated in GIS view. All the sewers in the dataset (or project) can be colour coded according to whether visual inspection data is available or not. An example of this report is given in Figure 5.2.

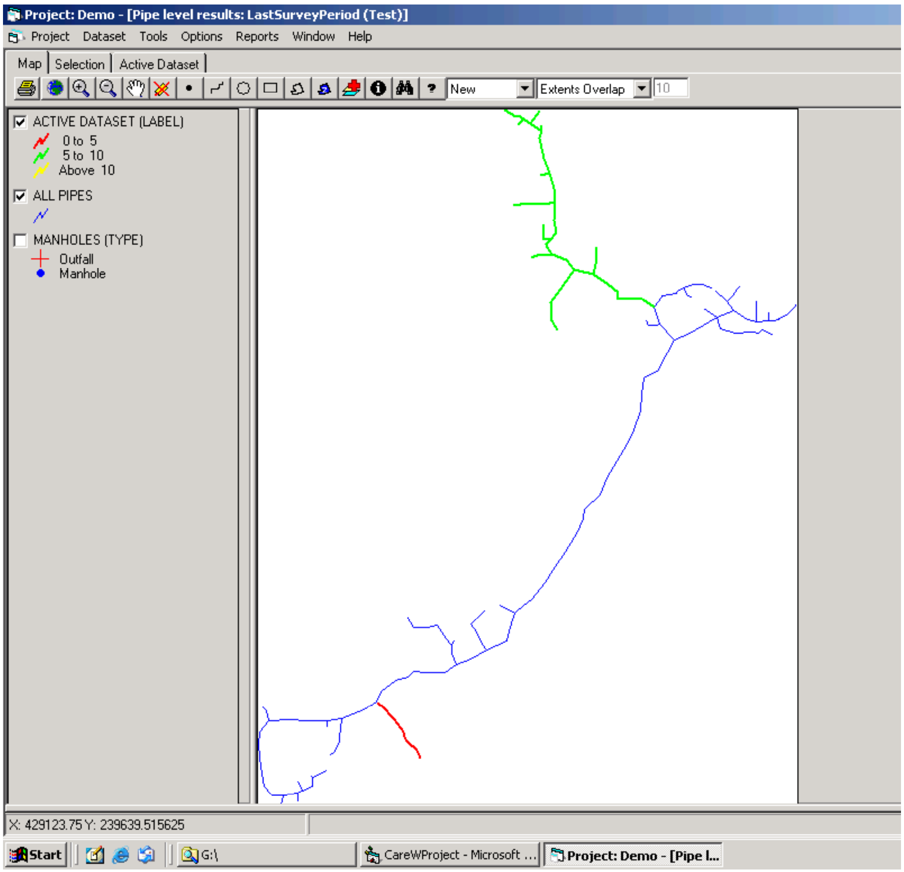


Figure 5.2 Current Status of Condition Inspection Data

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[2] A period of 5 years has been chosen as this corresponds to the asset management planning cycle in the UK.

5.6 Summary of Current Internal Condition

There are a number of mechanisms by which sewers can fail structurally. To be able to produce an effective rehabilitation plan the engineer must be able to identify current structural problems and reliably predict which problems may arise in the future. WP2 of the CARE-S project incorporates a number of tools developed to address specific structural problems. For a given CARE-S project, it may be necessary for only one, or a combination, of these tools to be used in order to determine the most significant modes of failure.

Task 2.1/T7 of the step-by-step guide requires the Rehabilitation Manager software to produce reports which will help the user to identify sewers with structural problems and the types of problems that are being experienced. The user can then use this information to decide which structural tools would be most appropriate for the dataset under consideration.

The most effective way to determine the type of structural defects that currently exist is to use the condition inspection survey data. The EN 13508-2 defect codes derived from the condition inspection survey(s) are related to the main types of structural failure, e.g. structural collapse, infiltration, exfiltration and blockages. Internal and external corrosion are other mechanisms by which a sewer may fail structurally. However, these forms of deterioration are limited to certain pipe materials and environmental conditions which can be located using other analysis methods. The internal corrosion model will incorporate a decision support element which will identify sewers that are at greatest risk of internal corrosion therefore it is not proposed to incorporate a corrosion element to the tabular report produced by the Rehabilitation Manager.

The *Summary of Current Internal Condition* report has two main elements; a summary sheet and detailed sheets for each failure mechanism. The summary sheet will detail the structural defects for each sewer in the dataset. This will then be summarised to show the most prevalent mode of failure within the dataset. The individual sheets will list the individual defect codes for each sewer, detailing the position of each[3]. An example of this report is given in Figures B.4 and B.5 of Appendix B.

5.7 Summary of High-Level Structural Deterioration Analysis

Task 2.1/T10 proposes a report summarising the results of the high-level structural deterioration analysis. It will be possible to run any one of three tools to analyse structural deterioration at this level. The overall output from these tools will be of the same form, even though different analysis methods will be used.

The output from these models will be:

i) The probability of survival of pipe cohort in each condition class;

ii) The probable time of residence in each failure/condition class.

The format of the outputs from these tools will be dependent on a number of factors, particularly the requirements of the WP2.4 tool (routine for comparing outputs from sewer assessment and deterioration process models) and the WP3.2 tool (hydraulic temporal

[3] This type of report is produced by commercial software (e.g. "Examiner") but end users may not have access to such products.

decline). Owing to current uncertainties about these requirements and the format of the high-level structural deterioration tool(s) and their outputs, it is not possible to develop a specific tabular report at this time. However, a suggestion for the possible content of this report is presented in Figure B.6 of Appendix B.

