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Valuation of groundwater protection versus water treatment in Denmark by Choice Experiments and Contingent Valuation

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Berit Hasler
Thomas Lundhede
Louise Martinsen
Sune Neye
Jesper S. Schou

Data sheet

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Abstract:	The benefits of groundwater protection are estimated to assess the non-marketed benefits associated with increased protection of the groundwater resource, as compared to purification of groundwater for drinking water purposes. The study comprises valuation of the effects on both drinking water quality and the quality of surface water recipients, expressed by the quality of the living conditions for wild animals, fish and plants in lakes and waterways. The methods Discrete Choice Experiments method (CE) and Contingent valuation (CV) are used for the valuation. The results indicate that there is a significant positive willingness to pay for groundwater protection, where the willingness to pay for drinking water quality exceeds that for surface water quality. The value of groundwater protection exceeds that from purification, and this result supports the current Danish groundwater policy and the aim of the Water Framework Directive that aims at a holistic management government of the aquatic environment.
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Preface

This report covers a valuation study where Danish consumers' willingness to pay for groundwater protection and purification of drinking water is assessed. The project is initiated by the Danish Environmental Protection Agency (EPA), and co-financed by EPA and the National Environmental Research Institute.

The work has been followed and commented by a steering group, which also followed and commented the pre-study for the present project (Miljøstyrelsen. - Miljøprojekt 969). The results of the main valuation study are described in the present report and in Danish in a "Miljøprojekt" report as part of the "Teknologiudviklingsprogram".

The members of the steering committee were:

Camilla K. Damgaard, Danish Environmental Protection Agency (EPA) (Miljøstyrelsen (MST))

Lisbeth Strandmark, Danish Environmental Protection Agency (EPA) (Miljøstyrelsen (MST))

Jørgen Schou, Danish Environmental Protection Agency (EPA) (Miljøstyrelsen (MST))

Kim Dahlstrøm, Danish Environmental Protection Agency (EPA) (Miljøstyrelsen (MST))

Bo Jellesmark Thorsen, Centre of Forest & Landscape Denmark, The Royal Veterinary and Agricultural University; Denmark (Skov og Landskab, Den Kgl. Veterinær- og Landbohøjskole (KVL))

Jette Bredal Jacobsen, Centre of Forest & Landscape Denmark, The Royal Veterinary and Agricultural University; Denmark (Skov og Landskab, Den Kgl. Veterinær- og Landbohøjskole (KVL))

Hans Jørgen Henriksen, The Geological Survey of Denmark and Greenland (Danmarks og Grønlands Geologiske Undersøgelse (GEUS))

Trine Bille, Institute of Local Government Studies – Denmark (Amternes og Kommunernes Forskningsinstitut (AKF))

Alex Dubgaard, Food and Resource Economics Institute, The Royal Veterinary and Agricultural University; Denmark. (Fødevareøkonomisk Institut, KVL)

Jacob Ladenburg, Food and Resource Economics Institute, The Royal Veterinary and Agricultural University; Denmark. (Fødevareøkonomisk Institut, KVL)

Claus Vangsgaard, Danish Water and Waste Water Association (DWWA) (Dansk Vand. og Spildevandsforening (DANVA))

Sven Jespersen, the Secretariat, the Danish Economic Council, (Det Økonomiske Råds Sekretariat (DØRS))

Thomas Bue Bjørner, the Secretariat, the Danish Economic Council, (Det Økonomiske Råds Sekretariat (DØRS))

Sven Erik Jepsen, Danish Environmental Protection Agency (EPA) (Miljøstyrelsen (MST))

Members until March 2004: Bente Villumsen, Danish Environmental Protection Agency (EPA) (Miljøstyrelsen (MST)), Lars Trier, Danish Forest and Nature Agency (Skov- og Naturstyrelsen (SNS)), Susanne Jørgensen, Danish Forest and Nature Agency (Skov- og Naturstyrelsen (SNS)).

The authors wish to acknowledge the comments from the steering committee, and for the enjoyable and helpful discussions in the group. We would also like to thank for the comments from the two referees, as well as for good advice and comments from colleagues. The responsibility for the report, for any mistakes and for the conclusions are the authors.

Roskilde, May 2005.

Berit Hasler,
Thomas Lundhede,
Louise Martinsen,
Sune Neye,
Jesper S. Schou

Dansk sammendrag

Den danske befolkning er meget optaget af kvaliteten af grundvandet, og blandt Europas mest bekymrede over forureningen af grundvandsressourcen (European Opinion Research Group 2002). I dette studie har vi brugt værdisætningsmetoder til at kvantificere gevinsterne som følge af at beskytte grundvandet. Betalingsviljen for beskyttelse af grundvandet er sammenlignet med betalingsviljen for et alternativ til beskyttelse, nemlig rensning af forurenet grundvand til drikkevandsformål. Rensningen kan foretages med osmose og aktivt kul. Gevinsterne ved beskyttelse af grundvandet omfatter rent drikkevand nu og i fremtiden samt bedre betingelser for dyre- og plantelivet i søer og vandløb. Gevinsterne af rensning af grundvandet er rent drikkevand nu og i fremtiden, men der er ingen positive effekter på søer og vandløb.

Det rene drikkevand og de gode betingelser for dyre og plantelivet i det ferske vandmiljø er ikke markedsomsatte goder, og har derfor ikke en pris. Vandprisen er nemlig ikke en markedspris som afspejler efterspørgselen efter goderne ved en ren grundvandsressource, men en pris som er fastsat politisk med henblik på at dække vandværkernes omkostninger ved fremskaffelsen af drikkevand til forbrugerne. Tidligere udførte undersøgelser indikerer, at vandprisen ikke dækker disse omkostninger fuldt ud (Hasler et al., 2004). Det udførte værdisætningsstudie viser, at befolkningen er villige til at betale en merpris for at være sikre på at kunne få rent og sikkert drikkevand, samt for at være sikre på at der er gode betingelser for dyre og plantelivet i de ferske vande nu og i fremtiden.

Værdisætningen er foretaget med de spørgeskemabaserede metoder Contingent Valuation og Choice Experiment, og rapporten præsenterer disse to metoder og hvordan metoderne er anvendt i studiet. Metoderne giver forskellige resultater, og disse forskelle diskuteres.

Hypoteserne i studiet er, at:

- *Forbrugerne foretrækker naturligt rent grundvand som ikke er renset ud over den simple vandbehandling på vandværkerne (iltning).* Dette er en målsætning og en forudsætning for den danske drikkevandspolitik. Ved at teste denne hypotese kan gevinsterne ved renset vand sammenlignes med gevinsterne ved at beskytte vandet.
- *Værdien af rent drikkevand er større end værdien af gode betingelser for dyre- og plantelivet*, da rent drikkevand påvirker human sundhed og derfor er drikkevand associeret med private goder i højere grad end kvaliteten af overfladevandet.
- *Betalingsviljen i byerne overstiger betalingsviljen i landområderne da det forventes at bybefolkningen har stærkere præferencer for rent vand.* Denne hypotese er begrundet i at tidligere analyser af forbruget af økologiske madvarer i Danmark og Storbritannien viser, at bybefolkningen forbruger økologiske produkter i højere grad end landbefolkningen, ofte af hensyn til egen sundhed, men også af hensyn til miljøet (Wier, 2004).

- *Betalingsviljen for familier med børn overstiger betalingsviljen for husholdninger uden børn, og betalingsviljen for kvinder er større end mænds*. Denne hypotese bygger på at de nævnte undersøgelser af forbrug af økologiske produkter viser, at husholdninger med børn under 15 år forbruger økologiske produkter i højere grad end andre husholdninger (Wier, 2004). Wier (op cit.) konkluderer, at tilstedeværelsen af børn i sig selv ikke øger tilbøjeligheden til at købe økologisk, men at tilstedeværelsen af mindre børn øger tilbøjeligheden til at købe økologisk. Forbruget af økologiske produkter er begrundet både med hensynet til egen sundhed og miljøhensyn, altså de samme hensyn der formodes at være udslagsgivende for betalingsviljen for rent drikkevand.

Foruden tests af disse hypoteser er formålet med studiet at sammenligne anvendelsen af de to nævnte værdisætningsmetoder.

For begge metoder viser resultaterne, at befolkningens betalingsvilje for at beskytte grundvandet mod forurening nu og i fremtiden er signifikant positiv, og at gevinsterne er større ved beskyttelse af grundvandet end ved rensning af forurenende kilder.

Betalingsviljen for beskyttet grundvand er med Choice Experiment beregnet til ca. 1900 kr./år per husstand i tillæg til den årlige vandregning, som i gennemsnit er på 4000 kr./år per husstand. Til sammenligning er betalingsviljen for renset vand ca. 900 kr./år per husstand, mens betalingsviljen for at beskytte dyre- og plantelivet i søer og vandløb ca. 1200 kr./år per husstand.

Med Contingent Valuation er der beregnet en betalingsvilje på 700 kr./år per husstand i tillæg til den årlige vandregning, og denne betalingsvilje omfatter både effekterne på drikkevandet og overfladevand, dvs. både det at være sikker på at få rent vand i fremtiden og på at opnå bedre betingelser for dyre og plantelivet i søer og vandløb. Betalingsviljen for renset vand er ca. 500 kr./år per husstand.

Begge metoder viser således, at befolkningen foretrækker beskyttelse af grundvandet frem for rensning, men også at betalingsviljen er positiv ved begge løsninger.

Resultatet af Choice Experiment-studiet viser endvidere, at der er samfundsøkonomiske gevinster ved at forvalte grundvandsressourcen i et holistisk perspektiv, hvor både drikkevandsbeskyttelsen og betingelserne for dyre- og plantelivet i søer og vandløb tages i betragtning. De samfundsøkonomiske omkostninger ved at beskytte og rense grundvandet i det omfang vi har forudsat, nu og i fremtiden, er dog ikke beregnet. Dvs. at nettogevinsterne ved at rense kontra at beskytte ikke kan beregnes på det foreliggende grundlag.

Summary and conclusions

Objectives of the study

The benefits of groundwater protection are estimated in order to measure whether there are welfare gains associated with increased protection of the groundwater resource, as compared to the current level of protection and to purification of groundwater for drinking water purposes. The term ”groundwater” refers to the groundwater resource in Denmark and local groundwater pollution problems are not considered. The study assesses only the benefits, and not the costs, of achieving these benefits.

Danish drinking water policy is based on the assumption that the public prefers clean groundwater to water that has been treated. These preferences have never actually been explored by Danish valuation studies.

The primary hypotheses in this study are that:

Consumers prefer naturally clean groundwater, which is not in need of purification or other treatment, to water that has been polluted and treated to clean, thereafter. This is a premise underlying Danish drinking water policy. By testing this hypothesis the benefits of groundwater protection versus purification are measured.

The value associated with clean drinking water exceeds the value associated with good surface water quality. The rationale here is that clean drinking water influences human health and hence private goods more directly than the quality of surface waters does.

The Willingness to Pay (WTP) in urban areas exceeds the WTP in rural areas. This hypothesis is motivated by the results of former analyses of the demand for organic foods in Denmark and Great Britain (Wier, 2004). These results show that urban residents consume organic foods to a higher degree than residents living in rural areas. Human health and environmental concern are the most commonly stated reasons for preferring organic to conventional food, and we expect that these reasons are also the drivers for the hypothesised preferences for clean groundwater.

The WTP in households with children exceeds the WTP in households without children and the WTP of females exceeds that for males. This hypothesis is motivated by results from the above-mentioned study, which also concludes that households with children under 15 years of age have a higher demand for organic foods than other households (Wier, 2004). The presence of children, in itself, does not increase the demand, but the presence of children under 15 years of age does. As mentioned above, human health and environmental concern are the most commonly stated reasons for preferring organic to conventional food, and we expect that these reasons are also the drivers for the hypothesised preferences for clean groundwater.

Besides elicitation of WTP for groundwater protection and purified water, an additional objective of the study is to compare the results obtained with the two methods, choice experiments and contingent valuation, and to analyse and assess the apparent differences.

The indicators and scenarios in the two surveys

The effects being valued comprise both changes in drinking water quality and surface water quality, represented by the living conditions for flora and fauna in lakes and watercourses in Denmark. The indicators for the quality of lakes, watercourses and drinking water are expressed in general terms, and not specifically for a certain area, as valuation is based on a general description of Danish drinking water quality and the quality of surface waters, i.e. watercourses and lakes. As a consequence the results can be used at a general level, but not to value changes in specific areas.

The use of qualitative indicators as opposed to quantitative indicators, such as limit values, has been selected because qualitative indicators are found to be more suitable when the aim is to assess the value of general protection of surface waters as opposed to more specific cases, e.g. valuation of quality changes of a specific lake or watercourse. Danish surface waters, e.g. lakes, differ widely from each other because of variations in the prevailing natural conditions (depth, nutrient richness, size), making it impossible to characterise them by using the same indicators. Furthermore, it was found, in testing the questionnaires, to be least demanding cognitively to use qualitative indicators. The indicators comprise choices between naturally clean drinking water of good quality resulting from protection, versus uncertain quality of drinking water. The uncertainty relates to fulfilment of the limit values of nitrate and pesticides in the future, although it is assumed that the present protection level is maintained in the future. Protection is also valued in relation to water that is purified and treated to remove pesticides and nitrates. The information supplied to the respondents explains that, under current conditions, a range of measures is carried out with regard to protection of groundwater against pollution from pesticides and nitrogen. They are informed that when a groundwater borehole is found to be polluted, it is closed and a new one is established. Furthermore, it is explained that it is uncertain whether clean drinking water can be provided in sufficient amounts at this protection level in the future. There is, therefore, a risk that tap water will exceed current limits for pesticides and nitrogen content in the future.

The respondents are also informed that by carrying out measures, primarily in agriculture, naturally clean drinking water can be secured both now and in the future. At the same time, good conditions can be secured for animal and plant-life in watercourses and lakes. This means that animal and plant-life will be more natural, varied and balanced, and affected by human activity to only a slight to average degree.

The respondents are, furthermore, informed that the general conditions for animal and plant-life in watercourses and lakes are not good at the present and that, under the current level of protection, animal and plant-life is in a state of imbalance many places, and differs markedly from how it would appear under natural conditions. The primary reason for changes in the condition of the aquatic environment is human activity.

In the Contingent Valuation (CV) survey, the respondents are provided with this information directly, and they are asked to choose how much they would pay for groundwater protection from a payment card listing 11 levels, ranging from 0 to 2400 DKK/year per household, representing additions to their water bill. In the Choice Experiment (CE) survey the respondents are asked to choose between alternatives where the levels of drinking water quality, surface water quality and price are varied systematically.

In the CE survey, the indicator levels are designed so as to approach the descriptions in the CV survey. The quality levels "good drinking water quality now and in the future", "uncertain quality now and in the future" and "purified water" describe drinking water. Surface waters are described by "very good conditions for flora and fauna in waterways and lakes", by "slight imbalance, markedly different than would be so under natural conditions" and "bad conditions". The price consists of six levels, ranging from 0 to 2,400 DKK/year per household again representing additional payments to the water bill. In both of the surveys the respondents are informed that it is assumed that the Danish consumer should cover the costs of protecting the groundwater, as well as those for purification. This would take place in the form of a fixed annual sum per household claimed once a year via the water bill. In other words, a payment additional to the annual water bill is used as the payment vehicle in both surveys. On average, Danish households pay 4,000 DKK/year in water service and supply bills.

Results

The Danish drinking water policy and the hypothesis of this study are based on the assumption that the public prefers clean groundwater to water that has been treated by purification methods to remove nitrates and residues from pesticides. This policy assumption and hypothesis is supported by the results of the CE study, i.e. the estimated willingness to pay for groundwater protection is higher than the willingness to pay for purified water. The result cannot be supported directly by the CV study as the WTP for effects of groundwater protection comprise effects on both drinking and surface water. However, the WTP for protection also exceeds that for purification in the CV study, although it has to be remembered that the WTP comprises both the effects on drinking water and surface water quality. The results are apparent from Table 0.1.

Table 0.1. WTP-results from CE and CV, DKK/year

	CE	CV
Naturally clean groundwater	1,899	
Very good conditions for plant and animal life	1,204	711
Total	**3,104**	**711**
Purified water	**912**	**529**

The WTP results represent water service payments in addition to households' present annual water bills, and reflects the respondents' willingness to pay for the good, "good drinking water quality" – obtained by protection or purification, as well as good living conditions for flora and fauna in lakes and watercourses. The initial average payment of 4,000 DKK/year represents the present cost of water delivery and wastewater disposal, as well as some of the costs for the present level of drinking water protection.

As apparent from Table 0.1., the CE has resulted in positive WTP estimates for groundwater protection, split into WTP estimates for both "natural clean groundwater for drinking water supply" and "very good conditions for plant and animal life". Using the CV method, the value of the total good "groundwater quality" is estimated, and this WTP estimate cannot be split into different attributes.

As mentioned above, it is explained in the CV-valuation scenario that both drinking water quality and surface waters will be influenced positively by an increase in groundwater protection over current levels of protection. As apparent from the results in Table 0.1., the CE results for groundwater protection of both surface water (plant and animal effects) and drinking water quality are more than four times greater than the CV WTP estimate.

The CE result for naturally clean water resulting from protection of the groundwater resource represents a marginal increase of almost 50%; from 4,000 to 5,899 DKK/year. It is apparent that the WTP for groundwater protection exceeds the WTP for purification. However, the WTP for purified water from the CE survey is only 30% of the total WTP for groundwater protection.

As mentioned, one of the hypotheses in this study is that consumers prefer clean groundwater to purified water, and this hypothesis is supported by the CE method. Another hypothesis is that the value associated with clean drinking water exceeds the value associated with good quality of surface waters. This hypothesis is once again supported by the CE results, which indicate that the WTP for good conditions in surface waters accounts for 63% of the WTP for good drinking water quality obtained by protection. One explanation for this difference is that clean drinking water influences human health and hence private goods more directly than the quality of surface waters does, both for present and future generations. Seen in relation to foreign valuation studies, as well as Danish, the results are in accordance with the assumptions.

Both the CV and the CE surveys find correlations between the household WTP and household income, education level of the respondent and household water consumption, i.e. the WTP increases with income level, educational skills as well as water consumption. Furthermore, the WTP of females is higher than that for males. Both age and children in the household are insignificant factors, i.e. the WTP is not dependent on whether there are children in the household or the age of the members of the household. Furthermore, the results of the estimations indicate that WTP differs between households in urban and rural areas, as the WTP is higher in urban than in rural areas.

Explanations for differences in results and advice for their treatment

Standard neo-classical assumptions support that open-ended CV results, which the CV-payment card answers used in the present study can be interpreted as, are lower than results from dichotomous choice formats and other choice methods. In other words, the results are in accordance with theory.

However, this conclusion does not suggest whether the CE results or the CV results are the most reliable. The literature provides no conclusive evidence on the reasons for the differences between the results. However, empirical results can be used to shed light on this and to support the results: In former water quality surveys, mean water values obtained by CV were three to four times lower than those obtained from the contingent ranking method. Contingent ranking is a choice modelling approach close to CE.

In the empirical literature, the differences are explained by a number of reasons. One explanation for lower WTP estimates from CV compared with CE is that CV may create incentives for respondents to understate their true willingness to pay. In past empirical research, these differences are explained by the facts that substitutes are expressed more explicitly in CE than in CV and, hereby, respondents are encouraged to make trade-offs. As choices that include price attributes are different from direct elicitations of willingness to pay, the prices often carry more weight and are given more attention in CE surveys. The last explanation is that it is easier to express indifference to choices in CE than in CV, and protest behaviour is a greater problem in CV compared with CE.

It is, therefore, proposed in this report to use the results from the CE compared with those from the CV method.

1 Background and aim of the study

1.1 Background

The quantity and quality of the groundwater resource are important for the provision of drinking water in Denmark, as 99% of the drinking water supply stems from groundwater. Consequently, protection of the drinking water resource with the aim of using clean groundwater as drinking water is a priority task in Danish environmental policy (cf. Andersen et al. 2003, Danish Environmental Protection Agency 2004). The objective is that groundwater should be usable after simple processing (oxygenation). Further treatment of groundwater is not desirable with regard to both national and regional targets for the existing and future drinking water supply (cf. Copenhagen County/Roskilde County 2003, Danish Environmental Protection Agency 2004). Tap water is the main source of drinking water in Denmark as bottled water is mainly used as a substitute for e.g. lemonade and soft drinks.

A Danish study from 1999 carried out by the "Institut for Konjunktur-Analyse" (IFKA) concluded that as much as 85% of the respondents answered that pollution of groundwater was the most important environmental problem in Denmark. They also answered that they were particularly concerned for the quality of drinking water. A more recent European survey carried out for the Directorate-General Environment indicates that the Danish population, generally, are more worried about pollution of waterbodies than the population in other countries. The European Opinion Research Group (2002) has found that 52% of Danes are very worried[1] about pollution of Danish tap water, and 56% are very worried about pollution of groundwater. In comparison, 43% of the average population in the EU countries are very worried about these topics.

However, it has recently been proposed in Denmark that good drinking water quality, meeting the drinking water requirements of the drinking water directive, could be provided by treatment of polluted groundwater (IMV, 2003). It is possible to purify polluted groundwater for both nitrates and pesticide residues by osmosis and by active charcoal filters, and this practice can be less costly as compared to protection of the groundwater against pollution by e.g. agricultural measures. The costs of purification increase with increasing pollution (Juhl & Bjerg, 2004). As opposed to purification, which only improves drinking water quality, protective measures improve both the quality and quantity of drinking water, the groundwater, the quality of streams, watercourses and lakes and the living conditions for flora and fauna therein (cf. GEUS, 2004; Bach et al. 2002). In order to be able to prioritise, both the costs and the benefits should be ac-

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[1] The notion "very worried" is used by The European Opinion Research Group (2002), as opposed to their notions "fairly worried", "not very worried" and "not at all worried", i.e. the notion "very worried" is the strongest indication of concern in their survey.

counted for, but good drinking water quality and good conditions for the living conditions of flora and fauna are mainly public, non-marketed goods. The provision of drinking water and other use-water from tap water has a price in Denmark, but this price is not a market price as it is set by the municipalities with the aim to cover the costs of drinking water sewerage and supply[2]. Consequently, the value of the goods created by groundwater protection has to be derived by valuation methods.

This non-marketed value of the effects of protection of the groundwater resource should be estimated comprising both the value of drinking water protection and the effects of protection of freshwaters and the flora and fauna therein. The value of protection of the groundwater resource should also be compared to the value of other measures to obtain good water quality, e.g. the above-mentioned possibility of purification of polluted groundwater.

1.2 Sources of groundwater pollution

Agriculture, industry, road traffic, landfill sites and sewerage systems represent important sources of groundwater pollution. Pollution protection can take place by locating these activities an appropriate distance from aquifers or by restricting the activity, itself. Nitrate pollution stems mainly from agriculture, where pesticide-use is also most widespread. Sources of groundwater pollution with pesticides are found both in urban areas and the wider countryside.

Measures in agriculture do, for example, include environmental management practices in the form of reductions in pesticide application and/or reductions in nitrogen/nitrate application, planting of forest areas and taking land out of production. However, the aim of this report is not to describe the sources of groundwater pollution in detail; such descriptions can be found in an extensive body of literature, Danish as well as international (see e.g. Østergaard et al., 2004; Bach et al. 2002; Henriksen et al., 2004).

It is a premise of this study that initiatives to protect groundwater against pesticides and nitrate can be implemented so that current and future generations can drink untreated groundwater, which at the same time is clean. Apart from measures to carry out defensive pumping and establish new boreholes, efforts to protect drinking water in sensitive areas include, for example, the planting of forest and restrictions on use of nitrogen and pesticides (environmentally-sensitive farming practices). These measures limit the loss of pesticides, nitrogen and phosphorous to both groundwater and surface waters in designated areas. Groundwater protection and the associated costs depend on the scope of protection measures and how the measures are put in place. The costs of such measures are not estimated in the present study, but can be estimated using other study results and models (see e.g. Schou 2004, Rasmussen 2004, Hasler & Schou 2004; Jacobsen et al. 2004).

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[2] On average Danish households pay 4,000 DKK annually for water sewerage and supply.

1.3 Valuation by use of stated preferences: the Contingent Valuation and the Choice Experiment methods

Stated preference methods consist of several methodological approaches, with the common property that people are asked what economic value they attach on certain goods and services, e.g. services and goods connected to groundwater protection and drinking water purification. The contingent valuation (CV) method and the choice experiment (CE) method are both survey-based methodologies that provide respondents with the opportunity to state a hypothetical economic decision concerning the relevant non-marketed good. Responses are most commonly collected by personal interviews or mail surveys. The value estimates are contingent on a hypothetical scenario that is presented to the respondents for valuation. In other words, it relies on the analyst to create a hypothetical market for the good in question.

Another group of valuation methods is *revealed methods*, where the analyst investigates how the public good influences a marketed good which is connected to the public good. The advantage of revealed methods is that the price is actually paid, and is not hypothetical. However, there are limitations as well, e.g. that there have to be existing and connected private goods that reflect the price of the public good (cf. Adamowicz et al. 1994, Adamowicz 1995). Houses are commonly used because house prices reflect characteristics of the house as well as its surroundings, including the environmental quality of the area (landscape, but potentially also quality of lakes, fjords etc).

However, no such marketed goods reflect the value of water quality adequately, including all the categories of values connected to groundwater mentioned above. Furthermore, non-use values, including existence values and option values (values of potential future use- and non-use values) cannot be elicited by revealed methods whereas with stated preference methods they can. Revealed methods only reflect the preferences of those who use the connected good, e.g. the house owners. Therefore, the total value of a public good cannot be assessed, including the use and non-use values of both existing projects as well as future development projects.

Valuation of groundwater protection, therefore, requires stated preference techniques, and in the present study it has been decided to use two methods and to compare them: Choice experiments (CE) and Contingent Valuation (CV). While CV has frequently been used in the literature, the CE-method has been developed more recently, and the method has been used in many studies during the last few years. Both CV and CE use hypothetical questions and choices to assess and reveal consumers' WTP.

With the CV method, the focus is on a description of the change in the provision of the good, as such, and the respondents are presented with the changes in the environmental good. Hereby, the CV method is a *direct* valuation method, as the respondents are asked directly what they would be willing to pay to achieve a given change in the quality or quantity of the public good - e.g. drinking water quality and/or surface water quality. In contrast to this, respondents are asked to make *choices* in CE. CE is built on discrete choices, and the good and the changes in the provision of the good are described in terms of its characteristics or attributes. The choices are used to reveal the respondents' trade-offs between the alternatives presented for them in the choice-sets.

In other words, respondents state their hypothetical WTP by answering hypothetical questions in CV studies, and make choices between hypothetical alternatives in CE studies (see e.g. Nunes & van den Bergh, 2001; Macmillan et al., 2001; Garrod & Willis, 1999, Bateman et al. 2002).

According to Bateman et al. (2002) and Navrud (2000), CV approaches should be chosen when the *total* environmental service or good is being valued. CE is the appropriate choice if the *relative* values of each attribute or characteristic of a public good are analysed and valued. The summing up (aggregation) of these results, however, can result in over-estimations of the value of the total environmental service or good (Foster & Mourato, 1999).

As mentioned, the present study comprises both CE and CV questions in two questionnaires. Except from the valuation questions, all other questions have been kept the same in the CV and CE-questionnaires, and the surveys have been sent out to an equal number of respondents (900 households, respectively). The valuation scenarios are also framed and worded as similarly as possible, with the aim to facilitate comparisons of both results and the methodological pros and cons. Both methods are chosen because it is the aim of the study to compare the methods, and value the single effects on groundwater protection for both drinking water and surface water and, at the same time, to evaluate the value of the total environmental service. With respect to comparison of the methods, it is the aim to evaluate whether respondents are more confident with one of the two methods, i.e. whether they answer with more certainty in one of the surveys compared with the other. Furthermore, it is an aim to explore whether the valuation questions can be framed and worded in equal terms in these two methods.

1.4 Prior valuation results on water quality with CV and CE

DØR (The Danish Economic Council, 2004), Görlach & Interwies (2003) and Hasler et al. (2004) comprise more extended descriptions of valuation studies on changes in water quality. As Hasler et al. (2004) is a pre-study for the present valuation study, detailed descriptions of the studies and the results are not provided here, but experiences from other studies are described briefly here, and other relevant studies are also commented upon throughout the report.

Bergstrom & Dorfman (1994) conducted two parallel CV studies in Georgia and Maine, respectively, and the policy question was the WTP for "safe" drinking water, where the safety indicator was indicated by the level of nitrate in the water. They found a WTP between 242 and 691 DKK per year per household. The amount is converted from dollars to DKK by a conversion rate of 605,87 (DØRS, 2004, p. 210).

In a French CV study, Stenger & Willinger (1998) found WTP estimates between 701 and 1755 DKK per year for a household for groundwater of good quality. The upper level refers to WTP questions posed by open-ended format, and the lowest level to a close-ended format.

An Italian CV study conducted by Press & Söderquist (1*996)* estimated a WTP of 2483 DKK per year per household. The valuation question is the WTP for securing water quality in Milan so that pollution limit values are not exceeded.

The two former studies used qualitative indications for water quality while the latter used pollution limit values. The three studies all focused on drinking water, and no further studies have been found focusing on both drinking water and surface water quality as is the case in this study. The results from the two first-mentioned studies can be used in comparison with the results from the present study.

Only one Danish study has previously investigated WTP for groundwater protection. Jensen et al., (1995) asked respondents to value several environmental problems. As part of this study the respondents were asked how much they were willing to pay for substantially reduced groundwater pollution, but did not elucidate WTP for purification versus protection. The indicator in that study was also qualitative, and the willingness to pay for groundwater protection was 1000 DKK/year elicited by an open-ended payment format, while it was 2100 using the close-ended format.

With regard to CE, no valuation studies of changes in groundwater quality have been found in the literature, although water quality studies have been conducted with focus on river basins (cf. Georgio et al., 2000). Adamowizc et al. are presently conducting a CE and CV study on tap water and drinking water quality in Canada, but results are not published yet.

1.5 Objectives and hypotheses in the study

The objective of this study is to estimate the benefits of groundwater protection to enable justification of whether there are welfare gains associated with increased protection of the groundwater resource, as compared to the current level of protection and to purification of groundwater for drinking water purposes. In this context, when the term “groundwater” is used, the groundwater resource in Denmark as a whole is implied.

As mentioned, Danish drinking water policy is based on the assumption that the public prefers clean groundwater to water that has been treated (Danish EPA, 1997). However, with the exception of the study by Jensen et al. (1995), which valued the Danish population’s preferences for decreases in pollution of groundwater, these preferences have never actually been explored in valuation studies. The opinion surveys by the Institut for Konjunkturanalyse (IFKA) (1999) and by the European Opinion Research Group (2002) indicate that the Danish population has strong attitudes towards the protection of groundwater. However, “asking questions about attitudes to public goods is not as powerful a predictor for underlying values as eliciting attitudes towards paying for public goods” (Bateman et al. 2002:115, referring to the work of Mitchell & Carson, 1989).

One of the hypotheses in this study is that consumers prefer clean groundwater, which is not in need of purification or other treatment, to water that has been polluted and treated to clean, thereafter. Through valuation, we can analyse these preferences and also assess their strength.

Another hypothesis is that the value associated with clean drinking water exceeds the value associated with good quality of surface waters. The rationale here is that clean drinking water influences human health, and hence private goods, more directly than the quality of surface waters does. Differences in households’ WTP between urban and rural areas, as well as in households with and without children, are also investigated.

Besides elicitation of WTP for groundwater protection and purified water another objective in the study is to compare the results obtained by the two methods, choice experiments and contingent valuation. The differences in willingness to pay for safe drinking water quality and improved conditions in surface waters are estimated, and differences in results between the methods are assessed and analysed as well. The differences are explained.

The aim of this report is to outline how these problems and hypotheses are treated in a valuation study of groundwater protection, comprising the use of two methods: the Contingent Valuation method and the Choice Experiment method.

1.6 Content of the report

In the following Chapter (2), the policy background for scenarios for groundwater protection is outlined, together with a description of environmental effects of groundwater protection. This forms the background for definition of the valuation scenarios in the study.

The study comprises application of both the Contingent Valuation (CV) method and the Choice experiment (CE) method, both methods being used to analyse and assess the same hypotheses and problems. One of the objectives of the study is, as mentioned, to compare the results of these two methods. Considerations of how the common part of the studies is designed are described in Section 3.

In Section 4, the application of the CE method is presented, documenting the CE design of this study. Similarly, the application of the CV method is described in Section 5 to document the CV design. The results of the CE survey are presented and discussed in Section 6, followed by description and discussion of the CV results in Section 7.

The surveys are compared and discussed in Section 8. The conclusions and perspectives are presented and discussed in the summary of the report.

A description of important notions and methods to create an effective design for a CE study is found in Annex 1. The questionnaires are to be found in Annexes 2 and 3, as both Danish and English versions.

2 The valuation scenarios

2.1 Groundwater quality – status and indicators for valuation

Scientific and monitoring results from the literature on groundwater, as well as from consultation of water experts, are used as a basis to establish relevant scenarios and indicators for the valuation of effects of groundwater protection and use of groundwater in the future.

A selection of the results from this research is presented in this section and is followed by a presentation of the information provided to the respondents. However, in the design of the questionnaires the use of too much complex information has been avoided. Scenarios, choices and valuation questions are kept as simple as possible to reduce the cognitive burden and to prevent information overload. At the same time, the design and the scenarios should not be so simple that they cannot be connected to real policy implications and estimations of welfare costs, because the aim of the study is both methodological and to guide policy development. This sounds simple, but is complicated as there are many interrelated aspects (goods and services) connected to groundwater quality.

One of the problems is that the quality of water can be characterised both by non-use and use values and by several indicators - clean water, swimming water, fishable water, drinkable water, visibility and sight depth. Furthermore, many of these characteristics might be correlated.

It has been decided not to focus on the groundwater quality as such, because it is anticipated that the term "groundwater resource" is too abstract for laymen to relate to. We have chosen to focus on two goods connected to groundwater use and protection: *Drinking water quality and surface water quality*, because use of groundwater and protection of the resource affects the quality and quantity of drinking water and the quality of surface waters. Furthermore, the focus is on surface freshwaters such as watercourses and lakes, and not e.g. wetlands and coastal areas.

2.1.1 Status for nitrate and pesticides in drinking water

Drinking water of good quality is, in Danish drinking water policy, defined as:

> "Groundwater which has only undergone a simple process at the waterworks (oxygenation)" (cf. E.g. DANVA 2003, National Association of County Councils 2003, Danish Environmental Protection Agency 2004, GEUS 2004).

Drinking water of good quality is below the limit values for nitrates and pesticides in drinking water, which are 50 mg /l and 0,1 µg/l of water, respectively. The argument behind the limit values for pesticides in groundwater (0,1 µg per litre of water) is that pesticides and pesticide residues are suspected to be carcinogenic, as well as of causing hormone disturbances (Vingaard et al., 2004). The actual limit value for pesticide residues reflects the minimum detectable level of pesticides at the time when the limit value was agreed upon (the 1970s). The monitoring technologies have since been improved, however the limit value is still 0,1 µg/l.

The argument behind the limit value for nitrates in groundwater (at 50 mg/l) is to prevent poisoning of small children via Methemoglobinemia ("Blue Baby" Syndrome) (GEUS 2003), and to prevent cancer. These effects are caused by conversion of nitrate to nitrite in the body, and there is a risk that too high a nitrate/nitrite content can lead to cancer. The nitrate limit value is relatively low compared with the nitrate content in many foodstuffs.

Pesticides and nitrates are the reason for waterworks boreholes to be closed where pollution is the culprit (GEUS, 2003). Frequently, extraction of water from polluted boreholes is continued in order to avoid spreading of the contamination. The water from this type of defensive operation is often discharged to rivers, streams and lakes, or is used as drinking water after being mixed with water from other waterworks boreholes. By this means, water delivered to the consumer can conform to the limit values for drinking water.

New boreholes can lead to localised pressure on specific groundwater sources if the requirement for groundwater and, thereby, extraction of groundwater exceeds the regeneration level for the resource. The time horizon for the generation of groundwater is highly variable. It can take from just a few years to hundreds of years for an aquifer to regenerate. Exploitation at too high a level can lead to the water-table sinking in a localised area and, thereby lead to that streams in that area can extraordinarily dry out in the summer period. Drying-out of streams impacts vital conditions for fish and other animals and plants drastically. It is for this reason that limits are applied for the rate at which the individual borehole can be exploited and for how many new boreholes that can be established in a locality.

Nitrates in groundwater

Half of the boreholes under countrywide groundwater surveillance contain nitrates, and 16% of boreholes contains nitrate over the limit value for drinking water of 50 mg/l. GEUS assesses (GEUS, 2004, p. 32) that, nationally, an indication of a fall in nitrate content is apparent in the youngest groundwater. This can potentially be ascribed to changing cultivation practices since adoption of the Aquatic Action Plan in 1987 (with later additions and amendments, cf. Jacobsen et al. 2004). The average concentration of nitrates in the youngest groundwater, however, still exceeds the limit value for drinking water (GEUS, 2003). The most significant problems in relation to nitrate in waterworks boreholes have been in North Jutland, West Zealand and Aarhus County, in the so-termed "nitrate belts", as well as in areas where aquifers are not deep-lying (GEUS, 2004). GEUS (2004) estimates, however, that nitrate concentrations in primary aquifers can also be high in other parts of the country.

Countywide, an indication of falling nitrate concentrations in deeper groundwater has not yet been recorded (GEUS, 2003). Despite the tendency for concentrations to decrease in younger groundwater, GEUS (2004, p.32) comes to the conclusion that:

> "the measures previously implemented are not likely to be adequate to reduce the nitrate content in groundwater sufficiently".

Pesticides in groundwater
In 2002 (GEUS 2004, p. 71), pesticides or pesticide residues were found in 27% of the boreholes studied in connection with the countrywide surveillance programme. There is no evidence for a geographical connection as in the case of nitrates. 9% of boreholes exceeded the limit for drinking water. With regard to drinking water, 33% of the waterworks boreholes under study in 2002 contained pesticides or pesticide breakdown products, and the limit value was exceeded in 7%. The substance most typically recorded is the breakdown product, BAM, found in 21% of waterworks boreholes in the period from 1992 - 2002. Next in frequency comes the group of pesticides called triazines (e.g. atrazine). Glyphosphate and its breakdown product, AMPA, were found in 1.5% and 1.0% of boreholes studied in the 1992-2002 period, respectively.

2.1.2 Status for surface water quality

Both the quality and quantity of groundwater have implications for the physio-chemical, biological and hydrological conditions in watercourses and lakes. The contribution from groundwater to surface water takes place in several ways:

- The part of the upper groundwater discharged from land drains and ditches contains high concentrations of both nitrates and pesticides in many locations around the country.
- Additions from the deeper-lying groundwater do not, for the most part, carry loads to the same high degree.
- Discharge of upper groundwater via land drains, etc. occurs mostly in the winter period, or in transitory periods with heavy rainfall.
- Discharge from deeper-lying groundwater is relatively constant and, as such, dominates groundwater additions to watercourses and lakes in the summer period (Henriksen and Sonnenborg, 2003). This is because groundwater contributes both quantitatively and with water of good quality, and in the summer period, the water in many watercourses consists solely of groundwater.
- The quantity of groundwater - i.e. the amount of groundwater discharged to the watercourse - holds great importance for the associated flora and fauna. In winter months, additions from the upper layers via land drains play a decisive role in determining the quality of surface-waters.

