Dutch Benefits Model Area Oriented Approach

Background report User Manual

Investing in Opportunities
This project has received European Regional Development Funding through INTERREG IV B.
INTERREG IVB

Summary

For multiple large scale groundwater contamination plumes within urban areas, an Area Oriented Approach (AOA) is an economical and applicable type of remediation. As AOA is a new approach, the costs of organizing, planning, implementation and maintenance are generally paid by the government. The implementation of the AOA, while mostly cheaper than classical approaches, is still cost intensive. The approach does, however, create benefits for not just the organization implementing this plan but also for other organizations having other plans using the groundwater. This saves copious amounts of effort and costs on the organizations behalf. Financial compensation for these benefits to the organization implementing the AOA might be considered but is a complex process, especially without the use of cost benefit analyses.

The focus of the Dutch Benefits Model is to calculate the costs and benefits when these countermeasures for the prevention of contaminated groundwater plume displacement can be omitted within the juridical and technical boundaries of an AOA. The output of the model can be used as a starting point for negotiation on compensation for benefits or to give a fair insight in the benefits of an AOA when making a cost benefit analysis before implementing such an approach; e.g. by making scenario analyses of possible benefits.

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Appendix I: Direct link to the Dutch Benefits Model of Area Oriented Approach

1 Introduction

1.1 General

For multiple large scale groundwater contamination plumes within urban areas, an Area Oriented Approach (AOA) is an economical and applicable type of remediation. This approach can cover the assessment of multiple groundwater contaminations, also for which no responsibility can be assigned, using one remediation plan. The implementation of the AOA, while mostly cheaper than classical approaches, is still cost intensive. The approach does, however, create benefits for not just the organization implementing this plan but also for other organizations having other plans using the groundwater. These benefits are offered the remediation approach which allows the displacement of groundwater contamination plumes. Which is not the case in a classical single case remediation approach. An AOA has been made possible since the adaption of the Dutch Soil protection act (since July 1st 2012). As a result, organizations responsible for activities within the urban area that would result in contaminated groundwater movement do not have to implement stringent measures to prevent the movement of groundwater contamination plumes. This saves copious amounts of effort and costs on the organizations behalf. Financial compensation for these benefits to the organization implementing the AOA might be considered but is a complex process, especially without the use of cost benefit analyses. This report, together with the excel calculation sheet, can be used as guideline how these cost can be calculated / estimated.
Advantages of the Dutch Benefits Model AOA:
- The model gives insight in financial savings for not taking countermeasures to prevent spreading of polluted groundwater within the fixed area;
- Results of the model can be used to calculate financial contribution for making use of the remediation plan AOA;
- Results of the model can be used during negotiations with partners, developers, investors in the area for the height of their financial contribution for a sustainable redevelopment.

In September 2011 the Municipality of Utrecht commissioned Grontmij Netherlands BV (SO11.078988) to develop a Dutch Benefits Model for the AOA. This model is to assist in determining the benefits using the area oriented remediation plan.
The Municipality of Utrecht and its Dutch partner AgentschapNL participate in the European CityChlor project, operating under the INTERREG IV B program for Northwest Europe. The Utrecht remediation approach for an AOA – the “Biowasmachine” – is a pilot in this CityChlor project. During the initiation of the Biowasmachine Utrecht developed a preliminary Dutch Benefits Model. This model has been redeveloped into a generic cost model available to all CityChlor partners as part of the CityChlor project. This report describes the scope, background and user manual for the model.

1.2 Scope of the Model

A part of the CityChlor project is to compare and evaluate the financial benefits of using the AOA to a classical single case approach in case artificial groundwater movements might displace groundwater polluted plumes. The classical approach used in the Dutch Benefits Model is the approach that does not allow the displacement of contaminated groundwater plumes within an urban area by any type of activity which could cause groundwater displacement. Preventing the displacement of contaminated groundwater otherwise caused by certain activities imposes complex and costly countermeasures. With the AOA artificial displacement of groundwater contamination plumes is allowed within the area covered by the AOA as longs as the contaminants will neither affect the boundaries of the AOA area nor cause human risks.

