# D2.5 A user-friendly decision-support tool to assess receiving water vulnerability to highway traffic pollution

## CEDR PROPER PROJECT

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## Table of contents



## Table of tables

## 1. Introduction

The main objective of the EU Water Framework Directive (EU WFD, 2000) is to ensure all of Europe's waters achieve 'good status' by 2027 at the latest. 'Good status' for surface waters is defined through both ecological and chemical conditions as a healthy ecosystem with low levels of chemical pollution. 'Good status' for groundwater refers to achieving good chemical status (defined as preventing the entry of hazardous substances to groundwater) and good quantitative status (ensuring that groundwater resources are not reduced by average rate of abstractions including prejudicing minimum flow status). Further, associated groundwater impacts on surface water linked with groundwater should be avoided (EU WFD, 2000). In addition, a number of related EU regulations including the Habitats Directive (especially Article 6(3) and Natura 2000 network), the amended EIA Directive and the Flood Risks Management Directive set out requirements of relevance to drainage from highway construction and operation. A full listing of such related regulations is given in D2.3 "*Evaluation of International, European and National Legislation Frameworks and Approaches"* which reviews the range of legislative instruments and designations of relevance to the identification and quantification of receiving waterbody vulnerability from highway traffic-derived discharges.

To fulfil their requirements, EU Member States need to establish water quality objectives for surface water and groundwater bodies and, where problems are identified, propose appropriate mitigating measures. River Basin Management Plans (RBMPs) and accompanying Programmes of Measures explain these proposals and how they will be achieved. The overall objective is to protect the whole water body and to initiate a coordinated response to solve identified problems. However, with 60% of the surface waters and 11% of groundwaters yet to achieve 'good status', considerable further efforts are required (EEA, 2018).

Whilst agricultural practices are recognised as key diffuse pollution pressures on water quality in many RBMPs, the role of urban diffuse pollution is less certain. As a category, urban diffuse pollution includes runoff from a range of sources such as roads, pavements, roofs and misconnections, and therefore the exact contribution from traffic activities is not readily ascertainable (see PROPER Deliverables 2.1 and 2.4). However, several detailed studies have reported a change in the nature or composition of receiving water ecologies in receipt of highway runoff, with differences in species composition, abundance and feeding behaviour identified (Kayhanian et al. 2008; Hurle et al. 2006). Despite this, the challenge of establishing a causal relationship remains, as even highway runoff discharges identified as exceeding certain environmental quality standards are not consistently associated with poor ecological status (and vice-versa) (e.g. Bruen et al., 2006). Irrespective of this, it is recognised that end-users e.g. National Road Administrations, are required to make decisions now on when, where and how highway runoff should be treated in order to demonstrate to the competent authority that the highway will not have unacceptable adverse environmental impacts..

As a contribution to addressing this need, this report presents a framework to support the systematic identification of receiving waters vulnerable to polluted discharges, which in this report refers to highway runoff. The approach directly builds on the findings of PROPER Deliverable 2.1 (where vulnerability was defined as a function of the inherent bio-physico-chemical characteristics of a waterbody) and Deliverable 2.2 (parameters to assess surface and groundwater vulnerabilities). In essence, the framework facilitates the evaluation of receiving waters within a defined road network area through the comparative assessment of a short-list of benchmarked criteria identified as influencing the relative vulnerabilities of waterbodies to highway runoff inputs. In keeping with the overall aim of the CEDR PROPER project (supporting the translation of research into practice), this screening-level tool is a pragmatic combination of data and (where this not available) expert judgement (as provided by the PROPER IAB).

## 2. Methodology

Assessments of vulnerability consider the differential impact of an identified hazard (e.g. highway runoff) within a local environment (i.e. receiving surface water or groundwater). In other words, what factors would make one waterbody more or less vulnerable to the same inlet loading in comparison with another? Within PROPER Deliverable 2.2, the inherent factors informing receiving water vulnerability were identified as

- Hydrological aspects: e.g. surface waters may be especially vulnerable to highway runoff during low-flow conditions
- Chemical aspects: e.g. highway runoff poses a greater risk to 'soft water' receiving waterbodies with regard to metal pollution
- Ecological aspects: e.g. water bodies that are host to sensitive species e.g. salmon fisheries are particularly vulnerable to highway discharges
- Geological aspects: e.g. chalk aquifers and shallow aquifers are often described as being vulnerable to highway discharges, especially following de-icing operations

A series of anthropogenic aspects were also identified in PROPER Deliverable 2.2 (e.g. the influence of surrounding land use on runoff quality and quantity actual / planned use of the waterbody, and rainfall and traffic characteristics). The first aspect (influence of surrounding land use) is not in scope of the PROPER project which focuses on the generation and impact of discharges from road networks only. The remaining aspects listed (planned/actual use of the waterbody and rainfall and traffic characteristics) are also not within scope of this Deliverable as the focus is vulnerability (defined above as pertaining to inherent receiving water characteristics). However, both these latter aspects are considered within the Decision Support System (DSS) under development within PROPER Deliverable 3.3.

Within PROPER Deliverable 2.2, the four vulnerability assessment criteria were supported by 14 indicators for surface water (see Table 3.1) and ten indicators for groundwater vulnerability (see Table 3.4). To support development of a pragmatic, user-friendly tool, these 24 indicators were reduced and - where feasible – integrated to a short-list of 11 indicators (see Tables 2 and 3 in Section 3; this report). Surface water indicators were short-listed by selecting parameters identified as having comparatively the greatest impact with regard to receiving water vulnerability (i.e. scored ≤ -2 or ≥ 2). Occurrence of an indicator in both the DRASTIC and DMRB models (both used to map receiving groundwater vulnerability) was used as the basis for shortlisting indicators to assess receiving groundwater vulnerability.

