Client:

Environment Agency, UK

National Groundwater Modelling System

Phase 2 – Detailed Architecture Design (Change Control Note 2005/03)

Project Implementation Plan
Version 1.0 (final deliverable Phase 2)

31 January 2006

wʟ | delft hydraulics

Tessella

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Preface

Groundwater models have been in use by the Environment Agency and its predecessors for many years. These have been initiated and implemented at regional level, and were not linked in a national context. Groundwater models are costly and have not been easily linked to the needs of operational customers. The fragmented approach to modelling was highlighted by the development of source protection zones in the early 1990's. It was recognised that a centrally co-ordinated, strategic approach was required to avoid duplication and reduce the risk of challenge.

To address this situation, a Strategic Review of Groundwater Modelling (R&D Project W6-034, R&D Technical Report W214; Brown and Hulme, 2001) was undertaken. The main output of the Strategic Review was the *Environment Agency Framework for Groundwater Resources Conceptual and Numerical Modelling* (R&D Technical Report W214) which contained a nationally consistent technical approach and programme for regional groundwater resources assessment and modelling.

The Head Office Hydrogeology Team presented a summary *Implementation Plan* for this work jointly with the Science Group which was accepted by the national Water Resource Management Team (WRMT) in October 2004. Regional modelling strategies were recognised by WRMT as strategic Water Resources capital programmes. This work therefore supports the Streamlining Abstraction Processes (SAP) and Restoring Sustainable Abstraction (RSA) programmes managed by the national Water Resources Regulation team.

The Head Office Hydrogeology team is now developing a more detailed *Implementation Strategy* comprising a series of measures to support groundwater modelling, ensuring appropriate national consistency, improving efficiency and accessibility by customers. The Implementation Strategy will address concerns like national planning of model development, benefit realisation, succession planning, business efficiency, IS performance, and customer accessibility to models. An *IT Strategy for Groundwater Resource Assessment and Modelling* is being prepared to address the infrastructure and IS performance issues.

The National Flood Forecasting Projects (NFFS) has implemented an IT architecture for a centrally hosted flood forecasting system for the Environment Agency (EA). It is recognised that there are strong links between the proposed IT Strategy for Groundwater Modelling and the NFFS. A feasibility study has been conducted which concluded that the IT-backbone, named National Groundwater Modelling System (NGMS), can be based on the NFFS architecture (and software components) if some minor modifications and extensions are implemented. This outcome of phase 1, the feasibility study, was the starting point of phase 2, the detailed architectural design.

Guide to the reader

This document presents the Project Implementation Plan for Phase 3 and an outlook to project implementation in Phase 4

New to this version

Revisions to version 0.5 based on EA input (discussion of the draft project implementation plan at the 4th workshop, October 6 2005 in London, and availability of funding for an early start):

- Kick-off and Pre-release SA-1 are moved forward in time (start first week February 2006, delivery mid March 2006)
- Pre-release SA-3 is of major importance to convince the end users. Therefore two development activities have been added for this pre-release, namely addition of Contour plotting functionality and a contingency fund for small GUI-updates.

Revisions to version 0.5 based on the two day design and planning meeting between Tessella and Delft Hydraulics, October 18/19 2005:

- Design solutions have been identified which meet the functionality requests without the risk of too much software complication. Therefore, the implementation of these solutions has been added while simultaneously skipping the reuse testing and prototyping activities.
- Version 0.5 of the PIP did not pay much attention to testing the integration of new software components to the system. Practical experiences indicate that this activity should not be forgotten.
- System development requires a (temporary) infrastructure at the developer's offices. Activities to setup and maintain this development infrastructure have been incorporated

Revisions to version 0.6, based on review by Karel Heynert (WL Delft Hydraulics project manager NFFS) and Erik Ruijgh (head Hydrological division WL Delft Hydraulics, steering group member of NFFS):

- Renamed pre-releases into PR01-04
- merged kick-off activities into pre-release PR01
- Merged completion activities into completion of pre-release PR04
- Moved client-server development forwards by delivering pre-release PR03 as a stand-alone application for testing, and as client-server application for demonstration
- Moved parallel development activities forward in time (starting April 2006)
- Emphasized relations with NFFS development and delivery

Revision to version 0.7:

- included proposal for Phase 4 planning

Revision to version 0.8:

- updated after project management meeting 10 November 2005-11-16
- identify potential roles for GW-consultants
- refined the target (delivery in time for WFD-planning) and rescheduled the deliveries

Revision to version 0.9

- updated based on review comments by Mark Whiteman for proposal Phase 3

Contents

1   Introduction

The National Groundwater Modelling System (NGMS) is intended to provide an IT-backbone for groundwater modelling activities within the EA. The IT-backbone primarily supports the operation of groundwater models and facilitates a wider and more accountable use of existing and future groundwater models.

It has been investigated whether the development of such backbone can be largely based on IT-architecture of the National Flood Forecasting System (NFFS). This has been found to be technically feasible and a rather efficient direction to proceed.

This document proposes a strategy for the development of the NGMS. The implementation is proposed to be carried out in 2 additional phases:
- Phase 3 – Pilot application (initial implementation)
- Phase 4 – Full system implementation and delivery (role out)

Phase 1 compromised the Feasibility Study which concluded that the NFFS could provide a suitable basis. Phase 2 included the detailed architecture design which identified the desired extensions that fit in the NFFS-architecture concept, as well as new emerging requirements that may be more difficult to meet without increasing of system complexity.

Upon completion of Phase 3, an initial implementation of the NGMS is anticipated to be operational and configured for 2 sample module datasets. On the basis of the third (intermediate) pilot-release, the user community should be able to decide whether and how the actual implementation of the NGMS should be taken up. On the basis of the last pilot-release, CIS should be able to assess the size of hardware infrastructure for the role out of the production system.

In addition, an organisational structure for such project is described. Both follow similar principles as have been applied successfully while developing the NFFS.

Phase 4 is the actual implementation and role out of the NGMS. The implementation will be based on the findings of Phase 2 and 3, and there is limited scope for (major) changes in specifications during this phase. This phase includes development of more module adapters as well as dedicated software developments for NGMS user interfaces to meet end users and custodian requirements. During this phase a number groundwater module datasets will be incorporated for each region. Further configuration should be carried out by custodians of EA and associated groundwater modelling partners in order to optimally embed the operation and management of the NGMS in organisation.

The following chapter will describe Phase 3 in detail, while the last chapter will provide an outlook to the assumed role-out in Phase 4.

2 Assumptions

The following assumptions are made in the preparation of the project implementation plan for phase 3:

- *EA project team*
  The development of the NGMS is very much a joint activity of the EA and the Contractor. It requires extensive input from the EA groundwater modelling group and CIS. Decisions need to be taken rapidly in order to meet the time constraints set by the EA. It is assumed that at least a core team of EA groundwater modelling specialists and CIS representatives will in principle be available during all of the proposed meetings and workshops. They should have a mandate to decide during these workshops upon the direction the pilot should go. They also should be prepared and available to study the draft project products in a short period (a few days) directly before the workshops.

- *The role of groundwater consultants*
  The NGMS development involves a variety of tasks to be conducted. While most of them are strongly related to system development, some tasks are closely related to the groundwater modelling work conducted by EA or consultants. The spread knowledge on the system and to improve its rate of acceptance, outsourcing to groundwater consultants should be considered for the following tasks:
  - development of module adapters
  - extension of the configuration with new module data sets and boundary condition sets

  However, outsourcing is primarily relevant for tasks with clear instructions and requirements. These tasks will primarily occur during the role-out (Phase 4) as the pilot still involves activities that have a clear target but no defined implementation path yet.

- *Hardware platform and system software*
  The design phase will provide the general specification of the hardware platform that will be required for developing, testing and running the NGMS. The detailed specification, installation and maintenance of the hardware platform are expected to be the responsibility of CIS. The hardware platform - or a temporary hosting option – should be available at the start of project phase 3 (certainly not later than April '06). A similar availability is expected to be followed with respect to the installation of the system software, like the database software (assumed to be ORACLE) and application server software.

- *Availability of base information*
  In order to configure groundwater models into the NGMS, module datasets and configuration data needs to be collected and delivered at the start of Phase 3. It is agreed that this will be done by EA with guidance of the contractor, following the strict data delivery schedules. Not meeting the deadlines data delivery schedule will generate the risk of not meeting the milestones in due time for decision making on Phase 4.

- *Testing of pre-releases*

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The NGMS will be delivered via so-called pre-releases, allowing a controlled incremental build up of functionality of pre-releases. Such delivery schedule ensures that products are delivered in time, and are meeting the requirements of the users. It allows for direct feedback of user comments into the development process. As agreed, EA assigns a team of custodians (and users for at least pre-release PR03) which will test the system in detail and deliver feedback in 10 working days after the delivery workshop.

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3   Pilot Implementation (Phase 3)

3.1   Introduction

The objectives of the pilot implementation are:
- Demonstrate to the end users (e.g. abstraction managers) what functionality will be offered to improve management and utilization of groundwater models.
- Obtain an operational though partially implemented version of the NGMS, having basic functionality available in a preconfigured setting.
- Cover nearly the entire scope of the system from running modules to public and user specific data access.
- Identify solutions that best address user requirements (mostly interaction related) within the NFFS-architecture concept.
- Obtain insight in the required capacity of the hardware infrastructure.
- Update of implementation plan for Phase 4.

In addition to the demonstration purpose, the pilot implementation is a risk reducing activity for both the EA and the Contractor. By developing a working prototype of the system, functional specifications can be fine tuned and technical choices can be tested. On the basis of the outcome of this phase well founded choices can be made prior to the start of the full implementation.