The focus of the Dutch Benefits Model is to calculate the costs and benefits when these countermeasures for the prevention of contaminated groundwater plume displacement can be omitted within the juridical and technical boundaries of an AOA.

The cost model is based on Dutch legislation as imposed by the Soil remediation act ('Wbb art. 13 counter measures). Countermeasures for the prevention of displacement are mostly implemented during groundwater extraction at constructions sites and at Aquifer Thermal Energy Storage systems (ATES). The model is focused on generic cost benefits when the countermeasures can be omitted. In the first instance the model will be made generic for the Dutch legislation. After having evaluated the applicability of the model for the CityChlor partners the model can be made adjusted to situations in partnering countries.

2 Preconditions of the model

During the building of the Dutch Benefits Model the following preconditions were taken into account.

The focus of the Dutch Benefits Model is to calculate the costs and benefits when countermeasures for the prevention of artificial contaminated groundwater plume displacement are not required on the basis of the juridical and technical boundaries of an AOA.

Artificial contaminated groundwater displacement is only allowed when an AOA remediation plan is available. The costs of such a remediation plan have not been incorporated into the Dutch Benefits Model.

Most of the artificial groundwater movements are caused by the following activities:

- Temporary groundwater withdrawal on constructions sites;
- Long term groundwater withdrawal and injection for Aquifer Thermal Energy Systems (ATES) systems.

As these two activities cause most of the artificial groundwater movements, the Dutch Benefits Model is focused on these activities. Other activities, such as long term groundwater withdrawal for industrial use or groundwater consumption, have not been incorporated into the model as these types of groundwater use are not often found in (polluted) urban areas. In addition, there are similarities between these activities and temporary groundwater withdrawal on construction sites, which has been incorporated in the model. If the model was validated for other activities then it could also be used for these. In case of technical equivalent artificial groundwater movements the model could be applied.

Dutch unit cost rates have been used in the model. However, these can be changed by users.

The model has been developed to only calculate the cost differences between the AOA and the classical approach. It does not estimate the complete costs of an ATES construction plan or remediation plan necessary for a groundwater withdrawal in a classical situation.

The formulas within the model are generic and thus not site specific. For this reason the model uses gross unit cost rates. As a result, case based discrepancies on a detailed scale can't be avoided. These discrepancies can vary anywhere from approximately 15 to 25 % (expert guess). The Dutch Benefits Model provides an educated and calibrated guess of the costs and benefits appropriate for negotiations on financial compensations or AOA feasibility studies.

The following aspects are out of the scope of the model:

- Costs and benefits of an AOA as a groundwater remediation approach;
- Benefits of the groundwater's functional uses; e.g. the energy savings that are generated through the operation of an ATES system;
- Benefits that are created due to shorter preparation periods for a construction plan with less risks for delay.

3 Revision data

The Dutch Benefits Model is based on a preliminary Dutch Benefits Model developed during the initiation of the Utrecht Biowasmachine. This model was site specific and not necessarily applicable for other AOAs. For this reason the preliminary model has been brought into the CityChlor project for redevelopment into a generic benefits model.
During redevelopment the following activities have been carried out:

- Revalidation of the geohydrological principles of the model as explained in section 4;
- Redesign of the model focused on:
  - Separate input and output fields; e.g. unit cost rates;
  - Broader range of withdrawn groundwater discharge capacities;
  - Broader range of withdrawn groundwater discharge duration;
- User instructions in the model;
- Validation of unit cost rates;
- Validation of the model output using Utrecht-cases;
- Optimizing the layout and overview of the model;
- Using CityChlor layout;
- Technical check of the formulas used.

4 Model description and backgrounds

4.1 Cost / benefit backgrounds

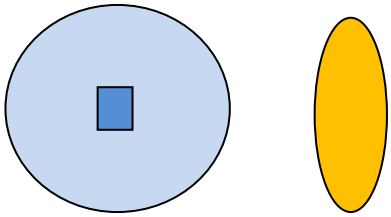
Table 4.1 gives an simplified overview of the most characteristic differences and similarities between a classical approach and an AOA situation when displacement of contaminated groundwater occurs. The final column of table 4.1 gives the basis for formulas used in de Dutch Benefits Model. Figure 4.1 gives a view of characteristic geographical outlines of groundwater contamination situations in relation to the AOA which can be distinguished.