The *quality targets for surface waters*, i.e. for the receiving environment in watercourses and lakes, are set in consideration of the conditions for fish, invertebrates (monitored by the Danish watercourse fauna index (DVFI)) and sight depth.

Effects of nutrient loads for the quality of water courses and lakes

The DVF-Index is the quality measure for watercourses. Based on invertebrate sampling by this index 44% of Danish watercourses is characterised as clean and varied (Andersen et al., 2003, p. 32), 39% as displaying a moderate fauna and 17% as in a particularly poor state. Quality is generally better in larger rather than smaller watercourses, amongst other reasons due to more stable additions of water (Andersen et al., 2003, p. 32).

The water quality of watercourses is not affected by additions of nutrients (nitrogen and phosphorous) from groundwater to any significant degree. Fish and other water organisms possess an optimal composition and, thereby, good living conditions despite nutrient content higher than background levels (Refsgaard et al., 2002, p. 51, Andersen et al., 2003, p. 34.).

The quality of lakes can be characterised by several indicators depending of the natural character of the lake, e.g. the dominating fish species in the lake, the number of fish species and/or the sight depth. This is because the characteristics of lakes vary a great deal. The natural conditions can, for instance, be both nutrient rich and nutrient poor, and the lake can be small or large, deep or shallow. The number of fish species (species total) in a lake is not much affected by the degree of eutrophication and other pollution-types, but is more dependent on lake size and other factors (Søndergaard et al., 2003, p. 64.).

Even a small change in the addition of nutrients can be highly significant for water quality in nutrient-poor lakes (Refsgaard et al., 2002, s. 43), where impact would be considerably less in one that is nutrient-rich. However, the nutrient content normally affects the quality of water in the lakes and fjords into which streams and rivers enter (Andersen et al., 2003, p. 34), and the same is true in the case of direct groundwater additions to lakes. Furthermore, Danish monitoring results demonstrate that total fish-catch in lakes is affected by nutrient content even though the number of fish species is not much affected by the degree of eutrophication (Søndergaard et al. 2003). Both number and biomass of fish caught increases with nutrient richness, for instance the biomass of pike rise with increased nutrient loading (Søndergaard et al., 2003, p. 62). The proportion of predatory fish measured in relation to weight, however, generally diminishes with increasing nutrient load and biomass of fish such as perch decreases with increasing nutrient load (Søndergaard et al., 2003, p. 63). Fish biomass can be particularly low in lakes where nutrient levels are especially high, as too high a level of eutrophication can lead to fish mortality.

A predominant pollution problem arising from nutrient additions to lakes, however, is an elevated level of algae in the lake water. This affects sight depth. In lakes, it is especially phosphorous which is to blame.

Effects of pesticide residues in lakes and watercourses

Additions of pesticides can have great significance for the ecological conditions in watercourses and lakes. Just as in groundwater, the breakdown product BAM is a considerable part of the pesticide content, the substance stemming from pesticides that are no longer on the market. However, traces of glyphosphate and its breakdown product AMPA are also found in watercourses, just as this substance is found in groundwater and water at the waterworks (Andersen et al., 2003, p. 46).

Crustaceans and insects can be heavily impacted by pesticides, just as the terrestrial flora alongside watercourses can. Consequently, the current pesticide load in watercourses can influence or totally eliminate insects and crustaceans, however, the effects have not been quantified. Pesticides can impact upon fish due to changes in food availability (insects and crustaceans), but quantitative studies relating to current conditions have not been undertaken. Fish can also be poisoned directly by pesticides (Refsgaard et al., 2002, p. 52).

Negative effects of pesticides in Danish lakes have not been demonstrated.

According to Andersen et al. (2003, p.47), few quality requirements are set for pesticides in Danish watercourses. On the basis of the few Danish requirements, as well as Dutch and Norwegian requirements with regard to pesticides in watercourses, Andersen et al. (2003) conclude that, for 9 pesticides, concentrations would breach the set of requirements in a number of the watercourses studied (Andersen et al., 2003).

Studies demonstrate, however, that the concentration of pesticides currently found in Danish watercourses is not affecting *plant growth* (Baattrup-Pedersen et al., 2004, p. 48). The macrophyte community is, thereby, likely not to be affected by pesticides. Pesticides can affect terrestrial plant communities along watercourses, however, but according to Battrup-Pedersen et al. (p. 48) no studies exist to confirm this.

Danish indicators for the quality of lake and watercourses

To sum up, lakes do not react in the same way with regard to nutrient additions, the process of eutrophication and pesticide residues, because natural conditions between Danish lakes vary greatly; depth, size, natural nutrient richness, etc. Therefore, it is difficult to choose one or a few indicators to characterise the quality of lakes at a general level.

An alternative to these quantitative indicators for quality is to use the objective set by the counties in their planning of the quality of waterbodies, as the counties have set more general objectives for lakes in the water policy and regional planning. These objectives are common for watercourses and lakes, and require that, “waterbodies shall be of a quality that secures conditions for a natural and varied animal and plant-life, being in balance and only slightly impacted from human activity “(Cf. Vejle County, 2001).

This objective is in harmony with the objectives of the Water Framework Directive (WFD) which requires, on a general level, that the state of all water resources shall be protected and enhanced. The overall objective is to achieve good water status for all water bodies by 2015, as compared to their natural characteristics. Quantitative measures for "good status" are not agreed upon and confirmed for all water bodies, as pilot studies are pending. As mentioned above, these measures will be very different for different lakes and other types of surface waters. The use of qualitative indicators, therefore, conforms to the policy objectives in the WFD, and valuation studies using these types of indicators can be used in accordance with the implementation of this directive.

2.2 Indicators used in former groundwater valuation studies

Surface water studies, many of them conducted with revealed methods (hedonic pricing and travel costs), have used some of the effect indicators mentioned above as indicators in Danish environmental policy; i.e. visibility and sight depth. Boyle et al. (1999) valued the quality of lakes by hedonic pricing, using visibility in lakes as indicator[3]. Visibility was chosen as an indicator because the visibility is a physical indicator for many other factors like algae and eutrophication level. Boyle et al.'s (op cit) results indicate that the willingness to pay (WTP) was influenced negatively with decreased visibility. Sandström (1996) and Soutukorva (2000) analyse the value of reduced eutrophication in coastal waters in Sweden by the travel cost method, and they also used visibility as an indicator. The WTP for reduced eutrophication is significantly positive and both authors conclude that the net welfare effect is positive. Legget & Bocksteal (2000) studied the pollution of the Chesapeake Bay in the US, also with the hedonic price method on house prices adjacent to the bay. They used the content of the bacteria E Coli as an indicator because the residents were well informed about the pollution with the bacteria, and the bacteria were monitored as a part of a monitoring programme. The results indicate that house prices are significantly influenced by the water quality in the bay.

Many former studies on groundwater and drinking water have used the more qualitative indicator "safe drinking water" as indicator. As mentioned in Chapter 1, Bergström & Dorfman (1994) and Stenger & Willinger (1998) also used qualitative indicators while Press & Söderquist used limit values explained by quantitative indicators (cf.DØRS 2004 and Hasler et al, 2004). Some of the questions asked in former studies were e.g. "Suppose your home tap water is contaminated by nitrates to a level that exceeds the EPA's minimum standard by 50%" and "How safe do you feel about your household drinking water supply?". The critique of these approaches has, among other things, been that they are not directly amenable to water managers in their consideration of the variety of policy outcomes it is necessary for them to consider (Poe & Bishop, 1999). Poe & Bishop (op cit), furthermore, propose reorientation of "future groundwater contingent valuation research towards a focus on actual, objectively obtainable, exposure levels experienced at a study site". This approach is also proposed by DØRS (2004).

[3] Boyle et al. (op cit.) investigate how water visibility influences house prices adjacent to 25 lakes in Maine, USA

It is agreed that this is a recommendable approach in case studies, but the approach is (too) demanding when the value of groundwater is assessed and analysed at a general, national level, as in this study. This is because many indicators have to be used to characterise lakes and river basin systems, which are highly variable in nature due to differences in their respective natural characteristics.

2.3 The choice of indicators in the present study

The basic purpose of the specifications of the indicators in the present study is to emphasise general and overall perspectives of groundwater protection. There are both advantages and disadvantages associated with the adoption of this overall approach, however, as this perspective has been chosen it is important to ensure that the indicators used relate to this approach. The respondent should not relate to, e.g. the specific conditions prevailing in their local area – which would require many local studies.

As apparent from the description above, *quantitative* indicators have some a priori advantages. These indicators could be based on information on e.g:

1. Absolute or relative reductions of nitrate and pesticide additions to the recipients
2. Absolute or relative numbers of plants and animals that would have worse/better living conditions if nutrients and/or pesticides were reduced

Changes in numbers, expressed numerically or relatively, would serve policy purposes because it is possible to create policy measures to obtain these reductions. Limit values can e.g. be used to characterise drinking water quality. But, as seen from the description above, different recipients, and especially the lakes, react very differently to reductions in nutrient loads, and no general quantitative indicator can therefore be applied.

Even though numbers and dose-response functions can be attractive for policy purposes, there is no evidence that numbers are perceived more uniformly by respondents than more qualitative descriptions on water quality and improvements. One result obtained in focus group interviews in the present study was that the respondents related more confidently to qualitative indicators than to quantitative. Among other reasons, this is because some of them did not trust the limit values, as they considered these to have been arrived at politically. Quantitative indications of pollution and effects on flora and fauna were found to be more demanding cognitively to relate to and to understand than qualitative indicators.

Based on this experience and on the description of the present quality and pollution pressure described above, we have found it warranted to chose *qualitative indicators* for the valuation in this study. This should increase the likelihood that the respondents understand the constructed scenario, and should reduce respondents' possible confusion by potential differences between the actual situation in their local area (or another specific area for that matter) and the hypothetical scenarios presented to them.

The policy implication of this is that the results can be used and, as mentioned before, the general approach to the quality of the water bodies is relevant in connection to the WFD. To secure that the respondents have the same minimum knowledge of the good being valued, a separate information sheet is enclosed with the questionnaires. This information is divided into three parts, comprising information on:

- "The freshwater aquatic environment in Denmark",
- "The price of water" and
- "Groundwater pollution".

We have chosen to emphasise that groundwater has an influence on freshwaters, including drinking water, watercourses and lakes. Emphasis is laid on expressing the fact that nearly all drinking water stems from groundwater, which has only been treated in a simple way, this representing a special situation for Denmark compared with very many other countries.

The sources of pollution are mentioned briefly, but numbers are not mentioned. Pollution limit values are also mentioned.

Box 2.1. Information sheet on freshwater and groundwater

The freshwater aquatic environment in Denmark
The majority of drinking water we use in Denmark stems from groundwater. Groundwater is found in cavities and water-bearing layers in the soil. Danish drinking water policy bases itself on that drinking water comes from groundwater which has undergone a very simple process (oxygenation), but which has not undergone any further treatment. This approaches a unique situation in relation to many other countries, where treated surfacewater, e.g. from lakes and rivers, is used.

Groundwater in Denmark is, many places, polluted with waste products from, among other sources, agriculture, industry, road traffic, households/private gardens, landfill sites and sewers. Pollution from pesticides and nitrogen represents the most common reason for many groundwater boreholes to be closed as the water can no longer be used as drinking water without first undergoing treatment processes.

Pollution from agriculture, households, industry, etc. similarly affects animal and plant-life in lakes and watercourses. Together with a range of physical conditions, pollution represents a significant factor in defining the condition of Danish watercourses and lakes and, therefore, also for animal and plant-life in water and adjacent areas.

The price of water
On average, the consumer pays 35 DKK per cubic metre of water (1,000 litre) and each household pays on average 4,000 DKK per year in Denmark in water bills (1,500 DKK per person). This price includes both drinking water supply and removal and treatment of water via sewers (wastewater).

Groundwater pollution
Pesticides are substances, which aim to protect agriculture from the adverse effects of weeds, insects and fungal diseases. Pesticides can also impact on human health and can be poisonous for animals and plants. No precise knowledge is to be found on how damaging pesticides are, however, pesticides and their residual products are suspected to contribute to hormone disturbance in humans and animals, and to be carcinogenic for humans.

Nitrogen and phosphorous are important nutrients for plants. If too much nitrogen and phosphorous is applied, the excess is lost to the environment, including groundwater. Just as with pesticides, excess nitrogen in drinking water is under suspicion for having a carcinogenic effect in humans. Excess nitrogen and phosphorous in the aquatic environment can lead to lakes becoming too rich in nutrients. This can lead to cloudy water and poor visibility through the depths, and, in rare cases, fish mortality can occur.

The information sheet is placed separately in the questionnaire to allow the respondents to use this information when answering the questions.

The qualitative indicators used in the study are presented below in the same wording as presented for the respondents.

2.3.1 The indicators in the CE and CV studies

All of the indicators are presented in Table 2.1.

Table 2.1 The indicators and their descriptions

Indicator / attribute	Levels	Description of levels
Drinking water quality	Naturally clean	Measures aimed primarily at agricultural practices prevent groundwater pollution from pesticides and nitrogen. In this way, clean drinking water is secured both now and in the future.
	Uncertain	The current situation, i.e. groundwater is protected as it is at the moment, however, no further measures to prevent pollution are introduced. When a groundwater borehole is found to be polluted it is closed and a new borehole is established. It is in this way that water authorities ensure a supply of clean drinking water for consumers today. It is uncertain whether sufficient supplies of clean drinking water can be provided in this way in future. There is, therefore, a risk that in future water from our taps will exceed current limit values for pesticides and nitrogen.
	Treated	By cleaning polluted groundwater for pesticide and nitrogen residues, supplies of clean drinking water can be ensured both now and in the future.
Conditions for animal and plant-life in watercourse and lakes	Very good	Animal and plant-life is natural, varied and in balance. Slight to medium impact from human activity.
	Less good	Animal and plant-life is markedly different than would be the case under natural conditions and is, to a degree, in a state of imbalance. Representative of the current situation.
	Poor	Animal and plant-life is significantly different that would be the case under natural conditions and is in a state of serious imbalance. Often completely changed due to human activity.

The quality levels are derived from the scientific and monitoring results referred to in Section 2.1.

In the CE survey, it is expressed that the following three quality levels can describe the general quality of Danish drinking water:

Naturally clean: Measures aimed primarily at agricultural practices prevent groundwater pollution from pesticides and nitrogen. In this way, clean drinking water is secured, both now and in the future.

Uncertain: The current situation, i.e. groundwater is protected as it is at the moment, however, no further measures to prevent pollution are introduced. When a groundwater borehole is found to be polluted it is closed and a new borehole is established. It is in this way that water authorities ensure a supply of clean drinking water for consumers today. It is uncertain whether sufficient supplies of clean drinking water can be provided in this way in future. There is, therefore, a risk that in future water from our taps will exceed current limit values for pesticides and nitrogen.

Treated/purified: By cleaning polluted groundwater for pesticide and nitrogen residues, clean drinking water supplies can be ensured both now and in the future.

As already mentioned, the conditions for animal and plant-life in the aquatic environment are affected both by the prevailing natural conditions and the degree of pollution. In consideration of that the conditions for animal and plant-life vary noticeably from place to place, the following three quality levels are used to characterise the conditions in Danish watercourses and lakes:

Very good: Animal and plant-life is natural, varied and in balance. Slight to medium impact from human activity.

Less good: Animal and plant-life is markedly different than would be the case under natural conditions and is, to a degree, in a state of imbalance. This represents the current situation.

Poor: Animal and plant-life is significantly different than would be the case under natural conditions and is in a state of serious imbalance. Animal and plant-life is often completely changed due to human activity.

In the CV study, the information provided prior to the valuation question is formulated in two separate scenarios.

The first scenario is: "By carrying out measures, primarily in agriculture, naturally clean drinking water can be secured both now and in the future.

At the same time, very good conditions can be secured for animal and plant-life in watercourses and lakes. This means that animal and plant-life will be more natural, varied and balanced, and affected by human activity to only a slight to average degree."

The second scenario is: "Via treatment of polluted groundwater, pesticide and nitrogen residue can be removed, so that the treated water can be used as water for drinking and other purposes. In this way, clean drinking water can be provided both now and in the future. In contrast with the previous proposal, however, groundwater is not protected from pollution with pesticides and nitrogen. Implementation of the treatment proposal will not involve improvements in conditions for animal and plant-life in watercourses and lakes, therefore, conditions will remain less than good. This means that animal and plant-life in watercourses and lakes will be markedly different than would be so under natural conditions and will be in slight imbalance".

By using these definitions we have made an effort to make the wordings of the scenarios resemble each other as closely as possible in the CE and CV-surveys to improve the possibility of comparing the results.

2.4 The scenarios

On the basis of current political discussions on groundwater quality and protection, three appropriate scenarios for groundwater protection and production of clean drinking water are chosen.

In terms of the levels chosen to describe drinking water and surface water quality, reference may be made to Section 1.5 where it is stated that one of the more specific objectives of the present study is to facilitate prioritisation among three different management options. The specific options being increased protection of the groundwater resource, purification of contaminated water and maintaining the current level of protection, which correspond to the naturally clean, treated and uncertain levels, respectively, listed in Table 2.1.

The scenarios are described al together in Table 2.2.

Table 2.2. Description of scenarios

Scenario characteristic	Status quo	Increased protection	Purification (treatment to clean)
Short description of scenario and measures	No protection takes place further to that currently in place.	Groundwater protected against further pollution, now and in the future.	Polluted groundwater is cleaned (purified) of pesticides and nitrates by means of active carbon, osmosis, etc.
Drinking water quality and source	Consumers are provided with clean drinking water from new boreholes, however, localised problems with availability of clean drinking water from untreated groundwater can arise, and drinking water quality will be uncertain in the future.	Consumers are provided with clean drinking water from untreated groundwater and clean groundwater is secured, now and in the future.	Consumers are provided with clean drinking water in the form of treated water or via purchase of bottled untreated water from groundwater and tap water.
Resultant effects on surface waters (watercourses and lakes)	Risk for pollution of watercourses with pesticides, impacts on fish and other organisms in watercourses. Eutrophication of nutrient-poor lakes. Rare cases of fish mortality in lakes.	Improved conditions in watercourses and lakes in those areas where groundwater additions are large. No difference in relation to the status quo in areas where runoff from fields is considerable.	Risk of pollution of watercourses with pesticides, negative impact on fish and other organisms. Eutrophication of lakes. Occasional cases of fish mortality.

2.4.1 The status quo-scenario - the current situation

The facts used to establish the status quo scenario are described in Section 2.2. The text presented to the respondents on the status quo scenario in the CV-study is:

"At the moment, a range of measures is carried out with regard to protection of groundwater against pollution from pesticides and nitrogen. When a groundwater borehole is found to be polluted, it is closed and a new one is established.

It is uncertain whether clean drinking water can be provided in sufficient amounts by this method in the future. There is, therefore, a risk that tap water will exceed current limits for pesticides and nitrogen content in the future.

Conditions for animal and plant-life in watercourses and lakes are not so good. Animal and plant-life is in a state of imbalance many places and is markedly different than would be so if conditions were natural. The primary reason for changes in the condition of the aquatic environment is human activity. "

In the CE study this text is the same as the definitions of the status quo-levels, cf. Section 2.3.1. above:

"The current situation is characterised as "uncertain": The current situation, i.e. groundwater is protected as it is at the moment, however, no further measures to prevent pollution are introduced. When a groundwater borehole is found to be polluted it is closed and a new borehole is established. It is in this way that water authorities ensure a supply of clean drinking water for consumers today. It is uncertain whether sufficient supplies of clean drinking water can be provided in this way in future. There is, therefore, a risk that in future water from our taps will exceed current limit values for pesticides and nitrogen.

Animal and plant-life is less good and markedly different than would be the case under natural conditions and is, to a degree, in a state of imbalance. This represents the current situation".

2.4.2 Protection scenario: Improved protection in drinking water areas

The information provided to the respondents on the protection scenario in the CV-survey is that:

"By carrying out measures, primarily in agriculture, naturally clean drinking water can be secured both now and in the future. At the same time, very good conditions can be secured for animal and plant-life in watercourses and lakes. This means that animal and plant-life will be more natural, varied and balanced, and affected by human activity to only a slight to average degree. "

In the CE study the scenario is formulated in the definitions of the attributes: *Naturally clean groundwater: Measures aimed primarily at agricultural practices prevent groundwater pollution from pesticides and nitrogen. In this way, clean drinking water is secured both now and in the future. Animal and plant-life in watercourses and lakes (ed.) is natural, varied and in balance. Slight to medium impact from human activity*.

An assumption behind this text and scenario is that the use of pesticides and nitrogen is reduced by agricultural measures, i.e. environmentally sensitive farming practices and reduced nutrient applications, set-aside, forestation and ceasing cultivation altogether.

An effort sufficient to prevent groundwater pollution, defined as breaching limit values, is implemented. Under this scenario, there would be no need to close boreholes in future. There would, however, be potential for borehole closure as a result of previous pesticide use.

2.4.3 Purification scenario - Groundwater treated for drinking water supply

The information provided to the respondents in the CV study is:

" Via treatment of polluted groundwater, pesticide and nitrogen residue can be removed, so that the treated water can be used as water for drinking and other purposes. In this way, clean drinking water can be provided both now and in the future. In contrast with the previous proposal (The protection scenario, ed.), however, groundwater is not protected from pollution with pesticides and nitrogen. Implementation of the treatment proposal will not involve improvements in conditions for animal and plant-life in watercourses and lakes, therefore, conditions will remain less than good. This means that animal and plant-life in watercourses and lakes will be markedly different than would be so under natural conditions and will be in slight imbalance. "

In the CE study, this description refers to the alternative, purification, which is described by the following indicators:

By cleaning polluted groundwater for pesticide and nitrogen residues, clean drinking water supplies can be ensured both now and in the future. Animal and plant-life will be markedly different than would be the case under natural conditions and is, to a degree, in a state of imbalance (as the current situation): Animal and plant-life is significantly different that would be the case under natural conditions and is in a state of serious imbalance. Animal and plant-life is often completely changed due to human activity.

The assumption behind this, is that groundwater can be treated with active carbon, osmosis or other treatment techniques. Almost all groundwater can, therefore, be used as drinking water, and the drinking water will conform to limit values for nitrates and pesticides. As protection measures are no higher than in the status quo scenario, nitrates and pesticides will be added to watercourses and lakes to the present or to a greater extent. There is, therefore, a risk that animal and plants associated with watercourses and lakes are impacted negatively by pesticides. This is particularly the case for animal-life, however, terrestrial plant communities along watercourses can also be affected. There is an increased risk for eutrophication of lakes, with more frequent cases of fish mortality as a result.

In all these three scenarios there would be continued need for defensive pumping and drilling to limit the pollution that has already taken place.

Further information of the wording of the scenarios in the CE and CV questionnaires, respectively, are found in the Annexes 2 and 3.

3 The part of the CV and the CE studies common to both

The CV and the CE surveys are aimed at estimating WTP for the same scenarios and problems regarding groundwater protection. As far as possible, the same wording and framing has been used in the two surveys. In this section, the common parts of the surveys are presented, comprising the scenarios and indicators as well as the common questions in the surveys – introduction and "warm up" as well as debriefing questions.

Detailed descriptions of the methods CV and CE are not provided here, but can be found in textbooks on environmental economics (see e.g. Bateman et al. 2002; Hanley et al. 1997; Mitchell & Carson 1989). A range of recommendations on how to perform reliable, realistic and credible valuation surveys can be found in these textbooks as well as in the recommendations from the NOAA panel (the National Oceanic and Atmospheric Administration, Arrow et al., 1993), and in the extensive literature in this field.

3.1 The stages in a stated preference study

3.1.1 Basic assumptions

The basic requirement for applying valuation is that it is possible and reasonable to assign a value to the environmental goods and that this value reflects the individual consumer's WTP for the good in relation to other goods. Some important assumptions behind this principle are that;

- it is assumed that the consumer holds a preference for *more over less*, i.e. that two units of a good will be preferred over one unit (scale).
- the consumer is able to carry out a *complete ranking* of the value of different goods. This means that the individual actor has well-defined preferences in relation to all goods, including those not necessarily consumed.
- it is assumed that the consumer has full information of his/her choices and the substitutes, and the consumer has what are called *transitive preferences*. This involves that the individual displays consistency in consumer choices: If good A is preferred over good B, and good B is preferred over good C, then good A will be preferred over good C (cf.Bateman et al., 2002).

3.1.2 Hypothetical bias and scope

If these basic assumptions fail there is a risk of hypothetical bias, this being an often-mentioned problem associated with stated preference methods, especially the CV method. One of the reasons is that respondents might be induced to behave *strategically*. This is a potential weakness of the hypothetical methods. Strategic behaviour can be explained by the fact that respondents do not always have the incentive to answer truthfully, as they are not going to pay the stated amount in reality. In other words, the respondent reduces his/hers bid in the belief that someone else will pay for providing the good. On the contrary, respondents who are very much pro-environment may potentially overbid or "yeah-say"' in order to influence the policy outcome. This risk is particularly the case when the valuation is about a public good that gives the respondents scope to "free-ride". However, the right kind of information, making the valuation scenario as realistic as possible, stressing that everyone must participate and using realistic payment vehicles can all help to tune down the hypothetical nature of the scenario and impede strategic answers (cf. Morrison, 2002) Furthermore, such bids can be identified by debriefing questions.

Other sources of bias are embedding and part-whole bias. Embedding refers to bias when WTP for a particular good vary "over a wide range depending on whether the good is assessed on its own or embedded as part of a more inclusive package" (Kahneman & Knetch 1992:58, here from Christie, 2001:256).

According to Christie and several CV practicians (Desvousges et al. 1993 and Arrow et al. 1993) embedding poses a threat to CV-validity. However, Hanemann (1994) identified three notions related to the embedding effects;

- *scope effects* appear when WTP does not change when scale or scope of the valuation problem changes;
- *sequencing effects* appear when WTP change according to when the WTP question on a good is asked in a sequence:
- *sub-additivity* appears when the WTP for a change in a composite of goods differs from the sum of individual valuation of these goods.

According to Hanemann (op cit.) scope effects can be avoided by survey design, while sequencing effects and sub-additivity can be explained by economic theory, i.e. from substitution effects and diminishing marginal rates of substitution (Christie 2001:257). The conclusion is that the two latter, i.e. sequencing and sub-additivity, do not pose a threat to CV-studies, and that scope effects can be avoided. Bateman et al. (2001) have tested scope sensitivity in an extensive paper on visible choice sets and scope sensitivity and conclude that scope sensitivity is not observed when applying advanced disclosure designs. For further elaboration of these results, see Bateman et al. (2001).

In this survey the goods are nested – i.e. there are several effects stemming from changes in the management of the groundwater resource – both effects for drinking water quality and quality of surface waters. This can create problems with the perception of scale, and attention has to be paid to how these goods are presented to the respondents in the two surveys.

3.1.3 The design of a stated preference study

Normally the design of a stated preference survey consists of three fundamental steps:

1. Introductory and detailed description of the environmental change, including the institutional setting which will provide the change and the scale.
2. Elicitation of willingness to pay. CV and CE represents two possibilities:
    - Description of the payment vehicle and a method to elicit the respondents' preferences with respect to the environmental change (CV), *or*
    - Description of the payment vehicle and presentation of choice-alternatives characterised with different levels of the environmental change and the price (CE)
3. Debriefing questions and socio-demographic information.

Evidently, all parts except from the payment elicitation questions should be held the same in a CE and CV survey to allow for comparisons.

Testing the questionnaire
Every part of the survey should be tested before submission. The present surveys are tested by several methods: focus group-testing, individual interviews and pre-testing of questionnaires. One focus group test was held and ten individual interviews were conducted. Subsequently, the questionnaires were revised and sent out to pilot respondents recruited at two research institutes, comprising service employees with short educations as well as administrators and researchers, both economists, sociologists, biologists and engineers.

3.1.4 The introductory information and questions

Most surveys start with an introductory text and introductory questions to "warm up" the respondents. Hereby, they are encouraged to think seriously about the topic of interest, the scale, etc. This is done both to provide the necessary information and to impede strategic answers (Bateman et al. 2002).

Information is of course of particular importance if it is a risk that the respondent is unfamiliar with the good in question. This would imply that the respondent is unlikely to provide an accurate response leading to hypothetical bias and poor estimates for the consumer surplus measure. Lack of familiarity is, however, less likely to be a problem for valuing services provided by e.g. water utilities because consumers are already accustomed to paying for a base level in service (CIE 2001). Goods connected to surface water and biodiversity are more likely to be unfamiliar to respondents, and proper information and introduction to the respondents are, therefore, important. However, too much information can affect the response unfavourably because of boredom and because the act of responding become too time-consuming.

It is it, however, necessary to keep in mind that survey respondents bring their own knowledge of the quality of the goods to valuation exercises. If information on the quality is not explicitly described and the respondents at the same time have different levels of prior information about the environmental quality of the good to be valued, the WTP estimates will vary due to differences in *quality perception,* not only preferences. In relation to the wording used in the description of the different alternatives and indicator levels it has been attempted to use as neutral a wording as possible.

The solution is, therefore, to make an understandable and unambiguous description of the good to be valued and describe the quality change or improvement in such detail that the respondents have the same level of basic information. It is also of importance to give sufficient information about the provision of the good so the respondent will be convinced that the good will be delivered. In addition, questions of knowledge and perceived quality of the good and change in this quality can be incorporated in the survey, and used as determinants of WTP.

The background information is, as mentioned, equal in the CE and CV questionnaires, and the wording is apparent from Box 2.1., presented and commented upon in Chapter 2.

In both the CV and the CE survey, this background information is followed by additional information of the scenarios connected to the valuation questions. This information deals with explanations of the scenarios and indicators (attributes), presented and described in Chapter 2. In connection with this information, the respondents are also informed that the issue relates to changes on a national scale, and that specific regional problems are not referred to in this study.

Determining the level of detail and amount of information necessary to describe the alternatives, including their attributes and levels, and the scenario has been afforded a great deal of attention in the study, even though the information presented is not very comprehensive.

The pre-tests conducted have provided interesting insights into different individuals demand for, and use of, information. With regard to the amount of information and level of detail provided in the present study, it was found that most "experts" – i.e. people employed within the environmental policy/management arena – felt that they needed more, and more detailed/subtle, information if they were to feel comfortable making a choice. Thus, they found it hard to accept the general perspective adopted in the study. Most non-experts, on the other hand, found the level of information and detail satisfactory; hence, they acknowledged that increasing the amount of information/level of detail would be likely to result in information overload. As it is important to ensure that all respondents receive the same information prior to completing the CE, it will evidently be impossible to satisfy everyone. Accordingly, the amount and detail of the information provided in the present study will no doubt be considered too extensive by some and too limited by others. For most, however, the amount and detail of the information is believed to be sufficient, while also being fairly easy to read and grasp.

The information provided intends to increase the likelihood that respondents understand the constructed scenario. The intention is also to ensure that respondents are not confused too much by potential differences between the actual situation in their local area (or another specific area for that matter) and the hypothetical scenarios presented to them, at the national, general level. At the same time, we have attempted to avoid information overload and, hereby, tiring the respondents. The information is submitted to the respondents on a separate sheet and they can read the information whenever they want. The information–sheet is introduced in the foreword (introductory text) to the questionnaire.

Suitable information and making people think of their present budgets are potential "preventive" measures in relation to mitigate problems related to the risk for hypothetical bias, mentioned earlier.

3.2 The payment vehicle in the surveys

3.2.1 The WTP questions and choice of a reliable payment vehicle

People are asked directly to state their WTP (or WTA) in CV. Different questions can be asked, e.g. open-ended questions (how much are you willing to pay?), close-ended questions in payment cards or dichotomous choices. In CE, respondents are supposed to state their WTP indirectly by making trade-offs between alternative choices. The alternatives are characterised by different levels of attributes. The attributes comprise a price attribute and, hereby, WTP can be elicited.

The welfare implications are expressed in terms of a change in the monetary amount which would be taken from the individual (WTP) to keep the individual's overall level of utility constant. The appropriate measure depends upon the relevant property right to the environmental good. The measure is often referred to as Hicksian consumer surplus measures (Carson et al. 2001).

When the environmental change is an improvement in quality, the measure is WTP. This implies that the researcher has to describe a method of payment in the scenario, commonly referred to as the payment vehicle.

The choice of payment vehicle forms a substantive part of the survey design and should have a plausible connection with the good it is being used to value (Garrod & Willis 1999). The payment vehicle can be coercive, e.g. taxes, fees or annual sums such as the water bills.

Alternatively, it can be voluntary in the form of donations to an environmental foundation. However, voluntary payments and donations have proved to overstate WTP more than coercive payments. It is important to choose a payment vehicle that will be perceived as realistic, fair and equitable for all respondents. If this can be the case, it may lead to fewer non-responses or fewer protest responses and avoid giving the respondent an opportunity for free-riding. Other aspects of payment are the timing of payment by the individual or the household, and the choice of format to elicit the payment bid.

An amount which represents an additional payment to the annual water bill was chosen as payment vehicle, as it is our assumption that this payment is credible, relevant, acceptable and coercive (Bateman et al., 2002), because consumers are accustomed to pay for the households' water in this way. An increase in the water tax would potentially not be credible as the present government intends to stop for tax increases in Denmark. Annual payments are chosen as opposed to monthly payments. It is not expected that the WTP will be higher if monthly payments were introduced, so an alternative would be to present both annual and monthly payments. It has been concluded, however, that information on both monthly and annual payments would be too information demanding for the respondents, and the yearly payment is most relevant because the water bill is paid annually. Household payment is chosen because the water bill is paid per household and not individually.

Using increases in the price of water, expressed as DKK/m^3, as payment vehicle was also considered, expecting that the water price would be an intuitively understandable and uncontroversial payment vehicle for the respondents due to its dependence on consumption. In relation to the subsequent interpretation of results and aggregation of WTP-estimates, however, it would require information on households' annual water consumption. According to the results of our pre-tests, this information is difficult to obtain as most people do not know how much water they consume. Based on this, the original idea of using the price of water as payment vehicle was abandoned in favour of using a fixed annual increase in the water bill per household, which – though probably being more controversial to the respondents – will significantly ease interpretation of the results.

3.2.2 The budget constraint and "cheap talk"

The information on the payment in both the CV and the CE is specified so that the respondents should be aware about the payment vehicle and constraints on the households' budget. In both of the surveys, the assumptions are that the costs of implementing the policy alternatives are covered by the Danish consumers, and that all consumers will contribute equally to implementation of the scenarios by means of a fixed annual sum per household. This sum is paid once a year via the water bill. The respondents are told that their stated amount (WTP) represents a sum over and above their present water bill. In addition so-called "cheap talk" is added. This text is added to the budget reminder (cf. the CV and CE questionnaires in the appendices):

"Results from similar studies have shown that people have a tendency to over-estimate how much they are actually willing to pay for implementation of the various policy measures. Before you mark your selection, therefore, we would ask you to be totally sure that you are willing and able to pay the stated sum associated with an alternative."

This text is intended to induce respondents to provide as valid and reliable responses as possible and to discourage the exhibition of strategic behaviour. Highlighting that all consumers must contribute, and that they must do so equally, is intended to discourage respondents from free-riding. Likewise, stipulating that the stated amounts are additional to the current water bill is considered relevant as it may serve to remind respondents that the amount they are asked to pay in the present survey is in fact only one among many expenses that they have to consider.

According to Cummings and Taylor (1999:650) who introduced the "cheap talk" concept, cheap talk may be defined as an attempt to eliminate hypothetical bias by including an explicit discussion of the problem. In their study Cummings and Taylor (1999) found that cheap talk could effectively, if not eliminate, then at least mitigate, hypothetical bias in the cases considered. Subsequently, the effect of different cheap talk designs, implemented in various contexts, has been investigated in a number of studies, but experiences here have been mixed. While Carlsson et al. (2004) and Murphy et al. (2003) found the inclusion of cheap talk to have a positive effect, Samnaliev et al. (2003) found it had no effect.

Despite the inconclusive effect of cheap talk, it has been decided to incorporate a short cheap talk section in the design of the present study. Compared with other studies it should, however, be emphasised that the script used in the present study, which only amounts to a couple of lines, is significantly shorter than the ones usually applied. As an example, the cheap talk in Cummings' and Taylor's (1999) article amounts to more than half a page. In relation to the present study, the inclusion of such an elaborate cheap talk section is considered inappropriate as it is expected that the resulting negative effect arising from increasing the length of the questionnaire would by far outweigh the potential positive effect arising from using cheap talk. Based on this, it may be questioned if what we term "cheap talk" in this study actually qualifies for what is usually implied by the term. However, as an explicit reference is made to the problem of hypothetical bias, it is considered acceptable to do so.

3.3 Additional questions

Apart from the payment questions used for elicitation of WTP, both the CV and CE surveys also collect additional information through questions on attitudes, opinions, knowledge, use of the public good, socio-demographics, as well as follow-up questions (debriefing). The latter comprise questions on valuation responses, and these are added both to allow the respondents to express their motivations for answering the way they do, and to identify their motivations, including strategic answers and protest bids.

3.3.1 Starting questions - attitudes, opinions, knowledge and use

The questions on attitudes, opinions, knowledge and use are placed in the introduction to both the CE and the CV surveys, which is praxis in most stated preference studies. These questions serve the purpose to:

- "warm up" the respondents
- check for consistency
- help them think about important aspects of the valuation problem

- provide information that can help to validate the valuations
- be used as predictors of WTP

Consequently, some of the questions are asked to facilitate tests of consistency between the respondents' statements, preferences and willingness to pay, e.g. about the respondents' general view on environmental problems and whether the current budgets for water protection are sufficient in relation to other environmental problems and other public services. By "warming up" the respondents, these questions also induce the respondents to think about the trade-offs between environmental policies and programmes as well as between public projects in general.

Questions asked in this section of the questionnaires comprise questions on attitudes to the environmental problems, which are regarded most important, and how is water quality positioned in relation to other environmental problems? The answers to these questions can be compared to the results of the studies referred to in Section 1.1. on the Danish population's concern for water quality problems (Cf. IFKA 1999; the European Opinion Research Group, 2002).

Furthermore, questions on consumption are asked. The questions of consumption of bottled water as a substitute for tap water serves the purpose of making the respondents think of these substitutes. Questions on water-savings and water consumption in quantitative (litre) and monetary terms (the annual water bill) make the respondents think about their own water consumption and relate to their present expenses for water, and hereby to their household budget. The water-saving questions are, furthermore, worded in the same terms as the questions in a survey done by the Statistics Denmark, and hereby the responses are comparable. By comparing the answers, we can also see whether the respondents of the CV and CE surveys are representative with regard to water-saving practices.

There are also questions on the use of surface waters for fishing and bathing, and questions on which qualities they prefer most, how often they bathe, fish, etc., cf. Annex 2 and 3.

3.3.2 Debriefing and follow up-questions

Inclusion of a set of follow-up questions upon completion of the valuation question(s) is recommended, and additional questions are asked in most surveys.

Follow-up and debriefing questions are used to control for biased and illegitimate answers. With such follow-up and debriefing questions, it is possible to check respondents' understanding and acceptance of the constructed scenarios and to identify their motives for answering as they did to the valuation question (Arrow et al., 1993; Bateman et al., 2002:145). Thereby, an assessment of the rationality and validity of the expressed preferences is facilitated.