5.8 Current and Future Structural Deficiencies

Interpretation of the individual results from the structural tools is required to identify which pipes have structural deficiencies, the nature of these deficiencies and their severity. The WP2.4 element of the CARE-S project consists of a software tool which compares outputs from the sewer assessment and deterioration process models. The aim is to identify the significant (critical) structural deficiencies for each sewer, at a future date or dates. The predicted modes of failures at a given point in the future will have been determined by the WP2.2 and 2.3 tools.

The CARE-S Rehabilitation Manager will again produce two reports to display this information, one in GIS and one in tabular format.

The GIS report will display the pipes colour-coded according to the predicted critical mode of failure for a given time period. A GIS report will be produced for each available results year, e.g. now (current Internal Condition Grade ICG), 5 years and 10 years hence (predicted failure modes). An example of a report of the current situation is shown in Figure 5.3.

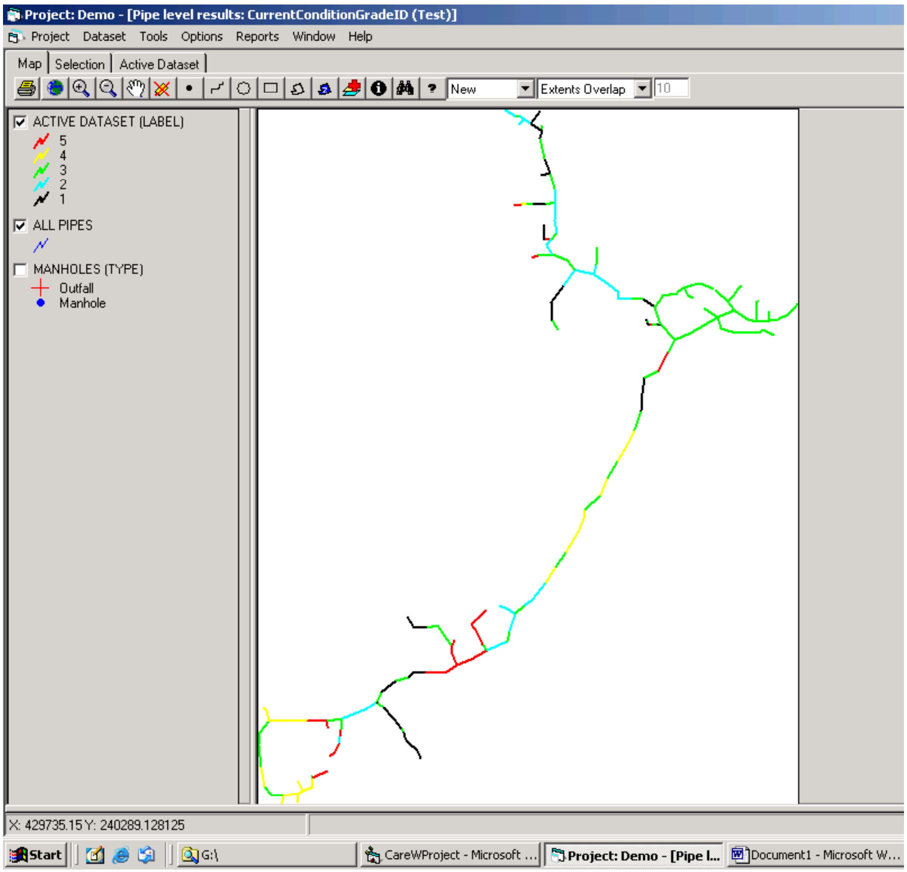

Figure 5.3 Current Structural Deficiencies GIS report

At this stage of the project, the input and output requirements of WP2.4 are not yet known. It is likely that the output would include the most significant failure mechanism for each pipe, based on the analysis undertaken by a number of the WP2 tools. However, the rehabilitation engineer would find it useful to know subsequent failure modes, and the times when these are likely to occur, as this will influence the final rehabilitation policy. A useful output from WP2.4 would be a list of the likely mechanisms of failure for a given pipe in chronological order. This information can be readily displayed in a tabular report. An example tabular report is given in Figure B.7 in Appendix B.

5.9 Current Hydraulic and Structural Performance

Task 2.2/T3 of the step-by-step guide proposes a report which summarises the combined structural and hydraulic status of a dataset, the dataset being a catchment or sub-catchment. Such a report would allow the rehabilitation planner to visualise areas with a combination of problems and could aid the targeting of further analysis and/or the development of a rehabilitation programme.

Structural deficiencies can be described in terms of the Internal Condition Grade (ICG) of a sewer. Hydraulic deficiencies can be described in terms of the volume of flooding and the depth of surcharge experienced by individual sewers during specified storm events.

There are currently two options available for displaying combined analysis results using the capabilities of the Rehabilitation Manager. The first option is known as thematic mapping and is the method by which all previously mentioned GIS reports have been produced. Thematic reporting displays all pipes and nodes colour coded according to a single attribute, either asset data such as material or results such as rate of infiltration. Different colours are used for a number of discrete bands which are bounded by the minimum and maximum values for that attribute.

In terms of displaying the combined structural and hydraulic results, the ICGs would be displayed as a pipe attribute and the surcharge and flooding results as attributes of the node or manhole. It would therefore be possible to display the ICG and surcharge results in one report and ICG and flooding in another. It should be noted that in a thematic report all the pipes and all the nodes will be colour coded and therefore the visual impact of specific hydraulic and structural deficiencies could be diminished by the complexity of the display.

The second option utilises the Find facility of the Rehabilitation Manager (see Section 4.4.2) to highlight nodes and pipes according to specific criteria, either asset data or results. The project database would be queried according to specific requirements and the results of this query displayed as a single colour highlighted in the GIS viewer. In terms of the combined results report, a query could be created which allowed sewers of ICG 4 and 5 which are downstream of nodes that flood during a specific storm event, to be highlighted. This option has the advantage of highlighting sections of the network with specific combined hydraulic and structural problems.