Table 4.1 Overview difference classical and an Area Oriented approach

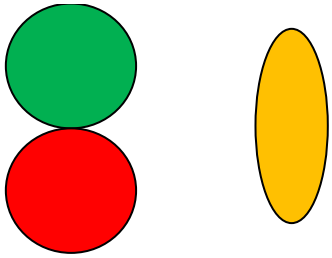
Aspect	Classical approach (1)	Area Oriented Approach (2)	Difference 1 and 2	Input for cost formulas *)
Displacement of pollutants in groundwater	Not applicable	Allowed within the boundaries of an Area Oriented Approach remediation plan	Displacement of all historic pollutants is allowed to	
Procedure	Groundwater remediation plan for displacement of pollutants in groundwater	Notification of local authorities including a short report evaluating the plans regarding the Area Oriented Approach remediation plan	Short procedure Secure period of preparation of activities with groundwater withdrawal	- Groundwater remediation plan + Short report evaluating the plans regarding the Area Oriented Approach remediation plan
Counter measures	Monitoring displacement of pollutants Non-displacement counter measures Monitoring Human risks Three different situations can be distinguished (figure 4.1)	Monitoring human exposure	Monitoring displacement of pollutants Non-displacement counter measures	- Monitoring displacement of pollutants - Design, installation and operation of Non-displacement counter measures including groundwater treatment - report to authorities

- saved costs / benefits under Area Oriented Approach conditions
+ costs under Area Oriented Approach conditions

Figure 4.2 View of characteristic geographical outlines

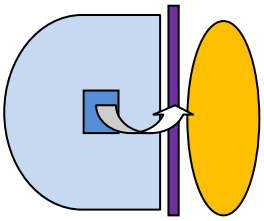


Pollutants and area influenced by groundwater withdrawal out of range.
→ No benefits from AOA

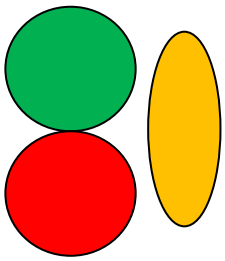


Pollutants out of range of area of influence of ATES.
→ No benefits from AOA

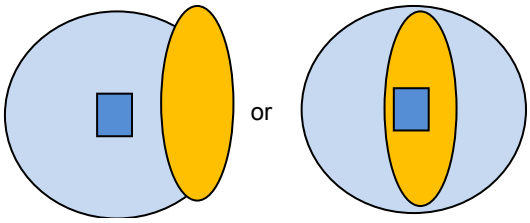
Deceasing distance from groundwater withdrawal to pollutants in groundwater



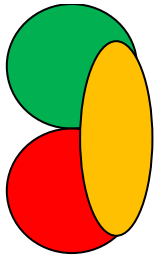
Pollutants in range of area of influence of an groundwater withdrawal.
→ Mayor benefits from AOA: no countermeasures necessary (treatment and infiltration of withdrawn groundwater)



Pollutants possible in range of area of influence of ATES.
→ Mayor benefits from AOA: no uncertainty for need of non-displacement counter measures



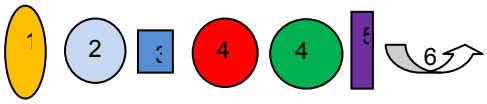
Overlap in pollutants and groundwater withdrawal.
→ Mayor benefits from AOA: no treatment of groundwater (polluted groundwater can be infiltrated)



Range of influence of ATES overlaps pollutants in groundwater
→ Mayor benefits from AOA: Without AOA , ATES will *not* be economical feasible unless soil remediation funds are incorporated in the ATES business case

Key

1	*pollutants in groundwater*
2	*area of influence of an groundwater withdrawal*
3	*groundwater withdrawal e.g.at a construction site*
4	*ATES area of hydrological (not thermal) influence*
5	*non-displacement counter measures*
6	*infiltration of treated groundwater*