Ideally, follow-up questions should be asked in relation to both CE and CV-surveys, but the formulation of questions that may serve to reveal irrational and/or invalid answers is less straightforward in CE than in CV-surveys due to the more indirect nature of the valuation exercise in the former.

In the present study, 6 questions regarding respondents' experience of the choice exercise and how they made their choices are asked immediately after both the CV and the CE exercise.

In the first of these questions (Question 6.1), respondents are asked whether or not they found it difficult to make the choices. One of the motives for asking the question is that respondents' answers may indicate something about the reliability of the choices. If choices are considered difficult, it may indicate that choice complexity was high – and perhaps too high – for the given respondent. A supplementary method when addressing and correcting hypothetical bias is, therefore, to use certainty calibration (Samnaliev et al., 2003:1). In both the present CV and the CE surveys, this certainty calibration approach is adopted. Respondents are – upon completion of the valuation task – asked on a scale ranging from 1 to 10 (with 0 denoting a low degree of certainty and 10 denoting a high degree of certainty) to state how certain they are about the answer they just stated.

It is then possible to treat the answers provided by respondents stating a level of uncertainty below the determined threshold level (e.g. 8) by subsequently "re-coding" them, so that positive answers to the WTP question for these respondents no longer are treated as a "yes" (Samnaliev et al., 2003:2).

Due to the survey format (i.e. mail administered), it has been considered inappropriate to ask explicit questions concerning respondents' understanding and acceptance of the scenario, while it has proved impossible to identify questions suitable for disclosing the underlying reasons for the implicitly stated WTPs.

Instead, the focus of the included follow-up questions is on assessing the extent to which respondents' decision strategies conform to the assumptions underlying the CV and the CE approach, and on shedding light on the level of certainty by which the WTP bids and the choices can be interpreted.

One example: In Question 6.6, respondents are asked whether or not they, if the water coming out of their tap was water that was cleaned of nitrogen and pesticides, would use it as drinking water. This question has been asked in order to prevent a potential shortcoming of the constructed scenario. More specifically, we do not know which consequences people associate with the "treated" and "uncertain" water quality levels. That is, we do not know if they still will perceive the water coming out of their tap as drinking water, albeit of a lower quality than "naturally clean" water, or if they will find it necessary to buy water for drinking purposes if we do not ask. This information might, therefore, prevent problems in relation to the interpretation of results, as the value estimates derived from peoples' choices are likely to reflect peoples' perception of these consequences. More specifically, people finding it necessary to buy drinking water are expected to state a relatively low value compared to others, as the value they associate with a given scenario needs to be adjusted with their expected expenses on buying water. Prior to making their choices, these respondents should, therefore, ideally make calculations regarding the more specific magnitude of their expected expenses on buying water in the situations described by the "uncertain" and "treated" water quality levels, otherwise their choices would not be completely rational. However, imposing such strict requirements on respondents' decision strategies is considered unreasonable. Thus, a more realistic expectation may be that respondents answering "no" to this question will exhibit a lower WTP than others for the "uncertain" and "treated" water quality levels. In this context, the basic purpose of Question 6.5 is to clarify if respondents perceive "treated" water as drinking water, while Question 2.3 serves to provide clarification on the issue in relation to the "uncertain" water quality level.

For respondents providing a negative answer to the question, a follow-up concerning their expected expenses on buying water should ideally be included. However, this was not considered appropriate in the present context due to the very general and hypothetical nature of the scenario, which does not invite people to engage in such very specific calculations. Thus, as indicated above, it is not only considered sufficient, but also highly satisfactory, if respondents take the issue into consideration. An interesting (though very weak) validity test may, therefore, be to investigate if respondents providing a negative answer to the question conform to the expectation by attaching a lower value to the "treated" water quality level than others. And if they do, how much does the WTP differ?

For further introduction to the follow-up questions, see the questionnaires in Annex 2 and 3.

3.3.3 Socio-demographic questions

These questions are asked in the final part of the questionnaires because respondents can be sensitive answering this type of question, e.g. questions of income. The questions asked in this section of the questionnaire relate to age, gender, household and personal income, household size and number of children, house-type and community number (location of residence). The answers to these questions can be used for the tests of differences in WTP between households with and without children, between regions, between income groups as well as differences explained by gender.

3.3.4 Survey mode and sample size

A professional survey institute has been used in the pre-tests and the submission of the surveys. The institute has been chosen in order to secure a good response rate, using a panel of respondents which is representative of the Danish population. The institute GfK-Denmark (Growth from Knowledge) has been used. They have sent the questionnaires to 1,800 households, 900 for the CV and 900 for the CE.

Based on statistical considerations, sample sizes between 250 and 1.000 (depending on the format) respondents are recommended for each subgroup of the population in CV surveys. Extending the recommendation from the CV case, the required sample sizes are probably smaller due to the increased amount of information collected from each respondent through the multiple choice tasks (Bateman et al., 2002:111). However, potential correlation between observations made by the same individual may imply that the scope for reducing sample sizes in the CE survey with reference to increased extraction per respondent is limited.

3.4 Socio-economic characteristics, attitudes and habits: The responses to the common part of the questionnaires

3.4.1 Socio-economic comparison between the sample and the population

This section describes the data collected from the responses from the first and the last section of the questionnaires. The responses from the two questionnaires (CE and CV) are pooled, or aggregated, to obtain an overview of the quality of the total sample. To find out whether the responses are representative they are compared to population data from Statistics Denmark (DST) by graphical comparison and testing of resemblance. The control of a discrete distribution is made by means of a Q-test. The responses are hereafter referred to as the "sample".

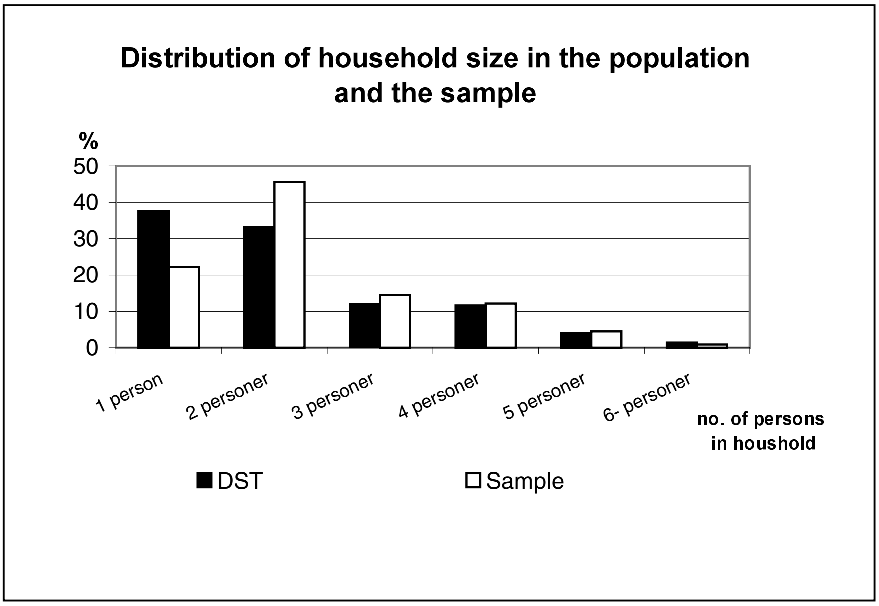

Figure 3.1. Household size

Figure 3.1 shows the distribution of the size of family in the sample. It appears that the sample contains a larger fraction of two-person families than the mean Danish population, and vice versa for "singles", i.e. households consisting of only one person. On the whole, the sample reflects the population well. Additionally, it is an important fact that the sample has been collected on an individual basis – not on a household basis. I.e. the individuals are representative of the population, but the households do not need to be so. The over-representation of 2-person households in the sample can be explained by the fact that the mean Danish family-size is 2 persons. Figure 3.2 shows the distribution by gender.

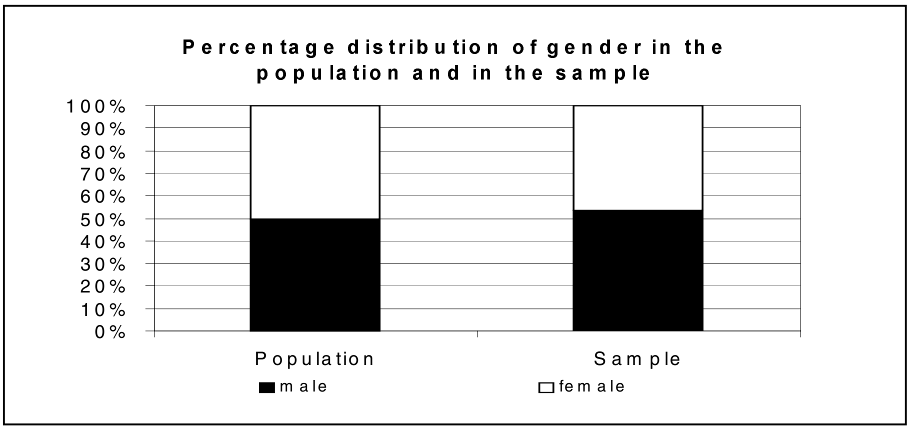

Figure 3.2. Gender

Compared with the Danish population, the sample contains a slightly higher percentage of male respondents. The figures with respect to male representation are 53.8% in the sample and 49.5% in the population.

In Figure 3.3 the distribution of age is illustrated. The difference between the sample and the population is here somewhat more significant. In particular the age groups 18-30, 46-60 and 61-75 in the sample diverge from the general population. The proportion in the 18-30 age group – and to some extent also the 31-45 age group – is much smaller in the sample than in the population.

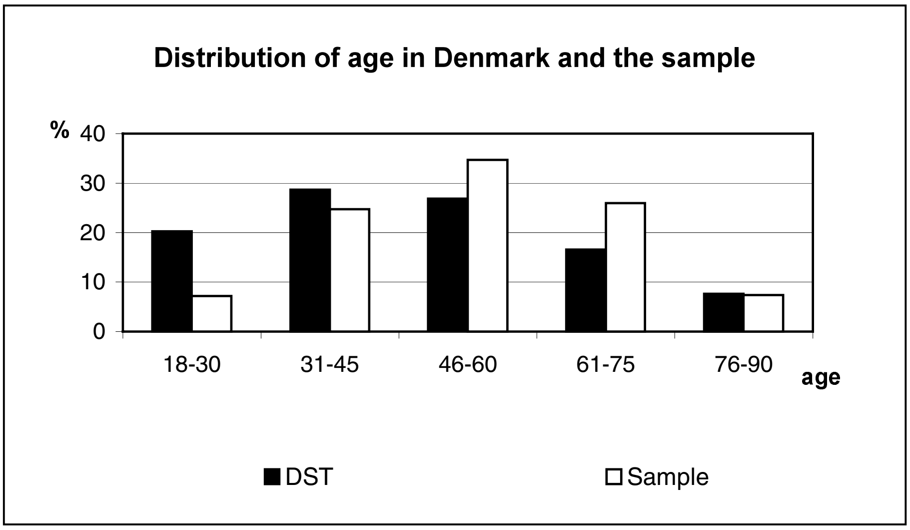

Figure 3.3. Age

Conversely, the 46-60 and the 61-75 age groups exhibit the opposite tendency, the sample showing a higher fraction than the population. In general, this tendency shows that the response rates are higher for people aged 46-75. The Q-test rejects the hypothesis that the sample is well described by the distribution of the population, in this respect.

The distribution of household income in the sample shows a better resemblance to the population. Two income intervals exhibit some difference though; namely "100,000-149,999 DKK" and "400,000 DKK and above". According to Statistics Denmark, 40% of Danish households has an income higher than 400,000, which is reasonable to expect. The sample, however, exhibits a much higher frequency of occurrence for that particular income group. Approximately 53% of the sample is in the high-income section. Again this might be caused by the problem of collecting data on an individual basis. After all, larger households have a higher yearly income. The above is illustrated in Figure 3.4.

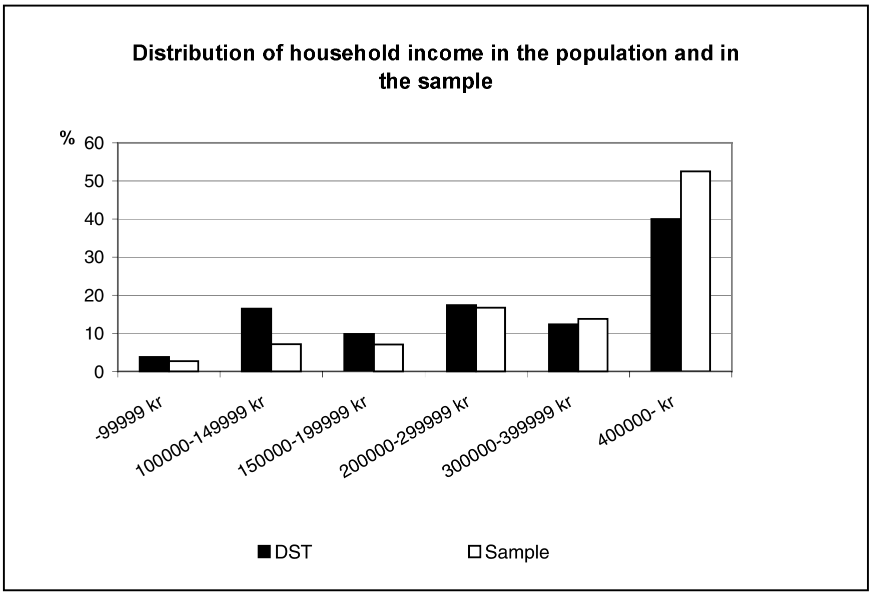

Figure 3.4. Income distribution

There are also apparent differences regarding households and families with and without children. From Figure 3.5, it is apparent that a large proportion of Danish families has no children. Approximately 77% of households have no children while, in the sample, households without children account for 55% of the response.

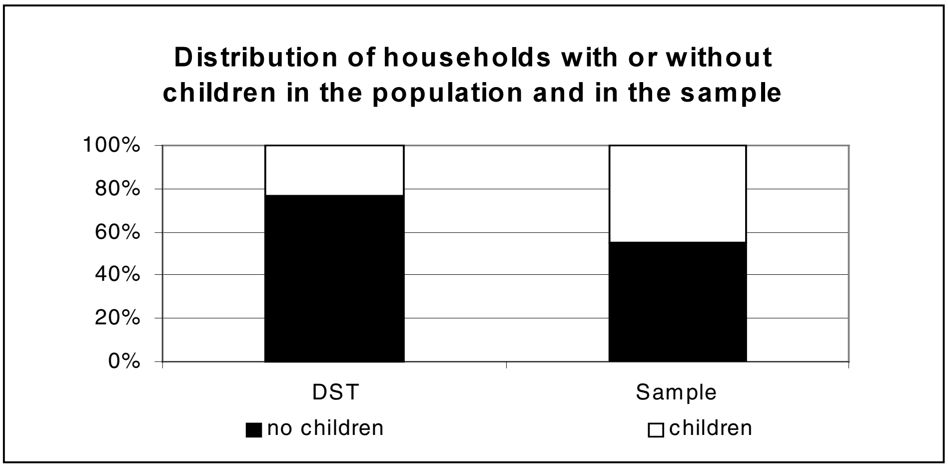

Figure 3.5. Children

The connection between households of more than one person and families with children is obvious. Similarly, there is a connection between the distribution of age in the sample and the distribution of the families with one or more children.

The differences between the sample and the population are considered further in the discussion of the results.

3.4.2 Comparison of habits in the sample and in the Danish population

Statistics Denmark (2003) has investigated the Danish populations' water saving behaviour by telephone-interviews. In order to be able to draw comparisons between the present survey and Statistics Denmark's population investigation we have used the same questions as in their survey, cf. Section 3.3.1.

The results from Statistics Denmark (DST) are compared with the answers from the present surveys in Table 3.1.

Table 3.1. Water saving habits: "What do you do to save water?"

	Water saving				turn water off while brushing teeth
	-toilet	-taps	-washing machine	-dishwasher	
DST	57	50	57	34	82
Sample	59	39	48	32	74

The figures are hyper-geometrically distributed and the standard deviations are used as a simple measurement of accuracy. That is, if the actual value is within the range of two standard deviations of the calculated values obtained from the questionnaires, they are assumed to be distributed equally. It appears that the problem of being out of range occurs three times in Table 3.1 regarding water saving taps, water efficient washing machines and the "turns water off..."-categories. A smaller share of the sample than the population displays water saving habits regarding their choice of washing machines and water saving taps, and a smaller share of them turn water off when they brush teeth. Regarding water efficient toilets and dishwashers, a good resemblance is exhibited.

However, no clear conclusions can be made as to how these differences influence the willingness to protect or purify groundwater.

Table 3.2 compares the respondents' reasons for water saving behaviour compared with the reasons stated in Statistics Denmark's survey.

Table 3.2. Reasons for water saving: "Why do you save water?"

	Very high importance	High importance	Some importance	No importance	Do not know	Do not save water
	The price as reason for water saving behaviour					
DST	19	29	20	25	1	6
Sample	23	25	28	9	3	12
	The environment as reason for water saving behaviour					
DST	31	33	19	10	1	6
Sample	29	37	15	3	4	12

The share of the sample that finds that price is of very high or high importance, when these two response categories are pooled together, is equal to that in the population - even though the sample is somewhat more price-aware. Only 9% of the sample finds that price has no importance, compared with 25% of the population. Conversely, the sample pays somewhat less attention to environmental reasons for saving water. Only 3% of the sample find that the environment has no importance for their water saving behaviour, while 10% of the population responds in this category. These differences can be interpreted to point to a lower willingness to pay for environmental improvements among the sample as compared to the population, but the differences are not large.

These results regarding water saving habits and the respondents' attitudes are interesting in themselves, but the answers are also used in the econometric analyses of the CV and CE responses in Section 6 and 7. The differences between the sample and the population are, furthermore, used in the comparison of the results in Section 8.

4 Application of the Choice Experiment method

4.1 The CE method

The CE method was, like the other Choice Modelling (CM) techniques, developed for market analysis (Batsell & Louviere 1992; Louviere 1988), but the methods have been increasingly used and further developed for the valuation of non-marketed goods (Adamowicz, 1995, Boxall et al. 1996, Hanley et al. 1998a,, Hanley et al. 1998b, Hanley et al. 2001).

In a CE study, respondents are requested to choose between predefined alternatives which each are connected with different implementation costs, drinking water quality, other environmental impacts, etc. Use of the approach on Danish environmental problems can be found in:

- Schou et al. (2003), who used CE in valuation of the impacts of pesticides on nature,
- Aakerlund (2000), who used contingent ranking for valuation of forest characteristics;
- Boiesen et al. (under preparation), who used CE for valuation of the management of heather moorland;
- Olsen & Lundhede (2005), who used CE for valuation of forest characteristics.

Furthermore, projects are underway using CE for assessment of the significance of information for consumer choice with regard to food, and assessments of windmill location.

In CE, respondents are requested to select their preferred alternative and, in contrast to the CV method, the term ”indirect method” is used as consumer preferences are estimated on the basis of preferred situations and not on the basis of actual expressed WTP. Respondents are, hereby, provided with an explicit basis for assessing costs in relation to effects and, therefore, the method is recommended in complex situations where the good has several characteristics, referred to as ‘attributes’. The method is also suitable if the nature of the environmental good is relatively removed from characteristics possessed by traditional consumer goods, because the choice situation places the valuation in a situation more reflective of real market conditions than with other forms of valuation exercise - all things being equal.

The CE-method presents respondents with several choice sets, and the choice situation is created to resemble the market situations that respondents are used to in everyday life. To approach the valuation as a market choice the CE-method describes public goods in terms of the attributes, defining the goods and attribute levels.

Consequently, the power of the CE method is that it is split into attributes and choice sets, and can avoid response difficulties, reduce problems of multi-collinearity and measure the marginal value of changes.

The method can be described formally by the following utility function. An individual i's utility from a good j (U_{ij}) can be described as a function of a deterministic part (V) and a stochastic element (•) as follows:

$$U_{ij} = V(Z_{ij}, S_i) + \bullet$$

where Z represents characteristics of the good, e.g. water quality, and S characteristics of the individual, e.g. gender, income etc. (See e.g. Adamowicz et al. 1994; Bateman et al. 2002)

The probability of a choice between alternative options for changes in water quality is described as a function of the attributes, and the probability for choice between the alternatives can be analysed by random utility models. Examples of attributes are drinking water quality, surface water quality and costs, but other attributes could be mentioned as well; groundwater exposure to pesticides and nitrates, human exposure as well as landscape changes. In the present study the costs are expressed as a fixed amount reflecting an increase in the yearly payment per household for water supply services.

The probability of an alternative being chosen can be expressed in terms of the logistic distribution (see Hanley et al., 2001), and depending on the nature of the data different logit models can be applied (Train, 2003). WTP for non-monetary attributes can, hereafter, be estimated as the marginal rate of substitution between the attribute and the monetary attribute.

4.2 Developing the CE part of the questionnaire

In the present section, different aspects related to the specific design of the choice experiment (CE) survey are presented.

4.2.1 The Attributes Defining the Alternatives

As mentioned in Chapter 2, the alternatives which respondents are asked to choose between in the CE each represent different policy proposals concerning future groundwater resource management options. The alternatives are defined by three attributes; two qualitative attributes related to the effects of different management options in relation to the quality of drinking water and the aquatic environment, respectively, and one quantitative attribute specifying the cost/price of the option. The inclusion of the monetary attribute is necessary in order to facilitate the derivation of monetary estimates of the value that respondents attach to the qualitative effects of different management options.

Choice of Attribute Levels

In relation to the amount of information provided to respondents, and the more specific way in which the information is provided, emphasis has been on securing correspondence between the CE and the

CV scenarios. Thus, the development of the CE scenario, including the choice of the more specific attribute levels, has occurred parallel with development of the CV scenario, cf. Section 2.2. in which the indicators are presented. The attributes, including descriptions of their more specific levels, which define the alternatives are presented in Table 2.1., where it appears that each of the two qualitative attributes can assume three different levels.

The cost/price attribute is expressed by six levels in the CE, compared with 10 closed levels and one additional open bid in the CV.

Thus, the levels of the drinking water attribute have been set to facilitate the assessment of the potential welfare economic gain associated with choosing one of the options over the others, thereby contributing to the fulfilment of the above-mentioned objective.

With reference to the CV part of the study, it is noted that the "uncertain" level corresponds to the water quality characterising the base case in both CV questions. Similarly, the "naturally clean" level corresponds to the water quality pertaining to the proposition advanced in Question 5.1 of the questionnaire, while the "treated" level corresponds to the water quality pertaining to the proposition advanced in Question 5.2., see Annex 3. As mentioned in Chapter 3, the wording used in the description of the different levels is as "neutral" as possible to take into consideration that choices should be a matter of taste/preferences, and value-laden words and phrases that can influence preferences should be avoided.

With respect to the attribute relating to the quality of the aquatic environment, the three levels have been chosen so that the associated value changes, both those for the better and for the worse, can be estimated. In relation to the correspondence between the CV and the CE surveys, the "less good" level reflects the quality characterising the base case in both CV questions, and the quality pertaining to the proposition advanced in Question 5.2. The "very good" level, on the other hand, reflects the quality pertaining to the proposition advanced in Question 5.1, whereas the "poor" level is unique to the CE part of the survey. Identification of the more specific wording used to describe the different levels has been quite troublesome, as the attribute incorporates complexities which are difficult to represent in brief and general terms, cf. Section 2.

As in the CV, the cost is stated in the form of an annual increase in water bill per household. The levels assumed by the cost attribute cover the same range as those covered in the CV, though with the exception that the payment card used in the CV provides respondents with the opportunity to state a higher WTP than the 2,400 DKK/Household/year.

4.2.2 Composition of the Choice Sets

Status quo and opt-out

In consulting the literature on how to conduct CE-studies, it is often recommended, sometimes even required, that a status quo alternative, or an "opt-out" option, is included in the design. The reason being that failure to do so may imply that respondents are forced to choose alternatives, which they do not desire. If this is the case, the observed choices should not be interpreted as expressions of respondents' true preferences, implying that they should not (or perhaps rather cannot) be used as the basis for deriving valid estimates of welfare changes (Bateman et al., 2002). It should, however, be noted that the inclusion of a status quo alternative, or an "opt-out"-option, is not necessarily unproblematic. Thus, while serving to eliminate bias caused by inducing respondents to make forced choices, it may simultaneously serve to create a new bias as respondents may systematically exhibit different preferences for the status quo alternative and non-status quo alternatives (Scarpa et al., 2004). Moreover, it may prove difficult to identify an appropriate way of presenting/including the status quo/opt-out (Adamowicz and Boxall, 2001:20).

Despite this, it is decided to include a status quo option in the present study. The main reason being that the results of the CE are to be compared with the results of a CV study, where respondents are given the option of stating a zero WTP. By doing so, they indicate that they prefer the status quo to the other alternatives, which in CE terms is equivalent to "opting-out" of choosing between the non-status quo alternatives. Thus, in order to ensure the greatest possible degree of similarity between the CE and CV scenarios, it is considered most appropriate to make sure that all respondents are provided with the opportunity to "opt-out", i.e. to choose the status quo. The status quo alternative is designed so that it corresponds to the base case in both CV questions, implying that it is characterised by an "uncertain" water quality level, a "not so good" quality of the aquatic environment and zero additional costs. Accordingly, it defines the baseline situation that will prevail if current initiatives are maintained while no further actions are taken.

The number of alternatives

Apart from the status quo alternative, which is constant across all choice sets, each choice set contains 2 alternatives. This is in line with the approach adopted in other environmental valuation studies, where 2-3 alternatives per choice set appears to be the standard (Adamowicz & Boxall, 2001:20). Along with a number of other factors – such as the number of attributes and their respective number of levels, and the extent to which respondents are familiar with the good prior to the choice exercise – the number of alternatives per choice set affects the complexity of the CE exercise (Swait & Adamowicz, 1997). According to Bateman et al. (2002:265), it is important to ensure that respondents are not asked to perform tasks, which are too complex, as this may induce respondents to provide unreliable answers or resort to using simplified decision strategies instead of the compensatory decision strategies, which are assumed to be used in CE.

In the present context, it is considered appropriate to operate with a choice set size of 3 alternatives per set. Thus, less than 3 alternatives per set would provide too little information per choice observation, while more than 3 alternatives per set might be difficult for respondents to grasp simultaneously, especially when considering respondents' unfamiliarity with the good subjected to valuation. In the pre-tests, respondents' perception of the difficulty of the choice task was investigated, and in this connection none of the respondents expressed any concern in terms of the size of the choice sets.

Number of Choice Sets per Respondent
There exist no exact rules regarding the number of choice sets to present to each respondent. In general, the number of choice sets that each respondent can be expected to evaluate is inversely proportional to the number of attributes and attribute levels, i.e. to the complexity of the task (Bateman et al., 2002:265). Compared with other studies, the number of attributes and their associated levels in the present study are fairly low, suggesting that respondents may be able to handle a relatively high number of choice sets. Apart from choice complexity, expectations regarding potential learning and fatigue effects also play a role in relation to determining the appropriate number of choice sets per respondent. Thus, just as choice complexity may influence the obtained parameter estimates, so may learning and fatigue effects (Adamowicz & Boxall, 2001:17), implying that these factors need to be considered carefully and balanced against each other prior to deciding on a specific number of choice sets per respondent.

The complexity and unfamiliarity of the issue needs to be seen in combination with the fact that the risk of a fatigue and/or boredom effect occurring increases with the number of choice sets. Therefore, each respondent is presented with 6 choice sets. In this context several of the pre-test respondents noted that it would be unproblematic to increase the number of choice sets per respondent; i.e. once they had understood the task it was straightforward to complete the choices. This comment may be taken to suggest either of two things, which both are treated by Bateman et al. (2002). One, that some respondents may develop and adopt a simplifying strategy already from the outset of the exercise, or two, that there is an important learning effect associated with multiple choice tasks. If either of these phenomena turns out to be present, it may imply that the number of choice sets, due to its impact in relation to decision strategy and learning effects, is no longer neutral in relation to respondents' stated preferences. The extent to which the chosen number of choice sets will affect the results of the present study cannot be assessed here; however, as 6 sets per respondent is within the range applied in most studies, the choice should be fairly uncontroversial.

4.2.3 Sample Size for the CE blocks

Given the lack of more specific statistical guidelines concerning how to determinate the appropriate sample size for a CE study in a given context, a rule-of-thumb is that the sample size should be chosen to ensure that each alternative is represented at least 30 times in the effective sample. An alternative rule of thumb is that each choice set should be answered by a minimum of 50 respondents (Bennet & Adamowicz, 2001:59). Finally, Bateman et al. (2002:268) mention that recent CE studies conducted in the UK on environmental issues have included between 250 and 500 respondents per survey.

As the total sample will need to be divided into sub-samples reflecting the number of blocks used in the experimental design (Bennet &

Adamowicz, 2001:59), it is decided that the adopted design should contain no more than three blocks. Thus, with a total effective sample size for the CE in the vicinity of 600 respondents, this would result in effective sub-sample sizes of around 200. Compared to the two rules of thumb, sample sizes of this magnitude should be more than sufficient.

In terms of the size of an experimental design, which will satisfy the requirements of 6 choice sets of 2 alternatives per respondent (excluding the constant status quo alternative, which is added to the choice sets once the final design has been identified) *and* no more than 3 different blocks of choice sets, it is found that it should consist of 36 alternatives. That is, (6 choice sets/block) * (2 alternatives/choice set) *(3 blocks) = 36 alternatives.

4.2.4 The Experimental Design

The basic principles underlying the design of the CE study are described in Annex 1, while the present section describes what has been carried out in this survey.

The extent to which the candidate set should be restricted only to contain realistic and non-dominated alternatives depends on the specific situation. There seems to be a consensus that obviously unrealistic or implausible alternatives should be eliminated (Bateman et al., 2002:264) as they may only serve to annoy or confuse respondents. Likewise, there seems to be a consensus that choice sets containing clearly dominated alternatives should be avoided, unless they are to be used as a test of respondent rationality. Hence, they will provide basically no information, assuming that the respondents answer rationally, while at the same time they may serve to increase the risk that respondents will find the exercise ridiculous and, therefore, lose patience or decide not to participate.

However, when eliminating certain alternatives/attribute combinations, the statistical efficiency of the design drops and correlation between attributes may be introduced (Kuhfeld et al., 2004). Determining the extent to which unrealistic/implausible and dominated alternatives should be excluded from the design, therefore, requires a trade-off to be made. That is, concerns for the statistical efficiency properties of the design have to be balanced against concerns related to choice tasks realism and relevance, where the latter affect the efficiency of the design in terms of its ability to extract information from the choices (Adamowicz & Boxall, 2001:15). As an example, Terawaki et al. (2003:11), who investigate the effects of excluding unrealistic alternatives from a design, find that a theoretically efficient design need not be efficient in practice. A likely reason is that respondents who are faced with unrealistic alternatives respond on the basis of utilities with large errors. Thus, the exclusion of unrealistic alternatives is found to improve the actual efficiency of designs significantly (Terawaki et al. 2003). Extending this result to the case of dominated alternatives, it appears likely that actual efficiency of a design may also be improved by the exclusion of choice sets containing dominated alternatives, as respondents are likely to perceive them to be either unrealistic or misrepresented.

As is often the case when working with issues involving ecological systems (Adamowicz & Boxall, 2001:15) – or the natural environment – it can turn out to be impossible to present the valuation task in "orthogonal terms", while maintaining an acceptable degree of task realism and relevance. Bennet & Adamowicz (2001:59) suggest that problems related to implausibility can be avoided by explaining to respondents why some alternatives may appear counterintuitive. Significant effort was devoted to an attempt to pursue this strategy, but unfortunately, it was found to be impossible. Subsequently, it was decided to delete some, though not all, of the unrealistic/implausible alternatives from the full factorial design prior to the creation of the final experimental design. The reason for only excluding some was that too many, seen from a statistical and methodological point of view, would need to be excluded if all alternatives were required to reflect situations likely to prevail in reality. Attempt has been made to deal with the presence of the remaining implausible/unrealistic alternatives through emphasising some, and through not paying emphasis to others.

The results of the pre-tests provide no unambiguous answer to the question as to whether or not this attempt has been successful. Thus, when presented with the choice sets, experts – exemplified by a significant proportion of those participating in an expert test – are troubled by the apparent implausibility of several of the alternatives. This, however, has not caused significant concern as "experts" are expected to be more critical and to scrutinise the set up more thoroughly than others. Non-experts, on the other hand, did not express the same level of concern and, therefore, it is not expected that implausibility/counter-intuitive related problems would cause significant problems in relation to the survey.

In relation to the exclusion of dominated alternatives, the definition of the constant status quo alternative turned out to have significant implications in relation to how many restrictions need to be imposed on the design in order to avoid the presence of dominating alternatives in the choice sets. Thus, with reference to the attribute levels characterising the status quo (i.e. not assuming the worst levels of the qualitative attributes), it becomes evident that the status quo clearly dominates quite a few of the other alternatives in the full factorial design. This implies that quite a few alternatives need to be excluded from the candidate set (initially comprised of the full-factorial design) prior to the identification of the final experimental design if the presence of alternatives dominated by the status quo in the choice sets is to be avoided.

Based on this, it was decided to exclude alternatives *clearly* dominated by the status quo alternative, while other potentially dominated alternatives have been kept in the design. In this connection, it may be noted that the results from the questionnaire pre-tests suggested that there are no choice sets for which all respondents have made identical choices. This suggests that there are no choice sets in the final design containing clearly dominant alternatives, although, the presence of fairly dominant alternatives cannot be dismissed.

With 3 attributes with 3, 3 and 6 levels, respectively, the full factorial design consists of 54 alternatives. Following the strategies just mentioned in relation to the exclusion of implausible/unrealistic and dominated alternatives, 6 are excluded on account of being implausible or unrealistic whereas 11 are excluded on account of being clearly dominated by the status quo alternative. Finally, the status quo alternative is deleted from the full factorial design, as this constant alternative is added to each choice set subsequent to the identification of the final design. Following the exclusion of these 18 alternatives, the candidate set consists of 36 alternatives, which – with reference to Section 5.3.3 – corresponds to the size of the experimental design which will satisfy the requirements in terms of desired number of choice sets and number of alternatives per choice set[4].

As already mentioned, the size of the candidate set corresponds to the maximum size of the desired design. Running the SAS *%ChoiceEff* macro, the resulting final design contains the required 36 alternatives; however, as some of the alternatives appear several times it does not consist of 36 different alternatives. Normally, there should be no duplicate alternatives in an efficient design, therefore, at first glance the observation of duplicates led to dismissal of the design, as it apparently possessed inefficient properties. On closer consideration, however, it was decided to keep the design, as the repetition of alternatives is believed to be a consequence of the large number of alternatives that have been excluded from the candidate set. That is, without doing so, it would probably not have been possible to attain a reasonable confounding structure and level of correlation among attributes.

On account of the large number of excluded alternatives, there has been some concern regarding the effect of the exclusions in relation to the correlations between attributes and the statistical efficiency of the design. In order to check that the efficiency of the design has not been affected to the extent that estimation of the desired effects has been hampered, data from 29 respondents participating in the above mentioned pre-test was used to estimate a very preliminary main effects model. All except one of the main effects/attributes turned out to be significant in the model, the signs on all parameters were as expected and the model fit was good. Based on this, it was decided that no

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[4] In terms of constructing the final experimental design it was originally the plan to adopt the cyclical design approach. Thus, given the lack of the information required in order to pursue a utility balanced design by using the choice design approach, a cyclical design was considered appropriate as it would ensure level balance, orthogonality and minimal overlap. Using the cyclical approach the exclusion of alternatives would, in practice, have to be undertaken after the construction of the final design, including the creation of choice sets and blocks. However, considering the significant number of exclusions entailed by the adopted strategy it was considered most appropriate to exclude alternatives from the full factorial design (i.e. the candidate set) prior to the construction of the final design. Thus, given the significant number of restrictions imposed on the design, it was expected that this particular order of events would increase the chance that the most efficient design would be found. The cyclical approach was, therefore, abandoned in favour of the choice design approach assuming that all parameters are zero. Considering the lack of prior information on the parameters, this choice may seem odd. However, the reason for choosing the choice design approach rather than the linear design approach is that it only is the SAS macro %ChoicEff macro that allows for alternatives to be excluded from the full factorial prior to the construction of the final design.

changes were necessary, implying that the design used in the pre-tests is identical to the design used in the full-scale survey.

Follow-Up Questions

As mentioned in Section 3, it is recommended to ask a set of follow-up questions upon completion of the valuation question(s). In the present study, 6 questions regarding respondents' experience of the choice exercise and how they made their choices are asked immediately after the payment exercise.

In the first of the questions (Question 6.1), respondents are asked whether or not they found it difficult to make the choices. One of the motives for asking the question is that respondents' answers may indicate something about the reliability of the choices. If choices are considered difficult it may indicate that choice complexity was high – and perhaps too high – for the given respondent.

The consequence hereof may either be that the respondent has been induced to provide less reliable answers or adopt a simplified decision strategy, or that completion of the task has been time-consuming for the respondent. Seen from another perspective, it may be more problematic if respondents have found the choices easy. Hence, in a study by Watson et al. (2004) it is found that people who find a CE task easy are more likely to pursue potentially non-compensatory decision-making strategies. Based on these considerations, it may therefore be relevant to investigate if there are scale and/or preference differences between those respondents providing a positive, and those providing a negative, response to the question.

Question 6.2, which focuses on disclosing why respondents have found the choice exercise difficult, is only relevant for those who answered yes to the previous question. Respondents' answers to this question are not intended to play a role in relation to the modelling of data. Instead, they may be used as input to future surveys, as they may serve to shed light on how respondents perceive different elements of a CE. In relation to the different answer-options provided in the question, it may be noted that one of them may actually serve to establish the validity of respondents' answers/choices. Hence, answering, "it was difficult to choose as several factors were important" stresses the fact that a compensatory decision-making strategy has been applied.

The follow-up questions on the CE exercise also include a certainty scale question (cf. Chapter 3), where respondents are asked to state how certain they are of the choices that they have made in the CE.

Apparently, a general framework for how certainty calibration should be applied in a CE context does not exist, however, the intention in the present study is to investigate the effect of excluding observations pertaining to respondents with a self-reported level of certainty below a certain threshold. In this connection it could – and probably can convincingly – be argued that a certainty scale should ideally have followed each choice.

Thus, as advanced by the participants in the focus group interview, some choices are more straightforward than others, implying that different degrees of certainty pertain to different choice sets. In order to take advantage of the full potential offered by the certainty calibration approach, such certainty heterogeneity across choice sets should probably be incorporated in the model. However, considering the length of the questionnaire, it was not considered wise to include more than one common certainty scale question. In terms of determining the threshold certainty level specifying which respondents should be excluded, it may be noted that respondents may have used the scale quite differently. This cardinal property of individuals' self-reported level of certainty implies that excluding observations associated with a level of certainty below the threshold does not correspond to excluding observations associated with an actual level of uncertainty below some specific level. Prior to interpreting the results, therefore, it should be acknowledged that if respondents with a reported level of certainty below a certain level are excluded, then some of the excluded observations are likely to be associated with less uncertainty than some of the observations remaining in the reduced data set.