The decision as to which of these options to recommend for the combined hydraulic and structural deficiencies GIS report would depend on the effectiveness of the reports in terms of clarity of data display and usefulness to the rehabilitation planner. The reporting of actual model results would be an effective method for testing the usefulness of both options.

5.10 Future Hydraulic and Structural Performance

The GIS report for the future hydraulic and structural performance would be of the same format as the current performance report, but would be based on simulation results for a specified future date.

5.11 Probability of Hydraulic Failure

Task 2.2/T10 of the step-by-step guide proposes that the results of the WP3.4 hydraulic reliability tool be reported. The aim of this report is to assist the user in identifying the sewers with existing and predicted hydraulic problems. At this stage of development the exact input and output requirements of the hydraulic reliability tool are not yet known. However the content of the GIS reports has been discussed. The following descriptions of these reports are based on the minutes of the WP3 workshop held in Trondheim in December 2003 (Ref. 3).

The results of the WP3.4 analysis would be a series of probability maps which would allow the reliability of the sewer network to be estimated. WP3.4 proposed three probability maps, namely:

- Hydraulic;
- Environmental; and
- Operational (depending on available results from WP2).

The hydraulic map will define the probability that each sewer and manhole will reach or exceed a critical water level. The critical water level will be defined by the user, based on local or national standards. This probability would be based on an evaluation of the number of years a pipe or manhole exceeds this critical water level, using simulations carried out for a specified number of years.

The environmental map will present the probability of failure by infiltration and exfiltration, for each pipe. It will present results for those pipes responsible for Combined Sewer Overflow (CSO) problems. The probability would be defined in terms of the number of years specific CSO discharge parameters exceed a given standard. This standard will be based on the requirements of the Water Framework Directive (Ref. 4) and on National standards.

The operational maps will define the probability that a blockage will occur for each pipe. The viability of this probability map will depend on the specific results obtainable from the WP2 blockages tool.

All three probability maps can be readily produced by the Rehabilitation Manager, provided that the format and content of the outputs from the Hydraulic Reliability tool are known.

5.12 Optimum short and long term rehabilitation solutions

Tasks 3.3/T1 and T2 of the step-by-step guide require the results of WP6 to be displayed. WP6.2 delivers the preferred rehabilitation solution for a given pipe, for the short term. This will constitute the short-term rehabilitation plan. This information can be readily displayed geospatially by the Rehabilitation Manager, colour coding each pipe according to the selected method. This information could also be displayed in terms of the year of rehabilitation and cost, if these results were available from the WP6.2 analysis.

The long term (10-30 year) rehabilitation plan is developed by the WP6.3 tool. Again the preferred rehabilitation solution for a given pipe will be identified. This can be displayed in a GIS report similar to the short term plan.

6. REFERENCES

1. Hulance J; Hurley R; Kowalski M; Orman N.; The CARE-S Procedure, Report D20 for Task 7.1, CARE-S WP7 – Wastewater Network Rehabilitation Manager. Swindon, UK; December 2003.

2. EN 13508-2: Conditions of drain and sewer systems outside buildings – Part 2: Visual inspection coding system. May 2003.

3. CARE-S WP3 Workshop, Trondheim. 16-19 December 2003.

4. Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy, EC, October 2000.

APPENDIX A DATA MODEL OF THE REHABILITATION MANAGER CENTRAL DATABASE

Note that Version 2 of the Data Model (29 March 2004) is presented here. This version has been produced as a result of discussions with individual tool developers. As many of the tools are still under development the data model presented here does not represent the final structure of the CARE-S database.

The data model describes the structure of the central database of the Rehabilitation Manager. The data items have been grouped together in the tables that appear in the CARE-S project database.

In the following table, the first column lists the data items. The second column denotes whether the item exists as a stand-alone field in the database or is derived (D) by the Rehabilitation Manager. The third column relates to data flows to and from the Rehabilitation Manager and the remaining columns are concerned with data flows to and from the individual tools.

To indicate the data flow for the Rehabilitation Manager and tools the following convention has been used:

Data flows for the Rehabilitation Manager

F - Data values are read into the Rehabilitation Manager from a file.

S - Data values are stored in the Rehabilitation Manager.

I - Data values are entered interactively, via a form in the Rehabilitation Manager.

D - Data derived by the Rehabilitation Manager (not stored in the database).

R - Items created and used by the Rehabilitation Manager. These items allow links between tables.

Data flows for the Tools

F - A tool will read this item from a file which will have been created or located by the Rehabilitation Manager.

I - This is an interactive input for the tool. The data item needs to be stored in the CARE-S project. The symbol is used so it is easy to distinguish between data that has been bulk read and the data that is to be entered interactively.

S - This item has been determined by a tool, and is required to be stored in the CARE-S project database.

O - Output from a tool that is not stored in the CARE-S project database.

C - These items are accessed directly by tools.

R - These items are created and used by the Rehabilitation Manager. These items allow links between tables.

L - Shows how the various tables in the CARE-S project database are linked. The most common item to link on is the ‘PipeID’.