Please note that Phase 3 will deliver a working version of the NGMS. This means that a hardware platform should be available at the start of this phase to support development and testing.

The development of an IT-backbone to support groundwater management also requires that the organisational aspects are addressed. In addition to a technical pilot (covered in this project implementation plan), it is strongly recommended that EA addresses the main organisational issues surrounding the organisational embedding and commissioning of the NGMS in this period.

3.2   Scope

The NFFS-architecture is characterized by the entire predefined configuration of the system layout and its data flows. It does not accommodate any interactive requests on data sets that are not identified beforehand. In addition its data access and data synchronization is fully automated and is only to a limited extent user specific.

After the full roll-out, a reasonable level of interaction should be supported. Therefore the scope of the pilot is primarily to provide the capabilities as far as they can be predefined in a configuration and at the same time identify which solution direction provides the best cost/benefit ratio to meet the requests of its users.

The pilot is defined in such way that during and after the pilot phase operational products are available, even if they do not meet the full requirement set of NGMS. Delivery of new software capabilities is limited and focussed on enabling the demonstration to the end users.

3.3   Deliveries and their time scheduling

3.3.1   Introduction

The pilot will be delivered in a set of pre-releases, each of them being an operational system that can be applied in practice. The pre-releases start from the NFFS system capabilities on a stand-alone system and gradually expand towards a predefined NGMS configuration on a client-server system.

The following pre-releases are foreseen for Phase3:
- Pre-release PR01: System setup
- Pre-release PR02: Modflow-VKD in default NFFS configuration
- Pre-release PR03: Modflow-VKD in preconfigured NGMS-configuration
- Pre-release PR04: Modflow-VKD in client server setting

Figure 3-1 provides an overview of the foreseen time schedule. Assuming a start early February, the schedule aims at delivering pre-release dedicated to groundwater (i.e. PR03) at the end of September. This pre-release is intended to include a stand-alone for testing of groundwater specific functionality, and a client-server implementation for demonstration purposes. To meet this dedication level, most software development is planned in the period between releases PR01 and PR03.

In general, the presented schedule should enable the DH/TS team, even during the holiday's period, to support the EA project manager in its planning for the year 2007. Note that obligations of crucial team members (e.g. lead developers) within the NFFS project may require some tuning of NFFS and NGMS project activities to prevent overloading..
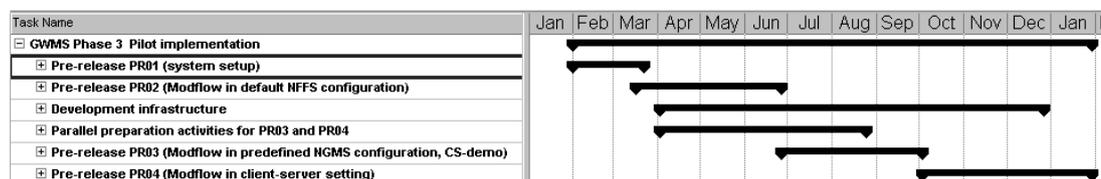

Figure 3-1 Time schedule foreseen for Phase 3 (assumed to be starting February 2006)

In the current schedule, NGMS pre-release PR01 and PR02 are planned two weeks later than the NFFS releases.

3.3.2   General procedures

The procedure of each pre-release is illustrated in Figure 3-2 and will be similar for each
pre-release:
1. the consultant prepares a work plan for PR0#
2. the EA project manager approves the work plan for PR01 at the project management
    kick-off and approves the other work plans at the delivery workshop for previous pre-
    release
3. the consultant implements the work plan, delivers the pre-release and prepares the work
    plan for the next pre-release
4. A) the EA users/custodians tests the pre-release, reports within 2 weeks. The report may
    include a list of change requests.
    B) simultaneously, the consultant starts with implementing the next pre-release
    according to plan
5. the consultant and EA project manager agree within a week after the test reporting
    period which change requests need to be implemented in the next pre-release
6. the consultant updates the plan and incorporate the approved changes in the next pre-
    release

If the agreement at point 5 cannot be reached by email/telephone, a face-to-face meeting
may need to be organised on a short notice to resolve the issue. The approved changes
and/or any associated meeting will be assigned to the 'change budget' i.e. a portion of the
contingency funds that whose management is delegated to the project manager.
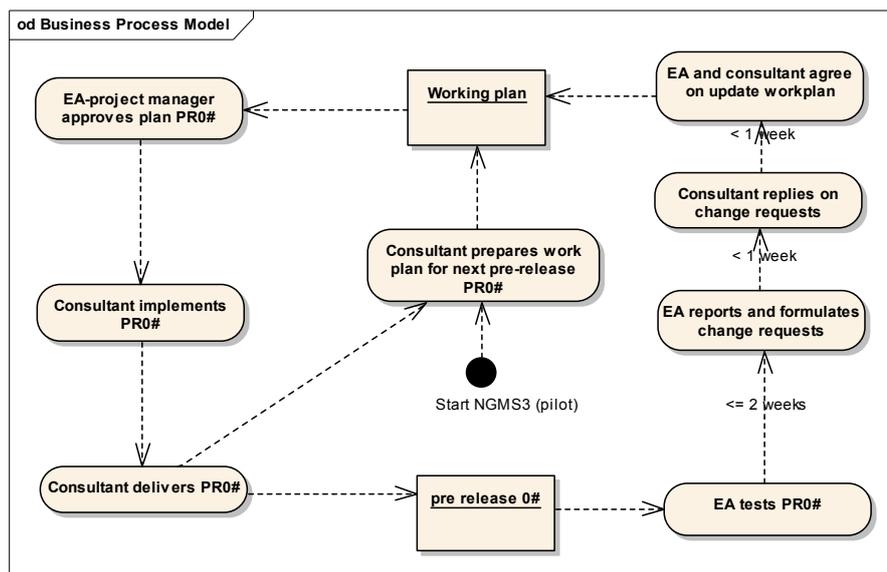
Figure 3-2 Diagram illustrating the iterative procedure for each pre-release of NGMS

The details of the pre-releases are described hereafter. Each pre-release starts with approval
of a pre-release plan and is completed with a follow up plan presented and discussed at the
delivery of the pre-release.

After PR01 a go/no go decision point is incorporated to stop or halt the project before the
financial year of 2005/2006 has started.

3.3.3   Project Start-up

The project start is planned for the first week of February '06.

Phase 3 will start with a project management meeting to define and agree a detailed project planning. In the first week of the project visits are planned to Anglian and Midlands region to collect data for and discuss the pilot implementations.

3.3.4   Pre-release PR01: System Setup

Scope

The first pre-release will be the initial system setup and will provide visual access to imported time series, grids and polygons at predefined assessment points, gauges and abstraction locations in (part of) the regions of Midlands and Anglia. Time series typically will relate to data from Standard Scenarios or they may hold actual monitoring series. The pre-release is a stand-alone application based on configuration of NFFS-software components. This pre-release is foreseen to be synchronised with, and scheduled after NFFS release v.7.3 (early March 2006).

Software development/implementation

A limited software development action is foreseen to import the data into NGMS.

Configuration

The following features will be configured and delivered:
- map layers (Explorer)
- locations (Explorer)
- time series navigation (Explorer)
- time series display
- workflow for data import

In Phase 3, two groundwater models will be configured. In Phase 2 has been agreed that a model will be configured for both Midlands and Anglian Region.

Testing

This delivery will include minor integration testing regarding data imports.

Documentation

Configuration documentation will be set up as a basis to be populated during the incremental delivery of the system. In addition, release and user testing documentation will be provided.

Delivery

The delivery of this phase will be the configured stand-alone application, including documentation. The product will be delivered on CD or via another digital medium.