In Question 6.4, respondents are asked to specify which of the three attributes they put greatest weight on when choosing between the different alternatives. In case there were none of the attributes that, in general, were considered more important than the others, respondents were also provided with the opportunity to answer that it varied across choices. Respondents' answer to this question cannot serve as a reliability or validity test, as such, but it may be used to identify which attributes are considered most important and are most likely to be the focus of non-compensatory decision strategies. Also, if respondents' answers to this question interact with the attributes in the analysis, the significance of the interaction variables may be used as a test of internal consistency. That is, it may indicate the degree of correspondence between what people state is most important to them and what they attach most weight to in their observed choices.

An assumption underlying the use of the CE approach as a valuation tool is that individuals apply compensatory decision-making strategies. That is, individuals are assumed to consider all attributes, and make trade-offs between all attributes within the choice sets comprised in the design (Watson et al., 2004:3). In this context the basic purpose of Question 6.5 is to, if not assess, then at least shed some light on whether or not respondents have applied choice strategies that potentially conflict with the assumption of compensatory decision-making.

With reference to the CE questionnaire in Annex 2, respondents are asked to specify if they only considered one of the attributes when making their choices, or if they took all attributes into consideration.

If respondents answer that they took all attributes into consideration, nothing suggests that the compensatory requirement be violated. If, on the other hand, respondents answer that they based their choices solely on considerations of one attribute, it is indicated that they might have pursued non-compensatory decision-making strategies. That is, it is suggested that the respondents concerned have exhibited lexicographic/dominant preferences, which are in conflict with the axioms underlying welfare economic theory.

It should, however, be emphasised that answering that choices have been based solely on consideration of one attribute is by no means proof of non-compensatory decision-making; it only indicates the presence of *potentially* non-compensatory decision-making. An important element in designing CE surveys is to assign attribute levels so that it is ensured that respondents actually make trade-offs (Carlsson & Martinsson, 2003:290). Hence, seen from this perspective, another explanation for only having focused on one attribute may be that the selected attribute ranges have simply been set too narrow to induce respondents to make trade-offs (Watson et al., 2004:12). If this turns out to be the case, the problem is not related to the behaviour exhibited by respondents, but to the design of the instrument used to elicit respondents' preferences. While care should therefore be taken not to declare respondents' choices invalid based just on respondents' answer to Question 6.5, it nevertheless may be interesting/relevant to test for differences between the two segments of the sample providing different answers to Question 6.5.

5 Application of the Contingent Valuation Method

The CV method is the most commonly used non-market valuation technique for environmental goods, internationally as well as in Denmark (Mitchell & Carsson 1989; Carson et al. 2001; Dubgaard 1996, 1998; Bjørner et al. 2000). Throughout the years it has been subject to many methodological discussions, which have elaborated the theoretical foundation underlying CV.

The aim of a CV-study is to elicit individuals' preferences for a change in a particular environmental good (Bateman et al. 2002). The CV method's foundation in utility theory makes it possible to translate these preferences into monetary terms. Thus, it allows measures of consumer welfare to be estimated for changes in the supply of the environmental good in question (CIE 2001).

5.1 Elicitation of WTP in the CV survey

5.1.1 Questions formats

Basically, CV involves asking a sample of individuals for the highest amount of money they are willing to pay to obtain an improvement in their environment.

There are three primary question formats in CV: open-ended questions, dichotomous choice and payment cards.

The first formats used to elicit payment bids were open-ended questions. With this type of questions the respondent is asked to state his/her WTP for a specified environmental improvement. However, respondents are not accustomed to such market behaviour, and the format has gradually become used more rarely due to problems arising from respondents stating a higher WTP than their real WTP – i.e. warm glow and moral satisfaction. That respondents act in this way can be due to problems with assessing how much one would actually pay for a good that is not otherwise marketed in monetary terms, and to an individual's desire to act in a "morally correct" manner. Under these circumstances, an estimate of the real WTP is not achieved.

Methods incorporating closed responses have now been more widely used, i.e. the payment cards and dichotomous choice methods. In using the payment card method, respondents are presented with a range of WTP values, or bids. The respondents can either be asked to pay directly or be asked whether they would vote for on the environmental change a referendum while at the same time being informed of the costs of this policy to an individual or a household. Their maximum WTP to cover the costs can be chosen from the payment card. The values on the payment card can progress in different ways, either by uniform increments or more or less exponentially, which takes into account the fact that the accuracy with which the respondents express values is proposed to be proportional to the value.

In the dichotomous choice method, respondents are presented with one bid and asked if they are willing to pay this amount for the change in environmental quality, or would vote yes or no in a referendum. The amounts chosen for the survey are randomly assigned to the respondents, and the respondents are offered the choice of responding "yes" or "no" to the amount (or vote "yes" or "no"). In double-bounded dichotomous choice, the respondents are offered a second higher amount, and it has been argued that this improves the efficiency of the WTP results (cf Reeves et al. 1999; Hanemann et al. 1991). The dichotomous format has resulted in lower WTP estimates than the two former formats.

The NOAA panel (Arrow et al. 1993) state that one problem with payment cards is that they are likely to create anchoring effects, as well as range and centering bias. However, studies indicate that there can be bias connected to the dichotomous choice format as well, in the form of starting point bias (Reeves et al., 1999). Rowe et al. (1996) test for range and centering bias in payment card formats using four different payment cards. Their findings do not support the existence of range and centering bias in payment cards. This potential benefit for payment cards relative to the other formats is supported by the findings of Reeves et al. 1999. They conclude that protest responses are higher in dichotomous choice and open-ended formats relative to payment cards, and that payment cards might ease the valuation task and, hereby, lead to efficiency in data collection (Reeves et al., p. 374). Furthermore, Ready et al. (2001) found that respondents using payment cards gave lower WTP than respondents using dichotomous choice, and that respondents using dichotomous choice were less certain of their responses than those responding to payment cards. Finally, dichotomous choice formats require more respondents than payment cards.

In evaluating these experiences, the use of payment cards has been chosen in the present CV survey.

5.1.2 The payment card in the present CV- survey

10 payment levels are represented in the payment card and one additional possibility to state a higher WTP. The range of the payment card is from 0 to 2400 DKK. The maximum amount is derived from focus group interviews, and this amount represents more than a 50% increase in the average annual water bill. Opportunities are provided to state a higher WTP, as there is an opportunity to tick the "other" box, and write the amount there. Very few respondents used this opportunity, however. As indicated in former studies the intervals are not held equal, the intervals between the lowest bids being narrower than between the highest bids.

Equal payment cards are used for the questions on WTP for clean groundwater by protection and for the purification scenario.

5.1.3 The scenarios

The scenario text is briefly described in Section 2.2 and is also apparent from Annex 2.

The treatment of the multidimensional effects of groundwater protection on surface water quality and drinking water quality has been included in the information provided in the valuation question. In this question the scenario is worded as closely to the wording of the scenario in the CE survey as possible. However, in comparison of the two questionnaires (cf. Annex 2 and 3), it is apparent that this is not easy because the CE includes trade-offs between the attributes (indicators) while the CV scenario text expresses how the effects on surface water and drinking water are achieved concurrently by enhanced protection. Furthermore, valuation of the protection of groundwater versus purification is carried out subsequently by two separate questions in the CV survey, while it is carried out by trade-offs between the two attributes in the CE. In other words, methodological differences provide different ways to express the valuation questions. It has, however, been attempted to describe the effects in the protection scenario as nested goods, i.e. that the protection scenario resulting in good drinking water quality from "natural" groundwater comprises both good A and B, A being good drinking water quality and B being good surface water quality.

The two subsequent CV questions on protection and purification are asked by first asking the question concerning WTP for protected groundwater where clean drinking water is guaranteed now and in the future, and thereafter by posing the valuation question on respondents' WTP for purified water. The sequence of these two scenarios is not tested by split samples because it was judged that there were not enough respondents to carry out split sample tests and that such tests are beyond the scope of this project. However, a test for ordering effects could evidently be of interest here, as it is assumed that the WTP for both the protection scenario and for clean drinking water from purified water would be higher than when the opposing sequence is chosen.

5.1.4 Debriefing questions in CV: The opportunity to define protests and confidence

Debriefing questions are especially important and commonly used in CV surveys to control for biased and illegitimate answers. Illegitimate responses are bids that do not reflect the respondents' actual or "true" WTP, which occur when the respondent is performing strategic bidding or free-riding, as mentioned above. Other kinds of illegitimate responses arise when the respondent exercises protest behaviour (Garrod & Willis 1999). This is when the respondent states a zero bid despite having a positive WTP for the good. Such protest answers will bias the grand mean downwards and should, therefore, be removed from the sample. Asking for the respondent's arguments for zero bids is the most common method to identify protest answers.

A frequent claim is that familiarity with the good is a prerequisite to ensure that the respondent will have well-defined preferences for the good in an economic sense; otherwise the respondent will not be able to provide meaningful responses to the valuation question. A recent development in trying to deal with this unfamiliarity is to take explicit account of the respondents' uncertainty in making the response (CIE 200I). This is done by asking respondents how certain (measured on a confidence rating scale) they were in making the bid. The information can be used to adjust estimated WTP from the sample and reduce a potential upward bias (Li & Mattsson 1995).

The debriefing questions are commented upon in Section 3.3, and they are apparent from Annex 2 and 3.

6 Results of the CE survey

6.1 Response statistics

The CE questionnaire was sent out to 900 people of whom 584 returned the questionnaire, which equates to a response rate of almost 65 percent. Each questionnaire contained 6 CE questions. 41 respondents answered between 1 and 5 of the CE questions and these respondents are included in the sample.

6.2 Non parametric relations

By way of introduction, the relationship between price of an alternative and frequency of the alternative being chosen can be depicted as in Figure 6.1. The figure shows the number of chosen alternatives (the vertical axis) for a given price or bid size (the horizontal axis), ignoring the influence from the 2 other attributes.

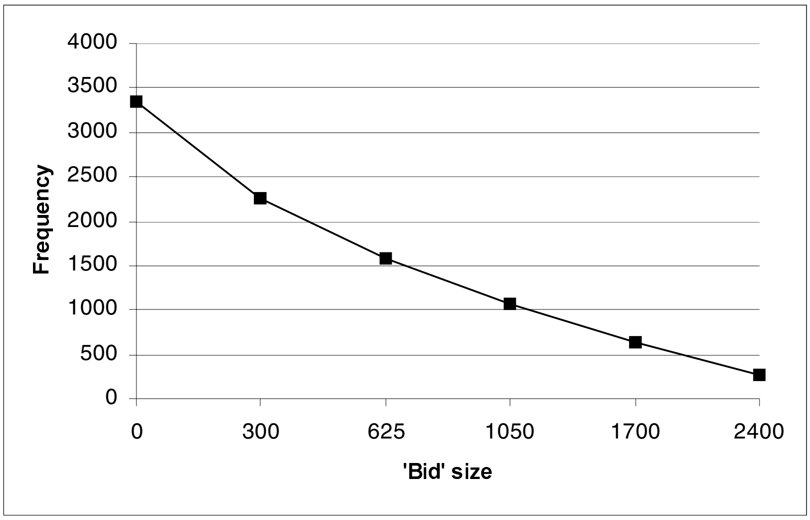

Figure 6.1. Relation between bid size and frequency of chosen alternative

Intuitively, one would expect that the number of chosen alternatives would decrease with increased price of the alternative. Figure 6.1 resembles a normal demand curve, and thus confirms this reflection. This points towards rational respondent behaviour in terms of decreasing demand in response to increasing prices.

6.3 The conditional logit model

The conditional logit model used is based on the utility function described in Section 4.1, where *i* denotes the individual respondent and *j* the alternative.

If the error terms ε are independently and identically distributed (IID) and follow the Gumbel distribution, the probability that alternative *k* is selected out of *K* alternatives is calculated as:

$$\Pr(respondent \quad i \quad chooses \quad k) = \frac{\exp(V_{ik})}{\sum_{j=1}^{K} \exp(V_{ij})} \tag{6.1}$$

where V is the vector representing both attributes of the alternative, i.e. drinking water quality, living conditions for animal and plants and the price and characteristics of the respondent.

6.4 WTP: Main effects and cross effects

At first, a conditional logit model based only on the main effects has been carried out. The dependent variable is the probability that the respondent chooses an alternative. The results are presented in Table 7.1. The estimates in this model and all the subsequent models are based on a change from the status quo situation, which equates to an uncertain quality of drinking water and less good conditions for animal and plant-life in watercourses and lakes.

Table 6.1. Main effect model

	Parameter		Std. error	WTP (DKK)
Price	-0.00059	***	0.0000	
Alternative specific constant	-0.7285	***	0.1018	-
Naturally clean groundwater	1.1205	***	0.0882	1,899
Purified groundwater	0.5381	***	0.0852	912
Very good conditions	0.7105	***	0.0661	1,204
Bad conditions	-1.0379	***	0.0737	-1,759
N	3,074			
Log L	-2,723.97			
χ^2	1,306.33			
Adjusted pseudo R^2	0.193			

Significance levels at 1%, 5% and 10% are denoted by three, two and one asterisk(s), respectively.

All the parameters are statistically significant at a 1 percent level and operate as expected. The cost parameter is negative whereas both naturally clean and purified groundwater suggests positive utility. A change to very good conditions for animal and plants contributes positively to utility whereas a change to poor conditions contributes negatively.

The model's adjusted pseudo R^2 is 0.193. This measure is statistically analogous to the R^2 used in OLS regression models. The adjusted pseudo R^2 should be above 0.1 to accept the model whereas a value between 0.2 and 0.4, according to Louviere et al. (2000), is considered an extremely good fit. Another way to evaluate the model is by looking at its ability to predict the right outcome for the used sample. The prediction result is shown in Table 6.2.

Table 6.2 Prediction table

	Predicted		
Observed	Not chosen (0)	Chosen (1)	Total
Not chosen (0)	5,421	727	6,148
Chosen (1)	1,613	1,461	3,074
Total	7,034	2,188	9,222

The prediction rate achieved of 74,6 percent (calculated as (5,421+1,461)/9,222) should be compared to a naive rule, where choice *0* (not chosen) for all alternatives would predict 68 percent of the choices correctly. If the predictions were carried out randomly, the prediction rate would only be 33 percent. On this basis, the rate of 74.6 percent obtained is satisfactory.

6.4.1 Alternative Specific Constant

The model also includes an alternative specific constant, representing the status quo alternative, which in this model appears to be associated with disutility. The parameter should be interpreted as the disutility connected to the status quo alternative, i.e. the present situation, which is not described by the attributes drinking water quality and plant and animal life. It is hard to tell why the status quo alternative is connected to disutility, but one explanation might be a preceding public discussion about the quality of the water distribution system and related health issues. The result of estimation of the parameters without an alternative specific constant is shown below in Table 6.3.

Table 6.3. Comparison of model with/without alternative specific constant

	Including alternative specific constant				***Excluding alternative specific constant***			
	Parameter		**std error**	**WTP (DKK)**	**Parameter**		**std. Error**	**WTP (DKK)**
Price	-0.00059	***	0.0000		-0.00055	***	0.0000	
Alternative specific constant	-0.7285	***	0.1018	-	n/a	***	n/a	-
Naturally clean groundwater	1.1205	***	0.0882	1,899	1.5705	***	0.0646	2,855
Purified groundwater	0.5381	***	0.0852	912	0.9775	***	0.0607	1,777
Very good conditions	0.7105	***	0.0661	1,204	1.0001	***	0.0534	1,818
Bad conditions	-1.0379	***	0.0737	-1,759	-0.8958	***	0.0714	-1,627
N	3,074						3,074	
Log L	-2,723.97						-2,749.55	
χ^2	1,306.33						1,255.16	
Adjusted pseudo R^2	0.193						0.186	

Significance levels at 1%, 5% and 10% are denoted by three, two and one asterisk(s), respectively

Omission of the alternative specific constant causes an increase in the WTP for most of the parameters, except for the *bad conditions* parameter which seems to be not much affected.

6.4.2 Consumption effect on WTP

The payment vehicle in this questionnaire is an annual lump sum paid for the household's consumption of water. Hence, it could be expected that high consumption of water would imply high WTP. The consumption of water is stated in two different ways; by a yearly amount of water measured in cubic meters and by the size of the yearly water bill. Roughly half of the respondents had knowledge of the household (HH) consumption of water expressed in these measures. An estimation of the main effects has been carried out, to ensure that the preferences of this half do not differ considerably from the total sample. The estimation result is shown in Table 6.6.

Table 6.4 Main effects and consumption of water

	Parameter		Std. error	WTP (DKK)
Price	-0.0006	***	0.0001	
Alternative specific constant	-0.7071	***	0.1409	-
Natural clean groundwater	1.1057	***	0.1227	1,842
Purified groundwater	0.3969	***	0.1186	661
Very good conditions	0.6734	***	0.0929	1,122
Bad conditions	-0.9447	***	0.1024	-1,575
N	1,592			
Log L	-1,435.55			
χ^2	626.87			
Adjusted pseudo R^2	0.176			

Significance levels at 1%, 5% and 10% are indicated by three, two and one asterisk(s), respectively

Comparing the WTP for the different attributes with the WTP estimated in Table 6.4, it seems safe to assume that the sub-sample which consists of half of the respondents who answered the consumption questions is not different from the sample as a whole.

Water consumption measured in both cubic metres and via the yearly water bill has been coded as "dummy variables" (also referred to as indicator variables) and enters the model as interactions between consumption and the main effects. The dummies are *Low* (corresponding to annual consumption of less than 75 cubic metres or a water bill less than 4,000 DKK a year), *Medium* (75-130 cubic metres or 4,000-6,000 DKK) and *High* (more than 130 cubic metres or more than 6,000 DKK a year). Table 6.5. shows the parameter estimates for the cross effects.

Table 6.5. Consumption divided in groups

	Consumption group	Consumption in cubic metres: Parameter		WTP (DKK)	Size of water bill: Parameter		WTP (DKK)
Price		-0.0006	***		-0.0006	***	
Alternative specific constant		-0.7036	***	-	-0.6514	***	-
Naturally clean groundwater	Low	0.9926	***	1,586	1.0641	***	1,860
	Medium	1.1331	***	1,811	1.1786	***	2,060
	High	1.1752	***	1,878	1.4129	***	2,470
Purified groundwater	Low	0.1817	***	290	0.4899	***	856
	Medium	0.4707	***	752	0.5088		889
	High	0.4411		705	-0.6371		-1,114
Very good conditions	Low	0.6676	***	1,067	0.7073	***	1,236
	Medium	0.6574	***	1,051	0.7747	***	1,354
	High	0.7320	***	1,170	0.3994		698
Bad conditions	Low	-0.7799	***	-1,247	-1.0403	***	-1,818
	Medium	-0.9081	***	-1,451	-1.0149	***	-1,774
	High	-1.1870	***	-651	-1.9145	***	-3,346
N		1,592			1,898		
Log L		-1,432.9			-1,707.66		
χ^2		632.17			755.01		
Adjusted pseudo R^2		0.181			0.181		

Significance levels at 1%, 5% and 10% are denoted by three, two and one asterisk(s), respectively

The first column in Table 6.5 is the attribute whereas the second column shows the 3 consumption groups.

Most of the parameters are statistically significant and it would seem that a link exists between the increase of consumption with an increase in parameters and WTP.

6.4.3 Self-reported certainty

The WTP has been analysed in connection with self-reported (un)certainty. Figure 6.2 shows the distribution of certainty.

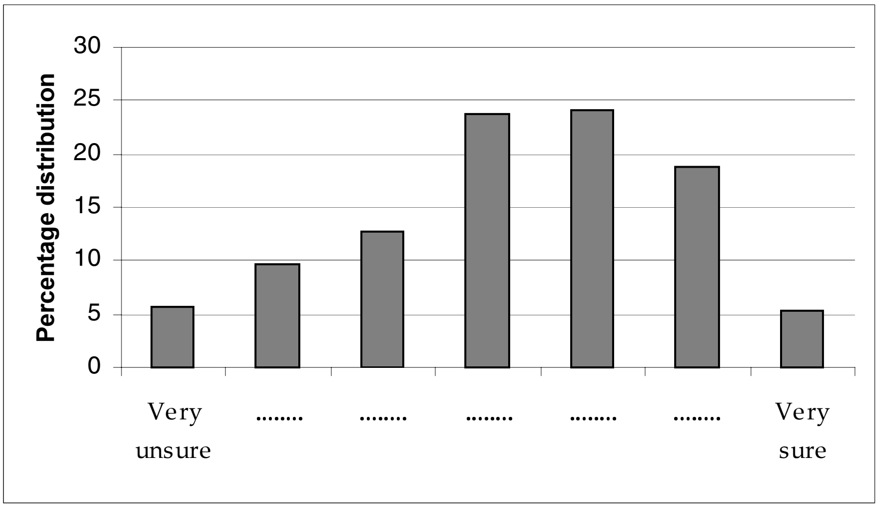

Figure 6.2. Self-reported uncertainty

The question of uncertainty was presented as a choice of 7 levels arranged on a line, and the depicted distribution could be a symptom of respondents' anchoring to the middle answer in the range. Dividing the sample into 7 sub-samples according to the certainty level makes it possible to estimate parameters for each certainty level. Aggregated WTP is illustrated in Figure 6.3 and implies that WTP increases with increasing level of certainty. Note that the WTP for the attribute *bad conditions* are shown as absolute numbers as the WTP are negative.

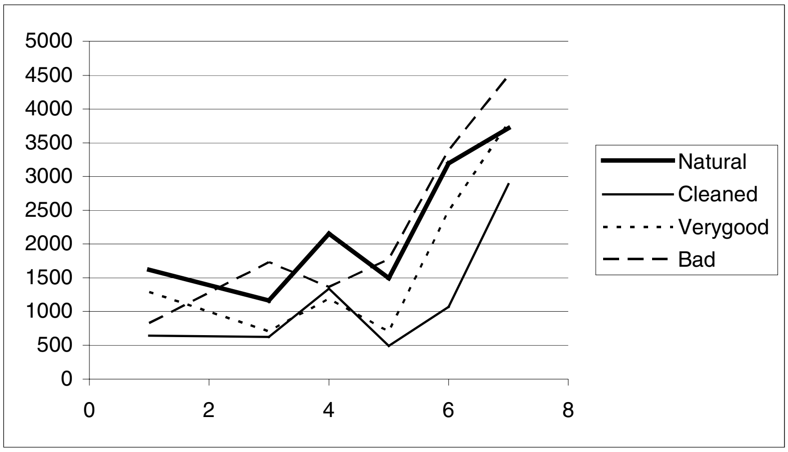

Figure 6.3. WTP and certainty on choices

As described in Chapter 4, the certainty adjustment can be used to exclude observations pertaining to respondents with a self-reported level of certainty below a certain threshold.

Table 6.6. Certainty adjusted estimates

	Parameter		Std. error	WTP (DKK)
Price	-0.0005	***	0.0000	
Alternative specific constant	-0.7748	***	0.1192	-
Naturally clean groundwater	1.1442	***	0.1027	2,120
Purified groundwater	0.5521	***	0.0989	1,023
Very good conditions	0.7030	***	0.0766	1,303
Bad conditions	-1.0627	***	0.0853	-1,969
N	2,256			
Log L	-1,975.42			
χ^2	1,006,09			
Adjusted pseudo R^2	0.200			

Significance levels at 1%, 5% and 10% are denoted by three, two and one asterisk(s), respectively

Excluding the approximately 25% of the sample that had stated a certainty level below 3 results in the parameter estimates is shown in Table 6.6. In line with the conclusions from Figure 6.3, it appears that higher certainty is connected to higher WTP.

Experienced bad water quality

An a priori hypothesis was that respondents who had previously experienced problems with the quality of drinking water would have a different WTP for purified and/or naturally clean water. About 18 percent of the respondents stated that they experienced these kinds of problems, but parameters for the interactions did not appear as statistically significant.

As mentioned earlier, it is a prerequisite of the survey that respondents consider the trade-offs between the attributes and the price of the good. The questionnaire collected information of whether the respondent exclusively put weight on a single attribute, which in Section 4.2.4 is referred to as non-compensatory decision-making. With this information, it is possible to estimate the effect of excluding the respondents who apparently have not been willing to trade. Table 6.7 shows the WTP of those who have stated that they took all factors into consideration (traders) compared to those who put weight on only a single attribute (non-traders).

Table 6.7 Comparison of WTP for traders and non-traders

	WTP (DKK)	
Parameter	**Traders**	**Non traders**
Naturally clean groundwater	1,776	2,399
Purified groundwater	920	740
Very good conditions	1,158	1,417
Bad conditions	-1,951	-1,025

Table 6.7 shows that the WTP of those who have not been willing to trade increases for naturally clean water, but decreases for purified water. This suggests that the WTP for naturally clean water might represent an overestimate in relation to the theoretical assumptions of trading among the attributes. Equally, it suggests an underestimate of the WTP for purified water.

6.5 WTP including socio-economic variables

In this section the effects of interactions with attitudinal and socio-economic characteristics of the respondents are analysed. Because these characteristics do not vary across the alternatives, such an analysis has to be carried out by dividing and comparing sub-samples or by including dummy variables. The dummy variables are indicators for interactions with the main effects. At first a comparison of sub-samples will be carried out.

6.5.1 Sub-sample analysis- gender

By dividing the sample with respect to gender, it would appear there is generally a higher WTP in the group of women compared with the group of men for both attributes. The result of the estimation can be depicted as follows:

Table 6.8. Comparison of females and males

		Parameter		Std. error	WTP (DKK)
Price		-0.0006	***	0.0000	
Alternative specific constant		-0.7292	***	0.1019	-
Naturally clean groundwater	Female	1.1338	***	0.1057	1,905
	Male	1.1124	***	0.1042	1,870
Purified groundwater	Female	0.6169	***	0.1039	1,037
	Male	0.4623	***	0.1013	777
Very good conditions	Female	0.7556	***	0.0835	1,270
	Male	0.6748	***	0.0822	1,134
Bad conditions	Female	-1.2393	***	0.1070	-2,083
	Male	-0.8625	***	0.0984	-1,450
N		3,074			
Log L		-2,717.06			
χ^2		1,320.14			
Adjusted pseudo R^2		0.190			

Significance levels at 1%, 5% and 10% are denoted by three, two and one asterisk(s), respectively

The reason for this difference is uncertain, but higher female WTP has been observed in several valuation studies.

6.5.2 Sub-sample analysis - area

In accordance with Hasler et al. (2002), the sample has been divided with respect to region of residence in order to estimate WTP for rural and urban areas.

Table 6.9 WTP for urban and rural areas

	Area	Parameter		Std. error	WTP (DKK)
Price		-0.00059	***	0.00003	
Alternative specific constant		-0.72757	***	0.10191	-
Naturally clean groundwater	Urban	1.17037	***	0.09230	1,976
	Rural	0.89333	***	0.14942	1,508
Purified groundwater	Urban	0.59154	***	0.08927	999
	Rural	0.28570	*	0.15050	482
Very good conditions	Urban	0.71361	***	0.06982	1,205
	Rural	0.71098	***	0.12701	1,200
Bad conditions	Urban	-1.09399	***	0.08079	-1,847
	Rural	-0.76865	***	0.16845	-1,298
N		3,074			
Log L		-2,720.57			
χ^2		1,313.13			
Adjusted pseudo R^2		0.191			

Significance levels at 1%, 5% and 10% are denoted by three, two and one asterisk(s), respectively

Table 6.9 shows that respondents in urban areas have higher WTP for naturally clean water as well as purified water compared with respondents living in rural areas.

In same manner as above it has been analysed whether households with children under the age of 18 have different WTP compared with the mean population. This resulted in no significant interactions for this subgroup.

6.5.3 Dummy coded variables

Dummy variables are, as mentioned, indicators for interactions between main effects and characteristics of the respondent. The characteristics include socio-economic variables and attitudinal variables and, as such, represent a large number of dummy variables to include in the interaction model. Hosmer and Lemeshow (2000), who recommend only taking interactions with a priori relevance into consideration, describe the approach used in this analysis.

Furthermore, a stepwise maximum likelihood estimation is carried out in order to estimate interaction effects. The method used is a so-called "forward selection" which starts out by estimating an empty model, finds the most significant variable and adds it to the model before starting the loop again by re-estimating the model including the variable.

Applying this method with a significance threshold level at 0.15 results in the model shown in Table 6.10.

Table 6.10 Main effects and interactions

	Parameter		Std. error	WTP (DKK)
Price	-0.0006	***	0.0000	
Alternative specific constant	-0.7407	***	0.1034	-
Naturally clean groundwater	0.8062	***	0.1347	1,319
The authorities should use more resources to protect	0.6198	***	0.1013	1,014
Saves water due to concern for environment	-0.2302	**	0.1008	-377
Tap water may be purified in substitute for natural	-0.2177	**	0.1100	-356
High income group	0.3544	***	0.1143	580
High education group	0.2295	*	0.1377	376
Purified groundwater	0.6011	***	0.1103	984
Knowledge of annual water consumption	-0.3564	***	0.0949	-583
Drinking water in Denmark is not clean	-0.5825	***	0.1979	-953
Group of blue collar worker	0.3106	**	0.1217	508
Group of high income	0.2987	**	0.1163	489
Very good conditions	0.4444	***	0.1130	727
The authorities should use more resources to protect	0.3143	***	0.1065	514
Pollution of aquatic environment is exaggerated	-0.4087	***	0.1360	-669
Does fish very often	0.9886	**	0.4239	1,618
Saves water due to future generations	0.1721	*	0.0988	282
High education group	0.2149		0.1386	352
Bad conditions	-0.6614	***	0.1232	-1,082
The authorities should use more resources to protect	-0.3955	***	0.1418	-647
Group of white collar workers	-0.4659	***	0.1606	-763
Group of supervisors	-0.3641	**	0.1787	-596
N	3,074			
Log L	-2,657.7			
χ^2	1,448,86			
Adjusted pseudo R^2	0.208			

Significance levels at 1%, 5% and 10% are denoted by three, two and one asterisk(s), respectively

The main effects are marked in bold and the respective interaction effects are listed below and represent an addition/deduction to the main effect, WTP. Respondents who believe the authorities should use additional resources to protect the aquatic environment also tend to have a higher WTP for naturally clean water and for conditions for plant and animal life compared with the average respondent. On the contrary, respondents who think that the problems of pollution of the aquatic environment are exaggerated exhibit a lower WTP for very good conditions for plant and animal life. Not surprisingly, respondents who regard purified water as just as good as non-purified groundwater have a lower WTP for naturally clean (non-purified) groundwater compared with the average respondent.

Respondents who disagree with drinking water in Denmark as being clean have a lower WTP for purified water compared to the sample. This is also the case for respondents who have knowledge of their household's annual water consumption.

6.5.4 Test of dominant attributes

The CE model is based on the idea that respondents make a trade-off between the price of the good and the different attributes. However, as mentioned in Chapter 4, one can not always be sure that the respondent has been considering the trade-offs as this can be due to a variety of circumstances. A proportion of the respondents might try to influence the results by answering strategically instead of answering the questionnaire according to their preferences.

By comparing the individual parameter estimates from the full model with those of a model with only 1 variable, it is possible to determine whether any of the attributes have dominated the choice of the respondents. The H0-hypothesis is that parameter estimates from the main effect model (with 6 parameter estimates) equal those of the less restricted model (with only one parameter estimate), implying that the variable in this case is dominating the other variables in the model. By mean of a pseudo T-test, the H0-hypotesis has been rejected for all the attributes meaning that none of the attributes has been dominating other attributes.

45 of the 584 respondents have been identified as choosing alternative number 1, i.e. the status quo situation, in all 6 choice sets. This could suggest use of a rule-of-thumb rather than a reflection of the trade-offs between the alternatives. This is supported by the fact that more alternatives offer a better quality of water or environment than the status quo alternative, at no expense for the respondent. These 45 respondents were removed prior to the estimations carried out in this chapter. However, the effect of not removing respondents for whom the status quo alternative has been dominant is shown in Table 6.11.

Table 6.11. Dominant choice of status quo not removed from sample

	Parameter		Std. error	WTP (DKK)
Price	-0.00056	***	0.0000	
Alternative specific constant	-0.3504	***	0.0958	-
Naturally clean groundwater	1.0288	***	0.0834	1,837
Purified groundwater	0.4791	***	0.0815	856
Very good conditions	0.6380	***	0.0634	1,139
Bad conditions	-1.0298	***	0.0724	-1,839
N	3,350			
Log L	-3,186.46			
χ^2	987.78			
Adjusted pseudo R^2	0.133			

Significance levels at 1%, 5% and 10% are denoted by three, two and one asterisk(s), respectively

A comparison of the WTP estimates in Table 6.12 shows that only the alternative specific constant is highly influenced by the omission of these respondents. At the same time, the adjusted pseudo R^2 changes from 0.19 to 0.13, indicating a poorer model-fit. On this basis, the respondents were permanently omitted from the estimations. Likewise, 1 respondent, who chose the most expensive alternative in each choice set, has been removed.

Table 6.12. Comparison of WTP with and without dominant choices

	Parameter		*WTP (DKK)*	
	3,350 obs.	*3,074 obs.*	*3,350 obs.*	*3,074 obs*
Price	-0.00056	-0.00059		
Alternative specific constant	-0.35	-0.73	-	-
Naturally clean groundwater	1.03	1.12	1,837	1,899
Purified groundwater	0.48	0.54	856	912
Very good conditions	0.64	0.71	1,139	1,204
Bad conditions	-1.03	-1.04	-1,839	-1,759

6.6 Summary and discussion of the CE results

Estimations of WTP have been conducted with a model based on 3,074 observations. All the four main effects are estimated with significant parameters, and show strong preferences for naturally clean water followed by very good conditions for plant and animal life, and subsequently preferences for purified water.

Furthermore, the analysis indicates that there seems to be a disutility connected with the present situation expressed by a negative WTP for the alternative specific constant describing the status quo situation.

The WTP seems to be correlated with a number of characteristics of the respondents. These include correlation with water consumption, gender and urban residence. There also seems to be a correlation between the respondents' self-reported certainty and the respondents' WTP, i.e. an increased WTP with increased certainty.

A number of socio-economic characteristics as well as a number of attitudes have, furthermore, been used to examine the WTP to reveal influencing factors.

7 Results of the CV survey

The CV-survey includes two subsequent valuation scenarios; the first is valuation of "Naturally clean groundwater, obtained by protection of groundwater" followed by a valuation of "Purified water". This chapter consists of 3 sections, beginning with a short description of the response statistics for both scenarios. This is followed by estimation of the WTP for the naturally clean water scenario, where the different steps of the procedure are reported and described. Lastly, the WTP estimation of the purified water scenario is presented. As this section follows the same structure as the naturally clean water section, some of the explanatory detail has been omitted to avoid repetition.

7.1 Response statistics

The CV questionnaire was sent out to 900 respondents and 663 questionnaires were returned which equals an overall response rate of 73,4 percent. The answers with respect to the groundwater protection scenario and the purified water scenario are distributed as follows.

Table 7.1. Response statistics, CV

	Naturally clean water		Purified water	
No response		13		19
Don't want/not able to answer		72		87
Want compensation		0		48
Protest zero	20		24	
Genuine zero	39		74	
Zero bids total		59		98
Positive bids		519		411
Total		**663**		**663**

The "no" response includes 8 and 11 respondents who did not answer the WTP questions in the naturally clean water and purified water scenario, respectively. Additionally, in both cases, there were 2 respondents who returned the questionnaire, but who did not answer either of the 2 WTP questions.

Debriefing questions were asked to identify genuine zero WTP from protest zero WTP.

7.2 Estimation of WTP for Naturally Clean Water

7.2.1 Identifying protest and genuine zero bids

Zero bids were conceived as protest zeros if the respondent stated that;

- it is not my responsibility to pay for clean water
- it is a public matter to ensure clean water
- the polluter of ground water should pay to ensure clean water.

Table 7.2 shows the distribution of genuine and protest zero

Table 7.2 Genuine and protest zeros

	Number of responses	Distribution in percent
At the moment I cannot afford to pay more for water than I already do	14	30
It is of no significance to me if limit values for pesticides and/or nitrogen content in drinking water are exceeded	4	9
It is of no significance to me if limit values for pesticides and/or nitrogen content in groundwater are exceeded	4	9
It is of no significance to me whether conditions for animal and plant-life in watercourses and lakes are improved or not	0	0
I need more information to be able to respond to questions such as these	11	23
I did not know how I should respond	2	4
Other	7	15
Do not know	5	10
Total non-protest answers	**47**	**100**
It is not my responsibility to pay for clean water	8	13
The public sector or the water companies should pay to secure clean water	14	22
Those, who pollute the water should pay to secure clean water in future	38	59
What I would pay to secure clean water is not a concern for others	4	6
Total protest answers	**64**	**100**

Note that the total number of responses of zero bids amounts to more than 59, as reported in Table 7.1, as the respondents were permitted to give several responses to the debriefing question. In cases where a respondent gave both a protest and a non-protest answer, the bid was regarded as a genuine zero. One can argue that the zero bids from respondents who are in need of more information or who did not know how to respond are not real zero bids. It is, however, considered as a conservative strategy to include these 13 respondents as genuine zeros.

7.2.2 Bid curves

In Figure 7.1 the cumulative distribution of the responses to the WTP question regarding groundwater protection is shown. The distribution is based on 578 observations including genuine and protest zero bids. It appears from the figure that 5 percent of the sample has chosen the "choke price" of 2,400 DKK.

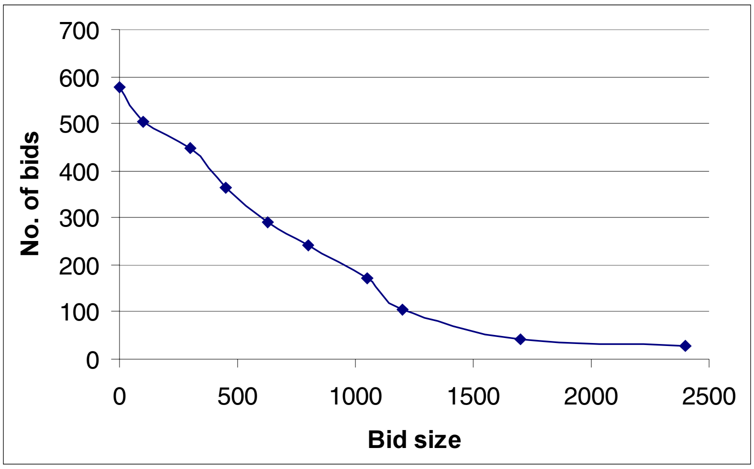

Figure 7.1. Bid curve for protected water

The figure confirms the expectation that the proportion of bids decreases with increased bid size.

7.2.3 Non parametric WTP

Figure 7.1 is based on bids chosen from the payment card with 10 payment options. The bid can be viewed as a lower bound for the respondents' WTP, and should ideally be treated as interval data, where the respondents' "true" WTP is between the bid and the next payment option. In the following econometric estimations, the effect on WTP of regarding the data as either interval or bids will be studied.

In Table 7.3, the mean, median and standard deviation of the WTP are described with and without zero bids and with different treatment of the interval data.