Dataset

		Rehabilitation Manager	PI tool	CCTV data conversion	Structural probability	Blockages	Infiltration	Exfiltration	Internal corrosion (selection)	Internal Corrosion Details	External corrosion	Load resistance	Structural results evaluation	Hydraulic models	Hydraulic temporal decline	Impact of in/exfiltration	Environ consequences	Hydraulic reliability	Operational methods	Rehab Technology database	Technique cost tool	Impact of failures	Impact of works	Choice of rehab technology	Selection of priority projects	Long term strategy
SetId		I	C						S																	
Type of hydraulic Model		I																								
Name		I																					F		F	
Description		I																								
Level – Type of dataset		I	C						S																	

HydraulicModel

		Rehabilitation Manager	PI tool	CCTV data conversion	Structural probability	Blockages	Infiltration	Exfiltration	Internal corrosion (selection)	Internal Corrosion Details	External corrosion	Load resistance	Structural results evaluation	Hydraulic models	Hydraulic temporal decline	Impact of in/exfiltration	Environ consequences	Hydraulic reliability	Operational methods	Rehab Technology database	Technique cost tool	Impact of failures	Impact of works	Choice of rehab technology	Selection of priority projects	Long term strategy
HydraulicModelID		R																								
Level		I																								
Model Type		I																								
Original Hydraulic Model ID		I																								
Prediction Year		I			S	S											F									
Total property count	D	I						F																		
Ave water consumption/ property		I						F									F									
File name		R																								
Date stamp		R																								
Storm ID		I																								

Storm data

		Rehabilitation Manager	PI tool	CCTV data conversion	Structural probability	Blockages	Infiltration	Exfiltration	Internal corrosion (selection)	Internal Corrosion Details	External corrosion	Load resistance	Structural results evaluation	Hydraulic models	Hydraulic temporal decline	Impact of in/exfiltration	Environ consequences	Hydraulic reliability	Operational methods	Rehab Technology database	Technique cost tool	Impact of failures	Impact of works	Choice of rehab technology	Selection of priority projects	Long term strategy
StormID		R																								
Name		I																								
DWF/Storm		I															F									
Storm Duration (mins)		I															F									
Storm frequency (years)		I															F									

SubCatchmentData

		Rehabilitation Manager	PI tool	CCTV data conversion	Structural probability	Blockages	Infiltration	Exfiltration	Internal corrosion (selection)	Internal Corrosion Details	External corrosion	Load resistance	Structural results evaluation	Hydraulic models	Hydraulic temporal decline	Impact of in/exfiltration	Environ consequences	Hydraulic reliability	Operational methods	Rehab Technology database	Technique cost tool	Impact of failures	Impact of works	Choice of rehab technology	Selection of priority projects	Long term strategy
Name		F/S												S			F									
NodeId		I																								
SubCatchmentType		I															F					F	F			
Inhabitatnts		F/S												S			F					F	F			
Hydraulic catchment area		F/S												F/S			F					F	F			
Impervious urban area		F/S												F/S			F									
Soil type (run off)		F/S												F/S												
Low flow (m3/s)		F/S												S			F									
Use of receiving water		F/S															F									
LandUse														S								F	F			
Mean Flow (DWF) (m3/s)		F/S												S			F									

PipeData

		Rehabilitation Manager	PI tool	CCTV data conversion	Structural probability	Blockages	Infiltration	Exfiltration	Internal corrosion (selection)	Internal Corrosion Details	External corrosion	Load resistance	Structural results evaluation	Hydraulic models	Hydraulic temporal decline	Impact of in/exfiltration	Environ consequences	Hydraulic reliability	Operational methods	Rehab Technology database	Technique cost tool	Impact of failures	Impact of works	Choice of rehab technology	Selection of priority projects	Long term strategy
PipeID		R														F	F									
Name MH (up) HM (dn)	D				F	F	F	F	F	F	F	F		F/S	F	F	F				F	F	F	F	F	F
material		F/S			F	F	F	F		F	F	F		F/S				O			F			F	F	F
Shape		F/S			F	F	F		F			F		F/S							F			F	F	F
Width		F/S			F	F	F		F			F		F/S	O			O			F			F	F	F
Height		F/S			F	F	F		F			F		F/S	O			O			F			F	F	F
Length		F/S			F	F	F	F	F			F		F/S							F	F	F	F	F	F
Pu Length		F/S			F		F	F																F	F	F
Installation Year		F/S			F	F	F	F		F	F	F													F	F
Upstream invert level		F/S				F	F	F						F/S								F				
Downstream invert level		F/S				F	F	F						F/S								F				
Ave Depth	D				F	F	F	F		F	F	F				F						F		F	F	F
Pipe Type		F/S			F	F	F		F					F/S										F	F	

		Rehabilitation Manager	PI tool	CCTV data conversion	Structural probability	Blockages	Infiltration	Exfiltration	Internal corrosion (selection)	Internal Corrosion Details	External corrosion	Load resistance	Structural results evaluation	Hydraulic models	Hydraulic temporal decline	Impact of in/exfiltration	Environ consequences	Hydraulic reliability	Operational methods	Rehab Technology database	Technique cost tool	Impact of failures	Impact of works	Choice of rehab technology	Selection of priority projects	Long term strategy
PipeTable cont																										
Surface		F/S			F									F/S										F	F	F
Upstream MH		F/S				F	F		F					F/S											F	
Downstream MH		F/S				F	F		F					F/S											F	
Slope		F/S				F	F	F	F					F/S												
Roughness type		F/S												F/S												
Bottom roughness		F/S												F/S	O			O								
Corrodible (y/n)	D								F																	
Alkalinity (gCaCO3 g)	D								F																	
Manhole energy loss (m)		F/S							F																	
Wall thickness (mm)		F/S				F	F			F/S	F/S	F/S														
SDR		F/S								F/S	F/S	F/S														
Pressure class		F/S								F/S	F/S	F/S													F	
Filling material		F/S								F	F	F				F									F	F
Ground water level (m)		F/S				F	F	F		F	F	F				F						F	F	F	F	F
Traffic level		F/S			F							F										F	F	F	F	F
External protection		F/S								F	F					F									F	
X/Y upstream MH	D						F	F																	F	
X/Y downstream MH	D						F	F																	F	
Joint type		F/S					F	F																	F	F
Flow direction	D						F	F																		
Priority for Condition Inspection		F/S					F	F																		S
Soil type		F/S					F	F								F								F	F	F
Soil permeability (m/s)	D															F										
Surface sealing (%)																F										