Task list and time schedule
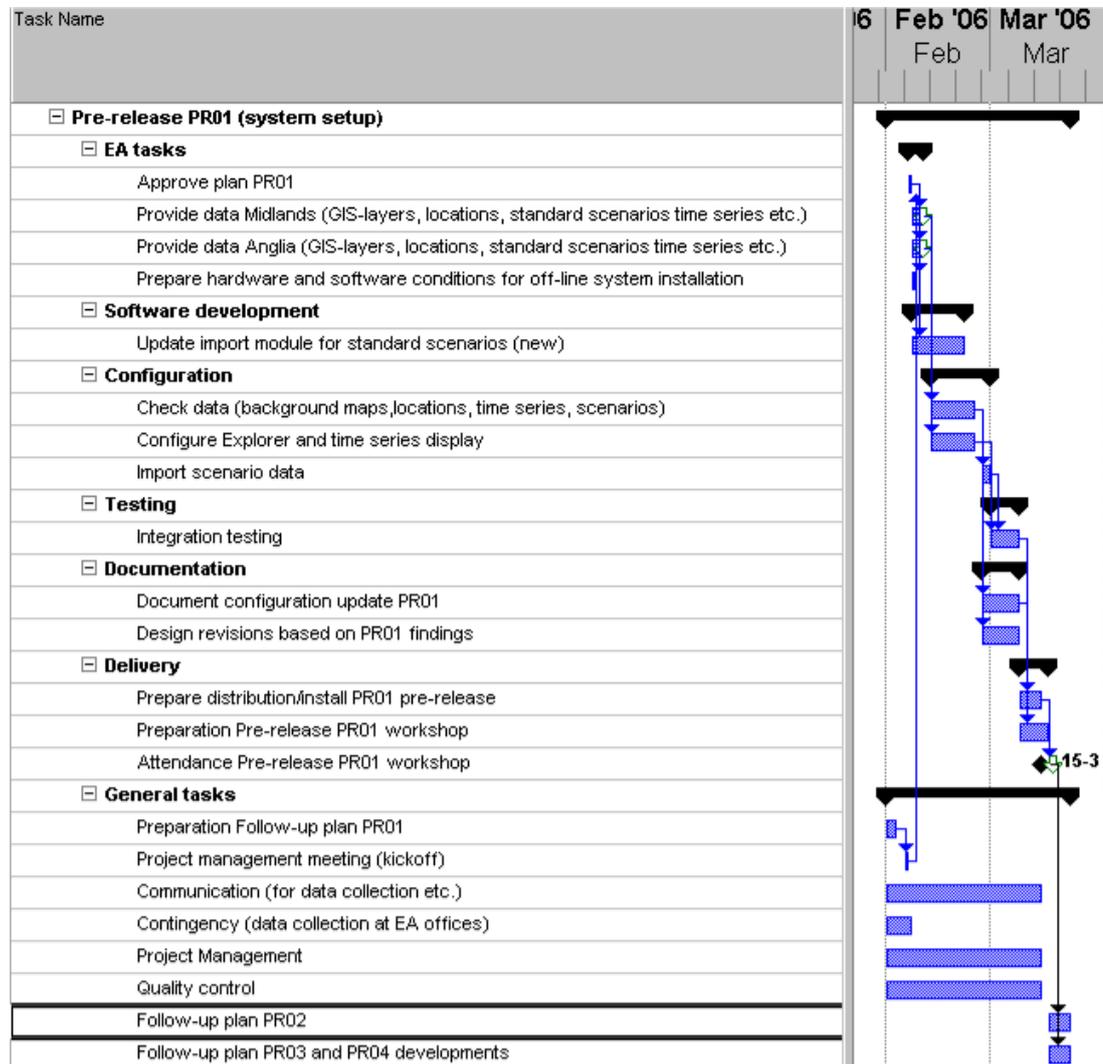
Figure 3-3 Time schedule foreseen for pre-release PR01

Meetings

This pre-release is started with a project management kick-off meeting (first week February) and is completed mid March with a 2-day delivery workshop (15-16 March) for custodians at the Agency's test-bed facilities at Fobney Mead. This delivery meeting includes a demonstration of the pre-release, hands-on practice, as well as the presentation of a follow-up plan for PR02, and software development activities for the thick client (PR03) and the central system (PR04).

Support by EA

The EA project manager should approve the working plan for this pre-release. The EA contact responsible for the groundwater model has to prepare and deliver the relevant data in time to prevent deadlines being passed. Note that data delivery is time constraining and should be completed within a week after the start of Phase 3.

Midlands and Anglian have been instructed at the end of Phase 2 with regard to the data to be delivered.

After PR01, a go/no go decision will be take by EA before any activities in the new financial year (2006/2007) start. The next sections assume that the decision is positive.

3.3.5 Pre-release PR02: Modflow-VKD in default NFFS configuration

Scope

Within this stand-alone pre-release, the module adaptor for Modflow-VKD is developed according to NFFS specification. Two module data sets (i.e. one for Midlands and one for Anglia) will be incorporated. Basic workflows and default graphic presentations (time series, grid displays) will be configured for generating module output. What-if scenarios can be defined for abstractions at predefined locations (i.e. existing abstractions) and surface water heads.

The pre-release is a stand-alone application based on configuration of NFFS-software components with a new module adaptor for Modflow-VKD. This pre-release is foreseen to be synchronised with, and scheduled after NFFS release v.7.5 (mid June 2006).

Software development/implementation

This pre-release will incorporate the major implementation activities for the Modflow-VKD module adaptor. The following Published Interfaces will be supported:
- diagnostics (pi_diag.xsd)
- grid locations (pi_cells.xsd)
- grid time series (pi_mapstacks.xsd)
- point locations (pi_locations.xsd) for abstractions
- abstraction time series (pi_timeseries.xsd)
- state management (pi_state.xsd), as far as supported by Modflow itself
- parameters for incorporating surface water heads at boundaries (pi_parameters.xsd).

Although the development of module adapters could be outsourced, two aspects should be considered for this activity:
- The delivery of this module adapter, in time and properly functioning, is essential for the success of the pilot. Any delay in this delivery will cause problems that are difficult to address before the most important pre-release PR03.

- The interaction between the Execution Controller and the module adapter is a development which has not been implemented, tested and proven yet. Mixing such development feature with a standardized 'off-the-shelf implementation' purchase may put the pilot system delivery at risk.

Given those considerations it is recommended to keep the development of *this* module adapter within the system development team. Future module adapters are recommended to be outsourced

Configuration

The following features will be configured and delivered:
- definition of locations representing modifiable boundary conditions
- definition of locations representing module output
- workflows for module execution
- default grid displays for module output (plugin gridDisplay)
- default time series displays for module output (plugin TimeSeriesDisplay)
- enable specification of what-if scenarios for predefined locations (plugin WhatIfScenariosDialog)
- enable deployment of module run based on NFFS-functionality (plugin ManualForecast)

Testing

This phase will include integration testing activities for the module adapter and the configuration

Documentation

The documentation will be updated to reflect the changes of this configuration update. Software revisions will be documented as well. In addition, release and user testing documentation will be provided.

Delivery

The delivery of this phase will be the configured stand-alone application as described above. It will include documentation as well as a set of test scripts to test system functionality. The product will be delivered on CD or via another digital medium.

Meetings

This pre-release has an official start in the new financial year (April 1, 2006), but is kicked off with the delivery meeting of pre-release PR01 (15-16 March). It will be completed with a 2-day delivery workshop for custodians at the Agency's test-bed facilities at Fobney Mead (28-29 June). This delivery meeting includes a demonstration of the pre-release, hands-on practice, a presentation on the software development progress for PR03, as well as the presentation of a follow-up plan for pre-release 03, as well as the follow-up plan for parallel software development activities for the central system.

In addition, this time box will include two meetings with CIS to kick-off and monitor the preparation of hardware infrastructure for delivery of the client-server demonstration in pre-release 03.

Finally it is recommended to include a meeting with the BGS and the EA-science group top discuss the need (or not) for model integration with river and other models using OpenMI. OpenMI is a standardized data exchange interface that accommodates river, groundwater and drainage models to interact at a step basis. Isis, InfoworksRS, SOBEK and Mike11 support this standard as well. Migration of a computational code to OpenMI is only possible with code access as OpenMI modification of the internal time loop.

Support by EA

The EA project manager should approve the working plan for this pre-release, either at the end of pre-release PR01 or at the beginning of this pre-release phase. Approval of the follow up plan for the thick client and the central system developments will enable those parallel activities to take off, hence enabling us to meet the deadlines.

The EA contact responsible for the groundwater model has to prepare and deliver the relevant data in the first week of April to prevent deadlines being passed. The EA-staff responsible for testing and system capabilities exploration should deliver their feedback within two weeks after delivery of pre-release PR01.

Section 3.3.2 illustrates the procedure to incorporate feedback of the testing in the work plan of the next pre-release.

CIS Delivery Services has to prepare the installation of the hard- and software system infrastructure for the pre-release 03. It is anticipated that DH/TS will have to assist in the installation of the NGMS environment.

Task list and Time schedule
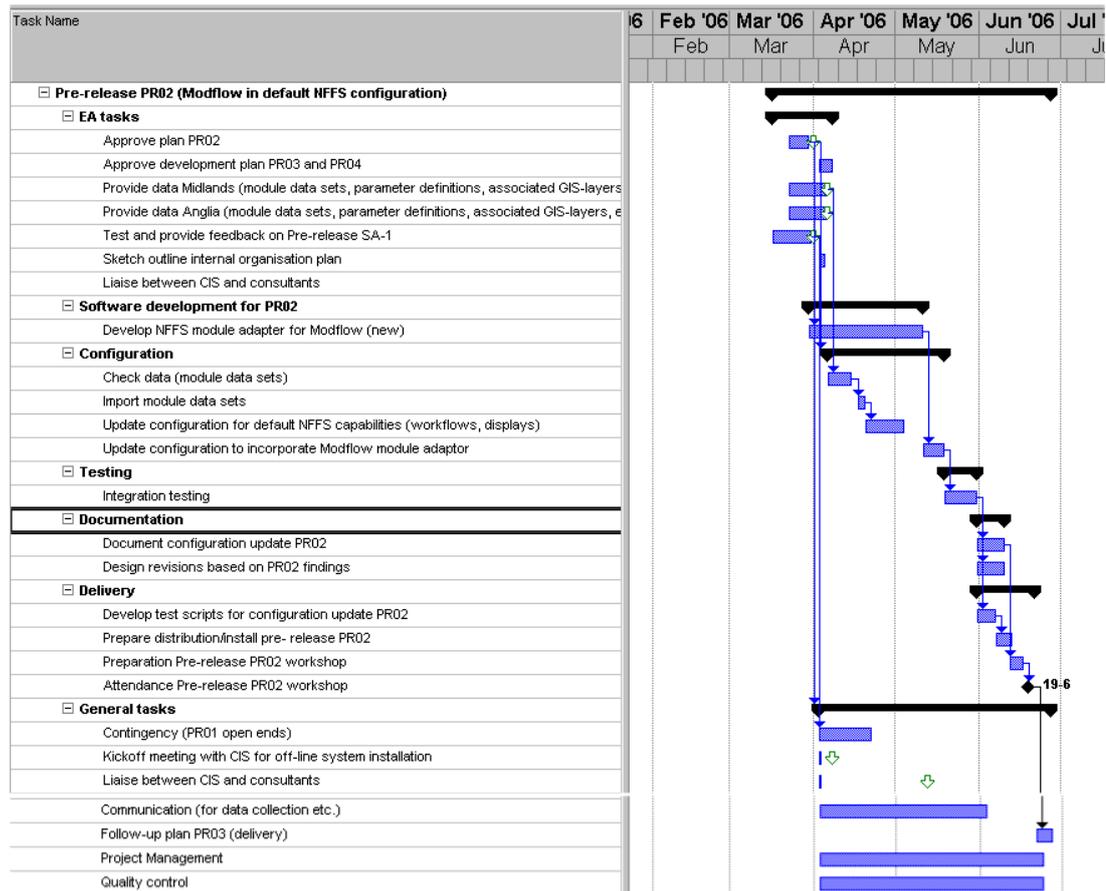
Figure 3-4 Time schedule foreseen for pre-release PR02

3.3.6　Parallel preparation activities for thick client (PR03) and central system (PR04)

Scope

To meet the entire scope of the NGMS, extensions are needed at the thick client to support groundwater specific post-processing and visualization, while the central system needs to provide additional support user specific data management, data access and data synchronization functionality. These software development activities need a head start as the effort involved in development and testing is too much for delivery in a normal pre-release schedule for PR03 and PR04.