Table 7.3 Willingness to pay for clean water obtained by protection - bid estimates

Bid type		Mean	Median	Std. dev	N
Positive and all zero bids	Lower bound	687	625	572	578
Positive and genuine zero	**Lower bound**	**711**	**625**	**567**	**558**
Positive and genuine zero	Upper bound	926	800	615	558
Positive and genuine zero	Interval average	819	713	587	558

A conservative estimate of WTP is chosen, i.e. the lower bound mean of 711 DKK/year. Table 7.3 also shows an upper bound WTP at 926 DKK/year, which is the mean of the bid just above the actual, stated bid. Furthermore, an average of these two bids is shown as the interval average at 819 DKK/year.[5]

7.2.4 Econometric estimations

In this section the estimation results for the naturally clean groundwater scenario is presented. All the estimations are based on the sample of positive and genuine zero bids. The estimations are made in an iterative process, where potential significant variables are tested in the model. For reasons of comparison with the estimation results of Chapter 6, some variables are shown in the table, even though they are not below the significance threshold of 10 percent. Table 7.4 shows, at first, 3 simple OLS regressions using the average bid, the lower bound bid (corresponding to the stated bid) and the upper bound bid, respectively. However, these models may be biased for 2 reasons:

1) The simple OLS regression does not take into account that the WTP cannot be less then zero. This is solved by using a Tobit model, which censors the WTP at zero. The average bid between the lower bound and the upper bound is used as dependent variable.
2) The used bids are stated via a payment card and should ideally be treated as interval data and not as open-ended bids. Therefore, the last estimation in Table 7.4 is an interval regression where the interval ranges from the actual stated bid to the bid that follows in the payment card.

5 Some respondents chose the option "*Other*" among the payment options. This involves 25 respondents with the naturally clean water scenario and 13 respondents with the treated water scenario. These are included using the maximum bid as upper bound bid.

Table 7.4. Estimation of WTP for natural clean water

	OLS regression WTP average		OLS regression WTP lower		OLS regression WTP upper		ML Tobit estimation WTP average		ML Interval WTP	
	Parameter		Parameter		Parameter		Parameter		Parameter	
Respondent characteristics										
Household income (INCOME)	0.48	***	0.48	***	0.49	***	0.51	***	0.51	***
Education level (EDUCATION)	107.39	***	94.52	***	120.25	***	107.81	***	107.49	***
Medium annual water consumption (CONSUMP)	116.08	**	109.65	**	122.51	**	104.75	*	120.27	**
High annual water consumption	-6.16		-17.05		4.72		-27.97		-15.83	
Living in rural areas	75.40		72.49		78.31		82.96		80.28	
Does fish very often	46.20		69.04		23.36		71.85		43.89	
Saves water	-51.29		-58.33		-44.26		-66.61		-54.48	
Respondent attitudes										
Authorities should use more resources (RESOURCE)	140.19	**	131.33	**	149.04	**	132.52	**	142.66	**
Bottled drinking water can bought as substitute	8.59		-1.03		18.22		12.32		6.79	
Tap water may be purified in substitute for naturally clean	27.35		14.91		39.80		25.69		26.78	
Watercourses and lakes should have rich biodiversity	2.79		-28.28		33.85		-40.35		-12.63	
Drinking water is not clean in Denmark	-0.21		-24.07		23.66		-23.94		-5.25	
Pollution of the aquatic environment is exaggerated	-42.49		-57.28		-27.70		-99.58		-49.65	
Payment motives										
Importance to plant and animal life (ANIMAL)	139.20	**	136.80	**	141.60	**	147.89	**	147.05	**
Importance to future generations (FUTURE)	252.49	***	231.09	***	273.88	***	287.64	***	257.86	***
Altruistic motives	68.81		69.87		67.74		98.03	*	72.72	
	N = 531		N = 531		N = 531		N = 531		N = 531	
	R^2 = 0.72		R^2 = 0.68		R^2 = 0.75		Log L= -3,866		Log L = -1,264	

Significance levels at 1%, 5% and 10% are denoted by three, two and one asterisk(s), respectively[6]

The use of different models is linked to the discussion whether to treat the stated bids as interval data or not. The interval regression model shown to the right in Table 7.4 is regarded the most suitable estimation method and the estimates from this model will thus be described. Table 7.4 shows, however, that the parameter estimates are not much affected by the choice of regression method.

A number of variables have been included in the models. A small share has shown significance, and only these will be commented upon in the following. Both income level and education level are significant, which means that WTP increases with increasing income and education. Furthermore, respondents who have an annual water consumption between 75 and 130 cubic metres apparently have a higher WTP than the average respondent. Note that only 60 percent of the sample had knowledge of the annual consumption, and approximately half of these belong to the 75-130 cubic meter consumption group.

Seeking for differences between the respondents' attitudinal characteristics, the attitude that the authorities should use more resources to

[6] Parameter estimates with standard errors are shown in Appendix 4

protect the aquatic environment than they do now turned out to be significant. The positive parameter estimate suggests that those who agree with this (63 percent of the sample) also are willing to spend more themselves.

The respondents' motives for stating a positive bid has been introduced to the model as well. These motives have been elicited from a debriefing question in the questionnaire and the answers are distributed as shown in Table 7.5.

Table 7.5 Motives for positive WTP

Reasons to state a positive bid	Number of responses	Distribution in percent (519 positive answers)
1) It was the highest sum I could afford	122	24
2) Clean *drinking water* is important to me and, therefore, I would willingly pay to ensure clean drinking water supplies	375	72
3) Clean *groundwat*er is important to me and, therefore, I would willingly pay to secure clean groundwater	307	59
4) Clean *groundwat*er is important to plant and animal-life and therefore, I would willingly pay to secure clean groundwater	263	51
5) Clean *groundwat*er is important to future generations and therefore, I would willingly pay to secure clean groundwater	326	63
6) I wanted to express my interest in ensuring a healthy and clean environment	184	35
7) Securing clean water is an important task and, by indicating a high sum, I hope to contribute to that soon something might be done about this issue	134	26
8) I indicated the sum I would wish I had at my disposal to pay to secure clean drinking water	42	8
9) I did not know how else I should respond	10	2
10) I set a sum taking into consideration what I pay for other things	128	25
11) Other	24	5
12) Do not know	27	5

Reasons no. 6 and 7 from Table 7.5 have been regarded as altruistic motives. However, in the Tobit estimation it appears that the 38 percent of the respondents who stated one of these reasons (or both) have a significantly higher WTP than the rest of the sample. It can be debated whether inclusion of altruistic motives is reasonable in connection with economic valuation as the benefits can potentially be double-counted in this way. For a further discussion see Bjørner et al. (2000).

Respondents who stated a positive bid due to conditions for plant and animal life (40 percent) or due to future generations (50 percent) also have a significantly higher WTP (147 DKK/HH/year and 258 DKK/HH/year respectively). These parameter estimates indicate the non-use value connected to the scenario. Further description of value types connected to groundwater can be found in Hasler et al. (2004).

7.2.5 WTP Function

The significant parameters make up the WTP function for naturally clean groundwater. Based on the interval regression, the function is:

$$WTP_{Natural} = 0.51xINCOME + 107.49xEDUCATION + 120.27xCONSUMP + 142.66xRESOURCE + 147.05xANIMAL + 257.86xFUTURE \quad (7\text{-}1)$$

The variable names corresponds to the names in brackets in the estimation Table 7.4

Based on the average sample, the WTP equals:

$$WTP_{Natural} = 0.51x430 + 107.49x2.48 + 120.27x0.28 + 142.66x0.63 + 147.05x0.40 + 257.86x50$$

$$=$$

797 DKK / HH / YEAR

The estimated yearly WTP per household at 797 DKK seems reasonable compared with the grand mean and the median of the average interval at 819 and 713, respectively.

7.2.6 WTP influenced by self-reported certainty

Parallel to examination of the influence of self-reported certainty on WTP in the chapter on CE, the influence of this on WTP for the naturally clean water scenario has been examined. The distribution of self-reported certainty on the 7-level scale is illustrated in Figure 7.1.

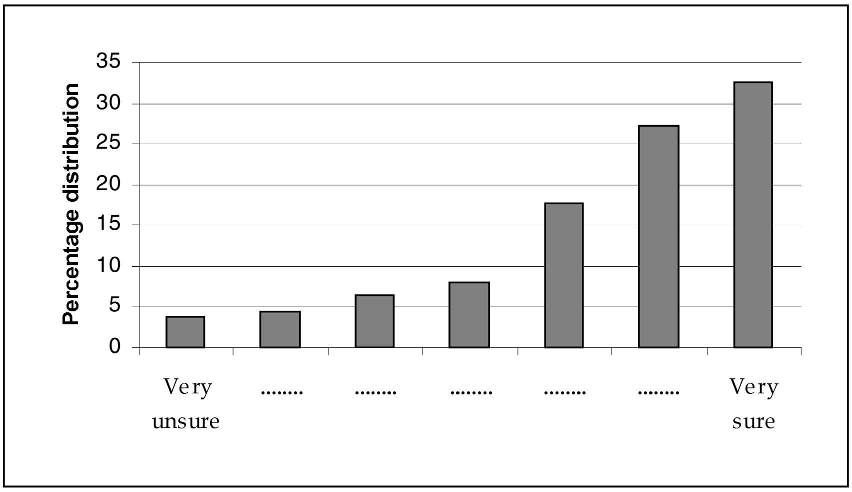

Figure 7.2 Distribution of certainty levels

Comparing the certainty level of the CE survey (Figure 6.2) with the present certainty level from the CV survey (Figure 7.2) indicates that answering the CV questionnaire was less demanding than answering the CE questionnaire. By using the same threshold level (3) to reduce the sample size as in the CE estimations, a certainty influenced WTP can be estimated. This is shown in Table 7.6.

Table 7.6 WTP for naturally clean water influenced by certainty

	OLS regression WTP average		ML Tobit estimation WTP average		ML Interval WTP	
	Parameter		Parameter		Parameter	
Respondent characteristics						
Household income, DKK (INCOME)	0.49	***	0.51	***	0.51	***
Education level (EDUCATION)	107.55	***	106.80	***	108.60	***
Medium annual water consumption (CONSUMPTION)	132.16	**	120.07	*	138.53	**
High annual water consumption	-24.02		-52.58		-33.46	
Living in rural areas	82.67		95.98		87.49	
Does fish very often	43.80		68.91		40.83	
Saves water	-66.40		-82.00		-66.38	
Respondent attitudes						
The authorities should use more resources (RESOURCES)	112.45	*	105.30	*	113.59	*
Bottled drinking water can bought as substitute	38.62		46.23		37.72	
Tap water may be treated in substitute for naturally clean	3.05		0.70		3.09	
Watercourses and lakes should have rich biodiversity	4.89		-39.68		-11.66	
Drinking water is not clean in Denmark	-10.52		-26.66		-16.31	
Pollution of the aquatic environment is exaggerated	-25.60		-87.41		-34.61	
Payment motives						
Importance to plant and animal life (ANIMAL)	177.15	***	186.54	***	183.77	***
Importance to future generations (FUTURE)	239.62	***	276.15	***	245.58	***
Altruistic motives	59.51		86.57		63.66	
	N = 452		N = 452		N = 452	
	R^2 = 0.73		Log L= -3,277.77		Log L = -1,070.70	

Significance levels at 1%, 5% and 10% are denoted by three, two and one asterisk(s), respectively

By using the parameter estimates from the interval regression in Table 7.6, a WTP for naturally clean water can be estimated at 795 DKK per year per household. This is in contrast to the CE results, where increasing level of certainty was connected to increasing WTP. In the CV estimation, the certainty level seems to have no effect on the WTP. This is, however, probably also related to the fact that only a small number of observations is removed in order to make the certainty adjustment in the CV estimation. This approach does not accord with the way in which certainty questions are typically used in CV analysis, where respondents who are uncertain, but still state a positive WTP, are changed to a zero WTP. The approach used, however, has been chosen in order to be able to compare how certainty affects both the CE and CV estimates.

7.2.7 Section summary of naturally clean water

The WTP for naturally clean groundwater has been estimated at 797 DKK per household per year. The estimation has been carried out by use of interval regression based on 531 observations.

The WTP is correlated with annual household income, education level of the respondent and the consumption of water. Furthermore, respondents in this sample who believe that the authorities should use more resources to protect the environment are willing to pay an additional 140 DKK per year. A significant part of the WTP is motivated by importance attributed to plant and animal life and to future generations.

The WTP seems not to be correlated with the respondents' self-reported level of certainty.

7.3 Estimation of WTP for purified water

7.3.1 Identifying protest and genuine bids

Figure 7.3 shows the cumulative distribution of the responses to the WTP question regarding purified water. Just as in the groundwater scenario, this distribution is also based on choices from a payment card and consists of 509 observations, including genuine zero bids. It can be seen from Figure 7.3.2 that 2.9 percent of the sample has chosen the "choke price" at 2,400 DKK. 48 respondents have stated that they want to be compensated. However, almost half of them have answered "don't know" to how much compensation they would require and, thus, no further attempt has been made to estimate a WTA for a change from naturally clean groundwater to purified groundwater. These 48 respondents have been excluded from the further estimations. Alternatively, they could have contributed as genuine zeros. In this case the estimated WTP would have been reduced.

7.3.2 Non parametric WTP and Bid curve

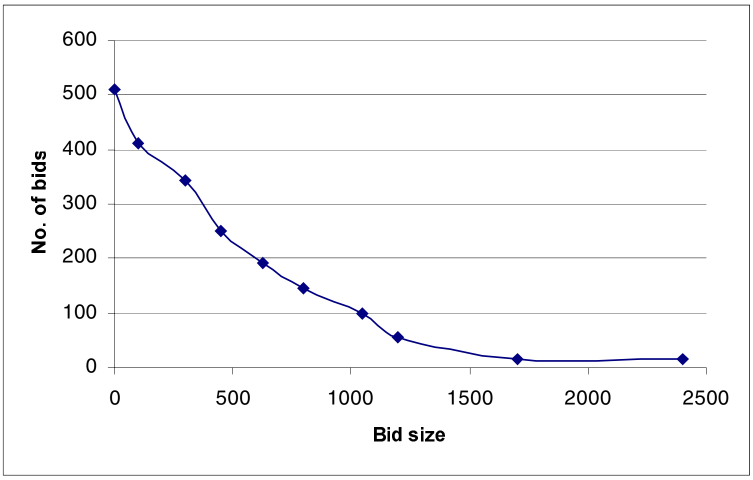

Figure 7.3. Bid curve for purified water

Table 7.7 shows the mean, median, standard deviation and number of observations for different WTP.

Table 7.7 Willingness to pay for purified water - bid estimated

		Mean	Median	Std. dev	N
Positive and all zero bids	Lower bound	504	300	512	509
Positive and genuine zero	**Lower bound**	**529**	**450**	**512**	**485**
Positive and genuine zero	Upper bound	718	625	553	485
Positive and genuine zero	Interval average	623	538	530	485

When only positive bids and genuine zero bids are included, the overall average WTP is 623 DKK/year, and the upper bound is 718 DKK. The lower bound WTP, at 529 DKK including genuine zeros, is chosen as a conservative estimate of respondents' WTP for purified water. Compared with the WTP for protection of groundwater, the WTP for purified water is somewhat lower, corresponding to 74% of the WTP for groundwater protection.

7.3.3 Econometric estimations of WTP

Results of the parameter estimates for the purified scenario using both OLS, Tobit and interval regression is shown in Table 7.8.

Table 7.8. Estimation of WTP for purified water

	OLS regression WTP average		OLS regression WTP lower		OLS regression WTP upper		ML Tobit estimation WTP Average		ML Interval WTP	
	Parameter		Parameter		Parameter		Parameter		Parameter	
Respondent characteristics										
Household income, DKK (INCOME)	0.42	***	0.42	***	0.43	***	0.45	***	0.44	***
Education level (EDUCATION)	77.50	***	63.58	**	91.42	***	77.56	***	75.41	***
Medium annual water consumption	84.30		75.15		93.46		69.38		83.85	
High annual water consumption	7.17		6.41		7.92		-4.77		8.66	
Living in rural areas	-54.04		-55.37		-52.71		-42.58		-55.96	
Does fish very often	-47.55		-25.68		-69.42		-26.13		-46.97	
Saves water	-57.97		-66.81		-49.13		-88.41		-59.95	
Respondent attitudes										
The authorities should use more resources	81.51		79.62		83.40		65.27		85.50	
Bottled drinking water can bought as substitute	-23.94		-28.47		-19.40		-24.94		-21.69	
Tap water may be purified instead of natural (PURIFY)	102.25	*	84.33		120.17	**	135.44	**	98.43	*
Watercourses and lakes should have rich biodiversity	124.83		94.19		155.47	*	77.52		119.95	
Drinking water is not clean in Denmark	66.47		42.13		90.80		43.92		69.53	
Pollution of the aquatic environment are exaggerated	-46.63		-55.77		-37.48		-94.45		-48.74	
Payment motives										
Altruistic motives (ALTRUIST)	363.51	***	345.45	***	381.58	***	440.37	***	368.40	***
	N = 462 R^2 = 0.64		N = 462 R^2 = 0.59		N = 462 R^2 = 0.68		N = 462 Log L = -3,092		N = 462 Log L = -1,124	

Significance levels at 1%, 5% and 10% are denoted by three, two and one asterisk(s), respectively

Just as in the case of the naturally clean groundwater scenario, both household income and education levels are significant parameters.

Unlike the estimations for naturally clean water, there is no reason to estimate parameters for motives related to the non-use values for the purified water scenario, as there are no such values connected to this scenario.

An interesting point is that WTP for purified water is connected to the respondent's attitude towards treatment of water. Respondents who, to a certain degree, have agreed that drinking water does not have to come from non-purified groundwater and that purified water is just as good (23 percent), have a significant WTP ranging from 98-135 DKK/HH/year depending on the estimation method used.

Also, in this case the motives to state a positive bid are examined and the associated distribution can be seen in Table 7.9.

Table 7.9 Reasons to state a positive bid

	Number of responses	Distribution in percent (411 positive answers)
1) It was the highest sum I could afford	94	23
2) Clean *drinking water* is important to me and, therefore, I would willingly pay to ensure clean drinking water supplies	287	70
3) Securing clean water is an important task and by indicating a high sum, I hope to contribute to that soon something might be done about this issue	124	30
4) I indicated the sum I would wish I had at my disposal to pay to secure clean drinking water	41	10
5) I did not know how else I should respond	21	5
6) I set a sum taking into consideration what I pay for other things	106	26
7) I chose a lower sum than in Question 5.1, as I do not think as much of the proposed alternative in Question 5.5 as of that in Question 5.	76	18
8) Other	13	3
9) Do not know	2	0

Just as in Section 2.2.4, reasons no. 3 and 4 in Table 7.9 are regarded as being altruistic.

When this motive is incorporated in the model, it turns out that a noteworthy proportion of the WTP is related to the respondents' desire to contribute to a good cause.

7.3.4 WTP Function

$$WTP_{Purified} = 0.44xINCOME + 75.41xEDUCATION + 98.43xPURIFY + 368.40xALTRUIST \quad (7\text{-}2)$$

The variable names correspond to the names in brackets in the estimation Table 7.8.

Based on the average sample, the WTP equals:

$$WTP_{Purified} = 0.44x430.02 + 75.41x2.48 + 98.43x0.23 + 368.40x0.23$$

$$=$$

$$\mathbf{461}\ \boldsymbol{DKK / HH / YEAR}$$

The estimated yearly WTP per household at 461 DKK is somewhat lower than the grand mean and the median of the average interval at 623 and 538, respectively.

7.3.5 WTP influenced by self-reported certainty

The distribution of the self-reported certainty connected to the purified water scenario is illustrated in Figure 7.4. The certainty scale goes from level 1 (very unsure) to level 7 (very sure).

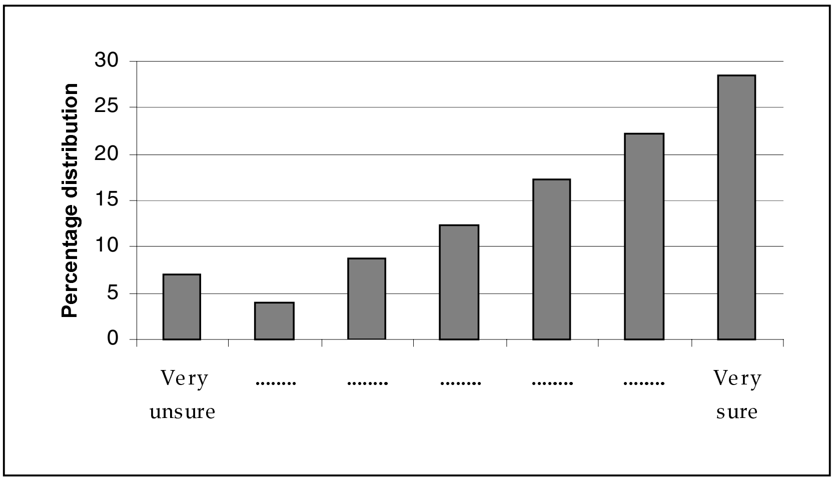

Figure 7.4. Distribution of certainty, purified water

Table 7.10, below, shows the estimation results after reducing the sample with respondents who stated a certainty below level 3.

Table 7.10 WTP for Purified water influenced by certainty

	OLS regression WTP max		ML Tobit estimation WTP average		ML Interval WTP min & max	
	Parameter		Parameter		Parameter	
Respondent characteristics						
Household income, DKK	0.47	***	0.51	***	0.49	***
Education level	59.32	**	52.93		57.93	*
Medium annual water consumption	80.58		60.11		80.94	
High annual water consumption	-12.45		-32.03		-13.32	
Living in rural areas	-46.95		-31.00		-50.25	
Does fish very often	-38.12		-6.70		-37.31	
Saves water	-35.22		-69.34		-38.40	
Respondent attitudes						
The authorities should use more resources	93.55		73.64		97.00	
Bottled drinking water can bought as substitute	-54.72		-67.77		-52.36	
Tap water may be treated instead of natural	83.79		118.35		78.20	
Watercourses and lakes should have rich biodiversity	147.92		115.08		144.39	
Drinking water is not clean in Denmark	66.76		60.54		70.43	
Pollution of the aquatic environment are exaggerated	-25.94		-86.77		-29.15	
Payment motives						
Altruistic motives	385.62	***	476.09	***	391.23	***
	N = 374 R^2 = 0.63		N = 374 Log L = -2,464.91		N = 374 Log L = -921.47	

Significance levels at 1%, 5% and 10% are denoted by three, two and one asterisk(s), respectively

By using the parameter estimates from Table 7.10, the certainty calibrated WTP is calculated at 427 DKK per year per household. Just as is the case for naturally clean water, it does not seem as if certainty influences the WTP for purified water.

7.3.6 Section summary purified water

The WTP for purified water has been estimated at 461 DKK per household per year. This number is correlated with the annual household income as well as the respondents' educational level. I.e. high-income levels and long education influence the WTP positively, and result in higher WTP. Respondents who trust the use of purified water as a substitute for naturally clean water have a higher WTP than those who do not put their trust in this. Furthermore, a significant part of the WTP can be assigned to the respondents' urge to do something for a good cause, i.e. altruism. Just as in the case of naturally clean water, there is no correlation between the respondents' WTP and self-reported level of certainty.

8 Comparison of the two surveys

8.1 The results from the two studies

Table 8.1 below compares and presents the WTP estimates from the CE and CV surveys.

Table 8.1 Estimated WTP-results

	CE	CV
Naturally clean groundwater	1,899	711
Very good conditions for plant and animal life	1,204	
Total	**3,104**	**711**
Purified water	**912**	**529**

All sums are household WTP in DKK per year.

In the CV survey, WTP has been elicited for an aggregate of both groundwater and environment. Thus, it is necessary to add the CE WTP from ″naturally clean groundwater″ with the CE WTP from ″very good conditions for plant and animal life″ in order to compare the CE results with the CV result. In general, this study shows that the WTP from the CE survey is approximately 2 to 4 times higher than the WTP from the CV survey. This is supported by a large amount of experimental evidence, which demonstrates that CE tends to produce much higher valuation estimates than CV (see e.g. Boyle et al., 2004). The issue is discussed further in Section 8.2.3 below.

In addition to the actual magnitude of the WTP sums, the CE estimations also provide information on the relative importance of the respondents' preferences for the attributes in question. The CE survey confirms that naturally clean water management is preferred to purification of water and that there is a positive WTP for improved conditions for animal and plant life.

The CE result for naturally clean water resulting from protection of the groundwater resource represents a marginal increase of almost 50 %; from 4,000 to 5,899 DKK/year. It is evident that the WTP for groundwater protection exceeds the WTP for purification. However, the WTP for purified water from the CE survey represents only 30% of the total WTP for groundwater protection.

As mentioned earlier, one of the hypotheses in this study is that *consumers prefer naturally clean groundwater, which is not in need of purification or other treatment, to water that has been polluted and treated to clean, thereafter.* This is a premise underlying Danish drinking water policy. By testing this hypothesis, the benefits of groundwater protection versus purification are measured and this hypothesis cannot be rejected by the results obtained from either of the two methods. The CE results support this hypothesis, as well as the hypothesis that the WTP for groundwater protection exceeds the WTP for purified water. The CV results confirm that there is a positive WTP for the aggregate scenario of naturally clean groundwater and very good conditions for plant and animal life.

The second hypothesis is that *the value associated with clean drinking water exceeds the value associated with good quality of surface waters.* The rationale here is that clean drinking water influences human health, and hence private goods, more directly than the quality of surface waters does. This hypothesis cannot be rejected either, as the CE results indicate that the WTP for good conditions in surface waters comprises 63% of the WTP for good drinking water quality obtained by protection. The explanation for this difference being that clean drinking water influences human health and hence private goods more directly than the quality of surface waters does, both for present and future generations, is therefore supported by the results. Compared with foreign valuation results, as well as Danish, the results are in agreement with the assumptions. The results can be explained by considerations for future generations, by altruistic motives and use-values, because clean drinking water influences human health and hence private goods more directly than the quality of surface waters does.

The third and fourth hypotheses are that the WTP in urban areas exceeds the WTP in rural areas, and that the WTP in households with children exceeds the WTP in households without children. Furthermore, we hypothesise that WTP of females exceeds WTP for males. These hypotheses are motivated by the results of former analyses of the demand for organic foods in Denmark and Great Britain (Wier, 2004). These results show that urban residents consume organic foods to a higher degree than residents living in rural areas. This study also concludes that households with children under 15 years of age have a higher demand for organic foods than other households (Wier, 2004). Therefore, it is not the presence of children, in itself, which increases the demand, but the presence of children under 15 years of age. Human health and environmental concern are the most stated reasons for preferring organic food to conventional, and we expect that these reasons are also the drivers for the hypothesised preferences for clean groundwater.

The results of the estimations indicate that there are differences in households' WTP between urban and rural areas, as the WTP is higher in urban than in rural areas. The hypothesis, therefore, cannot be rejected. Furthermore, the results show that the WTP of females are higher than those for males, but that the effect of age and the presence of children in the household are insignificant, i.e. the WTP is not dependent on whether there are children in the household or on the age of the members of the household.

In both surveys, a correlation between household income, education level of the respondent, household water consumption and the household WTP has been demonstrated. In Section 3.4.1, it was shown that, in a number of ways, the sample of respondents did not match the population of Denmark. This applies for example in the case of household income. Therefore, as the WTP estimates are correlated with income, the findings cannot be generalised without caution.

8.2 Discussion of results

8.2.1 Comparison to other studies

As mentioned in Section 1, no studies have been found focusing on both drinking water and surface water quality as in this study, and no studies have been found focusing on purification versus protection. The results from the two studies mentioned below can, therefore, be compared to the results from the present study, but only with respect to drinking water quality.

In their CV-study Bergstrom et al. (1994) on "safe" drinking water, a WTP between 242 and 691 DKK[7] per year per household was arrived at.

Stenger & Willinger (1998) found WTP estimates between 701 and 1,755 DKK[8] per year for a household for groundwater of good quality for drinking water. The upper level refers to WTP questions posed in an open-ended format, and the lowest level in a close-ended format.

Press & Söderquist (1996*)* estimated a WTP of 2,483 DKK[9] per year per household to secure water quality in Milan for pollution limit values for drinking water not to be exceeded.

Jensen et al. (1995) valued measures which secure substantial reductions in groundwater pollution, and reported WTP of 1,000 DKK/year elicited by an open-ended payment format, and 2,100 using the close-ended format.

It is apparent that the results from the present study are in the same range as these studies; the CV results for drinking water are comparable to Bergstrom's results and the lower bound from Stenger & Willinger. The results from Press & Söderquist and Jensen et al.'s upper bound are comparable with the results from the CE, but are somewhat higher. On analysis of the results of these previous studies, DØR (2004) concludes that a mean value for Danish water protection is approximately 900 DKK/year. If this benefit approximation is per household it can be considered to represent an underestimate compared with the results of the present study.

Georgiou et al., (2000) analysed WTP for water quality river basins, and they found a WTP of £2.76 per annum in the CV study and £5.08

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[7] The amount is converted from USD to DKK by a conversion rate on 605,87 (DØRS, 2004, p. 210)

[8] Conversion made by DØRS(2004), p.210

[9] Conversion made by DØRS(2004), p.210

per annum in a contingent ranking (CR) study, i.e. 61 and 33 DKK[10] per household per year, respectively. However, these valuations comprise the WTP for protection of one single river (the River Tame) and it should, therefore, be expected that the WTP estimates are much lower than the WTP for good quality in all Danish watercourses and lakes, which is the focus of the present study.

8.2.2 Discussion of the results compared to other comparative CV/CE studies

As mentioned in Section 8.1, the CE results are higher than those in the CV for all goods valued in the present study, and these results are supported by empirical results comparing choice methods with CV, cf. Georgiou et al. 2000, Stevens et al. (2000), Desvousges & Smith (1983), Hanley (1998a) and Foster & Mourato (2000).

Georgiou et al.'s study (2000) analysed the value of river water quality improvements with CV and CR, and they tested scope sensitivity and ordering effects with the two methods besides comparisons of the methods. They found that the CR results were larger than the CV results, which is consistent with the previous findings mentioned above.

Stevens et al. (op cit) found that WTP from choice modelling techniques, more specifically CR, are generally larger than those from CV. Desvousges & Smith (op cit) was one of the first studies comparing CV and choice modelling techniques (CM), i.e. CR, and was conducted in a study of water quality in a river. They found WTP that were three to four times lower than that obtained from CR.

Hanley (1998a) finds that the value of an environmental change obtained by dichotomous choice CV is more or less equal to the value obtained by CE. He also found, however, that CE results are three times as high as those obtained by open-ended CV, CE being more comparable to payment cards than to dichotomous choice.

In a comparative study, Foster & Mourato (1999) compare CV (dichotomous format, cf. Section 2) and CR in a study on two nested public goods:

1) An inclusive good: All charities operating in the housing and homelessness sector as well as the counselling and support service sector, the social services charities, health and medical charities and charities for culture, environment and overseas aid.

2) A less inclusive good: All charities operating in the housing and homelessness sector.

Their results indicate that the CR values exhibit greater sensitivity to scope, i.e. they are more sensitive to the framing of the questions and the scale than the CV values are. They find that the CR results produce significantly higher results than CV for the inclusive good (1), and significantly lower for the less inclusive good (2). When using the

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[10] The amount is converted from English pounds to DKK by a conversion rate of 1206 (the conversion rate 18.01.2000)

most preferred alternative (MPA) method on the CR data, the results are comparable to a choice experiment study. In using this method, Foster & Mourato (op cit) find that divergences are even greater when applying MPA compared with full ranking, indicating that divergences can be greater employing CE.

However, in a study on moose hunting, Boxall et al. (1996) compare CV (referendum format, cf. Section 2) and CE, and find opposing results. They estimate values derived from the two methods and use the choice experiment model to explain the differences between the values and to illustrate problems with the CV method. The empirical study of moose hunting yielded higher WTP estimates from the CV than from the CE. Boxall et al. (op cit) conclude that WTP estimates from CE are more comparable to estimates elicited by revealed methods than CV results are - and hereby lie closer to the "true" value.

8.2.3 Discussion of explanations for the differences found

As mentioned in Section 3, elicitation of WTP by both CV and CE methods is dependent on;

- the description of the hypothetical market
- what respondents know about the good and the information level
- the preferences of the respondents
- the availability of substitutes –and the information on substitutes
- the budget constraints of the respondents

Some of the differences in results between different hypothetical methods can, therefore, be explained by the fact that the perception of the public good can differ due to different descriptions of the hypothetical market and the good – i.e. the respondents do not value the same good. This can be a risk if the methods present the problem and the good in different ways – especially if it is a nested good.

Although the wording and framing is more or less equal in the two surveys in the present study this could still represent a problem and one of the explanations for the different results from the two methods. This can especially be the case when analysing the effects of aggregate policies and multiple effects versus partial effects from different components of the policy.

Hoehn & Randall (1987) prove theoretically that under standard neoclassical assumptions open-ended CV–results are lower than results from dichotomous choice. Dichotomous choice is more similar to discrete choice methods than to open-ended formats.

Steven et al. (op cit) and Georgiou et al. (2000) explain the differences between CV and CE results with the following explanations:

1. Substitutes are expressed more explicitly in CM than in CV and encourage respondents to make trade-offs
2. Choices and rankings will result in a larger emphasis on price compared to the direct decisions on WTP in CV

3. It is easier to express indifference to choices in CE than in CV, and protest behaviour is a less serious problem in CE compared with CV

Georgiou et al. (2000) conclude that they believe that "CV may create incentives for respondents to understate their true WTP" as a result of the four factors above. Ordering effects found by Georgiou et al. (op cit) might also influence the CV results in the present study, as there might be a risk of bias in asking the same respondent two subsequent WTP questions, i.e. first relating to the naturally clean water scenario then the purified water scenario.

Besides the above-mentioned explanations, Georgiou et al. (2000) found that 23% of the respondents in the CV survey did not respond to the valuation questions, while only 2% of the respondents in the Contingent Ranking (CR) survey did not respond. In the present study, no such differences have occurred, as the response is more or less equal in the two surveys.

Boxall et al. (1996) stated that information inefficiencies, supposed to affect the results of CV, are reduced by using the CE-method because of the repeated sampling method and the systematically varied choice situations employed in CE. Another important explanation of the difference in results from the two methods is, therefore, that WTP estimations in CV rely more on the accuracy of the information and on formulation of the precise changes in environmental services and goods than in CE. Rather than a specific change in the good or service, CE reveals WTP by representation of an array of choices. Therefore, the accuracy of the CE method relies on the *characteristics* used to describe the choice alternatives while the accuracy of the CV method relies on the precise *description of the changes* (cf. Boxall et al, op cit).

Boxall et al. (op cit) found three plausible explanations, where substitution and compliance bias are important (cf. the explanations above):

1. The respondents in the CV survey did not understand the questions and scenarios
2. Compliance bias; the respondents in the CV are "yeah-sayers"[11].
3. The respondents in the CV survey ignored substitution possibilities.

In the present study, respondents are asked how certain they were in their choices and to indicate their certainty level on a Likert scale from 1 to 7. Comparison of the results in Figures 6.2 and 7.2. indicates that the respondents were actually more certain of their answers in the CV survey compared with in the CE. Consequently, explanation 1 does not prove to be plausible for the present study. Furthermore, the debriefing questions in the CV indicate that 2 is not plausible either as the respondents are not "yeah-sayers"[11], but rather, altruistic motives are somewhat dominant among the CV respondents. It is, however, not known whether altruistic motives are dominant in the CE

[11] "Yeah-saying" means that the respondent has not really thought carefully about the stated WTP.

survey, as this debriefing question is not asked. It is more difficult to ask these questions in a CE survey than in a CV questionnaire.

Boxall et al. (op cit) conclude that explanation no. 3 is the most plausible explanation. In the present CV study, substitution effects are not accounted for in the same way as in the present CE survey, causing hypothetical bias, which most likely, is an explanation for the lower CV results as well. I.e. the respondents are not asked to make trade-offs between an uncertain delivery of pure water in the future, purified water or protected water. In the present study, we can judge if the CV respondents were less or more confident in their answers than the CE respondents were, from answers to the certainty question in both questionnaires. The respondents' self-reported certainty influenced the WTP in the CE survey, whereas there was no effect in any of the scenarios in the CV. By looking only at the levels of the self-reported certainty, it seems as though the CV survey has been an easier task to complete than the CE survey as, in general, the respondents state a higher level of certainty in the CV survey.

Boyle et al. (2004) list a number of studies where CM produces higher valuation estimates than CV and explain the divergence by the lack of incentive compatibility in CM. This includes respondents' choosing between more than two alternatives and repeated choices.

In their conclusion, Georgiou et al. (2000) presented an interval with the CV results as a lower bound and the CR result as the upper bound, but most emphasis was expressed on the CR results. Georgiou et al. (2000) conclude, however, that no conclusive evidence could be given for the reasons for the differences in CV and CE.

However, on the basis of the above-mentioned findings on the differences between CE and CV results, the results from the CE survey are recommended as an estimate of WTP for the different scenarios of groundwater management, but with the CV results used as a lower bound.

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Annex 1

Experimental design – general introduction to experimental design theory and concepts

As experimental design is very important to produce good results from Choice experiment surveys, an annex is included here explaining important features of the design of these surveys.

An important element of conducting a CE study is to identify an appropriate experimental design for the study. Thus, the extent to which the desired effects can be estimated, along with the degree of accuracy of the obtained estimated, is contingent upon the properties of the experimental design used to elicit respondents preferences for the good subjected to valuation.

Full vs. fractional factorial designs

In terms of design terminology, a basic distinction can be made between full factorial designs and fractional factorial designs, where the former refers to designs consisting of all possible alternatives that can be constructed from different combinations of attribute levels (Carlsson and Martinsson, 2003:283). The product of the levels of the attributes gives the size of the factorial design. Using a design with 2 attributes with 3 levels each and 2 attributes with 4 levels as an example, the resulting full factorial design will consist of (3*3*4*4=144) 144 alternatives (Louviere et al., 2000). A fractional factorial design, on the other hand, only contains a subset – i.e. a fraction – of the alternatives comprising the full factorial, and the specific subset is selected so that the effects of interest can be estimated with reasonable statistical efficiency (Louviere et al., 2000:90).

In relation to determining which sort of design to use, it may be useful to distinguish between main and interaction effects, where the former specifies the isolated effect of an attribute on utility/the probability of choice[12] and the latter refers to effects caused by interactions between two or more attributes (Kuhfeld, 2004). To illustrate the difference, the effect of e.g. price in a main effects model is constant across alternatives, whereas the effect of price in a model with interactions, e.g. between price and quality, will vary across alternatives characterised by different quality levels.

Using a full factorial design, all main and interaction effects are uncorrelated and therefore estimable (Kuhfeld et al., 2004). Despite this desirable property, the size of full factorial designs imply that it, except in relation to very simple experiments (i.e. experiments with few attributes with few levels), will often be impractical to use full factorial designs. In practice, it is therefore common to use fractional facto-

[12] A more formal definition of a main effect is: "a main effect is the difference in the means of each level of a particular attribute and the overall or "grand mean", such that the difference sum to zero" (Louviere et al., 2000:86).

rial designs which are smaller in size (Kuhfeld, 2004:46). Moving from a full to a fractional design is associated with loss of statistical information and implies that different effects may become confounded (Kuhfeld et al., 2004; Louviere et al., 2000). When effects are confounded it implies that they cannot be distinguished from each other anymore. For the purpose of illustration, assume that the effect of e.g. the price attribute has become confounded with the effect arising from a two-way interaction between e.g. a quality attribute and a colour attribute. Assume also that the interaction effect is, in fact, significant. In this case, using a fractional factorial design, that does not allow the interaction effect between quality and colour to be estimated, entails that the parameter estimate for the price attribute will be biased due to its being confounded with the omitted, though significant, effect of the quality-colour interaction.