		Rehabilitation Manager	PI tool	CCTV data conversion	Structural probability	Blockages	Infiltration	Exfiltration	Internal corrosion (selection)	Internal Corrosion Details	External corrosion	Load resistance	Structural results evaluation	Hydraulic models	Hydraulic temporal decline	Impact of in/exfiltration	Environ consequences	Hydraulic reliability	Operational methods	Rehab Technology database	Technique cost tool	Impact of failures	Impact of works	Choice of rehab technology	Selection of priority projects	Long term strategy
PipeTable Cont																										
Property connections					F	F	F	F														F	F	F	F	
Man entry (y/n)	D																							F	F	
City		F/S																					F		F	
Street		F/S		S																			F		F	
Inflow (m3/s)		F/S					F	F	F					F/S												
Surface Vegetation						F																				
BOD																										
COD																										
Straight/ Curved																								F		
NodeData																										
Node type		F/S												F/S												
Protection Zone		F/S													F											
Ground level (m)		F/S												F/S	F											
NodeID		F/S												F/S												
NonManholeNodeData																										
NodeID																										
Temperature (oC)																	F									
Max WWTP inflow																	F									
CSO (y/n)		F/S																								
WWTP (y/n)		F/S																								
Configuration and Plant layout																	F									

PipeResults

		Rehabilitation Manager	PI tool	CCTV data conversion	Structural probability	Blockages	Infiltration	Exfiltration	Internal corrosion (selection)	Internal Corrosion Details	External corrosion	Load resistance	Structural results evaluation	Hydraulic models	Hydraulic temporal decline	Impact of in/exfiltration	Environ consequences	Hydraulic reliability	Operational methods	Rehab Technology database	Technique cost tool	Impact of failures	Impact of works	Choice of rehab technology	Selection of priority projects	Long term strategy
Hydraulic model results ID							L	L	L		L	L		R		L	L									
PipeID					L	L								L											L	L
Forecast ICG					S																				F	F
Forecast ICG (Deform)																									F	F
Forecast ICG (Kanew)																									F	F
Blockage factor						S																			F	
24 hr infiltration volume							S									F									F	
24 hr exfiltration volume								S								F									F	
Chemical corrosion rate									S			F													F	
External corrosion rate (mm/y)											S	F													F	
Probability of structural failure												S													F	
First rainfall event which causes surcharging																										
FlowFileName														S			F									
Flow pattern	D																F	F								
FlowFile-DateStamp														R			F									
Hydraulic probability																		S							F	
Environmental probability																		S							F	
Operational probability																		S							F	
Risk for ground water on soil type																	S								F	
Trend of exfiltration																	S								F	
Endangered zone																	S								F	

		Rehabilitation Manager	PI tool	CCTV data conversion	Structural probability	Blockages	Infiltration	Exfiltration	Internal corrosion (selection)	Internal Corrosion Details	External corrosion	Load resistance	Structural results evaluation	Hydraulic models	Hydraulic temporal decline	Impact of in/exfiltration	Environ consequences	Hydraulic reliability	Operational methods	Rehab Technology database	Technique cost tool	Impact of failures	Impact of works	Choice of rehab technology	Selection of priority projects	Long term strategy
HydraulicPipeResults																										
Pipe name													S													
Flow (m3/s)													S			F									
Time													S			F									
HydraulicNodeResults																										
NodeName													S			F									
Level (m)													S													
Volume (m3)													S			F									
NodeHydraulicResultsData																										
Hydraulic Model Results ID		S																								
ID		S																								
FlowFileName													S			F									
Flow pattern	D															F	F								
First rainfall event which causes flooding		S																								
Spill frequency (per yr)													S			F									
Spill duration (h)													S			F									
Violation of standard																S									

		Rehabilitation Manager	PI tool	CCTV data conversion	Structural probability	Blockages	Infiltration	Exfiltration	Internal corrosion (selection)	Internal Corrosion Details	External corrosion	Load resistance	Structural results evaluation	Hydraulic models	Hydraulic temporal decline	Impact of in/exfiltration	Environ consequences	Hydraulic reliability	Operational methods	Rehab Technology database	Technique cost tool	Impact of failures	Impact of works	Choice of rehab technology	Selection of priority projects	Long term strategy
OperationalIncidents																										
UserReference		F/S																								
PipeID		F/S																								
X		F/S																								
Y		F/S																								
Incident Type		F/S																								
Cause		F/S																								
Asset type		F/S																								
Area type affected		F/S																								
CCTVSurveyIdentification																										
CCTVID				R		F	F	F																		
FileName				S		F	F	F																		
FileDateStamp				S		F	F	F																		
DateofSurvey				S		F	F	F																		F
CCTVDataResults																										
PipeID				L	L	F	F							L										L	L	L
CCTVID				L	L	F	F																	L	L	L
Defect code (CEN standard)				S	F	F	F							I										F	F	
Position				S	F	F	F							I										F	F	
Length (m)				S	F	F	F							I										F	F	
ICG				S	F	F	F							I		F								F	F	F