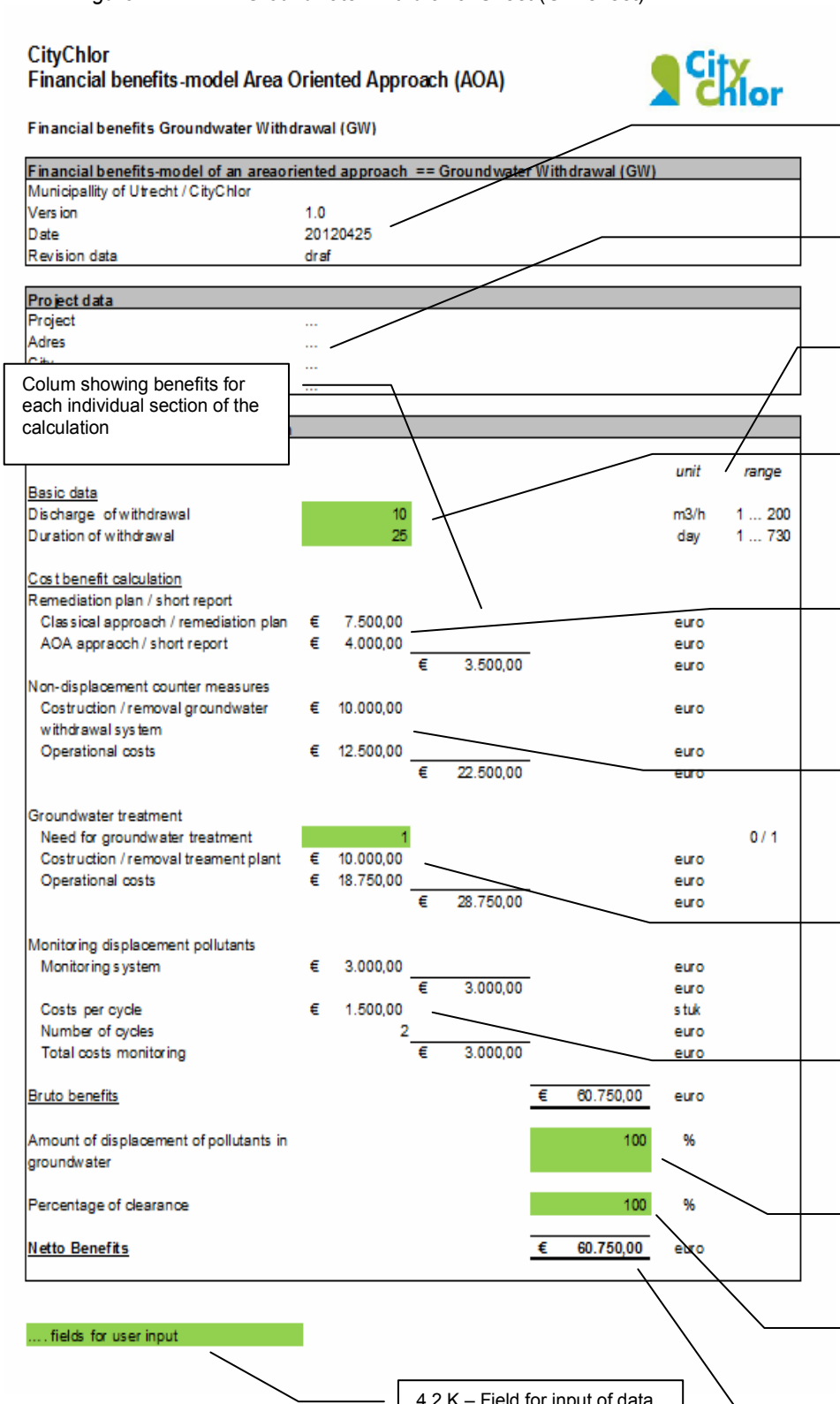


The characteristic geographical outlines and differences between the classical and AOA are used as a basis for the Dutch Benefits Model. The next sections gives a description of the model.

4.2 Model description and manual

The model calculates the financial benefits in relation to groundwater withdrawal and ATES systems and in two sheets separate sheets.
The Dutch Benefits Model is attached in the report (appendix I). Figure 4.2, figure 4.3 and figure 4.4 give a short introduction to the layout and principles of the model. In section 4.3 specific information on the model is provided for further background reading.