It is important to acknowledge that all fractional designs are based on assumptions of non-significance of some interactions (either two-way or higher-order interactions) (Louviere et al., 2000:90). That is, when using fractional factorial designs to estimate lower order effects, such as main effects or two-way interactions, higher order effects are implicitly assumed to be either zero or negligible (Kuhfeld, 2004:46). However, the more specific degree and structure of confounding depend on the size of the fractional design relative to that of the full design and the applied reduction strategy. The goal, therefore, is to find a design that has a manageable size, while it also ensures that the effects to be estimated are either non-confounded or only confounded with effects assumed to be insignificant.

Results from previous studies working with linear models suggest that main effects typically account for 70 to 90 per cent of explained variances, whereas two-way interactions typically account for 5 to 15 per cent, and higher-order interactions account for the remaining explained variance (Louviere et al., 2000:94). This may be taken to indicate that experimental designs should ideally encompass at least two-way interactions, as they may account for a significant proportion of the explained variance. However, it also suggests that a viable design strategy, which will make further reductions in design size possible, may be to use a main effect design, where main effects either are non-confounded or only confounded with three-way or higher order interactions. In practice, it may often be the case that the choice of design size is only partly based on considerations related to estimability and confounding considerations. Thus, in practice, concerns related to sample size and the number of alternatives/choice sets that each respondent can be expected to handle are likely to play an equally important role (Kuhfeld et al., 2004:80).

Efficiency criteria
As it is peoples' choices between the alternatives included in different choice sets that creates the basis for deriving value estimates, it is important to combine attribute levels into alternatives and choice sets in a way that maximises the efficiency of the design, i.e. maximises the amount of extractable information (Carlsson and Martinsson, 2003:290). One of the most commonly used measures of design efficiency is that of D-efficiency (Kuhfeld et al., 2004: 49). The relative statistical efficiency of different experimental designs depends on the

extent to which the following four criteria are satisfied; level balance, orthogonality, minimal overlap and utility balance. The former two criteria refer to the design as such – i.e. to the composition of the subset of the full factorial comprising the fractional factorial design – and the latter two criteria refer to the way that alternatives are combined into choice sets. If all four criteria are satisfied for a given design, the design has a maximum D-efficiency (Carlsson and Martinsson,, 2003:284). Below, each of the four criteria is defined and their potential implications in relation to which design to choose are discussed.

Level balance
The level balance criterion requires that the levels of each attribute occur with equal frequency in the design (Carlsson and Martinsson, 2003:284). For e.g. a 4 level attribute level balance implies that each of the four levels should be represented in precisely one fourth of the alternatives (Huber and Zwerina, 1996:309). If this criterion is meet it is ensured that the intercept is orthogonal to each effect (Kuhfeld, 2004:46).

Orthogonality
In an orthogonal design the levels of each attribute varies independently of the levels of all other attributes. Using a linear design this property ensures that the estimated effects are uncorrelated (Carlsson and Martinsson, 2004:284), and that the obtained parameter estimates are not influenced by the properties of the design. More specifically, the criterion of orthogonality specifies that every pair of levels either should occur equally often across all pairs of attributes or with proportional frequencies (Kuhfeld, 2004:46). That is, combinations of different levels across attributes should occur with equal or proportional frequencies. If the criteria of level balance and orthogonality are to be met simultaneously, the frequencies have to be equal.

In relation to the practical application of the orthogonality criterion, it may be noted that the criteria of level balance and orthogonality are often conflicting, implying that trade-offs between level balance and orthogonality have to be made (Huber and Zwerina, 1996:309). Another potential problem with orthogonal designs is that they are likely to contain implausible/unrealistic alternatives – i.e. alternatives where the levels of the attributes move in directions that would be counterintuitive to most respondents (Bennet and Adamowicz, 2001). The presence of such alternatives may negatively affect efficiency of the study as they may either serve to discourage people from participating or to provide "silly answers to silly questions". Based on this, it is often recommended that implausible/unrealistic alternatives be removed from the design[13]. Doing so, however, may just introduce new inefficiencies since the exclusion of alternatives will change the confounding structure of the design and is likely to introduce correlation between attributes (Bennet and Adamowicz, 2001; Kuhfeld et al., 2004). In practice, it will therefore often be necessary to make a

[13] Bennet and Adamowicz (2001) also advances the possibility that explaining to respondents why alternatives can appear counterintuitive may mitigate problems caused by the presence of implausible/unrealistic alternatives. At first glance, this suggestion sounds quite appealing, but its actual operability appears questionable once the presumably lengthy argumentation necessary for providing acceptable explanations is considered.

trade-off between the degree of orthogonality and the degree of realism. In this context, Kuhfeld et al., 2004:70) note that: "Orthogonality is not the primary goal in design creation. It is a secondary goal associated with the primary goal of minimising the variances of the parameter estimates". Thus, it is emphasised that care should be taken not to put undue emphasis on orthogonality even though it represents a much more tangible efficiency criteria than that related to ensuring the plausibility/realism of the alternatives.

Minimal overlap
The criterion of minimal overlap specifies that the probability that an attribute level repeats itself in a choice set should be, if not zero, then at least as small as possible (Carlsson and Martinsson, 2003:284; Huber and Zwerina, 1996:309). Thus, if the alternatives in each choice set have non-overlapping attribute levels for all attributes the amount of information to be extracted from each choice set is maximised.

Utility balance
Utility balance serves to ensure that the choice sets actually induce respondents to make trade-offs, and it requires that the utility of alternatives within a choice set is equal (Carlsson and Martinsson, 2003:284). That is, the more similar the alternatives in a choice set are in terms of the level of utility that they give rise to, the greater the amount of information to be extracted from observations of respondents' choices.

In contrast to the criteria of level balance, orthogonality and minimal overlap, which are fairly simple, if not to achieve, than at least to assess, then the criterion of utility balance is difficult to satisfy. Achieving utility balance requires prior information on the parameters of the choice model (Carlsson and Martinsson, 2003; Huber and Zwerina, 1996). Such prior information may be obtained either from the literature, focus groups, pilot studies or the study itself, if a sequential design approach is adopted (Carlsson and Martinsson, 2003:290).

When combining alternatives into choice sets, some alternatives may turn out to be dominated while others will be dominant. Dominated alternatives are alternatives that are combined with other alternatives that are universally superior in their experimental design-driven attribute levels (Bennet and Adamowicz, 2001:58), and vice versa for dominant alternatives. Choice sets containing dominated/dominant alternatives basically provide no information, while they increase the risk that respondents will find the exercise ridiculous and, therefore, lose patience or decide not to participate. Designs containing choice sets with either dominated or dominant alternatives will clearly fail to satisfy the utility balance criterion. Hence, obtaining a utility balanced design requires that all dominated/dominant alternatives be excluded from the design. However, deciding which alternatives should be excluded may prove difficult since the question of what constitutes a dominated/dominant alternative often turns out to be far from clear-cut (Bennet and Adamowicz, 2001:58). That is, especially when dealing with qualitative attributes, the utility associated with different attributes/attribute levels is likely to be a matter of taste, implying that it is difficult – if not impossible – to determine on a more general level what is good and what is bad.

Utility balanced designs may be problematic in two respects. Thus, as discussed in relation to the exclusion of implausible/unrealistic alternatives, the elimination of certain alternatives/attribute combinations (in this case dominated/dominant alternatives) implies that the efficiency of the design may drop and that correlation between attributes may be introduced[14] (Kuhfeld et al., 2004). Moreover, utility balance may cause problems due to the inherent increase in task complexity associated with choosing between more or less utility balanced alternatives as opposed to non-balanced alternatives. It is expected that a certain degree of utility balance will be beneficial, as it may increase task realism, make completion of the task seem worthwhile and provide an incentive for providing valid and reliable answers. However, a situation could also arise where the resulting task complexity is so great that it causes an increase in the variance of the error component, which surpasses the actual gain in terms of increased information. In this context, it may be noted that if minimal overlap is ensured simultaneously with utility balance, the complexity of the choice task may indeed be significant as several changes, which jointly are more or less utility neutral, need to be considered simultaneously.

In terms of how the utility balance criterion should be applied in practice, a study by Carlsson and Martinsson (2003) along with a paper by Huber and Zwerina (1996) recommend that the utility balance criterion be applied, as it is found to have the potential to significantly increase design efficiency. However, it should be recognised that, in many cases, it may not be possible to apply the criterion in practice due to lack of prior information on the relevant parameters. A less systematic approach is, therefore, likely to be more operational, and in this context it may be noted that there seems to be consensus throughout the literature that choice sets containing clearly dominated/dominant alternatives should be avoided. Following this approach will no doubt increase the utility balance of the design, while probably not increasing task complexity and correlation between attributes unduly.

Constructing an experimental design –different design options

In practice, experimental designs are usually created by using software programmes containing different procedures for constructing experimental designs. In this section, three different design options, and the procedures in the software programme SAS by which they may be implemented, will briefly be introduced. It may be noted that the different options vary in relation to the emphasis put on the different efficiency criteria set out in the previous section.

The linear design approach

The linear design approach is based on the assumption that a design, which is efficient for a linear model, also will be a good design for the models used in discrete choice studies, where it is aimed to measure

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[14] In this context it may also be noted that the criteria of orthogonality and utility balance are likely to be conflicting.

the utility of each alternative and the contributions of each attribute to that utility (Kuhfeld, 2004:57). By doing so, independence and normality, which are unlikely to apply in a discrete choice setting, are implicitly assumed Kuhfeld, 2004:57). Linear design efficiency emphasises level balance and orthogonality whereas the criteria of minimal overlap and utility balance are left unattended. Therefore, the efficiency value pertaining to the linear design does not correspond to the efficiency of the design when used in a choice experimental context. Despite these shortcomings, the linear design approach has been used quite successfully for many years Kuhfeld, 2004:57), and may be regarded as a both good and safe strategy. Thus, the resulting design is orthogonal or nearly orthogonal, and contains enough choice sets and collects the right information so that very complex models can be estimated (Kuhfeld, 2004:58).

In practice, the linear design approach can be implemented by using the %MktEx macro in SAS, which creates the fractional factorial design and the choice sets simultaneously. Unrealistic and or dominant/dominated alternatives cannot be excluded from the candidate set (i.e. the full factorial design) prior to the creation of the design, implying that such alternatives have to be removed from the design outputted by the %MktEx macro. If the design contains too many choice sets for each respondent to evaluate, the %MktBlock macro can be used to divide the choice sets into blocks containing the desired number of choice sets.

The cyclical design approach
An orthogonal design, consisting of a number of alternatives equal to the desired number of choice sets in the final design, is used as the basis for the creation of a cyclical design. The alternatives contained in this initial design will represent the first alternative in each choice set of the final cyclical design. Subsequent alternatives are constructed by adding cyclically generated alternatives to each choice set (Huber and Zwerina, 1996:310). That is, the attribute levels of the new alternatives are constructed by adding one level to the level of the previous alternative; if the level of one of the attributes of the first alternative is at its highest level, the cycle starts all over from the lowest level. In terms of efficiency, designs created through application of the cyclical design approach have desirable properties as they satisfy the criteria of level balance, orthogonality and minimal overlap (Carlsson and Martinsson, 2003:285). The utility balance criterion, however, is not met.

Using SAS, cyclical designs can be generated by using "proc plan" to create the full factorial design and "proc optex" to create the fractional factorial design from which the cyclical design is created. Proc optex can also be used to divide the design into blocks of choice sets if it is considered necessary to do so. Subsequently, the cyclical assignment of attribute levels to the new alternatives in each choice set is conducted in a data step.

The choice design approach - utility balanced designs
The dual of maximising the statistical efficiency of a choice design is that of minimising the variances of the parameter estimates (Kuhfeld, 2004:53). Thus, the goal of experimental design is to find a fractional

factorial design that is composed of design points, i.e. alternatives, which minimise the variance of the parameter estimates. In linear models where the variances of parameter estimates are proportional to the information matrix, this strategy can be pursued without prior knowledge about the size and sign of the parameter estimates. For choice models, however, where the variances of parameter estimates is a function of the parameter estimates themselves, the strategy cannot be pursued unless the parameter estimates are known (in which case, it could be argued that the experiment is redundant). Consequently, designs for choice experiment are most often created using efficiency criteria pertaining to linear models (Kuhfeld, 2004:57). However, procedures do exist for constructing choice designs based on efficiency criteria pertaining specifically to choice models.

Using the choice design approach, it becomes possible explicitly to incorporate the utility balance criterion in the design process. More specifically, this happens through the role played by the parameters of the model in relation to minimising variance, and in turn, maximising efficiency. However, two factors, which have already been discussed, may limit the number of cases where the approach will be relevant. One, it requires prior knowledge on the parameters of the model, which may be missing in many cases. Two, emphasising utility balance may negatively affect the design as it may conflict with the criteria of level balance and orthogonality, just as it may imply that task complexity becomes too high. In terms of the former, a study by Carlsson and Martinsson (2003), where simulation experiments are used to evaluate different design strategies, it is found that there may be significant efficiency gains associated with adopting a choice design approach, when information on parameters are available. Moreover, it is found that the approach may remain superior even if the available information on parameters is biased; whether this will apply to a given case, however, depends among other things on the extent of the bias. Thus, the study also finds that adopting the choice design approach and assuming that all parameters are zero – as might be the most reasonable assumption in cases where no specific prior information is available – may result in designs that perform worse in terms of efficiency than orthogonal or cyclical designs. Prior to favouring the choice design approach over other approaches, the potential benefits arising from introducing the utility balance criterion in the design process should, therefore, be weighed carefully against the potential cost.

In SAS, the %ChoicEff macro, which creates the fractional factorial and assign the alternatives into choice sets in the same step, may be used to generate utility balanced designs. Prior to the creation of the final design, unrealistic and or dominant/dominated alternatives can be excluded if a candidate set different from the full factorial (i.e. only containing the desired alternatives) is created in a data step and subsequently inputted to the %ChoicEff macro. Subsequently, if the design contains too many choice sets for each respondent to evaluate, the %MktBlock macro can be used to divide the choice sets into blocks containing the desired number of choice sets.

Annex 2

Danish Questionnaire

INFORMATIONSARK OM FERSKVAND OG GRUNDVAND

Det ferske vandmiljø i Danmark

Det meste af det drikkevand, vi bruger i Danmark, stammer fra grundvandet. Grundvandet findes i hulrum og magasiner i jorden. Den danske drikkevandspolitik bygger på, at drikkevandet kommer fra grundvand, som har gennemgået et simpel vandbehandling (iltning), men som ikke er renset. Dette er ganske unikt i forhold til mange andre lande hvor man bruger renset overfladevand, fx. fra søer og floder.

Grundvandet i Danmark er mange steder forurenet med affaldsstoffer fra blandt andet landbrug, industri, vejtrafik, husholdninger/private haver, lossepladser og kloakledninger. Forurening med sprøjtemidler og kvælstof er de hyppigste årsager til, at mange grundvandsboringer bliver lukket, fordi det forurenede vand i disse boringer ikke længere kan bruges til drikkevand, uden at vandet bliver renset først.

Dyre- og plantelivet i søer og vandløb påvirkes ligesom grundvandet af forurening fra landbruget, husholdningerne, industrien mv. Sammen med en række fysiske forhold har forureningen betydning for tilstanden af de danske vandløb og søer, og dermed også for livsbetingelserne for dyre- og plantelivet i vandet og i de vandløbsnære omgivelser.

Prisen på vand

I gennemsnit betaler forbrugerne 35 kr. per kubikmeter vand (1000 liter), og hver husstand i Danmark betaler i gennemsnit 4.000 kr. årligt på vandregningen (1.500 kr. per person). Denne pris omfatter både forsyningen med drikkevand og afledning og rensning af vand via kloakkerne (spildevand).

Forurening af grundvandet

Sprøjtemidler er stoffer, som forhindrer, at ukrudt, insekter og svampe påvirker udbyttet i landbruget negativt. Sprøjtemidlerne kan også påvirke menneskers sundhed og de kan være giftige for dyr og planter. Hvor skadelige sprøjtemidlerne er, findes der ikke helt eksakt viden om, men sprøjtemidler og deres restprodukter er mistænkt for at være medvirkende til hormonforstyrrelser hos mennesker og dyr, og til at være kræftfremkaldende for mennesker.

Kvælstof og fosfor er vigtige næringsstoffer for planterne. Hvis der tildeles for meget kvælstof og fosfor, så tabes det overskydende til miljøet, bl.a. til grundvandet. Ligesom med sprøjtemidler er for meget kvælstof i drikkevandet under mistanke for at fremkalde kræft hos mennesker. For meget kvælstof og fosfor i vandmiljøet kan føre til, at søerne bliver for næringsrige. Det kan føre til grumset vand og dårlig sigtedybde i søerne, og i sjældne tilfælde kan der opstå fiskedød.

Undersøgelse af holdninger til beskyttelse af vandmiljøet i Danmark *760-032*

Det medfølgende spørgeskema udgør en del af et forskningsprojekt vedrørende den fremtidige forvaltning af det ferske vandmiljø i Danmark. Projektet udføres af forskere fra Danmarks Miljøundersøgelser.

Det ferske vandmiljø består af grundvandet, søer og vandløb. Vandmiljøet kan beskyttes og forvaltes på forskellige måder, der har forskellig betydning for kvaliteten af grundvandet og drikkevandet, og for vilkårene for dyre- og planteliv i vandløb og søer. Formålet med dette spørgeskema er, at høre dine holdninger til, hvordan det ferske vandmiljø bør forvaltes fremover.

Vi vil bede dig om at svare i overensstemmelse med dine personlige synspunkter. Ingen svar er således mere rigtige end andre - vi er interesserede i din mening. Dine svar vil blive behandlet fortroligt og vil udelukkende blive brugt til videnskabeligt formål. Spørgeskemaet er i alt udsendt til 1.500 personer, og det er vigtigt for undersøgelsens resultater, at så mange som muligt svarer.

Vi har vedlagt et informationsark om ferskvand og grundvand, og vi vil bede dig om at læse dette inden besvarelsen af spørgeskemaet.

På forhånd tak for hjælpen og god fornøjelse med besvarelsen.

Spørgsmål 1: Holdninger til miljøet

1.1 Nedenfor er en række udsagn om det danske vandmiljø. På en skala fra 1-5 bedes du angive, hvor enig eller uenig du er i udsagnene. Du kan benytte tallene imellem til at graduere dit svar
- Sæt kun ét kryds i hver linie

	Helt uenig		Hverken/eller		Helt enig	Ved ikke	K01
Beskyttelsen af vandmiljøet er en af de vigtigste opgaver indenfor miljøpolitikken	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(11)
Vandet i vandhanen behøver ikke at være drikkevand. Drikkevand kan købes på flaske	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(12)
Forurening med sprøjtemidler er en væsentlig trussel mod kvaliteten af drikkevandet i Danmark	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(13)
Forurening med kvælstof er en væsentlig trussel mod kvaliteten af drikkevandet i Danmark	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(14)
Drikkevand behøver ikke komme fra urenset grundvand; renset vand er lige så godt	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(15)
Vandløb og søer bør have et rigt og naturligt dyre- og planteliv	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(16)
Drikkevandet er rent i Danmark	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(17)
Problemerne med forurening af vandmiljøet er overdrevne	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(18)
Myndighederne bør bruge flere ressourcer på beskyttelse af vandmiljøet end de gør nu	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(19)

Spørgsmål 2: Dit vandforbrug

2.1 Køber du eller nogen i din husholdning nogensinde flaskevand (kildevand mv. uden kulsyre) som alternativ til drikkevand fra vandhanen?
- Kun et svar

- Altid ☐ 1 (20)
- Ofte ☐ 2
- Sjældent ☐ 3
- Aldrig → ***Gå til spm. 2.3*** ☐ 4
- Ved ikke → ***Gå til spm. 2.3*** ☐ 5

2.2 Hvis/når du eller nogen i din husstand køber flaskevand, hvad er årsagen/årsagerne så?
- Gerne flere svar

- Det smager bedre ☐ 1 (21-27)
- Det er ikke forurenet ☐ 2
- Det er sundere på grund af mineraler mv. ☐ 3
- At det er i en praktisk emballage ☐ 4
- At jeg ikke har adgang til postevand (fx. når jeg er ude at handle) ☐ 5
- Andet ☐ 6
- Ved ikke ☐ 7

2.3 Hvis de nuværende grænseværdier for indholdet af kvælstof og/eller sprøjtemidler i drikkevand var overskredet, ville du så købe flaskevand til drikkeformål?

- Nej ☐ 1 (28-31)
- Ja, under alle omstændigheder ☐ 2
- Ja, hvis jeg synes overskridelsen er for stor ☐ 3
- Ved ikke ☐ 4

2.4 Gør du/din husstand noget for at spare på vandet?

- Ja ☐ 1 (32)
- Nej → ***Gå til spm. 3.1*** ☐ 2

2.5 Hvad gør du/I for at spare på vandet?
- Gerne flere svar

- Jeg/vi har vandbesparende vaner ☐ 1 (33-40)
- Jeg/vi har vandbesparende toilet. ☐ 2
- Jeg/vi har vandbesparende vandhaner ☐ 3
- Jeg/vi har vandbesparende vaskemaskine ☐ 4
- Jeg/vi har vandbesparende opvaskemaskine ☐ 5
- Jeg/vi undgår unødvendigt vandforbrug, fx ved at lukke for vandet under tandbørstning ☐ 6
- Andet, ***noter***: ____________________ (41-50) ☐ 7
- Ved ikke ☐ 8

2.6 Hvorfor sparer du/I på vandet? Angiv nedenfor, hvor stor betydning de nævnte forhold har for din/jeres beslutning om at spare på vandet.
- Sæt kun ét kryds i hver linie

	Meget stor betydning	Stor betydning	Nogen betydning	Ingen betydning	Ved ikke	
Prisen på vandet	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(51)
Hensyn til miljøet	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(52)
Vane	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(53)
Hensyn til fremtidige generationer	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(54)
Andet	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(55)

Spørgsmål 3: Din brug af vandløb og søer

3.1 Fisker du i danske vandløb og/eller søer i din fritid?
- Kun et svar

- Ofte → ***Gå til spm. 3.3*** ☐ 1 (56)
- Nogle gange → ***Gå til spm. 3.3*** ☐ 2
- Sjældent → ***Gå til spm. 3.2*** ☐ 3
- Jeg fisker aldrig i Danmark, kun i udlandet → ***Gå til spm. 3.2*** ☐ 4
- Jeg fisker aldrig → ***Gå til spm. 3.2*** ☐ 5
- Jeg dyrker kun kyst-/havfiskeri → ***Gå til spm. 3.3*** ☐ 6

3.2. Hvis du fisker, men sjældent eller aldrig fisker i Danmark, er det så fordi:
- Kun et svar

- Der er ingen egnede søer eller åer i nærheden ☐ 1 (57-61)
- Det er ikke tilstrækkelig udfordrende ☐ 2

- Jeg har ikke tid til at fiske så ofte .... ☐ 3
- Jeg interesserer mig ikke for at fiske .... ☐ 4
- Andet .... ☐ 5

3.3 Bader du i danske vandløb og/eller søer?
- Kun et svar

- Ofte → ***Gå til spm. 4.1*** ☐ 1 (62)
- Nogle gange → ***Gå til spm. 4.1*** ☐ 2
- Sjældent → ***Gå til spm. 3.4*** ☐ 3
- Jeg bader aldrig i ferskvand → ***Gå til spm. 3.4*** ☐ 4
- Jeg bader ikke → ***Gå til spm. 3.4*** ☐ 5

3.4. Hvis du sjældent eller aldrig bader i ferskvand, er det så fordi:
- Kun et svar

- Der er ingen egnede søer eller åer i nærheden ☐ 1 (63-67)
- Vandkvaliteten er for dårlig ☐ 2
- Bundforholdene er dårlige ☐ 3
- Jeg har ikke tid til at bade oftere ☐ 4
- Andet ☐ 5

Spørgsmål 4: Din vandforsyning

4.1 Hvor kommer husstandens drikkevand fra?
- Kun et svar

- Kommunalt vandforsyningsanlæg ☐ 1 (68)
- Privat, alment anlæg ☐ 2
- Privat boring ☐ 3
- Andet ☐ 4
- Ved ikke ☐ 5

4.2 Ved du ca., hvor mange kubikmeter (1.000 liter) vand din husholdning bruger årligt?

- Ja ☐ 1 (69)
- Nej ☐ 2

4.3 Hvis ja, angiv da det årlige forbrug i kubikmeter her: ☐☐☐☐ (70-73)

4.4 Ved du, hvor stor din husstands årlige vandregning er?
- Kun et svar

- Ja, den er mindre end 1500 kr ☐ 1 (74)
- Ja, den er mellem 1500 og 4000 kr. ☐ 2
- Ja, den er mellem 4000 og 6000 kr. ☐ 3
- Ja, den er over 6000 kr. ☐ 4
- Nej, jeg ved det ikke/jeg kan ikke huske det ☐ 5

Der kommer nu to spørgsmål, hvor vi vil spørge dig om, hvor meget din husholdning er villig til at betale årligt for sikring af:

1) Naturligt rent drikkevand (spørgsmål 5.1)
2) Renset drikkevand (spørgsmål 5.5)

Betalingen vil i begge tilfælde ske som et fast årligt tillæg til din vandregning. Vi gør dig opmærksom på, at du skal svare på begge spørgsmål, men forestille dig at *kun ét af alternativerne vil blive gennemført*.

Begge situationer indebærer en ændring i forhold til myndighedernes nuværende indsats for at sikre rent drikkevand.

Den nuværende situation

På nuværende tidspunkt er der gennemført en række tiltag med henblik på at beskytte grundvandet mod forurening med sprøjtemidler og kvælstof. Når en grundvandsboring viser sig at være forurenet lukkes den, og der bores et nyt sted.

Det er usikkert, om rent drikkevand kan fremskaffes på denne måde i tilstrækkelige mængder i fremtiden. Der er derfor en risiko for, at vand fra vandhanen i fremtiden vil overskride de nuværende grænseværdier for indholdet af sprøjtemidler og kvælstof.

Vilkårene for dyre- og plantelivet i vandløb og søer er mindre gode. Dyre- og plantelivet er således i ubalance mange steder, og markant anderledes end hvis tilstanden var naturlig. De primære årsager til ændringerne i vandmiljøets tilstand er menneskelig aktivitet.

I det følgende vil du blive præsenteret for to forslag, der kan bidrage til sikring af rent drikkevand både nu og i fremtiden. For hvert forslag vil du blive bedt om at angive din betalingsvilje for, at det givne forslag gennemføres.

5.1. Forslag til sikring af naturligt rent drikkevand

Ved at gennemføre tiltag primært indenfor landbruget kan det sikres, at der er naturligt rent drikkevand både nu og i fremtiden. Samtidig kan der sikres meget gode vilkår for dyre- og plantelivet i vandløb og søer. Det vil sige, at dyre- og plantelivet vil være naturligt, varieret og i balance, og kun svagt til middel påvirket af menneskelig aktivitet.

Det antages, at omkostningerne ved at gennemføre forslaget skal dækkes af de danske forbrugere. Dette vil ske gennem et **fast årligt beløb pr. husstand**, der opkræves én gang årligt over vandregningen.

Hvad er den maksimale pris, din husstand vil være villig til at betale for sådan en beskyttelse af grundvandet?

Husk, hvis tiltagene ikke gennemføres, så er der en risiko for, at vandet i vandhanerne i fremtiden vil overskride grænseværdierne for indholdet af sprøjtemidler og kvælstof, og vilkårene for dyre- og plantelivet i vandløb og søer vil forblive mindre gode.

På nedenstående skala bedes du afkrydse det *højeste* af de anførte beløb, som din *husstand årligt* vil være villig til at betale for gennemførslen af forslaget. Afkryds kun et felt, og bemærk at det beløb, du sætter kryds ved, skal lægges oveni det beløb, du/I på nuværende tidspunkt betaler for vand.

Inden du sætter dit kryds, gør vi dig opmærksom på, at erfaringer fra lignende undersøgelser viser, at mange har en tendens til at overvurdere, hvad de er villige til at betale, når de bliver spurgt i en undersøgelse som denne. Vi beder dig derfor om grundigt at overveje, hvor meget din husstand reelt vil være villig til, samt have råd til, at betale med den indkomst I har til rådighed nu.

Årligt beløb per husstand?
- ***Sæt kun et kryds***

K02

0 kr. .... ☐ 01 (11-12)
100 kr. .... ☐ 02
300 kr. .... ☐ 03
450 kr. .... ☐ 04
625 kr. .... ☐ 05
800 kr. .... ☐ 06
1.050 kr. .... ☐ 07
1.200 kr. .... ☐ 08
1.700 kr. .... ☐ 09
2.400 kr. .... ☐ 10
Andet.......... ☐ 11
Angiv venligst hvor meget i kr.:________________ () .... ☐ 12
Jeg *kan ikke* svare på spørgsmålet .... ☐ 13
Jeg *vil ikke* svare på spørgsmålet.......... ☐ 14

5.2. På en skala fra 1-7 bedes du angive, hvor sikker/usikker du er på det svar, du gav i spørgsmål 5.1. (**1 er meget usikker og 7 er meget sikker**). Vi gør opmærksom på, at graden af sikkerhed/usikkerhed ikke har nogen betydning for brugbarheden af dit svar. Du kan benytte tallene imellem til at graduere dit svar.

	Meget usikker						Meget sikker	
På mit svar føler jeg mig	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	(13)

Hvis du svarede 100 kr. eller mere i spørgsmål 5.1 – ellers gå til spm. 5.4

5.3 Angiv venligst baggrunden for, hvilket beløb du satte kryds ved i spørgsmål **5.1** omhandlende sikring af naturligt rent drikkevand

- Sæt gerne flere krydser

- Det var det højeste beløb, jeg havde råd til. ☐ 01 (14-37)
- Rent *drikkevand* er vigtigt for mig, og derfor betaler jeg gerne for sikring af rent drikkevand ☐ 02
- Rent *grundvand* er vigtigt for mig, og derfor betaler jeg gerne for sikring af rent grundvand ☐ 03
- Rent *grundvand* er vigtigt for *plante- og dyrelivet*, og derfor betaler jeg gerne for sikring af rent grundvand ☐ 04
- Rent *grundvand* er vigtigt for *fremtidige generationer*, og derfor betaler jeg gerne for sikring af rent grundvand. ☐ 05
- Jeg ønskede at give udtryk for min interesse for sikring af et sundt og rent miljø ☐ 06
- Sikring af rent vand er en vigtig opgave, og ved at afkrydse et højt beløb håber jeg at have bidraget til, at der snart bliver gjort noget ved sagen ☐ 07
- Jeg afkrydsede det beløb, jeg ville ønske, jeg havde råd til at betale for sikring af rent drikkevand ☐ 08
- Jeg vidste ikke, hvad jeg ellers skulle svare. ☐ 09
- Jeg fastsatte beløbet udfra, hvad jeg betaler til for andre ting. ☐ 10
- Andet ☐ 11
- Ved ikke ☐ 12

Hvis du svarede 0 kr. eller ikke kunne/ville svare i spørgsmål 5.1 – ellers gå til spm. 5.5

5.4 Angiv venligst årsagen/årsagerne til, at du svarede, som du gjorde i spørgsmål **5.1** omhandlende sikring af naturligt rent drikkevand

- Sæt gerne flere krydser

- På nuværende tidspunkt har jeg ikke råd til at betale mere for vand, end jeg gør nu ☐ 01 (38-61)
- Det betyder ikke noget for mig, hvis grænseværdierne for sprøjtemidler og/eller kvælstofindhold i drikkevand overskrides ☐ 02
- Det betyder ikke noget for mig, hvis grænseværdierne for sprøjtemidler og/eller kvælstofindhold i grundvand overskrides ☐ 03
- Det betyder ikke noget for mig, hvorvidt vilkårene for dyre- og planteliv i vandløb og søer forbedres eller ej ☐ 04
- Det er ikke mit ansvar at betale for rent vand ☐ 05
- Det er det offentlige eller vandværkerne, der bør betale for sikring af rent vand ☐ 06
- Det er dem, der forurener vandet, der bør betale for sikring af rent vand i fremtiden ☐ 07
- Jeg har behov for mere information for at kunne svare på sådanne spørgsmål ☐ 08
- Jeg vidste ikke, hvad jeg skulle svare ☐ 09
- Det kommer ikke andre ved, hvad jeg vil betale for sikring af rent vand ☐ 10
- Andet ☐ 11
- Ved ikke ☐ 12

5.5 Forslag om rensning af vand

Ved rensning af forurenet grundvand kan rester af sprøjtemidler og kvælstof fjernes, således at det rensede vand kan bruges som drikkevand og andet brugsvand. Herved kan der fremskaffes rent drikkevand både nu og i fremtiden. I modsætning til det foregående forslag sikres grundvandet dog ikke mod forurening med sprøjtemidler og kvælstof. Gennemførelse af rensningsforslaget vil altså ikke indebære forbedrede vilkår for dyre- og plantelivet i vandløb og søer, hvilket betyder, at disse vil forblive mindre gode. Det vil sige, at dyre- og plantelivet i vandløb og søer vil være markant anderledes end naturlig tilstand og i lettere ubalance.

Som før antages det, at omkostningerne forbundet med gennemførslen af forslaget skal dækkes af de danske forbrugere via et fast årligt beløb pr. husstand, der opkræves over vandregningen.

Hvad er den maksimale pris, din husstand vil være villig til at betale for rensning af grundvand, så det kan anvendes til drikkevand?

Husk, hvis rensning ikke gennemføres, så er der en risiko for, at vandet i vandhanerne i fremtiden vil overskride de nuværende grænseværdier for indholdet af sprøjtemidler og kvælstof.

På nedenstående skala bedes du afkrydse det højeste af de anførte beløb, som din husstand årligt vil være villig til at betale for gennemførslen af forslaget. Afkryds kun et felt, og husk at beløbet bliver lagt oveni din nuværende vandregning. Inden du sætter dit kryds, bedes du ligesom før grundigt overveje, hvor meget din husstand reelt vil være villig til, samt have råd til, at betale med den indkomst I har til rådighed nu.

Hvor meget vil du være villig til at betale for, at drikkevandet fra forurenet grundvand renses og anvendes som drikkevand?

Årligt beløb per husstand
- ***Sæt kun et kryds***

0 kr. .... ☐ 01 (62-63)
100 kr. .... ☐ 02
300 kr. .... ☐ 03
450 kr. .... ☐ 04
625 kr. .... ☐ 05
800 kr. .... ☐ 06
1.050 kr. .... ☐ 07
1.200 kr. .... ☐ 08
1.700 kr. .... ☐ 09
2.400 kr. .... ☐ 10
Andet .... ☐ 11
Angiv venligst hvor meget i kr.:______________________(64-78) ☐ 12
Jeg *kan ikke* svare på spørgsmålet.. ☐ 13
Jeg *vil ikke* svare på spørgsmålet.. ☐ 14
Hvis jeg skal gå med til renset drikkevand, vil jeg kompenseres med et årligt beløb i form af billigere vand.. ☐ 15

5.6. På en skala fra 1-7 bedes du angive, hvor sikker/usikker du er på det svar, du gav i spørgsmål 5.5.(**1 er meget usikker og 7 er meget sikker**). Vi gør opmærksom på, at graden af sikkerhed/usikkerhed ikke har nogen betydning for brugbarheden af dit svar. Du kan benytte tallene imellem til at graduere dit svar.

	Meget usikker						Meget sikker	
På mit svar føler jeg mig	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	(79)

Hvis du svarede 100 kr. eller mere i spørgsmål 5.5 – ellers gå til spm. 5.7

5.7 Angiv venligst baggrunden for, hvilket beløb du satte kryds ved i spørgsmål **5.5** omhandlende rensning af drikkevand

- *Sæt gerne flere krydser* K03

- Det var det højeste beløb, jeg havde råd til ☐ 1 (11-19)
- Rent *drikkevand* er vigtigt for mig, og derfor betaler jeg gerne for sikring af rent drikkevand ☐ 2
- Sikring af rent vand er en vigtig opgave, og ved at afkrydse et højt beløb håber jeg at have bidraget til, at der snart bliver gjort noget ved sagen ☐ 3
- Jeg satte kryds ved det beløb, jeg ville ønske, jeg havde råd til at betale for sikring af rent drikkevand ☐ 4
- Jeg vidste ikke, hvad jeg ellers skulle svare. ☐ 5
- Jeg fastsatte beløbet udfra, hvad jeg betaler til for andre ting. ☐ 6
- Jeg valgte et mindre beløb end i spørgsmål 5.1, idet jeg synes mindre om forslaget i spørgsmål 5.5 end om forslaget i spørgsmål 5.1. ☐ 7
- Andet ☐ 8
- Ved ikke ☐ 9

Hvis du svarede 0 kr. eller ikke kunne/ville svare i spørgsmål 5.5 – ellers gå til spm. 5. 8.

5.8 Angiv venligst årsagen/årsagerne til, at du svarede, som du gjorde i spørgsmål **5.5** omhandlende rensning af drikkevand

- *Sæt gerne flere krydser*

- På nuværende tidspunkt har jeg ikke råd til at betale mere for vand, end jeg gør nu ☐ 01 (20-41)
- Det betyder ikke noget for mig, hvis grænseværdierne for sprøjtemidler og/eller kvælstofindhold i drikkevand overskrides. ☐ 02
- Jeg opfatter renset vand som en forringelse i forhold til mit nuværende drikkevand ☐ 03
- Det er ikke mit ansvar at betale for rent vand ☐ 04
- Det er det offentlige eller vandværkerne, der bør betale for sikring af rent vand ☐ 05
- Det er dem, der forurener vandet, der bør betale for sikring af rent vand i fremtiden ☐ 06
- Jeg har behov for mere information for at kunne svare på sådanne spørgsmål ☐ 07
- Jeg vidste ikke, hvad jeg skulle svare ☐ 08
- Det kommer ikke andre ved, hvad jeg vil betale for sikring af rent vand ☐ 09
- Andet ☐ 10
- Ved ikke ☐ 11

Hvis du i spørgsmål 5.5 har svaret, at du vil kompenseres – ellers gå til spm. 5.10.

5.9 Angiv venligst hvor stort et beløb husstandens årlige vandregning skal reduceres med, for at du/I ville kunne acceptere renset vand frem for naturligt rent drikkevand. Den årlige vandregning skal reduceres med:

- ***Sæt kun et kryds***

- 100 kr. ☐ 01 (42-43)
- 300 kr. ☐ 02
- 450 kr. ☐ 03
- 625 kr. ☐ 04
- 800 kr. ☐ 05
- 1.050 kr. ☐ 06
- 1.200 kr. ☐ 07
- 1.700 kr. ☐ 08
- 2.400 kr. ☐ 09
- Mere ☐ 10
- Ved ikke ☐ 11

5.10 Hvad er din begrundelse for at ville kræve kompensation?
- ***Sæt kryds udfor det/de udsagn, der bedst beskriver, hvorfor du ville kræve kompensation***

Vandmiljøet – dvs. dyre- og plantelivet – bliver ikke beskyttet ved rensning .... ☐ 1 (44-50)

Jeg tror, det er usundt at drikke renset vand .... ☐ 2

Tanken om at drikke vand, der har været forurenet, er væmmelig .... ☐ 3

Det beløb, jeg angav, svarer til de ulemper, jeg mener, der er forbundet med renset frem for urenset vand .... ☐ 4

Jeg synes ikke, at vand fra vandhanen bør være renset, derfor angav jeg et meget højt beløb.............................. ☐ 5

Andet.............................. ☐ 6

Ved ikke.............................. ☐ 7

5.11. Hvis det vand, der kommer ud af din vandhane, var vand, der var renset for kvælstof og sprøjtemidler (frem for rent grundvand), ville du så bruge det til drikkeformål?