Setup and maintenance development infrastructure

New developments in support of the central system of NGMS require a mirror infrastructure at the developer's offices to enable implementation and testing of the new functionality. This infrastructure needs to be installed and needs at least to be maintained for the duration of the pilot phase.

Software developments for thick client (to be delivered in PR03)

After development of the module adapter, software developments activities will continue to ensure a timely release of pre-release PR03. Software developments for PR03 focus on NGMS requirements that are essential to demonstrate, in a straightforward way, the full scope of the future NGMS.

These software development activities include:
- Development of the ImportReferenceDataSet package, a module operating in the background, to enable comparing the model output of the current run to a reference data set from a Standard Scenario or a previous run.
- Development of the SliceFeeder package, a module operating in the background, to import a slice frame from an external file (in Shape-format), transfer it into a grid cell definition and feed this to the NGMS for use by the data slicer.
- Development of the ImportSlice plugin, a GUI-plugin which guides the slice definition process when attaching a slice frame from an external file.
- Extension of the GridDisplay with a contour plotting library.
- Development of the first version of the Data Slicing API, a package dedicated to slicing 3 dimensional time series data sets.
- Development of the first version of the Execution Controller module, a module that controls the computation process, performs run-time processing and status messaging of the computational code's log file, and allows manual interruption.

Software development for central system (to be delivered in PR04)

The following software development activities to the central system are required to meet requests for user specific data management:
- Update of the database schema to accommodate portioning of public and private (user specific) data
- Update of the Data access API to accommodate user and role specific access
- Development of a User and Role Management module
- Development of a System Administration module

The following software development activities are required to meet requests for interruption capabilities and to minimize data traffic:
- Update of the Data synchronization API to accommodate data downloads/ synchronization upon request
- Update of the TaskManager to handle new execution templates

Delivery

The software developments for the thick client, as well as document updates will be incorporated into pre-release PR03. Software developments for the central system will be delivered in PR04.

Meetings

This activity will have two internal technical developers meeting to synchronise the associated activities between the development teams of Tessella and Delft Hydraulics. The activities are to be approved at the end of pre-release PR02. EA support will only be indirect.

Task list and Time schedule

The presented time schedule (Figure 3-5) incorporates a substantial duration to accommodate for the holiday season. The maintenance of the development infrastructure finishes at the end of Phase 3.
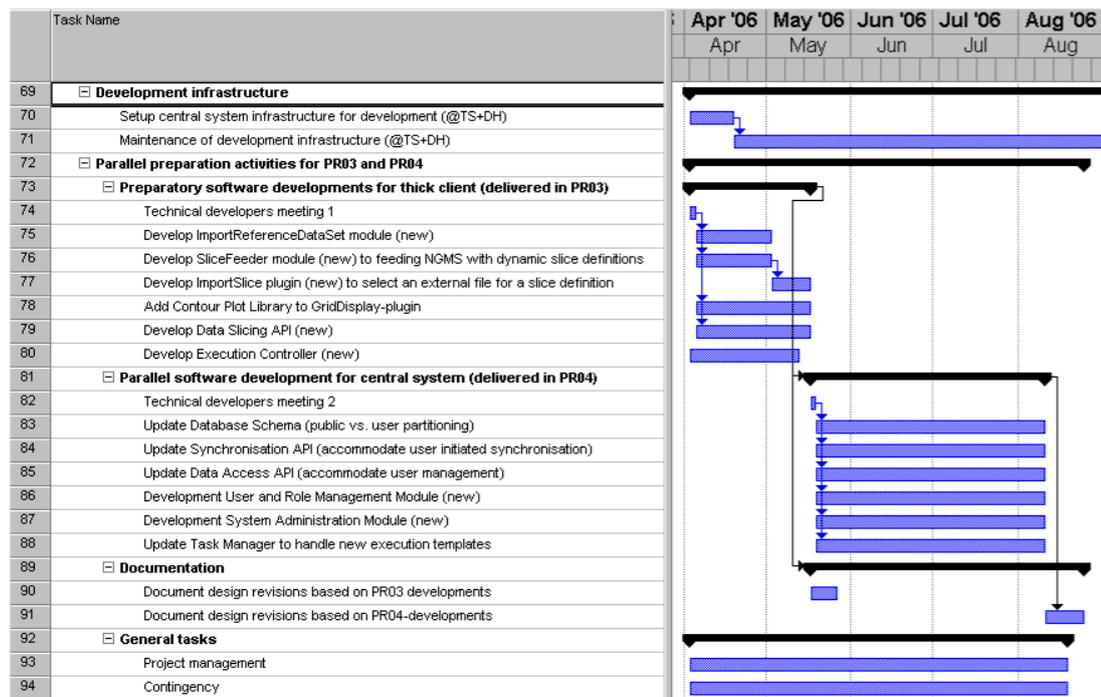
Figure 3-5 Time schedule foreseen for the preparation activities in parallel to PR02 and PR03

3.3.7 Pre-release PR03: Modflow VKD in Predefined NGMS Configuration (Client-Server demonstration)

Scope

The purpose of this pre-release is to demonstrate the end users what type of functionality they can expect from the NGMS. Within this pre-release, the predefined configuration is extended with more post-processing and presentation options to accommodate display and reporting of groundwater specific graphs and maps, including contour plots and comparison to reference situations (i.e. Standard scenarios) or a selected reference run. Groundwater unit budgets will only be supported for a vertical section as no functionality is yet available to

determine vector fields. This pre-release will accommodate user defined data slicing by use of externally provided slicing frames.

This pre-release will be delivered in a stand-alone application for testing purposes. Simultaneously an initial client-server setup is foreseen to be delivered as a demonstration. This pre-release is foreseen to be synchronised with NFFS release v.8.0 (mid July 2006).

This pre-release phase will feed the EA project manager, based on the findings of pre-release 01, 02 and 03, with information for the business case and the implementation plan for Phase 4.

Software development/implementation

Most software developments have taken place in parallel development activities. However, various small updates of existing GUI-plugins are foreseen as a contingency to improve support for the NGMS demonstration. The exact updates may be determined during feedback from PR02.

Configuration

The following features will be configured and delivered:
- workflows for data slicing, post-processing, and report generation.
- pre-defined data transformation scripts to transform raw module output into groundwater specific data sets representing stream accretion, stream outflow hydrographs, winterbourne signature, duration curves, frequency curves, contour plots, and groundwater unit budgets (vertical section as well as cross border).
- groundwater specific grid and contour displays for post-processed data (plugin SpatialDisplay).
- time series displays for post-processed data (plugin TimeSeriesDisplay).
- enable deployment of post-processing workflows based on NFFS-functionality (plugin ManualForecast).
- data slicing by predefined slicing templates or user selected slice templates (executed by DataSlicer module).

Configuring the post-processing activities for the first time is a big effort which requires in-depth knowledge of the data transformation capabilities. Once, the post-processing has been configured for one set of module output, the next one(s) becomes straightforward and can be outsourced to groundwater consultants.

Testing

As a number of software packages are added and updated, substantial integration testing activities will be required to ensure proper software integration.

Documentation

The documentation of the previous pre-release will be updated to reflect the changes of this configuration update. Software documentation will be updated to reflect design revisions.

Delivery

The delivery of this phase will be the configured stand-alone application as described above. It will include documentation as well as a set of test scripts to test system functionality. The product will be delivered on CD or via another digital medium.

Meetings

This pre-release starts with the delivery meeting of pre-release SA-2 and is completed with a 2-day delivery workshop for custodians and end users at the Agency's test-bed facilities at Fobney Mead (27-28 September).

This delivery meeting includes a demonstration of the pre-release, hands-on practice, a outlook to the full client-server pre-release (PR04) as well as an outlook to phase 4. In addition, this time box will include a meeting with CIS at the start of this pr-release to monitor the progress in preparation of hardware infrastructure for delivery of the client-server demonstration at the end of this pre-release.

Support by EA

The EA project manager should approve the working plan for this pre-release, either at the end of the pre-release PR02 or at the beginning of this pre-release phase.

The EA-staff responsible for testing and system capabilities exploration should deliver their feedback within two weeks after delivery of PR02 to include their suggestions, where feasible, into pre-release PR03. Section 3.3.2 illustrates the procedure to incorporate feedback of the in the work plan of the next pre-release.