Figure 4.2 Groundwater Withdrawal Sheet (GW sheet)



CityChlor
Financial benefits-model Area Oriented Approach (AOA)

Financial benefits Groundwater Withdrawal (GW)

Financial benefits-model of an areaoriented approach == Groundwater Withdrawal (GW)	
Municipallity of Utrecht / CityChlor	
Version	1.0
Date	20120425
Revision data	draf

Project data	
Project	...
Adres	...
City	...
	...

				unit	range
Basic data					
Discharge of withdrawal		10		m3/h	1 ... 200
Duration of withdrawal		25		day	1 ... 730
Cost benefit calculation					
Remediation plan / short report					
Classical approach / remediation plan	€	7.500,00		euro	
AOA appraoch / short report	€	4.000,00		euro	
			€ 3.500,00	euro	
Non-displacement counter measures					
Costruction / removal groundwater withdrawal system	€	10.000,00		euro	
Operational costs	€	12.500,00		euro	
			€ 22.500,00	euro	
Groundwater treatment					
Need for groundwater treatment		1			0 / 1
Costruction / removal treament plant	€	10.000,00		euro	
Operational costs	€	18.750,00		euro	
			€ 28.750,00	euro	
Monitoring displacement pollutants					
Monitoring system	€	3.000,00		euro	
			€ 3.000,00	euro	
Costs per cycle	€	1.500,00		stuk	
Number of cycles		2		euro	
Total costs monitoring			€ 3.000,00	euro	
Bruto benefits			€ 60.750,00	euro	
Amount of displacement of pollutants in groundwater			100	%	
Percentage of clearance			100	%	
Netto Benefits			€ 60.750,00	euro	

.... fields for user input

Colum showing benefits for each individual section of the calculation

4.2.A – Cost model version

4.2B – Data of project for which the benefits are calculated

4.2C – Units and range of input data

4.2.D – Basic data of the size (discharge) and duration of the ground-water withdrawal

4.2.E – Cost(difference) of remediation plan / short report needed for permission before implementing the groundwater withdrawal activities

4.2.F – Costs of counter measures to prevent the groundwater pollution from spreading

4.2.G – Costs of groundwater treatment in case the quality of the groundwater is to low for disposal

4.2.H – Costs for monitoring the artificial displacement of pollutants in groundwater during withdrawal of ground-water

4.2.I – Correction of effective displacement of groundwater displacement

4.2.J – Percentage of benefits to be settled with the party benefitting from the AOA

4.2.K – Field for input of data by user.
Note. No data entry checks are made.