AdditionalPipeData

		Rehabilitation Manager	PI tool	CCTV data conversion	Structural probability	Blockages	Infiltration	Exfiltration	Internal corrosion (selection)	Internal Corrosion Details	External corrosion	Load resistance	Structural results evaluation	Hydraulic models	Hydraulic temporal decline	Impact of in/exfiltration	Environ consequences	Hydraulic reliability	Operational methods	Rehab Technology database	Technique cost tool	Impact of failures	Impact of works	Choice of rehab technology	Selection of priority projects	Long term strategy
PipeID		R																						L		
Basement (y/n)																							F			
Description		I																						F		
Ground Water impact allowed		I																						F		
Noise allowed (y/n)		I																						F		
Dust allowed		I																						F		
Working space available		I																						F		
Min temp @ rehab time		I																						F		
Service connection cut off possible		I																						F		
Interruption of work		I																						F		
Max time for rehab (days)		I																						F		
Max time for possible interruption		I																						F		
Structural rehab (y/n)		I																						F		
Sealing required (y/n)		I																						F		
Pit Damage allowed (y/n)		I																						F		
Ground water type																						F	F			
Surface water type																						F				
Density of labour force																						F	F			
Backwater valves (y/n)																							F			
Ave basement level above pipe																							F	S		
Priority pipes file name																										

APPENDIX B CARE-S TABULAR REPORTS

The following tabular reports contain sample data to demonstrate the visual impact of the individual reports. The data has been manufactured by WRc and does not represent actual analysis results.

Asset Summary Report

Dataset name: V984-01
Project: Derby
Dataset type: Network

Summary of current status of dataset

Category of pipe				Era of Construction	Total length (km)
Material	**Shape**	**Height (mm)**	**Width (mm)**		
Concrete	Circular	0	300	Pre 1914	0.373
Concrete	Circular	0	375	Pre 1914	0.100
Concrete	Circular	0	450	Pre 1914	0.068
Concrete	Circular	0	525	Pre 1914	0.025
Vitrified clay	Circular	0	150	Pre 1914	0.871
Vitrified clay	Circular	0	225	Pre 1914	0.879
Concrete	Circular	0	300	Inter War	0.322
Concrete	Circular	0	375	Inter War	0.376
Concrete	Circular	0	450	Inter War	0.097
Concrete	Circular	0	600	Inter War	0.111
Concrete	Circular	0	675	Inter War	0.085
Concrete	Circular	0	825	Inter War	0.039
Concrete	Circular	0	900	Inter War	0.078
Concrete	Circular	0	975	Inter War	0.360
Concrete	Circular	0	1125	Inter War	0.219
Concrete	Circular	0	1200	Inter War	0.358
Vitrified clay	Circular	0	150	Inter War	2.003
Vitrified clay	Circular	0	225	Inter War	2.358
Vitrified clay	Circular	0	300	Inter War	0.186
Concrete	Circular	0	150	1945 to 1979	0.349
Concrete	Circular	0	225	1945 to 1979	0.359
Concrete	Circular	0	300	1945 to 1979	1.327
Concrete	Circular	0	375	1945 to 1979	1.758
Concrete	Circular	0	450	1945 to 1979	1.683
Concrete	Circular	0	525	1945 to 1979	0.828
Concrete	Circular	0	600	1945 to 1979	0.438
Concrete	Circular	0	675	1945 to 1979	0.790
Concrete	Circular	0	750	1945 to 1979	0.034
Concrete	Circular	0	825	1945 to 1979	0.730
Concrete	Circular	0	900	1945 to 1979	0.523
Concrete	Circular	0	975	1945 to 1979	0.325
Concrete	Circular	0	1200	1945 to 1979	0.342
GRP	Circular	0	375	1945 to 1979	0.055
GRP	Circular	0	510	1945 to 1979	0.050
GRP	Circular	0	525	1945 to 1979	0.005
PVC	Circular	0	150	1945 to 1979	0.031
Vitrified clay	Circular	0	100	1945 to 1979	0.231
Vitrified clay	Circular	0	150	1945 to 1979	13.643
Vitrified clay	Circular	0	225	1945 to 1979	9.266
Vitrified clay	Circular	0	300	1945 to 1979	1.303
Vitrified clay	Circular	0	375	1945 to 1979	0.028
Vitrified clay	Circular	0	225	Unknown	0.062
Vitrified clay	Circular	0	300	Unknown	0.062

Figure B.1 CARE-S Asset Summary Report

Project PI Summary Report

Project name: Derby

Datasets in project:

Dataset Name	Dataset type
V984-01	Network
V984-02	Network
V984-03	Network
V984-04	Network
V984-05	Network

Analysis Period

Mar-2001 to Apr-2002

Indicator Type	Performance indicator	Units	Code	Dataset V984-01	V984-02	V984-03	V984-04	V984-05
Operational	Sewer blockages	No./100 km sewer/year	sOp11	13.91	37.96	19.59	17.46	24.52
Operational	Flooding from sanitary or combined sew	No./100 km sewer/year	sOp15	4.64	21.09	4.01	4.36	1.29
Operational	Surface Flooding	No./100 km sewer/year	sOp18	2.32	8.44	4.01	3.49	1.29

Sheet 1 of the PI report showing the result for one analysis period

Project PI Summary Report

Project name: Demo1

Datasets in project:

Dataset Name	Dataset type
V984-01	Network
V984-02	Network
V984-03	Network
V984-04	Network
V984-05	Network

Analysis Period

Mar-2002 to Apr-2003

Indicator Type	Performance indicator	Units	Code	Dataset V984-01	V984-02	V984-03	V984-04	V984-05
Operational	Sewer blockages	No./100 km sewer/year	sOp11	13.91	37.96	19.59	17.46	24.52
Operational	Flooding from sanitary or combined sew	No./100 km sewer/year	sOp15	4.64	21.09	4.01	4.36	1.29
Operational	Surface Flooding	No./100 km sewer/year	sOp18	2.32	8.44	4.01	3.49	1.29