Active support of the EA representative groundwater modellers is desired to create appropriate layout schemes for the graphical displays and reports.

Smooth co-operation with CIS service delivery is essential for demonstration of an initial client-server setup.

Task list and Time schedule

The presented time schedule (Figure 3-6 Time schedule foreseen for pre-release PR03) incorporates some loose time to accommodate for the holiday season. Care should be taken during project execution to ensure delivery in time.

National Groundwater Modelling System (NFFS CCN 2005/03)   Q3986.05   January 31, 2006
Phase 2 – Detailed architecture design
Project Implementation Plan   version 1.0
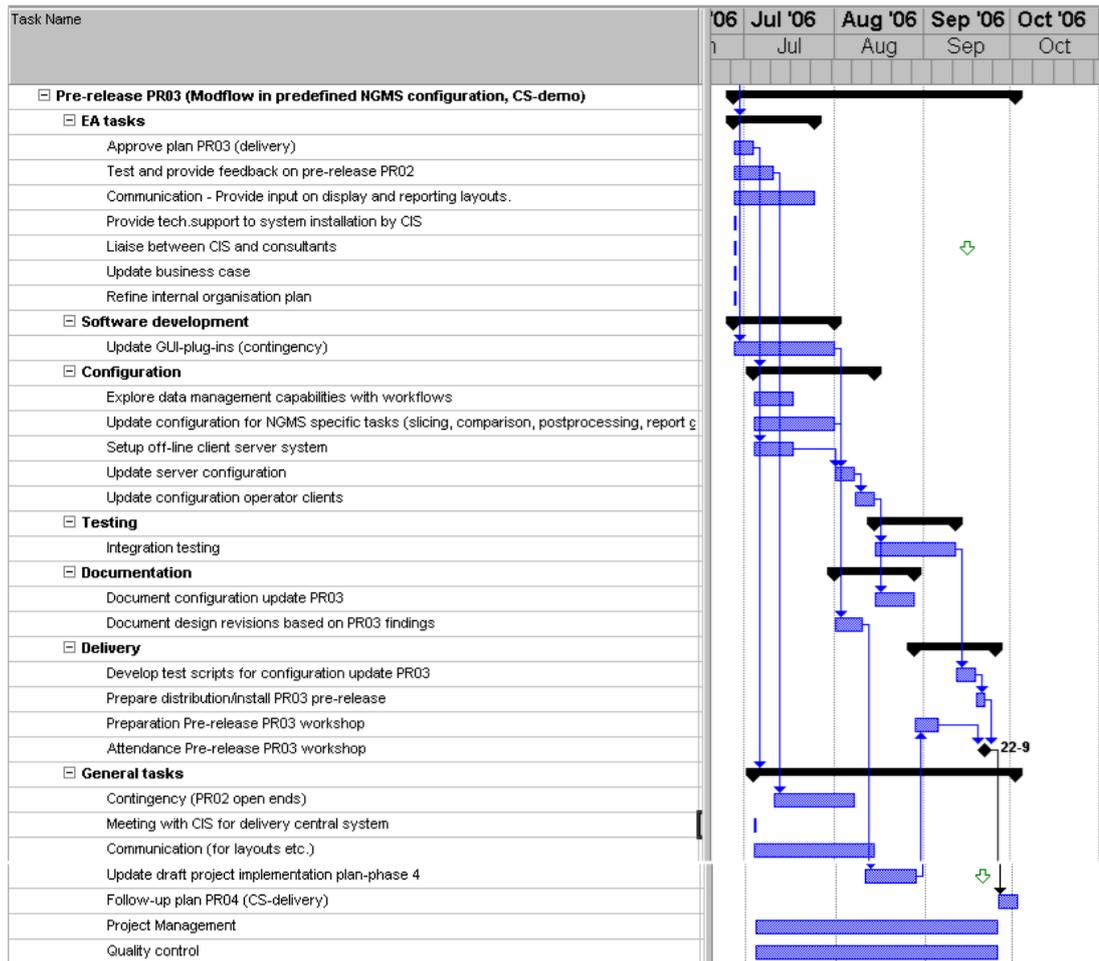
Figure 3-6 Time schedule foreseen for pre-release PR03

3.3.8 Pre-release PR04: Modflow-VKD in full client server setting

Scope

Pre-release PR03 is anticipated to end with a stand-alone version that incorporates in a predefined configuration most of the NGMS output production and presentation options as desired. These groundwater specific capabilities will be frozen and moved to the client-server environment in PR04. Please note that an initial client-server implementation is aimed for demonstration in PR03.

The client-server pre-release PR04 will be composed of an operator client, a master controller and database and a shell server. The central system has been extended to accommodate data access restrictions which can reflect user and role management issues.

Software development

To minimize risks in time scheduling during the holiday period, most software development activities have run parallel to development of pre-releases PR02 and PR03.

Some minor updates are foreseen for the Data Slicing API and Execution Controller. These updates will be based on the findings of the pre-release PR03.

Configuration

After setup of the off-line test system infrastructure, the following configuration will be delivered:

- The configured functionality of PR03 will be moved to the operator client and the shell servers.
- The server functionality will be configured to manage the data and job execution and to enable limited control on data access.

As part of the configuration and implementation activities a test series will be executed to check the functioning of both individual system components as well as the integrated system.

Testing

As a number of software packages are added and updated, substantial integration testing activities will be required to ensure proper software integration. In addition, a full system test will required to ensure proper system operation.

Documentation

The documentation of the previous pre-release will be updated to reflect the changes of this configuration update. Software documentation will be updated to reflect design revisions. In addition, initial versions will de developed for an Installation guide and for a Support Guide.

Delivery

The system delivery process has started early, during pre-release PR02, to ensure that CIS delivers the appropriate hardware and software infrastructure in time (i.e. early September). Within the delivery of PR04, deployment preparation is essential as part of the installation at EA.

The delivery and installation of the product will be conducted in co-operation with CIS.

Meetings

In addition to the kick-off meeting for this pre-release (i.e. the delivery meeting for PR03), some intermediate meetings will be needed with CIS to ensure proper hardware infrastructure conditions.

The pre-release will be completed by a delivery meeting which includes a preparation for the following phase.

National Groundwater Modelling System (NFFS CCN 2005/03)   Q3986.05   January 31, 2006
Phase 2 – Detailed architecture design
Project Implementation Plan   version 1.0

Task list and Time schedule
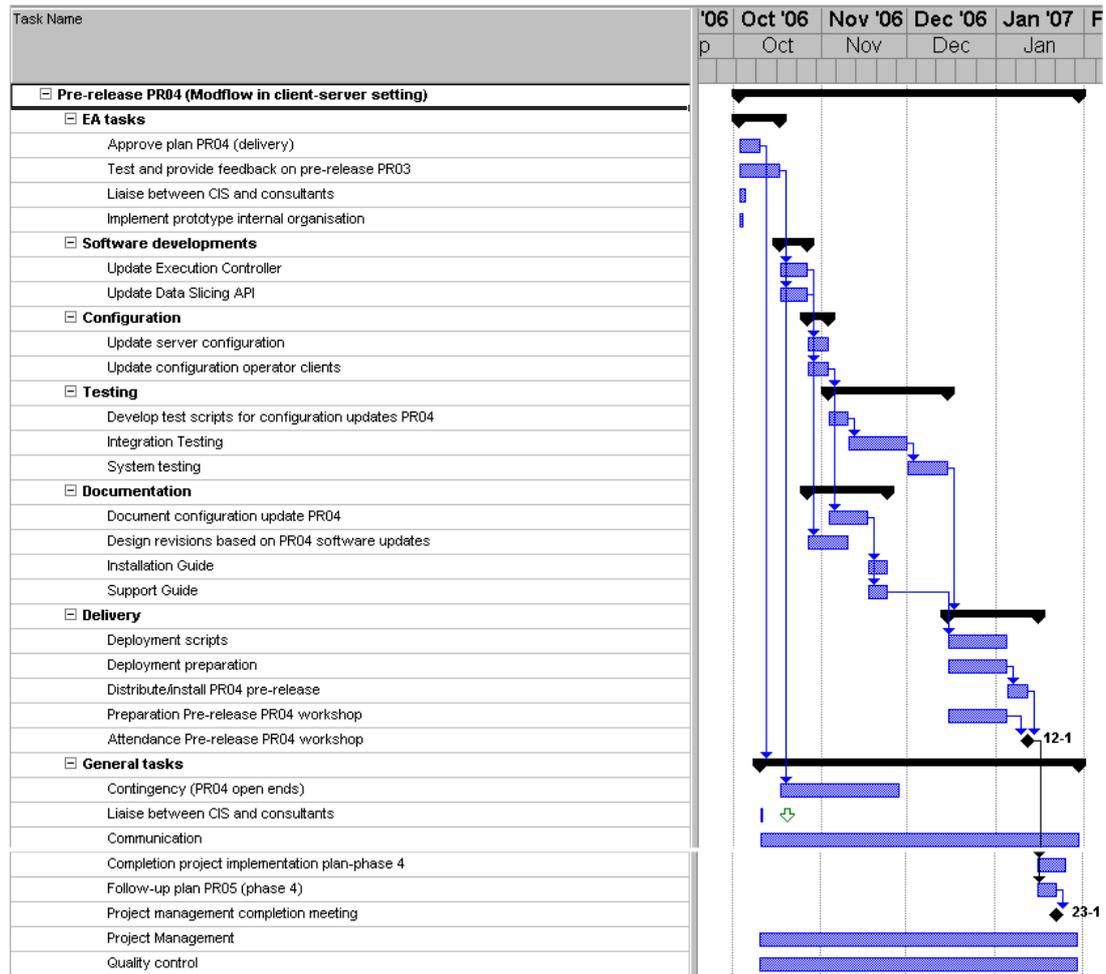
Figure 3-7 Time schedule foreseen for pre-release PR04

Support by EA

For this delivery, good co-operation between CIS and Tessella is essential to get the hardware and software infrastructure in place.