4.2.L - Total clearance of benefits of AOA for this specific groundwater

Figure 4.3 ATES sheet

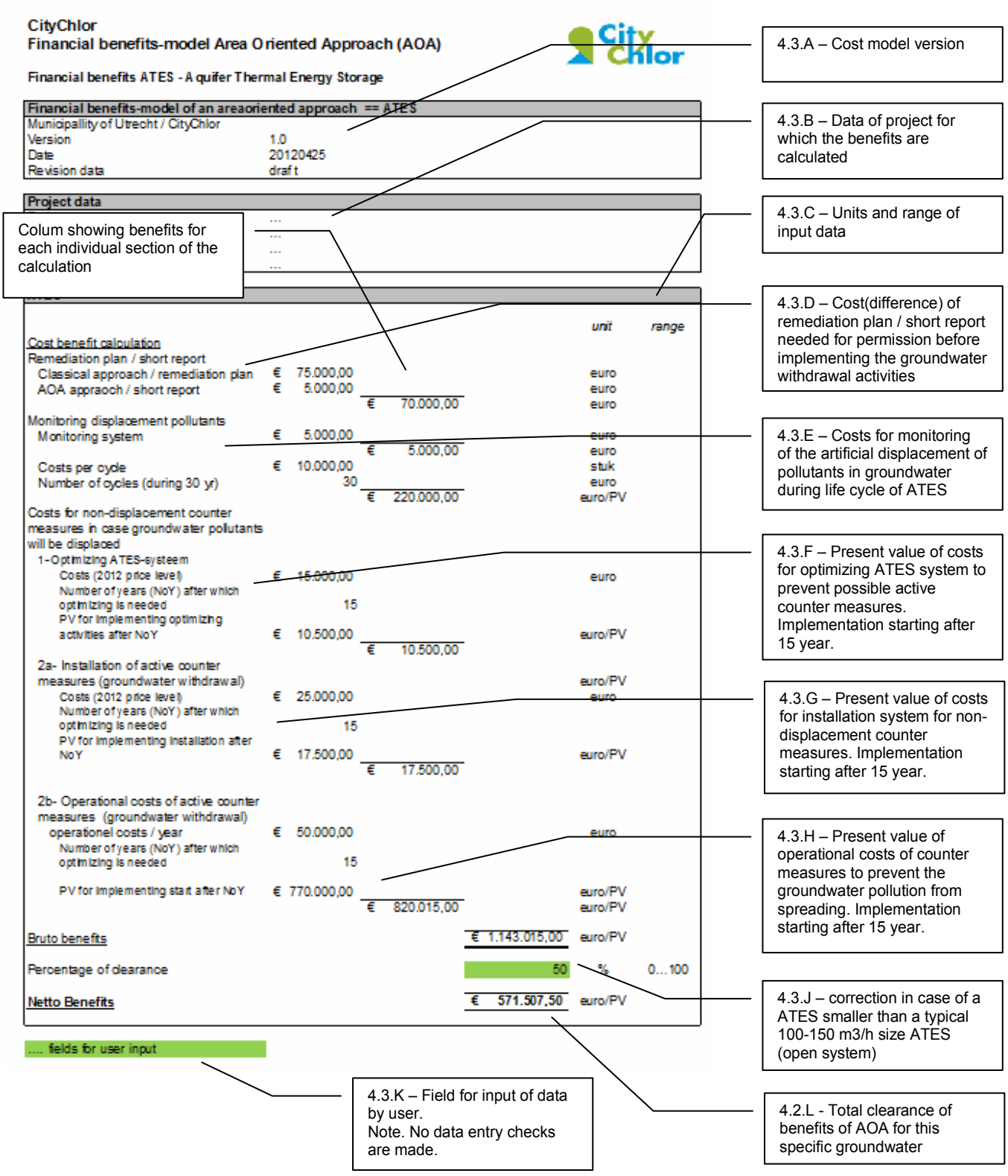
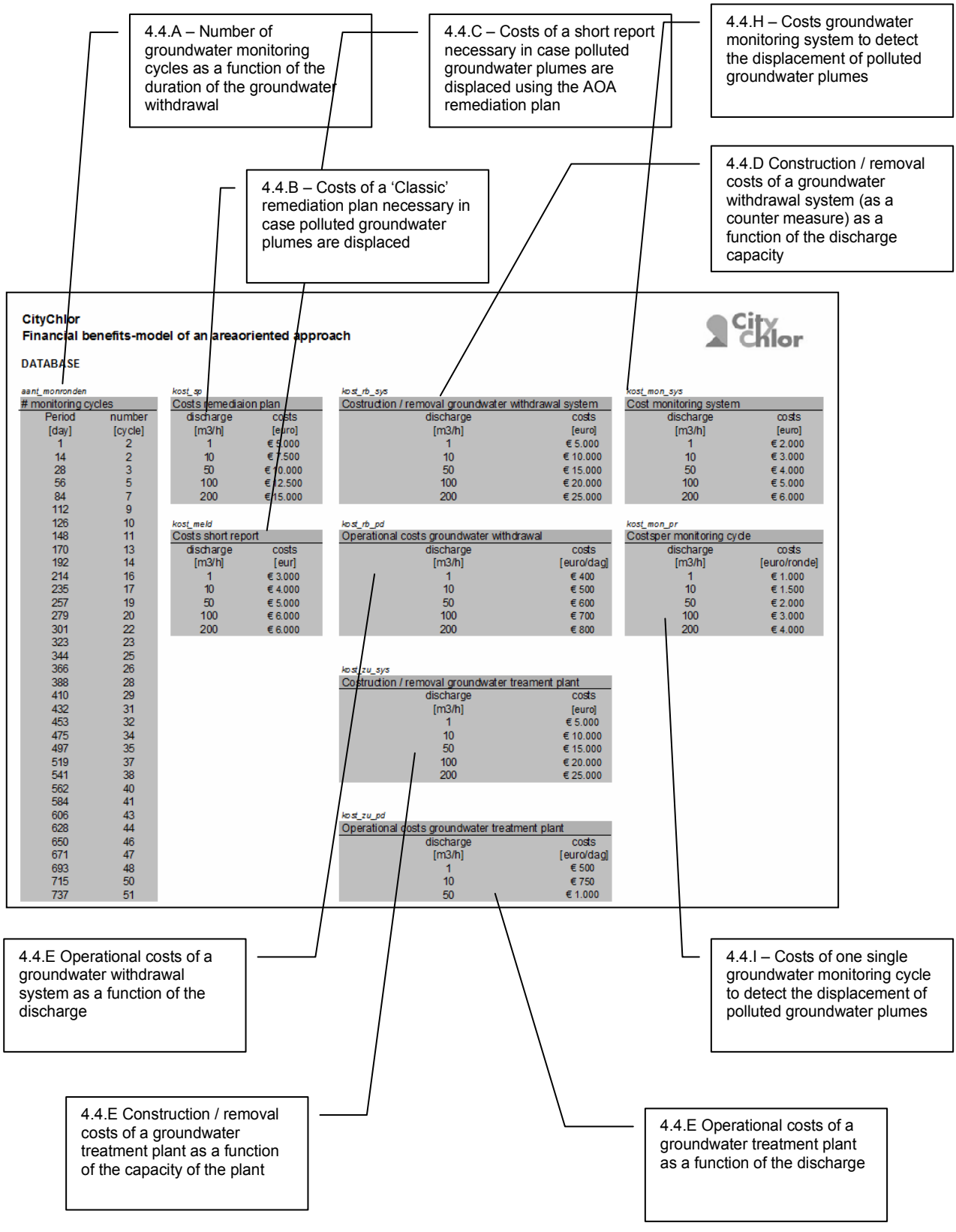