Ja .... ☐ 1 (51)

Nej .... ☐ 2

Spørgsmål 6: Information

6.1. Var du bekendt med informationerne i informationsarket, før du fik dette spørgeskema?

Slet ikke bekendt .... ☐ 1 (52)

Ikke bekendt .... ☐ 2

Bekendt .... ☐ 3

Meget bekendt .... ☐ 4

Ved ikke.............................. ☐ 5

6.2. Hvor har du dine informationer omkring grund- og drikkevand fra?
- ***Gerne flere svar***

Kommunen/amtet.............................. ☐ 1 (53-59)

Vandværket .... ☐ 2

Miljøstyrelsen .... ☐ 3

Pressen/medierne.............................. ☐ 4

Fra min uddannelse/mit arbejde .... ☐ 5

Fra kampagner .... ☐ 6

Andet.............................. ☐ 7

Spørgsmål 7: Vandet i dit område

7.1 Har du nogensinde oplevet, at der har været problemer med kvaliteten af dit drikkevand?

Ja .... ☐ 1 (60)

Nej .... ☐ 2

Baggrundsspørgsmål

Køn K04

Mand .... ☐ 1 (11)

Kvinde .... ☐ 2

Alder

Hvornår er du født?

Måned .... ☐☐ (12-13)

- Notér f.eks. 0 3 , hvis respondenten er født i marts

Årstal .... 1 9 ☐☐ (14-17)

Bopæl

Hvilken kommune bor du i? ***- Notér kommunenavn:***____________________

Husstandsstørrelse

Hvor mange *voksne, dvs. 18 år eller derover* bor der i husstanden i alt .... ☐ (26)

Er der barn eller børn i husstanden?

- Hvis ja: Hvad er barnets/børnenes alder?

	Dreng	Pige		Alder	
1. barn	☐ 1	☐ 2	(71)	______ år	(72-73)
2. barn	☐ 1	☐ 2	(74)	______ år	(75-76)
3. barn	☐ 1	☐ 2	(77)	______ år	(78-79)
4. barn	☐ 1	☐ 2	(80)	______ år	(81-82)

Nej, der er ingen børn i husstanden .... ☐ 1 (83)

Hvor mange personer, dvs. såvel voksne som børn, bor der i husstanden alt i alt .... ☐☐ (30-31)

Bolig

Hvilken type bolig bor du i?

Række-/kæde-/klyngehus .... ☐ 1 (37)

Lejlighed/etageejendom .... ☐ 2

Fritliggende enfamilieshus .... ☐ 3

Landbrugsejendom/gård .... ☐ 4

Andet .... ☐ 5

Indkomst

Hvor stor er familiens samlede årlige bruttoindkomst? ***- Det skal være indkomst før eventuelle fradrag i skat***

Under kr. 50.000 .... ☐ 01 (40-41)

Kr. 50.000 - 99.999 .... ☐ 02

Kr. 100.000 - 149.999 .... ☐ 03

Kr. 150.000 - 199.999 .... ☐ 04

Kr. 200.000 - 249.999 .... ☐ 05

Kr. 250.000 - 299.999 .... ☐ 06

Kr. 300.000 - 349.999 .... ☐ 07

Kr. 350.000 - 399.999 .... ☐ 08

Kr. 400.000 - 449.999 .... ☐ 09

Kr. 450.000 - 499.999 .... ☐ 10

Kr. 500.000 - 749.999 .... ☐ 11

Kr. 750.000 - 999.999 .... ☐ 13

Kr. 1.000.000 eller derover .... ☐ 14

Hvad er din egen årlige bruttoindkomst? ***- Det skal være indkomst før eventuelle fradrag i skat***

- Under kr. 50.000 ☐ 01 (57-58)
- Kr. 50.000 - 99.999 ☐ 02
- Kr. 100.000 - 149.999 ☐ 03
- Kr. 150.000 - 199.999 ☐ 04
- Kr. 200.000 - 249.999 ☐ 05
- Kr. 250.000 - 299.999 ☐ 06
- Kr. 300.000 - 349.999 ☐ 07
- Kr. 350.000 - 399.999 ☐ 08
- Kr. 400.000 - 449.999 ☐ 09
- Kr. 450.000 - 499.999 ☐ 10
- Kr. 500.000 - 749.999 ☐ 11
- Kr. 750.000 - 999.999 ☐ 13
- Kr. 1.000.000 eller derover ☐ 14

Uddannelse

Hvad er din senest afsluttede uddannelse?

- Afsluttet uddannelse ved 14-15 års alderen og ingen yderligere uddannelse (f.eks. 7., 8. eller 9. klasse) ☐ 1 (42)
- Afsluttet uddannelse ved 16-19 års alderen og ingen yderligere uddannelse (f.eks. 10. kl., realeksamen, studenter-eksamen/HF/HH/lærlingeuddannelse m.v.) ☐ 2
- Mellemlang videregående uddannelse (f.eks. seminarium/teknikum/EG/HA-eksamen) ☐ 3
- Lang uddannelse på højere læreanstalt (f.eks. universitet, teknisk højskole, tandlægehøjskole, handelshøjskole m.v.) ☐ 4
- Er under uddannelse ☐ 5

Stilling

Hvad er din stilling?

- Arbejder, ufaglært ☐ 01 (48-49)
- Arbejder, faglært ☐ 02
- Funktion uden ledelsesansvar/tjenestemand ☐ 11
- Højere funktionær/tjenestemand (ledende medarbejder) ☐ 12
- Selvstændig landbruger ☐ 04
- Selvstændig detailhandlende/håndværksmester ☐ 05
- Selvstændig i liberalt erhverv ☐ 06
- Lærling/studerende/elev ☐ 07
- Husmor/medhjælpende ægtefælle ☐ 08
- Pensionist/efterløn (ude af arbejde) ☐ 09
- Arbejdsløs ☐ 10

Spørgeskemaet er slut – tak for hjælpen!

Undersøgelse af holdninger til beskyttelse af vandmiljøet i Danmark *760-032*

Det medfølgende spørgeskema udgør en del af et forskningsprojekt vedrørende den fremtidige forvaltning af det ferske vandmiljø i Danmark. Projektet udføres af forskere fra Danmarks Miljøundersøgelser.

Det ferske vandmiljø består af grundvandet, søer og vandløb. Vandmiljøet kan beskyttes og forvaltes på forskellige måder, der har forskellig betydning for kvaliteten af grundvandet og drikkevandet, og for vilkårene for dyre- og plantelivet i vandløb og søer. Formålet med dette spørgeskema er, at høre dine holdninger til, hvordan det ferske vandmiljø bør forvaltes fremover.

Vi vil bede dig om at svare i overensstemmelse med dine personlige synspunkter. Ingen svar er således mere rigtige end andre - vi er interesserede i din mening. Dine svar vil blive behandlet fortroligt og vil udelukkende blive brugt til videnskabeligt formål. Spørgeskemaet er i alt udsendt til 1.500 personer, og det er vigtigt for undersøgelsens resultater, at så mange som muligt svarer.

Vi har vedlagt et informationsark om ferskvand og grundvand, og vi vil bede dig om at læse dette inden besvarelsen af spørgeskemaet.

På forhånd tak for hjælpen og god fornøjelse med besvarelsen.

Spørgsmål 1: Holdninger til miljøet

1.1 Nedenfor er en række udsagn om det danske vandmiljø. På en skala fra 1-5 bedes du angive, hvor enig eller uenig du er i udsagnene. Du kan benytte tallene imellem til at graduere dit svar

- Sæt kun ét kryds i hver linie

	Helt uenig		Hverken/eller		Helt enig	Ved ikke	K01
Beskyttelsen af vandmiljøet er en af de vigtigste opgaver indenfor miljøpolitikken	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(11)
Vandet i vandhanen behøver ikke at være drikkevand. Drikkevand kan købes på flaske	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(12)
Forurening med sprøjtemidler er en væsentlig trussel mod kvaliteten af drikkevandet i Danmark	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(13)
Forurening med kvælstof er en væsentlig trussel mod kvaliteten af drikkevandet i Danmark	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(14)
Drikkevand behøver ikke komme fra urenset grundvand; renset vand er lige så godt	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(15)
Vandløb og søer bør have et rigt og naturligt dyre- og planteliv	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(16)
Drikkevandet er rent i Danmark	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(17)
Problemerne med forurening af vandmiljøet er overdrevne	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(18)
Myndighederne bør bruge flere ressourcer på beskyttelse af vandmiljøet end de gør nu	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(19)

Spørgsmål 2: Dit vandforbrug

2.1 Køber du eller nogen i din husholdning nogensinde flaskevand (kildevand mv. uden kulsyre) som alternativ til drikkevand fra vandhanen?

- Kun et svar

Altid .... ☐ 1 (20)
Ofte .... ☐ 2
Sjældent .... ☐ 3
Aldrig .... → ***Gå til spm. 2.3*** .... ☐ 4
Ved ikke .... → ***Gå til spm. 2.3*** .... ☐ 5

2.2 Hvis/når du eller nogen i din husstand køber flaskevand, hvad er årsagen/årsagerne så?

- Gerne flere svar

Det smager bedre .... ☐ 1 (21-27)
Det er ikke forurenet .... ☐ 2
Det er sundere på grund af mineraler mv. .... ☐ 3
At det er i en praktisk emballage .... ☐ 4
At jeg ikke har adgang til postevand (fx. når jeg er ude at handle) .... ☐ 5
Andet .... ☐ 6
Ved ikke .... ☐ 7

2.3 Hvis de nuværende grænseværdier for indholdet af kvælstof og/eller sprøjtemidler i drikkevand var overskredet, ville du så købe flaskevand til drikkeformål?

- Nej ☐ 1 (28-31)
- Ja, under alle omstændigheder ☐ 2
- Ja, hvis jeg synes overskridelsen er for stor ☐ 3
- Ved ikke ☐ 4

2.4 Gør du/din husstand noget for at spare på vandet?

- Ja ☐ 1 (32)
- Nej → ***Gå til spm. 3.1*** ☐ 2

2.5 Hvad gør du/I for at spare på vandet?
- Gerne flere svar

- Jeg/vi har vandbesparende vaner ☐ 1 (33-40)
- Jeg/vi har vandbesparende toilet. ☐ 2
- Jeg/vi har vandbesparende vandhaner ☐ 3
- Jeg/vi har vandbesparende vaskemaskine ☐ 4
- Jeg/vi har vandbesparende opvaskemaskine ☐ 5
- Jeg/vi undgår unødvendigt vandforbrug, fx ved at lukke for vandet under tandbørstning ☐ 6
- Andet, ***noter***:________________(41-50) ☐ 7
- Ved ikke ☐ 8

2.6 Hvorfor sparer du/I på vandet? Angiv nedenfor, hvor stor betydning de nævnte forhold har for din/jeres beslutning om at spare på vandet.
- Sæt kun ét kryds i hver linie

	Meget stor betydning	Stor betydning	Nogen betydning	Ingen betydning	Ved ikke	
Prisen på vandet	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(51)
Hensyn til miljøet	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(52)
Vane	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(53)
Hensyn til fremtidige generationer	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(54)
Andet	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(55)

Spørgsmål 3: Din brug af vandløb og søer

3.1 Fisker du i danske vandløb og/eller søer i din fritid?
- Kun et svar

- Ofte → ***Gå til spm. 3.3*** ☐ 1 (56)
- Nogle gange → ***Gå til spm. 3.3*** ☐ 2
- Sjældent → ***Gå til spm. 3.2*** ☐ 3
- Jeg fisker aldrig i Danmark, kun i udlandet → ***Gå til spm. 3.2*** ☐ 4
- Jeg fisker aldrig → ***Gå til spm. 3.2*** ☐ 5
- Jeg dyrker kun kyst-/havfiskeri → ***Gå til spm. 3.3*** ☐ 6

3.2. Hvis du fisker, men sjældent eller aldrig fisker i Danmark, er det så fordi:
- Kun et svar

- Der er ingen egnede søer eller åer i nærheden ☐ 1 (57-61)
- Det er ikke tilstrækkelig udfordrende ☐ 2

Jeg har ikke tid til at fiske så ofte .... ☐ 3
Jeg interesserer mig ikke for at fiske.. ☐ 4
Andet .... ☐ 5

3.3 Bader du i danske vandløb og/eller søer?
- Kun et svar

Ofte .... → ***Gå til spm. 4.1*** .... ☐ 1 (62)
Nogle gange .... → ***Gå til spm. 4.1*** .... ☐ 2
Sjældent .... → ***Gå til spm. 3.4*** .... ☐ 3
Jeg bader aldrig i ferskvand .... → ***Gå til spm. 3.4*** .... ☐ 4
Jeg bader ikke .... → ***Gå til spm. 3.4*** .... ☐ 5

3.4. Hvis du sjældent eller aldrig bader i ferskvand, er det så fordi:
- Kun et svar

Der er ingen egnede søer eller åer i nærheden .... ☐ 1 (63-67)
Vandkvaliteten er for dårlig .... ☐ 2
Bundforholdene er dårlige .... ☐ 3
Jeg har ikke tid til at bade oftere .... ☐ 4
Andet .... ☐ 5

Spørgsmål 4: Din vandforsyning

4.1 Hvor kommer husstandens drikkevand fra?
- Kun et svar

Kommunalt vandforsyningsanlæg .... ☐ 1 (68)
Privat, alment anlæg .... ☐ 2
Privat boring .... ☐ 3
Andet .... ☐ 4
Ved ikke .... ☐ 5

4.2 Ved du ca., hvor mange kubikmeter (1.000 liter) vand din husholdning bruger årligt?

Ja .... ☐ 1 (69)
Nej .... ☐ 2

4.3 Hvis ja, angiv da det årlige forbrug i kubikmeter her: .... ☐☐☐☐ (70-73)

4.4 Ved du, hvor stor din husstands årlige vandregning er?
- Kun et svar

Ja, den er mindre end 1500 kr .... ☐ 1 (74)
Ja, den er mellem 1500 og 4000 kr. .... ☐ 2
Ja, den er mellem 4000 og 6000 kr. .... ☐ 3
Ja, den er over 6000 kr. .... ☐ 4
Nej, jeg ved det ikke/jeg kan ikke huske det .... ☐ 5

Spørgsmål 5: Undersøgelse af politikforslag

Du vil nu blive bedt om at vælge mellem en række forskellige politikforslag vedrørende den fremtidige forvaltning af vandmiljøet. Forslagene varierer med hensyn til deres konsekvenser for:

1. Kvaliteten af drikkevand
2. Vilkårene for dyre- og plantelivet i vandløb og søer
3. Størrelsen af din husstands vandregning

1. Kvaliteten af drikkevand:
Kvaliteten af drikkevandet i et givent område vil selvfølgelig afhænge af de mere specifikke lokale forhold, men følgende tre kvalitetsniveauer kan beskrive den generelle kvalitet af det danske drikkevand.

- ***Naturligt rent:*** Tiltag primært i landbruget forebygger at grundvandet forurenes med sprøjtemidler og kvælstof. Herved sikres det, at der er naturligt rent drikkevand både nu og i fremtiden.

- ***Usikker:*** Nuværende situation, dvs. grundvandet beskyttes som nu, men der indføres ikke yderligere tiltag for at forebygge forurening. Når en grundvandsboring viser sig at være forurenet lukkes den, og der bores et nyt sted. Det er det, vandmyndighederne gør i dag for at sikre rent drikkevand til forbrugerne. Det er usikkert, om rent drikkevand kan fremskaffes på denne måde i tilstrækkelige mængder i fremtiden. Der er derfor en risiko for, at vandet i vandhanerne i fremtiden vil overskride de nuværende grænseværdier for indholdet af sprøjtemidler og kvælstof.

- ***Renset:*** Ved at rense det forurenede grundvand for rester af sprøjtemidler og kvælstof sikres det, at der er rent drikkevand både nu og i fremtiden.

2. Vilkårene for dyre- og planteliv i vandløb og søer:
Vilkårene for planter og dyr i vandmiljøet påvirkes både af de naturlige fysiske forhold og af graden af forurening. Vilkårene for dyr og planter vil derfor variere fra sted til sted. De følgende tre kvalitetsniveauer karakteriserer tilstanden for de danske vandløb og søer.

- ***Meget gode:*** Dyre- og plantelivet er naturligt, varieret og i balance. Kun svagt til middel påvirket af menneskelig aktivitet.

- ***Mindre gode:*** Dyre- og plantelivet er markant anderledes end naturlig tilstand og i lettere ubalance. Betydeligt påvirket af menneskelig aktivitet. Svarer til den nuværende situation.

- ***Dårlige:*** Dyre- og plantelivet er væsentlig anderledes end naturlig tilstand og i alvorlig ubalance. Ofte fuldstændig ændret på grund af menneskelig aktivitet.

3. Størrelsen af husstandens vandregning:
Det antages, at omkostningerne ved at gennemføre forslagene dækkes af de danske forbrugere. Vi beder dig om at forestille dig, at alle forbrugere skal bidrage på lige fod til gennemførsel af forslagene gennem et fast årligt beløb pr. husstand, der opkræves én gang årligt over vandregningen.

Du vil blive bedt om at foretage i alt 6 valg. I hver enkel valgsituation skal du vælge mellem 3 alternative politikforslag, der varierer med hensyn til kvaliteten af drikkevandet, vilkårene for dyre- og planteliv i søer og vandløb samt prisen. Prisen for hvert enkelt forslag er anført i form af et fast årligt beløb, der skal betales over vandregningen.

Bemærk, at det anførte beløb skal lægges oveni det beløb, du/I på nuværende tidspunkt betaler for vand. Bemærk desuden, at Alternativ 1 i hver valgsituation svarer til en videreførelse af den nuværende politik.

Inden du foretager et valg, bedes du nøje studere alle 3 alternativer. Resultater fra lignende undersøgelser har vist, at folk har en tendens til at overvurdere, hvor meget de rent faktisk er villige til at betale for gennemførslen af forskellige tiltag. Inden du sætter kryds ved dit foretrukne forslag, bedes du derfor være helt sikker på, at du rent faktisk er villig til, og i stand til, at betale det beløb, der står anført ved alternativet.

Du bedes nu foretage dine valg – god fornøjelse.

Valg 1.

	Alternativ 1	**Alternativ 2**	**Alternativ 3**	K02
Drikkevand:	Usikker	Naturligt rent	Renset	
Dyre- og planteliv i vandløb og søer:	Mindre gode	Meget gode	Mindre gode	
Årlig stigning i vandregning pr. husstand:	0 kr.	2.400 kr.	625 kr.	
Jeg foretrækker (***sæt ét kryds***):	☐ 1	☐ 2	☐ 3	(11)

Valg 2.

	Alternativ 1	**Alternativ 2**	**Alternativ 3**	
Drikkevand:	Usikker	Usikker	Naturligt rent	
Dyre- og planteliv i vandløb og søer:	Mindre gode	Meget gode	Mindre gode	
Årlig stigning i vandregning pr. husstand:	0 kr.	1.700 kr.	300 kr.	
Jeg foretrækker (***sæt ét kryds***):	☐ 1	☐ 2	☐ 3	(12)

Valg 3.

	Alternativ 1	**Alternativ 2**	**Alternativ 3**	
Drikkevand:	Usikker	Renset	Naturligt rent	
Dyre- og planteliv i vandløb og søer:	Mindre gode	Meget gode	Dårlige	
Årlig stigning i vandregning pr. husstand:	0 kr.	0 kr.	1.050 kr.	
Jeg foretrækker (***sæt ét kryds***):	☐ 1	☐ 2	☐ 3	(13)

Valg 4.

	Alternativ 1	**Alternativ 2**	**Alternativ 3**	
Drikkevand:	Usikker	Usikker	Renset	
Dyre- og planteliv i vandløb og søer:	Mindre gode	Meget gode	Mindre gode	
Årlig stigning i vandregning pr. husstand:	0 kr.	1.050 kr.	1.700 kr.	

Jeg foretrækker (***sæt ét kryds***):	☐ 1	☐ 2	☐ 3	(14)

Valg 5.

	Alternativ 1	**Alternativ 2**	**Alternativ 3**	
Drikkevand:	Usikker	Renset	Naturligt rent	
Dyre- og planteliv i vandløb og søer:	Mindre gode	Mindre gode	Dårlige	
Årlig stigning i vandregning pr. husstand:	0 kr.	1.050 kr.	300 kr.	
Jeg foretrækker (***sæt ét kryds***):	☐ 1	☐ 2	☐ 3	(15)

Valg 6.

	Alternativ 1	**Alternativ 2**	**Alternativ 3**	
Drikkevand:	Usikker	Renset	Naturligt rent	
Dyre- og planteliv i vandløb og søer:	Mindre gode	Meget gode	Mindre gode	
Årlig stigning i vandregning pr. husstand:	0 kr.	300 kr.	2.400 kr.	
Jeg foretrækker (***sæt ét kryds***):	☐ 1	☐ 2	☐ 3	(16)

Spørgsmål 6: Opfølgning på spørgsmål 5

6.1. Fandt du det svært at foretage valgene i spørgsmål 5?

Ja .... ☐ 1 (17)
Nej .... ☐ 2

6.2. Hvis ja, hvad var det så der gjorde det svært?
- Sæt ét eller flere kryds

Jeg kunne ikke forholde mig til oplysningerne .... ☐ 1 (18-25)
Jeg syntes, der var for meget information at tage stilling til.......................... ☐ 2
Jeg forstod ikke spørgsmålene.......................... ☐ 3
Jeg syntes, alternativerne var for dyre .... ☐ 4
Det var svært at vælge, idet flere egenskaber var vigtige.......................... ☐ 5
Principielt mener jeg ikke, at forbrugerne skal betale for at sikre et rent vand og godt vandmiljø .... ☐ 6
Andet.......................... ☐ 7
Ved ikke.......................... ☐ 8

6.3. På en skala fra 1-7 bedes du angive, hvor sikker/usikker du er på de valg, du foretog i spørgsmål 5 (**1 er meget usikker og 7 er meget sikker**). Vi gør opmærksom på, at graden af sikkerhed/usikkerhed ikke har nogen betydning for brugbarheden af dine svar. Du kan benytte tallene imellem til at graduere dit svar.

	Meget usikker						Meget sikker	
På mine svar føler jeg mig................	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	(26)

6.4. Nedenfor bedes du sætte kryds ud for den egenskab, som du lagde størst vægt på i dine valg i spørgsmål 5.
- Sæt kun ét kryds

- Drikkevand.. ☐ 1 (27)
- Dyre- og planteliv i vandløb og søer.. ☐ 2
- Størrelsen af den årlige stigning i vandregning .... ☐ 3
- Det varierede fra valg til valg .... ☐ 4
- Ved ikke.. ☐ 5

6.5. Var det udelukkende den egenskab, du satte kryds ved i spørgsmål 6.5, du kiggede på, da du foretog dine valg i spørgsmål 5, eller tog du alle egenskaber i betragtning?

	Ja	Nej	
Udelukkende den egenskab jeg lagde vægt på........................	☐ 1	☐ 1	(28)
Tog alle egenskaber i betragtning........................	☐ 2	☐ 2	(29)

6.6. Hvis det vand, der kommer ud af din vandhane, var vand, der var renset for kvælstof og sprøjtemidler (frem for rent grundvand), ville du så bruge det til drikkeformål?

- Ja .... ☐ 1 (30)
- Nej .... ☐ 2

Spørgsmål 7: Information

7.1. Var du bekendt med informationerne i informationsarket før du fik dette spørgeskema?

- Slet ikke bekendt.. ☐ 1 (31)
- Ikke bekendt.. ☐ 2
- Bekendt .... ☐ 3
- Meget bekendt .... ☐ 4
- Ved ikke.. ☐ 5

7.2. Hvor har du dine informationer omkring grund - og drikkevand fra?
- ***Gerne flere svar***

- Kommunen/amtet.. ☐ 1 (32-38)
- Vandværket .... ☐ 2
- Miljøstyrelsen .... ☐ 3
- Presse0n/medierne.. ☐ 4
- Fra min uddannelse/mit arbejde .... ☐ 5
- Fra kampagner.. ☐ 6
- Andet.. ☐ 7

Spørgsmål 8: Vandet i dit område

8.1 Har du nogensinde oplevet, at der har været problemer med kvaliteten af dit drikkevand?

- Ja .... ☐ 1 (39)

Nej .... ☐ 2

Baggrundsspørgsmål

Køn K04

Mand .... ☐ 1 (11)
Kvinde .... ☐ 2

Alder

Hvornår er du født?

Måned .... ☐☐ (12-13)

- Notér f.eks. 0 3 , hvis respondenten er født i marts

Årstal .... 1 9 ☐☐ (14-17)

Bopæl

Hvilken kommune bor du i? ***- Notér kommunenavn:***______________________________

Husstandsstørrelse

Hvor mange *voksne, dvs. 18 år eller derover* bor der i husstanden i alt .... ☐ (26)

Er der barn eller børn i husstanden?
- Hvis ja: Hvad er barnets/børnenes alder?

	Dreng	Pige		Alder	
1. barn	☐ 1	☐ 2	(71)	_____ år	(72-73)
2. barn	☐ 1	☐ 2	(74)	_____ år	(75-76)
3. barn	☐ 1	☐ 2	(77)	_____ år	(78-79)
4. barn	☐ 1	☐ 2	(80)	_____ år	(81-82)

Nej, der er ingen børn i husstanden .... ☐ 1 (83)

Hvor mange personer, dvs. såvel voksne som børn, bor der i husstanden alt i alt .... ☐☐ (30-31)

Bolig

Hvilken type bolig bor du i?

Række-/kæde-/klyngehus .... ☐ 1 (37)
Lejlighed/etageejendom .... ☐ 2
Fritliggende enfamilieshus .... ☐ 3
Landbrugsejendom/gård .... ☐ 4
Andet .... ☐ 5

Indkomst

Hvor stor er familiens samlede årlige bruttoindkomst? ***- Det skal være indkomst før eventuelle fradrag i skat***

Under kr. 50.000 .... ☐ 01 (40-41)
Kr. 50.000 - 99.999 .... ☐ 02
Kr. 100.000 - 149.999 .... ☐ 03
Kr. 150.000 - 199.999 .... ☐ 04
Kr. 200.000 - 249.999 .... ☐ 05
Kr. 250.000 - 299.999 .... ☐ 06
Kr. 300.000 - 349.999 .... ☐ 07
Kr. 350.000 - 399.999 .... ☐ 08
Kr. 400.000 - 449.999 .... ☐ 09
Kr. 450.000 - 499.999 .... ☐ 10
Kr. 500.000 - 749.999 .... ☐ 11
Kr. 750.000 - 999.999 .... ☐ 13

Kr. 1.000.000 eller derover... ☐ 14

Hvad er din egen årlige bruttoindkomst? ***- Det skal være indkomst før eventuelle fradrag i skat***

- Under kr. 50.000 .... ☐ 01 (57-58)
- Kr. 50.000 - 99.999 .... ☐ 02
- Kr. 100.000 - 149.999 .... ☐ 03
- Kr. 150.000 - 199.999 .... ☐ 04
- Kr. 200.000 - 249.999 .... ☐ 05
- Kr. 250.000 - 299.999 .... ☐ 06
- Kr. 300.000 - 349.999 .... ☐ 07
- Kr. 350.000 - 399.999 .... ☐ 08
- Kr. 400.000 - 449.999 .... ☐ 09
- Kr. 450.000 - 499.999 .... ☐ 10
- Kr. 500.000 - 749.999 .... ☐ 11
- Kr. 750.000 - 999.999 .... ☐ 13
- Kr. 1.000.000 eller derover .... ☐ 14

Uddannelse

Hvad er din senest afsluttede uddannelse?

- Afsluttet uddannelse ved 14-15 års alderen og ingen yderligere uddannelse (f.eks. 7., 8. eller 9. klasse) .... ☐ 1 (42)
- Afsluttet uddannelse ved 16-19 års alderen og ingen yderligere uddannelse (f.eks. 10. kl., realeksamen, studenter-eksamen/HF/HH/lærlingeuddannelse m.v.) .... ☐ 2
- Mellemlang videregående uddannelse (f.eks. seminarium/teknikum/EG/HA-eksamen) .... ☐ 3
- Lang uddannelse på højere læreanstalt (f.eks. universitet, teknisk højskole, tandlægehøjskole, handelshøjskole m.v.) .... ☐ 4
- Er under uddannelse .... ☐ 5

Stilling

Hvad er din stilling?

- Arbejder, ufaglært .... ☐ 01 (48-49)
- Arbejder, faglært .... ☐ 02
- Funktion uden ledelsesansvar/tjenestemand .... ☐ 11
- Højere funktionær/tjenestemand (ledende medarbejder) .... ☐ 12
- Selvstændig landbruger .... ☐ 04
- Selvstændig detailhandlende/håndværksmester .... ☐ 05
- Selvstændig i liberalt erhverv .... ☐ 06
- Lærling/studerende/elev .... ☐ 07
- Husmor/medhjælpende ægtefælle .... ☐ 08
- Pensionist/efterløn (ude af arbejde) .... ☐ 09
- Arbejdsløs .... ☐ 10

Spørgeskemaet er slut – tak for hjælpen!

Annex 3

English Questionnaire

INFORMATION SHEET ON FRESHWATER AND GROUNDWATER

The freshwater aquatic environment in Denmark

The majority of drinking water we use in Denmark stems from groundwater. Groundwater is found in cavities and water-bearing layers in the earth. Danish drinking water policy bases itself on that drinking water comes from groundwater which has undergone a very simple process (oxygenation), but which has not undergone any further treatment. This approaches a unique situation in relation to many other countries, where treated surface-water, e.g. from lakes and rivers, is used.

Groundwater in Denmark is, many places, polluted with waste products from, among other sources, agriculture, industry, road traffic, households/private gardens, landfill sites and sewers. Pollution from pesticides and nitrogen represents the most common reason for many groundwater boreholes to be closed as the water can no longer be used as drinking water without first undergoing treatment processes.

Pollution from agriculture, households, industry, etc. similarly affects animal and plant-life in lakes and watercourses. Together with a range of physical conditions, pollution represents a significant factor in defining the condition of Danish watercourses and lakes and, therefore, also for animal and plant-life in water and adjacent areas.

The price of water

On average, the consumer pays 35 krone per cubic metre of water (1000 litre) and each household pays on average 4.000 krone per year in Denmark in water bills (1.500 krone per person). This price includes both drinking water supply and removal and treatment of water via sewers (wastewater).

Groundwater pollution

Pesticides are substances which aim to protect agriculture from the adverse effects of weeds, insects and fungal diseases. Pesticides can also impact on human health and can be poisonous for animals and plants. No precise knowledge is to be found on how damaging pesticides are, however, pesticides and their residual products are suspected to contribute to hormone disturbance in humans and animals, and to be carcinogenic for humans.

Nitrogen and phosphorous are important nutrients for plants. If too much nitrogen and phosphorous is applied, the excess is lost to the environment, including groundwater. Just as with pesticides, excess nitrogen in drinking water is under suspicion for having a carcinogenic effect in humans. Excess nitrogen and phosphorous in the aquatic environment can lead to lakes becoming too rich in nutrients. This can lead to cloudy water and poor visibility through the depths, and, in rare cases, fish mortality can occur.

Study of attitudes to the protection of the aquatic environment in Denmark *760-032*

The accompanying questionnaire forms part of a research project concerning future management of the freshwater aquatic environment in Denmark. The project is being undertaken by researchers at Denmark's National Environmental Research Institute.

The freshwater aquatic environment consists of groundwater, lakes and watercourses. The aquatic environment can be protected and administered in various ways, each with different consequences for the quality of groundwater and drinking water, and for conditions for animal and plant-life in watercourses and lakes. The purpose of this questionnaire is to learn about your attitudes on how the aquatic environment should be administered in the future.

We will ask you to answer in accordance with your personal viewpoint. In this way, no answer is more right than another - we are interested in your opinion. Your answers will be treated confidentially and will be used exclusively for scientific purposes. The questionnaire has been sent out to 1.500 people, and it is important for the results of the study that as many as possible respond.

We have attached an information sheet on freshwater and groundwater, and would ask you to read this before responding to the questionnaire.

Thank you in advance for your help and we hope you find the experience enjoyable.

Question 1: Attitudes to the environment

1.1 Below is a range of statements on the aquatic environment in Denmark. On a scale of 1-6, please reveal how far you are in agreement or disagreement with the statement. You can use the figures in between to gradate your response

- Please mark with just one cross in each line

	Completely disagree		Neither/nor		Agree completely	Do not know	K01
Protection of the aquatic environment is one of the most important tasks in environmental policy.......	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(11)
Tap water does not have to be drinking water. Bottled drinking water can be bought	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(12)
Pesticide pollution is a significant threat against the quality of drinking water in Denmark............	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(13)
Nitrogen pollution is a significant threat against the quality of drinking water in Denmark............	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(14)
Drinking water does not have to come from non-treated groundwater; treated water is just as good	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(15)
Watercourses and lakes should have a rich and natural animal and plant-life	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(16)
Drinking water is clean in Denmark.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(17)
Problems of pollution of the aquatic environment are exaggerated	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(18)
The authorities should use more resources to protect the aquatic environment than they do now.......	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(19)

Question 2: Your water consumption

2.1 Do you/does anyone in your household buy bottled water (spring-water or the like (not sparkling)) as an alternative to drinking water from the tap?

- Only one response, please

- Always .... ☐ 1 (20)
- Often .... ☐ 2
- Rarely .... ☐ 3
- Never.................................... → ***Go to Q. 2.3***........... ☐ 4
- Do not know .... → ***Go to Q. 2.3***........... ☐ 5

2.2 If/when you/anyone in your household buy(s) bottled water, why is this?

- You may give more than one response

- It tastes better .... ☐ 1 (21-27)
- It is not polluted .... ☐ 2
- It is healthier due to the mineral content, etc. .... ☐ 3
- It comes in handy packaging .... ☐ 4
- I do not have access to tap water (e.g. when I am out shopping) .... ☐ 5
- Other .... ☐ 6
- Do not know .... ☐ 7

2.3 If the current limit values for nitrogen and/or pesticide content in drinking water were exceeded, would you then buy bottled water to drink?

- No .... ☐ 1 (28-31)
- Yes, under all circumstances .... ☐ 2
- Yes, if I thought the excess was too large .... ☐ 3
- Do not know .... ☐ 4

2.4 Do you/does your household do anything to save water?

- Yes .... ☐ 1 (32)
- No .... → ***Go to Q. 3.1*** .... ☐ 2

2.5 What do you do to save water?
- You may give more than one response

- I/we have water-saving habits .... ☐ 1 (33-40)
- I/we have a water-saving toilet. .... ☐ 2
- I/we have water-saving taps .... ☐ 3
- I/we have a water-efficient washing machine .... ☐ 4
- I/we have a water-efficient dishwasher .... ☐ 5
- I/we avoid unnecessary water consumption, e.g. turn water off while brushing teeth .... ☐ 6
- Other, ***please describe***: ____________________ (41-50). ☐ 7
- Do not know .... ☐ 8

2.6 Why do you save water? Indicate below how significant the factors mentioned are for your decision to save water.
- *Please mark with just one cross in each line*

	Very high significance	High significance	Some significance	No significance	Do not know	
Price of water	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(51)
Concern for the environment	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(52)
Habit	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(53)
Consideration for future generations	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(54)
Other	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(55)

Question 3: Your use of watercourses and lakes

3.1 Do you fish in Danish watercourses and/or lakes in your leisure time?
- Only one response, please

- Often .... → ***Go to Q. 3.3*** .... ☐ 1 (56)
- Sometimes .... → ***Go to Q. 3.3*** .... ☐ 2
- Rarely .... → ***Go to Q. 3.2*** .... ☐ 3
- I never fish in Denmark, only abroad .... → ***Go to Q. 3.2*** .... ☐ 4
- I never fish .... → ***Go to Q. 3.2*** .... ☐ 5
- I only do coastal/sea fishing .... → ***Go to Q. 3.3*** .... ☐ 6

3.2. If you fish, but rarely fish in Denmark, is it because:
- Only one response, please

- There are no suitable rivers or lakes close-by .... ☐ 1 (57-61)
- It is not challenging enough .... ☐ 2

I do not have time to fish that often .... ☐ 3
I am not interested in fishing .... ☐ 4
Other .... ☐ 5

3.3 Do you bathe in Danish watercourses and/or lakes?
- Only one response, please

Often	→ ***Go to Q. 4.1***	☐ 1	(62)
Sometimes	→ ***Go to Q. 4.1***	☐ 2	
Rarely	→ ***Go to Q. 3.4***	☐ 3	
I never bathe in freshwater	→ ***Go to Q. 3.4***	☐ 4	
I do not bathe	→ ***Go to Q. 3.4***	☐ 5	

3.4. If you rarely or never bathe, is it because:
- Only one response, please

There are no suitable rivers or lakes close-by	☐ 1	(63-67)
Water quality is too poor	☐ 2	
Bottom conditions are poor	☐ 3	
I do not have time to bathe more often	☐ 4	
Other	☐ 5	

Question 4: Your water supply

4.1 Where does your household's water come from?
- Only one response, please

Council water supply	☐ 1	(68)
Private, communal supply	☐ 2	
Private borehole	☐ 3	
Other	☐ 4	
Do not know	☐ 5	

4.2 Do you know approximately how many cubic metres (1.000 litres) of water your household uses in a year?

Yes	☐ 1	(69)
No	☐ 2	

4.3 If yes, please state your annual consumption in cubic metres here: ☐☐☐☐ (70-73)

4.4 Do you know how big your household's annual water bill is?
- Only one response, please

Yes, it is less than 1.500 kr. .	☐ 1	(74)
Yes, it is between 1.500 and 4.000 kr..	☐ 2	
Yes, it is between 4.000 and 6.000 kr..	☐ 3	
Yes, it is over 6.000 kr.	☐ 4	
No, I do not know/cannot remember	☐ 5	

Now come two questions where you will be asked how much your household is willing to pay annually to secure:

1) Naturally clean drinking water (Question 5.1)
2) Purified drinking water (Question 5.5)

Payment, in both cases, would take place via a fixed annual supplement to your water bill. Please note that you should answer both questions, but imagine that *just one of the alternative proposals would be implemented*.

Both situations involve a change with regard to the authorities' present efforts to ensure clean water.

The current situation
At the moment, a range of measures is carried out with regard to protection of groundwater against pollution from pesticides and nitrogen. When a groundwater borehole is found to be polluted, it is closed and a new one is established.

It is uncertain whether clean drinking water can be provided in sufficient amounts by this method in the future. There is, therefore, a risk that tap water will exceed current limits for pesticides and nitrogen content in the future.

Conditions for animal and plant-life in watercourses and lakes are not so good. Animal and plant-life is in a state of imbalance many places and is markedly different than would be so if conditions were natural. The primary reason for changes in the condition of the aquatic environment is human activity.

In the following, you will be presented with two proposals which could ensure clean drinking water, both now and in the future. For each proposal you will be asked to state your willingness to pay for the proposal to be implemented.

5.1. Proposal to secure naturally clean drinking water

By carrying out measures, primarily in agriculture, naturally clean drinking water can be secured both now and in the future. At the same time, very good conditions can be secured for animal and plant-life in watercourses and lakes. This means that animal and plant-life will be more natural, varied and balanced, and affected by human activity to only a slight to average degree.