The EA project manager should approve the working plan for this pre-release, either at the end of the pre-release PR03 or at the beginning of this pre-release phase.

The EA-staff responsible for testing and system capabilities exploration should deliver their feedback within two weeks after delivery of pre-release PR04 to include their suggestions, where feasible, into pre-release PR04.

3.3.9 Completion

Following the PR04 workshop, the feedback on PR04 will be incorporated in the follow up plan for PR05 (Phase 4). In addition, the Phase 4 project implementation plan will be updated and completed according to the latest views. Phase 3 will be concluded with a

project management meeting to reflect on Phase 3 and to look forward if Phase 4 can and will be implemented according to plan.

All associated activities are scheduled in pre-release PR04.

3.3.10 Project calendar

To keep track of deadlines, meeting dates etc., a project calendar will be maintained. Table 3-1 provides the project calendar with the dates agreed upon so far.

Table 3-1 Project calendar

Weeks after start	Week nr	Starting on	Milestone / Activity
1	5	30/01/2006	**01 Feb.** - Project management meeting, Leeds ?
2	6	06/02/2006	
3	7	13/02/2006	
4	8	20/02/2006	
5	9	27/02/2006	
6	10	06/03/2006	*Deadline:* **PR 01 delivery, PR02+ workplan**
7	11	13/03/2006	**15-16 March** - PR01 delivery workshop, Fobney Mead Approve work plan PR02 (EA)
8	12	20/03/2006	Invoicing 2005/2006 completed
9	13	27/03/2006	*Deadline (31-03): PR 01 functional testing comments compiled (EA)*
10	14	03/04/2006	**between 3-6 April** - CIS preparatory meeting #1 (1 day) *Deadline (07-04): PR 02 updated workplan agreed (DH/TS/EA) and approved (EA)*
11	15	10/04/2006	**early April** - DH/TS developers meeting (2 days)
12	16	17/04/2006	
13	17	24/04/2006	
14	18	01/05/2006	
15	19	08/05/2006	
16	20	15/05/2006	**before 20 May** - CIS preparatory meeting #2 (1 day)
17	21	22/05/2006	**mid May** - DH/TS developers meeting (2 days)
18	22	29/05/2006	
19	23	05/06/2006	
20	24	12/06/2006	
21	25	19/06/2006	*Deadline:* **PR 02 delivery, PR03 workplan**
22	26	26/06/2006	**28-29 June** - PR02 delivery workshop, Fobney Mead Approve work plan PR03 (EA)
23	27	03/07/2006	
24	28	10/07/2006	*Deadline (14-07): PR 02 functional testing comments compiled (EA)*
25	29	17/07/2006	CIS preparatory meeting #3 (1 day) *Deadline (21-07): PR 03 updated workplan agreed (DH/TS/EA) and approved (EA)*
26	30	24/07/2006	
27	31	31/07/2006	
28	32	07/08/2006	
29	33	14/08/2006	
30	34	21/08/2006	
31	35	28/08/2006	

32	36	04/09/2006	
33	37	11/09/2006	*Deadline: update Project Implementation Plan-Phase4 (DH/TS)*
34	38	18/09/2006	*Deadline:* **PR 03 delivery, PR04 workplan**
35	39	25/09/2006	**28-29 September** - PR03 delivery workshop, Fobney Mead Approve work plan PR04 (EA)
36	40	02/10/2006	
37	41	09/10/2006	*Deadline (13-10): PR 03 functional testing comments compiled (EA)*
38	42	16/10/2006	*Deadline (20-10): PR 04 updated workplan agreed (DH/TS/EA) and approved (EA)*
39	43	23/10/2006	
40	44	30/10/2006	
41	45	06/11/2006	
42	46	13/11/2006	
43	47	20/11/2006	
44	48	27/11/2006	
45	49	04/12/2006	
46	50	11/12/2006	
47	51	18/12/2006	
48	52	25/12/2006	*Christmas period*
49	1	01/01/2007	
50	2	08/01/2007	*Deadline:* **PR 04 delivery, PR05 workplan**
51	3	15/01/2007	**17-18 January** - PR04 delivery workshop, Fobney Mead
52	4	22/01/2007	
53	5	29/01/2007	*Deadline (02-02): PR 04 functional testing comments compiled (EA)*
54	6	05/02/2007	**early Feb** - project management meeting (completion) *Deadline (09-02): PR 05 updated workplan agreed (DH/TS/EA) and approved (EA)*
55	7	12/02/2007	
56	8	19/02/2007	
57	9	26/02/2007	
58	10	05/03/2007	
59	11	12/03/2007	
60	12	19/03/2007	
61	13	26/03/2007	

3.4   Organisation and Effort

3.4.1   Implementation organisation at EA side

For the implementation of technical pilot, the following aspects need to be covered by EA representatives (or delegates):
- project management
- regional custodians
- local end users and consultant users
- testers at various levels to provide feedback
- CIS implementation support
- Quality review

As agreed, regional custodians of Anglian and Midlands will ensure that functionality tests will be conducted and feedback reports, including change requests for the next pre-release, are provided in time.

The completion meeting of Phase 2 recommends that each region signs up to a service level agreement with Head Office to provide a custodian etc.

The QA-manager/reviewer needs to have knowledge and time for its activity, while he/she should not be tightly involved in the development process. Outside peer-review is acceptable as long as the TOR is clearly defined.

The QA-areas identified are:
- *IT-aspects*: delivery according to technical standards of CIS
- *Domain/content aspects*: delivery of a system that producing similar results as the current situation
- *Fitness-for-purpose*: assessment whether the delivery meets the needs of EA

However, in addition to the technical pilot it is recommended that EA initiates an organisational pilot during Phase 3 as well. This organisational pilot will have to focus on the mapping of the NGMS roles identified (viewer, user, custodian, national super user, system manager) to the EA functional system. This aspect is crucial to system's acceptance as each role receives different functionality and data access privileges within the system. In the end, the success of the NGMS project is to a large extent related to the capability of EA to improve its working procedures for groundwater management.

The technical pilot includes the development of user and role management functionality with associated data access aspects to stimulate this discussion and formalize competencies, responsibilities, privileges of the various functions within EA. budgets etc. Generally speaking, the system will allow to a certain extend a redefinition of roles and privileges, or further distinction of sub-levels within a role. However, the sooner these organisational aspects are tackled, the less work will be involved to reconfigure some parts in the system.

For Phase 3, the following EA-staff has been assigned tasks within the project
- project executive: Mike Eggboro (Technical Manager, Hydrogeology)
- project management: Mark Whiteman (Head Office Hydrogeology)
- day-to-day support: Rolf Farrell (Head Office Hydrogeology)
- regional custodians:
    - Paul Shaw (Southern)
    - James Finnegan (North East)
    - Simon Gebbett (North West)
    - Martin Shepley (Midlands)
    - Nigel Hoad (Thames)
    - Andrea Mann (EA Wales)
    - Jim Grundy (South West)
- local end users and consultant users:
    - Keith Philipsson (Entec, representing Anglian)
- testers at various levels to provide feedback (at least from Midlands and Anglian):
    - Martin Shepley + others to be appointed
    - Entec
- CIS implementation support:
    - Richard Jasinski
    - CIS coordinator (?)
- Quality review:
    - to be appointed

3.4.2   Implementation organisation at consultant side

The consultant's team should at least have the following capacity:

- project management for large ICT projects
- system development capabilities:
    - software developers that have in-depth knowledge and experience with NFFS
    - system analyst(s) that have sufficient background knowledge of groundwater modelling and experience with IT-systems to configure the NGMS
    - a groundwater domain specialist to support the system analyst for groundwater specific.

Given the pilot character of Phase 3 with the associated risk of change during the pilot, it is recommended to keep all development activities concentrated within one consortium. The consortium may be extended with a British groundwater consultant as long as the work is done in collaboration with the system developers. Phase 4 will be much more suitable for outsourcing module adapter development or configuration activities to groundwater consultants outside the consortium. Indeed, it is highly recommended to have groundwater consultants move the model they developed into NGMS. GW-consultants listed by EA for software development (module adapters) are ESI and WMC. Suggestions for configuration activities include ESI, WMC, Entec, Atkins, MottMacDonald.

3.5 Effort

3.5.1 Associated effort at EA side

For the technical implementation of the pilot phase, active involvement is needed from the project manager, the EA groundwater community (custodians, end users) and CIS service delivery.

The associated effort for the EA groundwater community (preferably by all regions) is:
- workshops attendance custodians (1 per region)
  - project management meeting (kick-off and completion)
  - delivery workshops (2 days each):
    - 15-16March 2006
    - 28-29 June 2006
    - 27-28 September 2006
    - 17-18 January 2007
- workshop attendance end users (at least 1 per region)
  - delivery workshop pre-release PR03 (2 day workshop 27-28 September 2006)
  - attendance at other workshops is appreciated
- system capabilities exploration, testing and feedback reporting
  - Test regions (Anglian and Midlands): 2 days work per pre-release. Reporting deadline in two weeks after pre-release delivery workshop.