Figure 4.4 Gross Units Cost Rates sheet



4.3 Evaluation

The results of the model are a theoretical approach of daily situations. As such, site specific properties may influence the results of individual cases. On the other hand the results are based on data derived from multiple cases of groundwater withdrawal systems, countermeasures and expert judgments. The results could be used as a starting point for negotiation on compensation for benefits or to give a fair insight in the benefits of an AOA when making a cost benefit analysis before implementing such an approach; e.g. by making scenario analyses of possible benefits.

Financial benefits Groundwater Withdrawal (GW sheet, appendix I)
The results of the Groundwater Withdrawal Sheet (GW sheet) have been compared with data from one of the groundwater withdrawal case studies in the Utrecht city centre. From this comparison it appears that the results of the model are within a range of approximately 15 % accuracy (depending on the definition and scope of the gross cost data provided).
When compared with the Arnhem Presikhaaf model (dd 20110615, GGB-plan, projectnr. C09052) – also a GW sheet – the following should be mentioned:

- The Arnhem AOA remediation plan does not facilitate the infiltrating contaminated groundwater as a counter measure. Subsequent treatment of polluted groundwater withdrawn is needed. The Dutch Benefits Model allows to infiltrate untreated withdrawn polluted groundwater in case of an AOA. The costs of groundwater treatment are significant;
- The results of the 'formula' of the Utrecht/CityChlor and Presikhaaf model are comparable but are dependent on the percentage of clearance of the calculated benefits.

Financial benefits ATES (ATES sheet, Appendix I)
The results of the ATES sheet are dominated by the risk of having to use countermeasures for the prevention of possible groundwater contamination displacement. The number of years after which countermeasures for the prevention of contaminated groundwater displacement are obligatory will be of influence of the go / no-go decision for implementation of an ATES system. Furthermore, the present value of the countermeasures will very much depend on the moment these measures are necessary.

In case an ATES system is planned to be installed within the range of groundwater contamination, countermeasures will be necessary from the first day of operation. In this case the business case of the ATES system can only be economically attractive if groundwater remediation funds are made available for the business case. Benefits provided by the ATES system should therefore be evaluated in this perspective. In this case it is better not to speak of 'ATES benefits' but to regard AOA as a precondition for an ATES system.

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