Sheet 2 of the PI report showing the result for second analysis period

Figure B.2 CARE-W PI Tool – Project Current Performance

Current Status of Condition Inspection Data

Project: Derby
Active Dataset: V984-04
Dataset type: Network

Sewer inspection survey data

User Ref			Main characteristics						
Upstream node	Downstream node	Link ID	Material	Shape	Height (mm)	Width (mm)	Depth to downstream invert (m)	Length (km)	Date of last survey
SK37371276	SK37371393	1	Concrete	Circular	750	0	0.00	0.014	26-Feb-03
SK37379500	SK37379504	1	Concrete	Circular	375	0	66.78	0.075	26-Feb-03
SK37371300	SK37372307	1	Concrete	Circular	525	0	60.99	0.050	26-Feb-03
SK37386002	SK37376901	1	Vitrified clay	Circular	225	0	82.27	0.077	26-Feb-03
SK38360702	SK38360600	1	Vitrified clay	Circular	225	0	48.66	0.081	27-Feb-03
SK38360803	SK38360804	1	Vitrified clay	Circular	225	0	53.38	0.042	27-Feb-03
SK38371003	SK38361901	1	Vitrified clay	Circular	225	0	54.91	0.110	27-Feb-03
SK38360802	SK38360803	1	Vitrified clay	Circular	225	0	54.00	0.019	27-Feb-03
SK38369501	SK38368503	1	Concrete	Circular	225	0	66.89	0.051	28-Feb-03
SK38361203	SK38360304	1	Vitrified clay	Circular	150	0	48.74	0.107	28-Feb-03
SK38368501	SK38367503	1	Vitrified clay	Circular	225	0	64.05	0.031	28-Feb-03
SK38360600	SK38360601	1	Vitrified clay	Circular	225	0	48.18	0.027	28-Feb-03
SK38361207	SK38361206	1	Vitrified clay	Circular	225	0	52.74	0.033	28-Feb-03
SK38363401	SK38363402	1	Concrete	Circular	1050	0	51.13	0.043	4-Mar-03
SK38360305	SK38360301	1	Concrete	Circular	300	0	47.85	0.044	4-Mar-03
SK38360200	SK38360301	1	Concrete	Circular	175	0	47.86	0.111	4-Mar-03
SK38360101	SK38360200	1	Concrete	Circular	175	0	48.38	0.030	4-Mar-03
SK38363600	SK38362601	1	Concrete	Circular	375	0	0.00	0.063	4-Mar-03
SK38365006	SK38355906	1	Concrete	Circular	225	0	59.38	0.093	4-Mar-03
SK38360303	SK38360302	1	Vitrified clay	Circular	225	0	44.54	0.033	4-Mar-03
SK38361206	SK38361200	1	Vitrified clay	Circular	225	0	51.75	0.030	4-Mar-03
SK38361200	SK38360303	1	Vitrified clay	Circular	225	0	48.24	0.087	4-Mar-03
SK38364002	SK38365007	1	Vitrified clay	Circular	150	0	61.42	0.084	4-Mar-03
SK38365008	SK38365005	1	Vitrified clay	Circular	225	0	60.17	0.082	4-Mar-03
SK38369305	SK38369306	1	Vitrified clay	Circular	225	0	62.55	0.038	4-Mar-03
SK38369306	SK38369302	1	Vitrified clay	Circular	225	0	61.89	0.048	4-Mar-03
SK37389600	SK37389603	1	Concrete	Circular	675	0	83.95	0.043	17-Mar-03
SK37386701	SK37387701	1	Concrete	Circular	675	0	87.21	0.078	17-Mar-03

Figure B.3 Current Status of Condition Inspection Data

Current Internal Condition - Summary

Project: Derby
Active Dataset: V984-04
Dataset type: Network

Total length of sewers in dataset (km): 114.56
% length of sewer inspected 1.19%

User Ref				Failure Mode				
Upstream node	**Downstream node**	**Link ID**	**Length (km)**	**Structural**	**Infiltration**	**Exfiltration**	**Internal Corrosion**	**Blockages**
SK37371276	SK37371393	1	0.014					#
SK37371300	SK37372307	1	0.050					#
SK37379500	SK37379504	1	0.075					
SK37386002	SK37376901	1	0.077	#				
SK37386701	SK37387701	1	0.078	#				#
SK37389600	SK37389603	1	0.043					
SK38360101	SK38360200	1	0.030					
SK38360200	SK38360301	1	0.111					#
SK38360305	SK38360301	1	0.044					
SK38360600	SK38360601	1	0.027	#				#
SK38360702	SK38360600	1	0.081	#				
SK38360802	SK38360803	1	0.019					#
SK38360803	SK38360804	1	0.042	#				
SK38361200	SK38360303	1	0.087	#				#
SK38361203	SK38360304	1	0.107	#				#
SK38361206	SK38361200	1	0.030	#				
SK38365006	SK38355906	1	0.093					
SK38365008	SK38365005	1	0.082	#				#
SK38368501	SK38367503	1	0.031					#
SK38369305	SK38369306	1	0.038	#				#
SK38369306	SK38369302	1	0.048					
SK38369501	SK38368503	1	0.051					#
SK38371003	SK38361901	1	0.110	#				#
No of sewers with detected defects				9	0	0	0	10
% length of sewers in Dataset				0.66%	0.00%	0.00%	0.00%	0.70%