The associated effort for CIS implementation support is:
- hardware /infrastructure preparatory meetings (1 day each):
  - January/February
  - early April
  - before mid May
  - July/August
- attendance at workshops:
  - pre-release workshop PR03 (end September 2006)
  - pre-release workshop PR04 (mid January 2007)
- hardware and software infrastructure setup ($\geq$ 10 days):
  - May/June 2006
- NGMS system deployment and installation (5 days ?)
  - October/November 2006

The associated effort for CIS implementation support is:
- ongoing from February 2006-January 2007

In addition, it is recommended to start an organizational pilot in parallel to find a proper way forward in structuring the groundwater assessment procedures within EA.

3.5.2 Associated effort at consultant side

Section 3.3 provided an overview of the activities, deliverables, etc. The time schedule includes a task list. As a table with detailed effort estimates is difficult to interpret, a set of summarizing tables has been created.

Table 3-2 provides an overview of the effort associated with each pre-release or sub-phase. The associated budget does not include expenses on travel, hardware or software licenses.

Table 3-2 Effort and cost estimate per pre-release/sub-phase

Sub-Phase/Activity	Effort (days)	Budget (£)
Pre-release PR01 (System setup)	38	£26,980
Pre-release PR02 (Modflow-VKD in default NFFS configuration)	85	£5,7430
Development infrastructure (setup and maintenance)	22	£12,936
Parallel preparation activities for thick client (PR03) + central system (PR04)	108	£65,052
Pre-release PR03 (Modflow-VKD in predefined NGMS configuration)	92	£61,913
Pre-release PR04 (Modflow-VKD in client-server setting)	97	£63,266
Sub-total effort (incl. contingency)	**442**	**£287,577**

Table 3-3 provides an effort distribution per type of task for the entire pilot phase. A distinction between effort conducted by Delft Hydraulics (DH) and Tessella (TS) has been made to accommodate the cost estimate of Table 3-4. Given the pilot character of this activity, it is recommended to keep implementation of Phase 3 within one consortium. The current NFFS-contract framework allows DH/TS to sub-contract activities under their responsibility to others, e.g. ESI or WMC.

Table 3-3 Effort distribution between DH and TS per type of task

	Total effort	DH			TS		GW con.
		£595	£740	£740	£581	£715	£600
	days	lead softw. dev.	senior system analyst / GW-expert	TechMan / PrMan	softw. dev	TechMan / PrMan	pr.eng.
Software Development	**133**	42	3		62	1	25
Configuration	**48**		28		15		5
Testing	**36**	9	6		21		
Delivery (excl.meetings)	**17**	4	2		11		
Documentation	**28**	7	6		9	6	
Development Infrastructure	**22**	11			11		
Project Management	**36**			18		16	2
Intermediate Planning	**20**			13		7	
Meetings	**58**		13	20		25	
Communication (NGMS specific)	**8**		6			2	
QA	**5**			5			
Contingency	**31**	3	15		13		
Total effort	**442**	**76**	**79**	**56**	**142**	**52**	**32**

Table 3-4 Cost estimate per type of task

	Total effort days	DH effort days	TS effort days	GW cons. effort days	DH costs (£) estimate	TS costs (£) estimate	GW cons. costs (£) estimate	Total Cost estimate
Software Development	**128**	65	63	25	£27,210	£36,737	£15,000	£78,947
Configuration	**48**	32	15	5	£20,720	£8,715	£3,000	£32,435
Testing	**36**	15	21		£9,795	£12,201		£21,996
Delivery (excl.meetings)	**17**	6	11		£3,860	£6,391		£10,251
Documentation	**28**	13	15		£8,605	£9,519		£18,124
Development Infrastructure	**22**	11	11		£6,545	£6,391		£12,936
Project Management	**34**	18	16	2	£13,320	£11,440	£1,200	£25,960
Intermediate Planning	**20**	13	7		£9,620	£5,005		£14,625
Meetings	**56**	31	25		£24,420	£17,875		£42,295
Communication (NGMS specific)	**8**	6	2		£4,440	£1,430		£5,870
QA	**5**	5			£3,700	£0		£3,700
Contingency	**31**	18	13		£12,885	£7,553		£20,438
Total effort	**433**	**234**	**199**		**£145,120**	**£123,257**	**£19,200**	**£287,577**

The pilot phase is scheduled to include the following meetings:
- 6 workshops (4 overnight stays for 3 persons)
- 4 CIS liaison meetings
- 2 developers meetings (2 over night stays for 1 person)
- 1 system setup period of 10 days (10 overnight stays for 1 person)

Table 3-5 provides an overview of the associated cost estimate. This table also includes an estimate for the additional hardware that is needed to establish the development and testing infrastructure for NGMS at the consultant's offices.

Table 3-5 Cost assessment for other expenses

Type	# items	Rate (£)	Costs (£)
Flights	22	£ 200	£ 4,400
DSA*	34	£ 200	£ 6,800
Inland travel	20	£ 50	£ 1,000
Hardware for development system	2	£ 3,000	£ 6,000
Total			£ 15,800

* includes overnight stay during system setup

The total budget estimate is thus £ 287,577 + £ 15,800 = £ 303,377.

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4   NGMS Implementation (Phase 4)

4.1   Setting the target

The NGMS-project has been initiated to support groundwater management and planning activities of the Environment Agency. As known, the EU Water Framework Directive poses the requirement to deliver river basin management plans in 2009. Within the UK, groundwater management will play a major role in these plans. As such, it is highly desirable that the NGMS is operational early 2008, as this will allow EA to utilize their investment immediately for an important task.

It has been agreed at a project management meeting in Leeds (10 November 2005) that the project should aim at:

> *a fully operational and accepted system by the end of the financial year 2007/2008.*

While this statement refers to the aim to have the FST passed before 31 March 2008, it should be kept in mind that module data sets (and hence new models) can be added continuously, as long as no new module adapters need to be developed and incorporated.

Furthermore, it is wise to consider the following WFD-specific extension.

The groundwater assessment is conducted to feed into the ecological assessment to meet WFD targets, while such assessments may be conducted using habitat suitability methods. Within Delft Hydraulics a tool is operational which determine habitat suitability based on a assessing resource conditions using straightforward knowledge rules. The engine core of this tool, the grid-based PCRaster kernel, is already operational in the NFFS and the NGMS. If the knowledge rules for habitat assessment can be defined, it is rather straightforward to configure an NGMS workflow which takes the results forward from a groundwater assessment to an ecological status assessment.

4.2   Deliverables

Within Phase 4, the initial implementation of NGMS has to be expanded in various directions, namely:
- the number of module data sets
- the number of modules (e.g. 4R, EA-recharge code, any other)
- the GUI-functionality (hardly touched upon in the pilot)
- extend/update the central system (e.g. user/ role management and data access)
- improve configuration support facilities

4.2.1   More module data sets in the configuration

During the pilot, the configuration of various NGMS specific items (e.g. data processing) took substantial time. Since adding new module adaptors does not involve many new types

of data processing, it is expected that adding new module data set will take relative limited efforts to add those items. As configuration maintenance is foreseen to be handed over to the custodians, it is proposed to configure some 20 models (module data sets) in Phase 4. At the same time, effort will be put in the development of custodian oriented GUI-support to allow them to update the configuration with new module data sets.

As indicated this task is very suited for outsourcing to groundwater consultants.

4.2.2   More computational codes (i.e. module adapters)

Phase 3 realised the incorporation of Modflow-VKD into the NGMS using the 'traditional module adapter approach'. Codes to be incorporated in Phase 4 are at least 4R and the EA-recharge code. As an NFFS-OpenMI adapter is under development, it is expected that the integration of an OpenMI-compliant ZoomQ3D will be mainly a configuration effort.

The discussion on OpenMI during Phase 3 should determine if 4R, EA-recharge and other computational codes should be incorporated in the NGMS by encapsulating them in an NGMS module adapter or by making them OpenMI compliant. The step-based data exchange interface of OpenMI improves the simulation capabilities for river-recharge-groundwater systems as they can be coupled to interact as one integrated model, as river models such as Isis, InfoworksRS, SOBEK and Mike11 support this standard as well.

However, code access is essential for adoption of the OpenMI standard as this interface requires modification of the internal time loop. If code access is not available, the traditional module adapter approach will be applied, with sequential linkage between module codes.

Coding and testing efforts are foreseen to be in the range of 30-40 days. They depend on the method chosen and the structure of the existing code. Turning a badly structured code into a code fit for OpenMI compliancy is a big effort. Such activity should preferably done by software developers that have knowledge of the underlying code.

4.2.3   Improved GUI-functionality

While the GUI of Phase 3 was mainly derived from the NFFS, additional plug-in development is foreseen to meet the dedicated needs of groundwater managers.

New plug-ins (most complex, ca. 40 days incl. testing and documentation):
- SliceLocator (could be extended to SliceWizard)
- AbstractionLocator (could be merged with What-IfScenario to ScenarioWizard)

New plug-ins (medium complex, ca. 25-30 days incl. testing and documentation):
- WhatIfScenarioDialog (could be merged with AbstractionLocator to ScenarioWizard)
- ConfigurationUpdateWizard

New plug-ins (least complex, ca. 20 days incl. testing and documentation):
- ModuleInputBrowser
- DataDownloadManager
- TaskRunManager

Update existing plug-in (ca. 10-15 days incl. testing and documentation):

- TimeSeriesDialog
- GridDisplay
- DataExport

4.2.4   Central system updates

Within Phase 3, the data slicing API, data access API, data synchronisation API and some MC components have been adapted to meet the NGMS needs. In addition the ExecutionController module has been developed. A complementary update is foreseen to optimize performance and robustness of the Phase 3 updates. The development, testing and documentation effort is foreseen to be 10-15 days for each activity.