It is assumed that the Danish consumer should cover the costs of implementing the proposal. This will take place in the form of a **fixed annual sum per household** claimed once a year via the water bill.

What is the maximum price that your household would be willing to pay for this type of groundwater protection?

Please remember, if the measures are not implemented, there is a risk that tap water will exceed the limit values with regard to pesticide and nitrogen content, and that conditions for animal and plant-life in watercourses and lakes will be less good.

On the scale below, you are asked to mark with a cross the *highest* of the sums listed that your *household* would be willing to pay *annually* for implementation of the proposal. Please give only one response and note that the sum you put your cross by represents a supplement in excess of that sum you pay for water at the moment.

Before you mark your response, we would like to draw your attention to that similar studies reveal that people tend to overestimate what they are willing to pay when responding to questions in studies like this one. You are, therefore, asked to consider fully how much your household would actually be willing, and able, to pay with the income you have at your disposal at the moment.

Annual sum per household?
- ***Only one response, please*** K02

0 kr.	☐	01	(11-12)
100 kr.	☐	02	
300 kr.	☐	03	
450 kr.	☐	04	
625 kr.	☐	05	
800 kr.	☐	06	
1.050 kr.	☐	07	
1.200 kr.	☐	08	
1.700 kr.	☐	09	
2.400 kr.	☐	10	
Other	☐	11	
Please state how much in kr.: ________ ()	☐	12	
I *cannot* respond to this question	☐	13	
I *do not want* to respond to this question	☐	14	

5.2. On a scale of 1-7 you are asked to indicate how certain/uncertain you are of the answer you gave in Question 5.1. (**1 is very uncertain and 7 is very certain**). Please note that the degree of certainty does not have any significance for the usefulness of your response. You can use the range of numbers to gradate your response.

	Very uncertain						Very certain	
On my response, I feel very	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	(13)

If you indicated 100 kr. or more in Question 5.1 – otherwise go to Q. 5.4

5.3 Please indicate the reasoning behind your choice of sum in Question **5.1** concerning the securing of naturally clean drinking water

- You may give more than one response

- It was the highest sum I could afford .... ☐ 01 (14-37)
- Clean *drinking water* is important to me and, therefore, I would willingly pay to ensure clean drinking water supplies .... ☐ 02
- Clean *groundwat*er is important to me and, therefore, I would willingly pay to secure clean groundwater .... ☐ 03
- Clean *groundwat*er is important to plant and animal-life and therefore, I would willingly pay to secure clean groundwater.. ☐ 04
- Clean *groundwat*er is important to future generations and therefore, I would willingly pay to secure clean groundwater.. ☐ 05
- I wanted to express my interest in ensuring a healthy and clean environment .... ☐ 06
- Securing clean water is an important task and, by indicating a high sum, I hope to contribute to that soon something might be done about this issue .... ☐ 07
- I indicated the sum I would wish I had at my disposal to pay to secure clean drinking water .... ☐ 08
- I did not know how else I should respond .... ☐ 09
- I set a sum taking into consideration what I pay for other things .... ☐ 10
- Other .... ☐ 11
- Do not know .... ☐ 12

If you indicated 0 kr. or could not/did not want to respond to Question 5.1 – otherwise go to Q. 5.5

5.4 Please indicate the reason(s) for why you responded as you did in Question **5.1** concerning the securing of naturally clean drinking water

- You may give more than one response

- At the moment I cannot afford to pay more for water than I already do .... ☐ 01 (38-61)
- It is of no significance to me if limit values for pesticides and/or nitrogen content in drinking water are exceeded .... ☐ 02
- It is of no significance to me if limit values for pesticides and/or nitrogen content in groundwater are exceeded.. ☐ 03
- It is of no significance to me whether conditions for animal and plant-life in watercourses and lakes are improved or not.. ☐ 04
- It is not my responsibility to pay for clean water.. ☐ 05
- The public sector or the water companies should pay to secure clean water............................ ☐ 06
- Those, who pollute the water should pay to secure clean water in future .... ☐ 07
- I need more information to be able to respond to questions such as these.............................. ☐ 08
- I did not know how I should respond.. ☐ 09
- What I would pay to secure clean water is not a concern for others....................................... ☐ 10
- Other.. ☐ 11
- Do not know .... ☐ 12

5.5 Proposal to treat water

Via treatment of polluted groundwater, pesticide and nitrogen residue can be removed, so that the treated water can be used as water for drinking and other purposes. In this way, clean drinking water can be provided both now and in the future. In contrast with the previous proposal, however, groundwater is not protected from pollution with pesticides and nitrogen. Implementation of the treatment proposal will not involve improvements in conditions for animal and plant-life in watercourses and lakes, therefore, conditions will remain less than good. This means that animal and plant-life in watercourses and lakes will be markedly different than would be so under natural conditions and will be in slight imbalance.

As previously, the costs connected with implementation of the proposal are to be covered by the Danish consumer in the form of a fixed annual sum per household charged via the water bill.

What is the maximum price that your household would be willing to pay for treatment of groundwater so that it could be used for drinking water?

Please remember that if treatment is not implemented there is a risk that water in the taps will exceed the limit values with regard to pesticide and nitrogen content.

On the scale below, you are asked to mark with a cross the highest of the sums listed that your household would be willing to pay annually for implementation of the proposal. Please give only one response and note that the sum you put your cross by represents a supplement in excess of that sum you pay for water at the moment. Before indicating your choice, please consider fully how much your household would actually be willing, and able, to pay with the income you have at your disposal at the moment.

How much would you be willing to pay for drinking water from polluted groundwater to be treated and used as drinking water?

Annual sum per household
- ***Only one response, please***

0 kr. .... ☐ 01 (62-63)
100 kr. .... ☐ 02
300 kr. .... ☐ 03
450 kr. .... ☐ 04
625 kr. .... ☐ 05
800 kr. .... ☐ 06
1.050 kr. .... ☐ 07
1.200 kr. .... ☐ 08
1.700 kr. .... ☐ 09
2.400 kr. .... ☐ 10
Other .... ☐ 11
Please state how much in kr.:____________________(64-78)... ☐ 12
I *cannot* answer this question .... ☐ 13
I *do not want* to respond to this question .... ☐ 14
If I were to agree to treatment of groundwater, I would want to be compensated in the form of cheaper water.................... ☐ 15

5.6. On a scale of 1-7 you are asked to indicate how certain/uncertain you are of the answer you gave in Question 5.5. (**1 is very uncertain and 7 is very certain**). Please note that the degree of certainty does not have any significance for the usefulness of your response. You can use the range of numbers to gradate your response.

	Very uncertain						Very certain	
On my response, I feel....................	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	(79)

If you indicated 100 kr. or more in Question 5.5 – otherwise go to Q. 5.8

5.7 Please indicate the reasoning behind your choice of sum in Question **5.5** concerning the treatment of drinking water

- You may give more than one response K03

- It was the highest sum I could afford ☐ 1 (11-19)
- Clean *drinking water* is important to me and, therefore, I would willingly pay to ensure clean drinking water supplies ☐ 2
- Securing clean water is an important task and by indicating a high sum, I hope to contribute to that soon something might be done about this issue ☐ 3
- I indicated the sum I would wish I had at my disposal to pay to secure clean drinking water ☐ 4
- I did not know how else I should respond. ☐ 5
- I set a sum taking into consideration what I pay for other things. ☐ 6
- I chose a lower sum than in Question 5.1, as I do not think as much of the proposed alternative in Question 5.5 as of that in Question 5.1. ☐ 7
- Other ☐ 8
- Do not know ☐ 9

If you indicated 0 kr. or could not/did not want to respond to Question 5.5 – otherwise go to Q. 5.9

5.8 Please indicate the reason(s) why you responded as you did in Question **5.5** concerning the treatment of drinking water

- You may give more than one response

- At the moment I cannot afford to pay more for water than I already do ☐ 01 (20-41)
- It is of no significance to me if limit values for pesticides and/or nitrogen content in drinking water are exceeded ☐ 02
- I regard treated water as inferior in relation to the drinking water I have now ☐ 03
- It is not my responsibility to pay for clean water ☐ 04
- The public sector or the water companies should pay to secure clean water ☐ 05
- Those, who pollute the water should pay to secure clean water in future ☐ 06
- I need more information to be able to respond to questions such as these ☐ 07
- I did not know how I should respond. ☐ 08
- What I would pay to secure clean water is not a concern for others ☐ 09
- Other ☐ 10
- Do not know ☐ 11

If in response to Question 5.5 you indicated that you would want compensation - otherwise go to Question 5.10.

5.9 Please indicate how large a sum the household water bill is to be reduced by, before you would accept treated water rather than naturally clean drinking water. The annual water bill should be reduced by:

- ***Only one response, please***

- 100 kr. ☐ 01 (42-43)
- 300 kr. ☐ 02
- 450 kr. ☐ 03
- 625 kr. ☐ 04
- 800 kr. ☐ 05
- 1.050 kr. ☐ 06
- 1.200 kr. ☐ 07
- 1.700 kr. ☐ 08
- 2.400 kr. ☐ 09
- More ☐ 10

Do not know .... ☐ 11

5.10 On what grounds would you demand compensation?

- ***Mark with a cross the statement(s) that best describe why you would demand compensation***

The aquatic environment – i.e. animal and plant-life – is not protected under the treatment alternative ☐ 1 (44-50)
I think it is unhealthy to drink treated water ☐ 2
The thought of drinking water that has been polluted is disagreeable ☐ 3
The sum I indicated equates to the disadvantages I think are associated with treated rather than naturally clean water ☐ 4
I do not feel that tap water should be treated, therefore, I indicated a very high sum ☐ 5
Other ☐ 6
Do not know ☐ 7

5.11. If the water that came out of your tap was water treated to remove nitrogen and pesticides (rather than clean groundwater), would you use it as drinking water?

Yes ☐ 1 (51)
No ☐ 2

Question 6: Information

6.1. Were you familiar with the information in the information sheet before you received this questionnaire?

Absolutely not at all ☐ 1 (52)
Not familiar ☐ 2
Familiar ☐ 3
Very familiar ☐ 4
Do not know ☐ 5

6.2. Where do you have your information on groundwater and drinking water from?

- ***You may give more than one response***

Local council/County council ☐ 1 (53-59)
Water companies ☐ 2
Denmark's governmental Environmental Protection Agency ☐ 3
Press/media ☐ 4
From my education/my work ☐ 5
From campaigns ☐ 6
Other ☐ 7

Question 7: The water in your local area

7.1 Have you ever noticed problems with the quality of your drinking water?

Yes ☐ 1 (60)
No ☐ 2

Background questions

K04

Sex

Male .... ☐ 1 (11)

Female..................... ☐ 2

Age

When were you born?

Month .... ☐☐ (12-13)

- Put e.g. 0 3 ***, if the respondent is born in March***

Year .... 1 9 ☐☐ (14-17)

Location

What local authority area do you live in?

- State name of local authority:___________________________

Size of household

How many *adults, i.e. 18 years or above* live in the household in total .... ☐ (26)

Is there a child/are there children in the household?

- If yes: How old is/are the child/children?

	Boy	Girl		Age	
1. child.....................	☐ 1	☐ 2	(71)	________year(s)	(72-73)
2. child.....................	☐ 1	☐ 2	(74)	________year(s)	(75-76)
3. child.....................	☐ 1	☐ 2	(77)	________year(s)	(78-79)
4. child.....................	☐ 1	☐ 2	(80)	________year(s)	(81-82)

No, there are no children in the household .... ☐ 1 (83)

How may people, i.e. adults and children, live in the household in total .... ☐☐ (30-31)

Residence

What type of residence do you live in?

Terraced house/cluster housing .... ☐ 1 (37)

Apartment/apartment block..................... ☐ 2

Detached one-family house .... ☐ 3

Farm property .... ☐ 4

Other..................... ☐ 5

Income

What size is the family's collective yearly gross income? ***- This should be income before any tax deductions***

Under 50000 kr. .... ☐ 01 (40-41)

Kr. 50.000 - 99.999 .... ☐ 02

Kr. 100.000 - 149.999..................... ☐ 03

Kr. 150.000 - 199.999..................... ☐ 04

Kr. 200.000 - 249.999..................... ☐ 05

Kr. 250.000 - 299.999..................... ☐ 06

Kr. 300.000 - 349.999..................... ☐ 07

Kr. 350.000 - 399.999..................... ☐ 08

Kr. 400.000 - 449.999..................... ☐ 09

Kr. 450.000 - 499.999..................... ☐ 10

Kr. 500.000 - 749.999..................... ☐ 11

Kr. 750.000 - 999.999 .... ☐ 13

Kr. 1.000.000 or above .... ☐ 14

What is your own yearly gross income? ***- This should be income before any tax deductions***

Under 50.000 kr.	☐	01	(57-58)
Kr. 50.000 - 99.999	☐	02	
Kr. 100.000 - 149.999	☐	03	
Kr. 150.000 - 199.999	☐	04	
Kr. 200.000 - 249.999	☐	05	
Kr. 250.000 - 299.999	☐	06	
Kr. 300.000 - 349.999	☐	07	
Kr. 350.000 - 399.999	☐	08	
Kr. 400.000 - 449.999	☐	09	
Kr. 450.000 - 499.999	☐	10	
Kr. 500.000 - 749.999	☐	11	
Kr. 750.000 - 999.999	☐	13	
Kr. 1.000.000 or above	☐	14	

Education

Please indicate your most recent education?

Education finished at 14-15 years old without continuing education (e.g. 7th, 8th or 9th class)	☐	1	(42)
Education finished at 16-19 years old without continuing education (e.g. 10th class, lower secondary school-leaving exam, higher secondary school-leaving exam or equivalent, apprenticeship training, etc.)	☐	2	
Medium-length further education (e.g. teacher training college/technical school or equivalent)	☐	3	
Longer-term education in an institution of higher education (e.g. university, technical college, dentist college, business school, etc.)	☐	4	
Currently studying	☐	5	

Occupation

What is your occupation?

Unskilled worker	☐	01	(48-49)
Skilled worker	☐	02	
Non-managerial employee/civil servant	☐	11	
Managerial-level employee/civil servant	☐	12	
Independent farmer	☐	04	
Independent retailer/craftsperson	☐	05	
Independent professional	☐	06	
Apprentice/student/trainee	☐	07	
Housewife/assisting spouse	☐	08	
Retired	☐	09	
Unemployed	☐	10	

The questionnaire is now finished – thank you for your help!

Study of attitudes to the protection of the aquatic environment in Denmark *760-032*

The accompanying questionnaire forms part of a research project concerning future management of the freshwater aquatic environment in Denmark. The project is being undertaken by researchers at Denmark's National Environmental Research Institute.

The freshwater aquatic environment consists of groundwater, lakes and watercourses. The aquatic environment can be protected and administered in various ways, each with different consequences for the quality of groundwater and drinking water, and for conditions for animal and plant-life in watercourses and lakes. The purpose of this questionnaire is to learn about your attitudes on how the aquatic environment should be administered in the future.

We will ask you to answer in accordance with your personal viewpoint. In this way, no answer is more right than another - we are interested in your opinion. Your answers will be treated confidentially and will be used exclusively for scientific purposes. The questionnaire has been sent out to 1.500 people, and it is important for the results of the study that as many as possible respond.

We have attached an information sheet on freshwater and groundwater, and would ask you to read this before responding to the questionnaire.

Thank you in advance for your help and we hope you find the experience enjoyable.

Question 1: Attitudes to the environment

1.1 Below is a range of statements on the aquatic environment in Denmark. On a scale of 1-6, please reveal how far you are in agreement or disagreement with the statement. You can use the figures in between to gradate your response

- Please mark with just one cross in each line

	Completely disagree		Neither/nor	Agree completely		Do not know	K01
Protection of the aquatic environment is one of the most important tasks in environmental policy.......	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(11)
Tap water does not have to be drinking water. Bottled drinking water can be bought	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(12)
Pesticide pollution is a significant threat against the quality of drinking water in Denmark.............	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(13)
Nitrogen pollution is a significant threat against the quality of drinking water in Denmark.............	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(14)
Drinking water does not have to come from non-treated groundwater; treated water is just as good	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(15)
Watercourses and lakes should have a rich and natural animal and plant-life	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(16)
Drinking water is clean in Denmark.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(17)
Problems of pollution of the aquatic environment are exaggerated	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(18)
The authorities should use more resources to protect the aquatic environment than they do now.......	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	(19)

Question 2: Your water consumption

2.1 Do you/does anyone in your household buy bottled water (spring-water or the like (not sparkling)) as an alternative to drinking water from the tap?

- Only one response, please

- Always .... ☐ 1 (20)
- Often .... ☐ 2
- Rarely .... ☐ 3
- Never.. → ***Go to Q. 2.3***........... ☐ 4
- Do not know .... → ***Go to Q. 2.3***........... ☐ 5

2.2 If/when you/anyone in your household buy(s) bottled water, why is this?

- You may give more than one response

- It tastes better .... ☐ 1 (21-27)
- It is not polluted.. ☐ 2
- It is healthier due to the mineral content, etc. .... ☐ 3
- It comes in handy packaging.. ☐ 4
- I do not have access to tap water (e.g. when I am out shopping) .... ☐ 5
- Other.. ☐ 6
- Do not know .... ☐ 7

2.3 If the current limit values for nitrogen and/or pesticide content in drinking water were exceeded, would you then buy bottled water to drink?

- No .... ☐ 1 (28-31)
- Yes, under all circumstances .... ☐ 2
- Yes, if I thought the excess was too large .... ☐ 3
- Do not know .... ☐ 4

2.4 Do you/does your household do anything to save water?

- Yes .... ☐ 1 (32)
- No .... → ***Go to Q. 3.1*** .... ☐ 2

2.5 What do you do to save water?
- You may give more than one response

- I/we have water-saving habits .... ☐ 1 (33-40)
- I/we have a water-saving toilet. .... ☐ 2
- I/we have water-saving taps .... ☐ 3
- I/we have a water-efficient washing machine .... ☐ 4
- I/we have a water-efficient dishwasher .... ☐ 5
- I/we avoid unnecessary water consumption, e.g. turn water off while brushing teeth .... ☐ 6
- Other, ***please describe***: ________________ (41-50). ☐ 7
- Do not know .... ☐ 8

2.6 Why do you save water? Indicate below how significant the factors mentioned are for your decision to save water.
- *Please mark with just one cross in each line*

	Very high significance	High significance	Some significance	No significance	Do not know	
Price of water	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(51)
Concern for the environment	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(52)
Habit	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(53)
Consideration for future generations	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(54)
Other	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	(55)

Question 3: Your use of watercourses and lakes

3.1 Do you fish in Danish watercourses and/or lakes in your leisure time?
- Only one response, please

- Often .... → ***Go to Q. 3.3*** .... ☐ 1 (56)
- Sometimes .... → ***Go to Q. 3.3*** .... ☐ 2
- Rarely .... → ***Go to Q. 3.2*** .... ☐ 3
- I never fish in Denmark, only abroad .... → ***Go to Q. 3.2*** .... ☐ 4
- I never fish .... → ***Go to Q. 3.2*** .... ☐ 5
- I only do coastal/sea fishing .... → ***Go to Q. 3.3*** .... ☐ 6

3.2. If you fish, but rarely fish in Denmark, is it because:
- Only one response, please

- There are no suitable rivers or lakes close-by .... ☐ 1 (57-61)
- It is not challenging enough .... ☐ 2

I do not have time to fish that often 3

I am not interested in fishing 4

Other 5

3.3 Do you bathe in Danish watercourses and/or lakes?
- Only one response, please

Often .... → ***Go to Q. 4.1***........ ☐ 1 (62)
Sometimes .... → ***Go to Q. 4.1***........ ☐ 2
Rarely .... → ***Go to Q. 3.4***........ ☐ 3
I never bathe in freshwater .... → ***Go to Q. 3.4***........ ☐ 4
I do not bathe .... → ***Go to Q. 3.4***........ ☐ 5

3.4. If you rarely or never bathe, is it because:
- Only one response, please

There are no suitable rivers or lakes close-by .... ☐ 1 (63-67)
Water quality is too poor .... ☐ 2
Bottom conditions are poor .... ☐ 3
I do not have time to bathe more often .... ☐ 4
Other .... ☐ 5

Question 4: Your water supply

4.1 Where does your household's water come from?
- Only one response, please

Council water supply .... ☐ 1 (68)
Private, communal supply .... ☐ 2
Private borehole .... ☐ 3
Other .... ☐ 4
Do not know .... ☐ 5

4.2 Do you know approximately how many cubic metres (1.000 litres) of water your household uses in a year?

Yes .... ☐ 1 (69)
No .... ☐ 2

4.3 If yes, please state your annual consumption in cubic metres here: .... ☐☐☐☐ (70-73)

4.4 Do you know how big your household's annual water bill is?
- Only one response, please

Yes, it is less than 1.500 kr. .... ☐ 1 (74)
Yes, it is between 1.500 and 4.000 kr.. .... ☐ 2
Yes, it is between 4.000 and 6.000 kr.. .... ☐ 3
Yes, it is over 6.000 kr. .... ☐ 4
No, I do not know/cannot remember .... ☐ 5

Question 5: Study of policy alternatives

You will now be asked to choose between a range of policy alternatives concerning future management of the aquatic environment. The alternatives vary according to the consequences they hold for:

1. Drinking water quality
2. Conditions for animal and plant-life in watercourse and lakes
3. The size of your household's water bill

1. Drinking water quality:
The quality of drinking water in a given area will of course depend on more specific local conditions, however, the following three quality levels can describe the general quality of Danish drinking water.

- ***Naturally clean:*** Measures aimed primarily at agricultural practices prevent groundwater pollution from pesticides and nitrogen. In this way, clean drinking water is secured both now and in the future.

- ***Uncertain:*** The current situation, i.e. groundwater is protected as it is at the moment, however, no further measures to prevent pollution are introduced. When a groundwater borehole is found to be polluted it is closed and a new borehole is established. It is in this way that water authorities ensure a supply of clean drinking water for consumers today. It is uncertain whether sufficient supplies of clean drinking water can be provided in this way in future. There is, therefore, a risk that in future water from our taps will exceed current limit values for pesticides and nitrogen.

- ***Treated:*** By cleaning polluted groundwater for pesticide and nitrogen residues, supplies of clean drinking water can be ensured both now and in the future.

2. Conditions for animal and plant-life in watercourse and lakes:
Conditions for animal and plant-life in the aquatic environment are affected both by the natural physical conditions and the degree of pollution. Conditions for animal and plant-life will, therefore, vary from place to place. The following three quality levels characterise the conditions in Danish watercourses and lakes.

- ***Very good:*** Animal and plant-life is natural, varied and in balance. Slight to medium impact from human activity.

- ***Less good:*** Animal and plant-life is markedly different than would be the case under natural conditions and is, to a degree, in a state of imbalance. Representative of the current situation.

- ***Poor:*** Animal and plant-life is significantly different that would be the case under natural conditions and is in a state of serious imbalance. Often completely changed due to human activity.

3. Size of household water bill:
It is assumed that the costs of implementing the policy alternatives are covered by the Danish consumer. We ask you to imagine that all consumers will contribute equally to implementation of the alternatives by means of a fixed annual sum per household, paid once a year via the water bill.

You will be asked to make 6 choices in total. Within each choice, you will be asked to choose between 3 alternative policy measures, which vary according to the quality of the drinking water, conditions for animal and plant-life in lakes and watercourses, as well as the price of drinking water. The price for each individual policy alternative is stated in the form of a fixed annual sum to be paid via the water bill.

Please note that the amount stated represents a sum over and above the sum which you pay for water at the moment. Furthermore, please note that Alternative 1 in each of the 6 choices represents continuation of current policy.

Before you make your choice, we ask you to study all 3 alternatives carefully. Results from similar studies have shown that people have a tendency to over-estimate how much they are actually willing to pay for implementation of the various policy measures. Before you mark your selection, therefore, we would ask you to be totally sure that you are willing and able to pay the stated sum associated with an alternative.

Please continue to make your choices now - we hope you find the experience enjoyable.

Choice 1.

	Alternative 1	**Alternative 2**	**Alternative 3**	K02
Drinking water:	Uncertain	Naturally clean	Treated	
Animal and plant-life in watercourses and lakes:	Less good	Very good	Less good	
Annual increase in water bill per house-hold:	0 kr.	2.400 kr.	625 kr.	
I would prefer (***please mark with a cross***):	☐ 1	☐ 2	☐ 3	(11)

Choice 2.

	Alternative 1	**Alternative 2**	**Alternative 3**	
Drinking water:	Uncertain	Uncertain	Naturally clean	
Animal and plant-life in watercourses and lakes:	Less good	Very good	Less good	
Annual increase in water bill per house-hold:	0 kr.	1.700 kr.	300 kr.	
I would prefer (***please mark with a cross***):	☐ 1	☐ 2	☐ 3	(12)

Choice 3.

	Alternative 1	**Alternative 2**	**Alternative 3**	
Drinking water:	Uncertain	Treated	Naturally clean	
Animal and plant-life in watercourses and lakes:	Less good	Very good	Poor	
Annual increase in water bill per house-hold:	0 kr.	0 kr.	1.050 kr.	
I would prefer (***please mark with a cross***):	☐ 1	☐ 2	☐ 3	(13)

Choice 4.

	Alternative 1	Alternative 2	Alternative 3	
Drinking water:	Uncertain	Uncertain	Treated	
Animal and plant-life in watercourses and lakes:	Less good	Very good	Less good	
Annual increase in water bill per house-hold:	0 kr.	1.050 kr.	1.700 kr.	
I would prefer (***please mark with a cross***):	☐ 1	☐ 2	☐ 3	(14)

Choice 5.

	Alternative 1	Alternative 2	Alternative 3	
Drinking water:	Uncertain	Treated	Naturally clean	
Animal and plant-life in watercourses and lakes:	Less good	Less good	Poor	
Annual increase in water bill per house-hold:	0 kr.	1.050 kr.	300 kr.	
I would prefer (***please mark with a cross***):	☐ 1	☐ 2	☐ 3	(15)

Choice 6.

	Alternative 1	Alternative 2	Alternative 3	
Drinking water:	Uncertain	Treated	Naturally clean	
Animal and plant-life in watercourses and lakes:	Less good	Very good	Less good	
Annual increase in water bill per house-hold:	0 kr.	300 kr.	2.400 kr.	
I would prefer (***please mark with a cross***):	☐ 1	☐ 2	☐ 3	(16)

Question 6: Follow-up to question 5

6.1. Did you find it difficult to make the choices in Question 5?

Yes .... ☐ 1 (17)

No .... ☐ 2

6.2. If yes, what made the choices hard?

- Mark with one or more crosses

I could not relate to the questions .... ☐ 1 (18-25)

I think there was too much information to consider .... ☐ 2

I did not understand the questions .... ☐ 3
I think the alternatives were too expensive .... ☐ 4
It was difficult to choose as several factors were important.................... ☐ 5
In principle I do not think that consumers should pay to ensure clean water and a healthy aquatic environment .... ☐ 6
Other.................... ☐ 7
Do not know .... ☐ 8

6.3. On a scale of 1-7 please indicate how certain/uncertain you are of the choices you made in Question 5 (**1 is very uncertain and 7 is very certain**). The degree of certainty/uncertainty does not have any consequences for the usefulness of your answers. You can use the range of figures to grade your answer.

	Very uncertain						Very certain	
On my answers, I feel....................	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	(26)

6.4. Please mark with a cross below the item you put greatest weight on in your choices in Question 5.
- Please enter only one cross

Drinking water.................... ☐ 1 (27)
Animal and plant-life in watercourses and lakes.................... ☐ 2
Size of annual increase in water bill .... ☐ 3
It varied from choice to choice .... ☐ 4
Do not know .... ☐ 5

6.5. Was it exclusively the factor you marked with a cross in Question 6.5 that you looked at in your choices in Question 5, or did you take all factors into consideration?

	Yes	No	
It was exclusively that factor I put weight on	☐ 1	☐ 1	(28)
I took all factors into consideration....................	☐ 2	☐ 2	(29)

6.6. If the water coming out of your tap was water that was cleaned of nitrogen and pesticides (rather than naturally clean groundwater), would you use it as drinking water?

Yes.................... ☐ 1 (30)
No .... ☐ 2

Question 6: Information

6.1. Were you familiar with the information in the information sheet before you received this questionnaire?

Absolutely not at all .... ☐ 1 (52)
Not familiar .... ☐ 2
Familiar.................... ☐ 3
Very familiar.................... ☐ 4
Do not know .... ☐ 5

6.2. Where do you have your information on groundwater and drinking water from?
- ***You may give more than one response***

Local council/County council.................... ☐ 1 (53-59)
Water companies.................... ☐ 2

Denmark's governmental Environmental Protection Agency ☐ 3
Press/media ☐ 4
From my education/my work ☐ 5
From campaigns ☐ 6
Other ☐ 7

Question 7: The water in your local area

7.1 Have you ever noticed problems with the quality of your drinking water?

Yes ☐ 1 (60)
No ☐ 2

Background questions

Sex K04

Male ☐ 1 (11)
Female ☐ 2

Age

When were you born?

Month ☐☐ (12-13)

- Put e.g. 0 3 ***, if the respondent is born in March***

Year 1 9 ☐☐ (14-17)

Location

What local authority area do you live in?

- State name of local authority:______________________________

Size of household

How many *adults, i.e. 18 years or above* live in the household in total ☐ (26)

Is there a child/are there children in the household?

- If yes: How old is/are the child/children?	Boy	Girl		Age
1. child	☐ 1	☐ 2	(71)	______year(s) (72-73)
2. child	☐ 1	☐ 2	(74)	______year(s) (75-76)
3. child	☐ 1	☐ 2	(77)	______year(s) (78-79)
4. child	☐ 1	☐ 2	(80)	______year(s) (81-82)

No, there are no children in the household ☐ 1 (83)

How may people, i.e. adults and children, live in the household in total ☐☐ (30-31)

Residence

What type of residence do you live in?

Terraced house/cluster housing ☐ 1 (37)
Apartment/apartment block ☐ 2
Detached one-family house ☐ 3
Farm property ☐ 4
Other ☐ 5

Income

What size is the family's collective yearly gross income? ***- This should be income before any tax deductions***

Under 50000 kr. 01 (40-41)

Kr. 50.000 - 99.999 02

Kr. 100.000 - 149.999.. 03

Kr. 150.000 - 199.999.. 04

Kr. 200.000 - 249.999.. 05

Kr. 250.000 - 299.999.. 06

Kr. 300.000 - 349.999.. 07

Kr. 350.000 - 399.999.. 08

Kr. 400.000 - 449.999.. 09

Kr. 450.000 - 499.999.. 10

Kr. 500.000 - 749.999.. 11

Kr. 750.000 - 999.999.. 13

Kr. 1.000.000 or above 14

What is your own yearly gross income? ***- This should be income before any tax deductions***

Under 50.000 kr.	☐	01	(57-58)
Kr. 50.000 - 99.999	☐	02	
Kr. 100.000 - 149.999	☐	03	
Kr. 150.000 - 199.999	☐	04	
Kr. 200.000 - 249.999	☐	05	
Kr. 250.000 - 299.999	☐	06	
Kr. 300.000 - 349.999	☐	07	
Kr. 350.000 - 399.999	☐	08	
Kr. 400.000 - 449.999	☐	09	
Kr. 450.000 - 499.999	☐	10	
Kr. 500.000 - 749.999	☐	11	
Kr. 750.000 - 999.999	☐	13	
Kr. 1.000.000 or above	☐	14	

Education

Please indicate your most recent education?

Education finished at 14-15 years old without continuing education (e.g. 7th, 8th or 9th class)	☐	1	(42)
Education finished at 16-19 years old without continuing education (e.g. 10th class, lower secondary school-leaving exam, higher secondary school-leaving exam or equivalent, apprenticeship training, etc.)	☐	2	
Medium-length further education (e.g. teacher training college/technical school or equivalent)	☐	3	
Longer-term education in an institution of higher education (e.g. university, technical college, dentist college, business school, etc.)	☐	4	
Currently studying	☐	5	

Occupation

What is your occupation?

Unskilled worker	☐	01	(48-49)
Skilled worker	☐	02	
Non-managerial employee/civil servant	☐	11	
Managerial-level employee/civil servant	☐	12	
Independent farmer	☐	04	
Independent retailer/craftsperson	☐	05	
Independent professional	☐	06	
Apprentice/student/trainee	☐	07	
Housewife/assisting spouse	☐	08	
Retired	☐	09	
Unemployed	☐	10	

The questionnaire is now finished – thank you for your help!

Annex 4

	OLS regression WTP average			OLS regression WTP lower			OLS regression WTP upper			ML Tobit estimation average			ML Interval regression WTP		
	Coef		Std. e	Coef		Std. e	Coef		Std. e	Coef		Std. e	Coef		Std. e
Respondent characteristics															
Income, DKK	0.48	***	0.11	0.48	***	0.11	0.49	***	0.12	0.51	***	0.12	0.51	***	0.12
Education level	107.39	***	25.36	94.52	***	24.49	120.25	***	26.64	107.81	***	26.49	107.49	***	26.20
Medium annual water consumption	116.08	**	55.55	109.65	**	53.65	122.51	**	58.36	104.75	*	58.17	120.27	**	57.40
High annual water consumption	-6.16		74.70	-17.05		72.15	4.72		78.48	-27.97		78.18	-15.83		77.19
Living in rural areas	75.40		63.09	72.49		60.94	78.31		66.28	82.96		65.98	80.28		65.16
Does fish very often	46.20		182.73	69.04		176.48	23.36		191.96	71.85		189.56	43.89		187.59
Saves water	-51.29		70.57	-58.33		68.16	-44.26		74.13	-66.61		74.13	-54.48		72.88
Respondent attitudes															
The authorities should use more resources	140.19	**	54.58	131.33	**	52.72	149.04	**	57.34	132.52	**	57.12	142.66	**	56.32
Bottled drinking water can bought as substitute	8.59		73.25	-1.03		70.75	18.22		76.95	12.32		77.25	6.79		75.49
Tap water may be treated instead of natural	27.35		57.06	14.91		55.11	39.80		59.94	25.69		59.77	26.78		59.02
Watercourses and lakes should have rich biodiversity	2.79		87.68	-28.28		84.68	33.85		92.11	-40.35		91.97	-12.63		90.39
Drinking water is not clean in Denmark	-0.21		92.39	-24.07		89.23	23.66		97.06	-23.94		96.30	-5.25		95.36
Pollution of the aquatic environment are exaggerated	-42.49		68.87	-57.28		66.51	-27.70		72.35	-99.58		73.11	-49.65		71.01
Payment motives															
Plant and animal life is important	139.20	**	57.35	136.80	**	55.39	141.60	**	60.25	147.89	**	59.51	147.05	**	59.26
Future generations are important	252.49	***	55.67	231.09	***	53.77	273.88	***	58.49	287.64	***	57.99	257.86	***	57.47
Altruistic motives	68.81		49.83	69.87		48.13	67.74		52.35	98.03	*	51.86	72.72		51.50
	N = 531			N = 531			N = 531			N = 531			N = 531		
	$R^2 = 0.72$			$R^2 = 0.68$			$R^2 = 0.75$			Log L= -3,866			Log L = -1,264		

Significance levels at 1%, 5% and 10% are indicated by three, two and one asterisk(s), respectively

	OLS regression WTP average			OLS regression WTP min			OLS regression WTP max			ML Tobit estimation average			ML Interval WTP		
	Coef		**Std. e**	**Coef**		**Std. e**	**Coef**		**Std. e**	**Coef**		**Std. e**	**Coef**		**Std. e**
Respondent characteristics															
Income, DKK	0.42	***	0.11	0.42	***	0.11	0.43	***	0.12	0.45	***	0.13	0.44	***	0.11
Education level	77.50	***	25.58	63.58	**	24.73	91.42	***	26.71	77.56	***	29.10	75.41	***	25.89
Medium annual water consumption	84.30		56.16	75.15		54.30	93.46		58.65	69.38		64.19	83.85		56.83
High annual water consumption	7.17		73.41	6.41		70.97	7.92		76.66	-4.77		83.69	8.66		74.27
Living in rural areas	-54.04		61.57	-55.37		59.53	-52.71		64.30	-42.58		70.21	-55.96		62.21
Does fish very often	-47.55		190.33	-25.68		184.02	-69.42		198.76	-26.13		216.10	-46.97		191.78
Saves water	-57.97		70.04	-66.81		67.71	-49.13		73.13	-88.41		79.86	-59.95		70.89
Respondent attitudes															
The authorities should use more resources	81.51		52.99	79.62		51.24	83.40		55.34	65.27		60.38	85.50		53.59
Bottled drinking water can bought as substitute	-23.94		70.30	-28.47		67.97	-19.40		73.41	-24.94		80.46	-21.69		71.11
Tap water may be treated instead of natural	102.25	*	55.19	84.33		53.36	120.17	**	57.63	135.44	**	62.62	98.43	*	55.92
Watercourses and lakes should have rich biodiversity	124.83		87.94	94.19		85.02	155.47	*	91.83	77.52		99.96	119.95		88.94
Drinking water is not clean in Denmark	66.47		93.02	42.13		89.94	90.80		97.14	43.92		105.53	69.53		94.17
Pollution of the aquatic environment are exaggerated	-46.63		64.30	-55.77		62.16	-37.48		67.14	-94.45		73.87	-48.74		65.01
Payment motives															
Altruistic motives	363.51	***	50.50	345.45	***	48.82	381.58	***	52.73	440.37	***	57.17	368.40	***	51.18
	N = 462			N = 462			N = 462			N = 462			N = 462		
	R^2 = 0.64			R^2 = 0.59			R^2 = 0.68			Log L = -3,092			Log L = -1,124		

Significance levels at 1%, 5% and 10% are indicated by three, two and one asterisk(s), respectively

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Addresses:

URL: http://www.dmu.dk

National Environmental Research Institute
Frederiksborgvej 399
PO Box 358
DK-4000 Roskilde
Denmark
Tel: +45 46 30 12 00
Fax: +45 46 30 11 14

Management
Personnel and Economy Secretariat
Monitoring, Advice and Research Secretariat
Department of Policy Analysis
Department of Atmospheric Environment
Department of Marine Ecology
Department of Environmental Chemistry and Microbiology
Department of Arctic Environment
Project Manager for Quality Management and Analyses

National Environmental Research Institute
Vejlsøvej 25
PO Box 314
DK-8600 Silkeborg
Denmark
Tel: +45 89 20 14 00
Fax: +45 89 20 14 14

Department of Terrestrial Ecology
Department of Freshwater Ecology

National Environmental Research Institute
Grenåvej 12-14, Kalø
DK-8410 Rønde
Denmark
Tel: +45 89 20 17 00
Fax: +45 89 20 15 15

Department of Wildlife Biology and Biodiversity

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The benefits of groundwater protection are estimated to assess the non-marketed benefits associated with increased protection of the groundwater resource, as compared to purification of groundwater for drinking water purposes. The study comprises valuation of the effects on both drinking water quality and the quality of surface water recipients, expressed by the quality of the living conditions for wild animals, fish and plants in lakes and waterways. The methods Discrete Choice Experiments method (CE) and Contingent valuation (CV) are used for the valuation. The results indicate that there is a significant positive willingness to pay for groundwater protection, where the willingness to pay for drinking water quality exceeds that for surface water quality. The value of groundwater protection exceeds that from purification, and this result supports the current Danish groundwater policy and the aim of the Water Framework Directive that aims at a holistic management government of the aquatic environment.

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