Figure B.4 Summary sheet from Summary of Internal Condition report

Current Internal Condition - Blockage Defects

Project: Derby
Active Dataset: V984-04
Dataset type: Network

Sewer inspection survey data

User Ref			Defect code	Defect Description	Clockface Position	Distance from manhole (m)
Upstream node	Downstream node	Link ID				
SK37371276	SK37371393	1	BBC A	Fine deposits	10	1.30
SK37371276	SK37371393	1	BBC A	Fine deposits	10	5.40
SK37371300	SK37372307	1	BBC	Settled deposits	10	15.50
SK37371300	SK37372307	1	BBC	Settled deposits	20	28.30
SK37371300	SK37372307	1	BBC	Settled deposits	15	29.80
SK37371300	SK37372307	1	BBC	Settled deposits	10	34.60
SK37371300	SK37372307	1	BBC	Settled deposits	10	39.00
SK37386002	SK37376901	1	BBA B	Fine roots		3.90
SK37386002	SK37376901	1	BBC	Settled deposits	10	5.10
SK37386002	SK37376901	1	BBC	Settled deposits	10	29.50
SK37386002	SK37376901	1	BBB A	Encrustation	10	51.80
SK37386003	SK37376900	1	BBA B	Fine roots	0	3.90
SK37386003	SK37376900	1	BBC	Settled deposits	10	5.10
SK37386701	SK37387701	1	BBC	Settled deposits	5	20.90
SK37386701	SK37387701	1	BBB A	Encrustation	5	29.70
SK37386701	SK37387701	1	BBC	Settled deposits	5	65.30
SK37386701	SK37387701	1	BBB A	Encrustation	5	74.70
SK38360200	SK38360301	1	BBA B	Fine roots		13.80
SK38360200	SK38360301	1	BBA B	Fine roots		44.70
SK38360200	SK38360301	1	BBC	Settled deposits	20	50.60
SK38360200	SK38360301	1	BBA B	Fine roots		55.10
SK38360200	SK38360301	1	BBC	Settled deposits	25	58.00
SK38360600	SK38360601	1	BBC Z	Grease deposits	5	26.60
SK38360802	SK38360803	1	BBA C	Complex mass of roots	10	0.20
SK38360802	SK38360803	1	BBA C	Complex mass of roots	15	2.00
SK38360802	SK38360803	1	BBA B	Fine roots		2.80
SK38360802	SK38360803	1	BBA B	Fine roots		4.10
SK38360802	SK38360803	1	BBA C	Complex mass of roots	30	5.00
SK38361200	SK38360303	1	BBA B	Fine roots		9.70
SK38361200	SK38360303	1	BBA B	Fine roots		11.20
SK38361200	SK38360303	1	BBA B	Fine roots		16.70
SK38361203	SK38360304	1	BBC	Settled deposits	10	1.60
SK38361203	SK38360304	1	BBC	Settled deposits	10	11.40
SK38361207	SK38361206	1	BBA B	Fine roots		0.70
SK38361207	SK38361206	1	BBC	Settled deposits	10	3.60
SK38361207	SK38361206	1	BBA B	Fine roots		3.80
SK38365008	SK38365005	1	BBC	Settled deposits	20	1.10
SK38365008	SK38365005	1	BBC	Settled deposits	40	7.00
SK38365008	SK38365005	1	BBC	Settled deposits	20	18.70
SK38365008	SK38365005	1	BBC	Settled deposits	25	20.60
SK38365008	SK38365005	1	BBC	Settled deposits	25	30.00
SK38368501	SK38368503	1	BBC	Settled deposits	5	12.80
SK38368501	SK38368503	1	BBC A	Fine deposits	5	20.60
SK38369305	SK38369306	1	BBC	Settled deposits	25	10.60
SK38369305	SK38369306	1	BBC	Settled deposits	20	26.40
SK38369501	SK38368503	1	BBC A	Fine deposits	10	6.00
SK38369501	SK38368503	1	BBC	Settled deposits	20	11.70
SK38369501	SK38368503	1	BBC A	Fine deposits	10	12.60
SK38369501	SK38368503	1	BBC	Settled deposits	10	42.50
SK38369501	SK38368503	1	BBC	Settled deposits	10	46.50
SK38371003	SK38361901	1	BBB A	Encrustation	4	33.80
SK38371003	SK38361901	1	BBC	Settled deposits	5	51.70
SK38371003	SK38361901	1	BBA B	Fine roots		64.90
SK38371003	SK38361901	1	BBC	Settled deposits	10	69.40
SK38371003	SK38361901	1	BBC	Settled deposits	10	71.40
SK38371003	SK38361901	1	BBC Z	Grease deposits	5	81.30
SK38371003	SK38361901	1	BBC Z	Grease deposits	5	85.00

Figure B.5 Detailed sheet from Summary of Internal Condition Report

High Level Structural Analysis Results

Project: Derby
Active Dataset: V984-04
Dataset type: Network
Results dataset: V984-04 Structural

Cohort Name	Cohort Description	Total Sewer Length (km)	Mean time to transition (yrs)			
			From ICG 1 to ICG 2	From ICG 2 to ICG 3	From ICG 3 to ICG 4	From ICG 4 to ICG 5
"up to 600mm Brick"	<=600mm, Brick, medium soil, 1945-1979	0.065	30	40	50	55
"up to 600mm concrete"	<=600mm, concrete, medium soil, 1918 to 1945	10.934	20	35	65	71
"greater than 600mm concrete"	>600mm, concrete, medium soil, 1945 to 1979	2.657	15	20	25	32

Figure B.6 High Level Structural Analysis Report

Future Structural Deficiencies

Project: Derby
Active Dataset: V984-04
Dataset type: Network
Results dataset: V984-04 Structural

User Ref			Earliest failure		Next likely failure		Next likely failure	
Upstream node	Downstream node	Link ID	Time (yrs)	Mechanism	Time (yrs)	Mechanism	Time (yrs)	Mechanism
SK37371276	SK37371393	1	5	Blockage	10	Infiltration	10	Structural
SK37379500	SK37379504	1	2	Blockage	6	Structural		
SK37371300	SK37372307	1	10	Structural				
SK37386002	SK37376901	1	3	Infiltration	7	Structural		
SK38360702	SK38360600	1	4	Blockage	12	Structural		

Figure B.7 Current and Future Structural Deficiencies Report

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Work package 7, Task 2, Deliverable D21