Phase 3 also included an initial implementation of user and role management and associated system administration. Within Phase 4, those implementations will be extended to cover the full range of requirements in a mature and reliable version. New functionality will need to be added for archiving purposes and to accommodate configuration management updates. Development efforts are foreseen at some 40 days for each activity.

4.3   Delivery schedule and preliminary effort estimate

It is recommended to deliver Phase 4 in a set of pre-releases which is concluded with an acceptance testing session (see Section 4.4). Within this schedule, it is proposed to divide a specific software development activity over two pre-releases. At the first pre-release of some software functionality (e.g. a plug-in), it can be tested by end users to provide feedback for the update and completion.

Delivering the NGMS in time for the WFD, the target set in section 4.1, will be a challenge. However, it is feasible if:

- Phase 4 can start in February 2006 i.e. at the end of the financial year 2006/2007
- Phase 4 is well planned
- all involved stick to the plan
- sufficient human capacity is generated for the implementation and supervision
- the associated budget can be generated

A planning has been prepared with pre-releases at a 2-monthly interval. This intensive release-schedule will require fast feedback from EA to incorporate the suggestions into the next pre-release. Table 4-1 provides a suggestion for scheduling the incremental development of the system.

Table 4-1 Possible pre-release schedule for Phase 4 (including preliminary effort estimates)

	Year	2007 Feb-Mar PR05	Apr-May PR06	Jun-Aug PR07	Sep-Oct PR08	Nov-Dec PR09	2008 Jan-Feb PR10	Mar-Apr Accept.
	Month ID							
Core system delivery effort (days)	1137	181	168	160	176	160	139	153
Outsourceable effort (days)	240	21	63	28	56	51	21	0
Total effort	**1377**	**202**	**231**	**188**	**232**	**211**	**160**	**153**
Software development								
central system updates	**210**	**35**	**35**	**40**	**40**	**30**	**30**	**0**
data access API	14	7	7					
synchronization API	14	7	7					
archive (new)	40					20	20	
user and role management	40			20	20			
system administration	40			20	20			
MC components	14	7	7					
update Execution controller	14	7	7					
update DataSlicer API	14	7	7					
Configuration Management updates	20					10	10	
		55	55	70	50	60	35	
plugins	**270**	**60**	**55**	**40**	**55**	**40**	**20**	**0**
SliceLocator	40			20	20			
AbstractionLocator	40	20	20					
WhatIfScenarios	25	15	10					
OutputFilter	20			10	10			
ModelInputBrowser	20	10	10					
DataDownloadManager	20				10	10		
TaskRunManager	20			10	10			
DataExport update	14				5	9		
TimeSerieDisplay update	15	7	8					
GridDisplay updates	15	8	7					
ModelRun journal (logbook)	14					7	7	
Configuration Update-wizard	27					14	13	
System maintenance	**35**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
Central development system maintenance	35	5	5	5	5	5	5	5
Testing	**159**	**8**	**12**	**9**	**11**	**11**	**8**	**100**
Module adapter acceptance	9		3		3	3		
Integration testing (configuration acceptance)	20	3	4	4	3	3	3	
Develop test scripts	30	5	5	5	5	5	5	
pre-FAT	20							20
FAT/SAT	40							40
Commisioning period	20							20
FST	20							20
Meetings	**128**	**13**	**13**	**21**	**17**	**29**	**27**	**8**

Task	Total							
Project management (monthly)	32	4	4	4	4	4	4	8
Preparation workshops	18	3	3	3	3	3	3	
Attendance workshops	36	6	6	6	6	6	6	
CIS operational training	12			8			4	
CIS troubleshoot course	6					4	2	
Custodian training	12					8	4	
End user training	12					8	4	
Delivery	**90**	**25**	**13**	**13**	**13**	**13**	**13**	**0**
Production system setup CIS	10	10						
Installation and operation guide	25	5	4	4	4	4	4	
Prepare distribution/installation	25	5	4	4	4	4	4	
NGMS User Guide	30	5	5	5	5	5	5	
General tasks	**245**	**35**	**35**	**32**	**35**	**32**	**36**	**40**
Communication (supervision of outsourced tasks etc.)	6	1	1	1	1	1	1	
Project Management (4 days/month for DH/TS together)	58	8	8	8	8	8	8	10
Liaise between CIS and DH/TS	12	3	3		3		3	
Quality control	7	1	1	1	1	1	2	
Follow-up plans	12	2	2	2	2	2	2	
Contingency	150	20	20	20	20	20	20	30
Tasks that can be outsourced								
Module adapter development	**100**	**0**	**35**	**0**	**35**	**30**	**0**	**0**
4R	35		35					
EA-recharge	35				35			
to be decided	30					30		
Configuration	**140**	**21**	**28**	**28**	**21**	**21**	**21**	**0**
Communication with system developers	20	3	4	4	3	3	3	
configuration+documentation	120	18	24	24	18	18	18	

Table 4-1 includes a preliminary effort estimate based on the latest views on tasks to be executed. As can be noted, the demand for resources is substantial

4.4 Acceptance Testing

Testing will be achieved by means of demonstrations at appropriate progress meetings and formal witnessing at defined milestones. Additional testing will be carried out independently by the EA staff following the progress meetings and the milestones.

The following types of acceptance tests can be identified:
- Pre-Release Test (Functional Testing)
- Pre Factory Acceptance Test (Pre FAT)
- Factory Acceptance Test (FAT)
- Site Acceptance Test (SAT)
- Commissioning Period (Operational Testing)
- Final System Test (FST)

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Pre-release testing

During the implementation phase pre-release will become available at regular intervals to allow for testing of implemented functionality and the regional system configuration. The future users can familiarise themselves with the software, and comment at an early stage about the way the functional design and the regional specification is implemented. The tests will have a formal character which means that an agreed period of time will be allocated for this purpose and formal test reports will be written and agreed upon.

In total 3 pre-releases of the NGMS will become available during the implementation period at approximately 4-month intervals. The EA Project Team will be introduced to new functionality in 2-day workshops following the progress meetings.

Pre Factory Acceptance Test (Pre FAT)

Pre Factory Acceptance Testing (Pre FAT) will be carried out by the contractor to prepare for the actual FAT. The Pre-FAT should ensure that the FAT can be expected to be successful. In this way should be guaranteed that the effort that has to be invested by the EA in the FAT is well spent.

Factory Acceptance Test (FAT)

The Factory Acceptance Testing (FAT) is a major milestone in the development. The tests shall prove, as far is practical, that the NGMS implementation meets the functional and performance requirements of the EA. The FAT will start directly after the software implementation has been completed and the reported results of the Pre-FAT indicate that a successful completion of the FAT is probable. It covers a total period of 8 weeks.

FAT will be carried out on the basis of previously agreed test scripts. The FAT will be carried out by the contractor and witnessed by the EA. The results of the tests will be reported formally.

Site Acceptance Test (SAT)

The aim of the SAT is to prove that the system as tested during the FAT has been installed correctly, works correctly with the site power supplies and, is integrated correctly with the EA's communications and other systems infrastructure. This will include testing system resilience including standby operation etc. The basic standalone functionality of the system that was proved during the FAT will not be tested again.

The SAT follows directly after the FAT and will cover a maximum period of 8 weeks. The SAT will be performed at the locations of future operation of the NGMS.

The SAT will be conducted by the contractor and witnessed by the EA. SAT will be carried out on the basis of previously agreed test scripts. The results of the tests will be reported formally.

Commissioning Period (Operational Testing)

The operational testing shall demonstrate that the overall system performs all required functions under actual operating conditions. The system will be controlled by EA's staff and shall be treated as if it were fully operational.

User acceptance testing will expose a larger group of professionals to the NGMS. Defects discovered during this type of testing will be corrected by contractor within the implementation contract.

Operational testing will start directly after the SAT and cover a period of maximum 20 weeks.

Final System Test (FST)

The Final System Test (FST) shall be conducted after the complete system has been installed and tested as described earlier and the Commissioning Period is completed. After successful completion of the FST - meaning acceptance by the EA - the NGMS implementation formally becomes operational and the software warranty period starts.

FST will last 4 weeks and will be conducted by EA. Part of the tests will be observed by the contractor. The FST shall be completed in accordance with a test specification produced by the EA. The results of the tests will be reported formally in a previously agreed manner.

4.5   Organisation

The total effort for Phase 3 is estimated over 1300 man days depending on the implementation method and training effort involved (i.e. outsourcing requires additional supervision and testing). Tom meet the WFD-target, the duration of Phase 4 is around 14 months until the system can be operationally used by EA (has passed FST).
During the implementation of the NGMS, a series of pre-release workshops is planned at approximately 2 month intervals (see previous section). During these workshops, the implementation will be demonstrated and made available to the user community. The workshops will last 2 days and will be followed by a period of testing by EA.

Project management meetings will be held at monthly intervals. For each project management meeting, progress report will be produced.

4.6   Documentation

The following type of user and system documentation are foreseen:
- NGMS User Guide
- NGMS Configuration Guide
- NGMS Installation Guide
- NGMS Support Guide

The following additional documentation will be prepared:
- Release documents will be produced with each (pre-)release.

- Acceptance testing document for FAT and SAT
- Project management documentation

4.7   Training

The following types of training courses are foreseen:
- NGMS end users course
- NGMS configuration course (for custodians and national super users)
- NGMS operational management course (for CIS)
- NGMS troubleshoot course (for CIS)

Table 4-1 provides suggestions for delivery of the various courses.