Following the identification of a short-list of indicators, the next stage of a vulnerability assessment is to develop an approach to benchmarking each indicator. In keeping with a need to develop a screening tool that is both user-friendly and which may be applied within a range of Member States and climates, a primarily qualitative approach to benchmarking surface water vulnerability indicators is adopted. Qualitative assessment uses a relative scale where numeric values are pre-defined to represent a comparatively escalating likelihood of occurrence (see Table 1).

**Table 1 Guide to how the likelihood of a specific descriptor occurring could be graded and scored**

| Possible descriptors for relative grading | Ordinal value associated with likelihood |
|---|---|
| Likely (expected to occur) | 4 |
| Possible (may occur sometimes) | 3 |
| Unlikely (uncommon but known to occur) | 2 |
| Rare (lack of evidence but not impossible | 1 |

The use of such a qualitative approach is well recognised and globally accepted (e.g. DEFRA, 2004; USDA, 2003; Elgallel *et al.,* 2016). However, its use is not without its critics as, by definition, the approach is subjective and the results dependent on the experience of the team undertaking the assessment (Ramona, 2011). Whilst widely used in the occupational health and safety arena, its use within environmental risk assessment is a more recent step. It should be noted that the values given in Table 1 are ordinal in nature, not numeric, and therefore represent only the likelihood of specific descriptor occurring and do not have any exact quantitative meaning. The exception to the use of a qualitative approach is the indicator for receiving water hardness which is informed through an adaptation of the EU Priority Hazardous Substance (2013) water hardness classification scheme from five categories to four (by merging the 40-50mg/l and the 50-100mg/l bands into one single 40-100mg/l category). In relation to benchmarking and scoring of indicators for assessing groundwater vulnerability, three of the ten indicators identified (in Table 3.4 of PROPER Deliverable 2.2) appear in both DRASTIC and the DMBR models as follows:

- depth to water table: increases migration pathway for surface pollution to reach water table
- impact of vadose zone - low permeability soils may impede infiltration and pollutant transfer
- aquifer media: permeable (and fractured) rock materials render aquifer more vulnerable

As described in PROPER Deliverable 2.2, the characterisation of groundwater bodies at a European level (e.g. under the EU WFD (2000) and the EU Groundwater Directive (2006)) is assessed as a combined function of the thickness and permeability of substrates overlying the groundwater body (i.e. the vadose zone). This led to the development of a categorisation scheme involving four categories of vulnerability (Daly and Misstear, 2001; see Table 3.3 in PROPER Deliverable 2.2) which integrates information on depth to groundwater with overlying soil permeability, and this scheme has been adapted for use in Table 3.

Together Tables 2 and 3 form the framework to support the systematic identification of receiving waters vulnerable to highway traffic pollution (see Matrices A1 and A2 in the Appendix). The matrix can be implemented as a stand-alone tool, through the following steps:

- allocation of a score per indicator
- multiplication of allocated score by its respective weight (i.e. calculation of a weighted score per indicator).
- summation of the weighted scores allocated to each indicator to develop a single integrated vulnerability score per water body
- derive a ranked order of water body vulnerability (e.g. from most vulnerable water body (lowest score) to the least vulnerable (highest score).

Whilst default weightings are suggested in Tables 2 and 3, the user can – if they wish - replace these with their own weightings in relation to local concerns/user priorities. As noted above, it should be remembered that allocated scores are ordinal and not numeric. For example, the integrated vulnerability scores can be ordered to indicate which water body is more (or less) vulnerable than another to highway discharge. The integrated vulnerability scores give no indication of how important that difference may be. It does not provide any information on what e.g. a 'most vulnerable' means, nor can it be used to determine how important the difference is between, for example, a water body ranked 1$^{st}$ as opposed to one identified as being 2$^{nd}$. However, the resulting vulnerability score can be used to identify – or short-list - which waterbodies are relatively of most concern and should be prioritised for further research. Whilst the score itself has no quantitative meaning, such scores are often interpreted using a matrix (or heat map) such as that provided in Table 4 (see Section 3.2).

## 3. CEDR PROPER receiving water vulnerability framework

### 3.1 Short-listed criteria and indicators, and example benchmarks, scores and weights

Table 2 and 3 identify the short-listed characteristics selected for use in the receiving water vulnerability framework. Each criterion is supported by an indicator and descriptor which specify the particular aspect under consideration, together with example benchmarking and scoring schemes. Each indicator is also allocated a weighting as an indication of their respective impacts on the health of receiving waters. For a full discussion of the selected criteria, indicators and weightings see PROPER Deliverable 2.2.

**Table 2. Characteristics which inform the vulnerability of receiving surface waters and an indication of how these could be graded and scored**

| Criteria | Indicator | Descriptor | Benchmark | Score | Weighting |
|---|---|---|---|---|---|
| Hydrological | Dilution capacity | >8:1 dilution | Expected to occur | 1 | 3 |
| | | | May occur | 2 | |
| | | | Uncommon | 3 | |
| | | | Rare | 4 | |
| | Scouring of basal sediments | Blanketing of basal substrates | Expected to occur | 1 | 2 |
| | | | May occur | 2 | |
| | | | Uncommon | 3 | |
| | | | Rare | 4 | |
| | First flush effect | Elevated concentrations at start of event | Expected to occur | 1 | 3 |
| | | | May occur | 2 | |
| | | | Uncommon | 3 | |
| | | | Rare | 4 | |
| Chemical | Elevated sodium chloride levels | Frequency of winter maintenance activities | Expected to occur | 1 | 4 |
| | | | May occur | 2 | |
| | | | Uncommon | 3 | |
| | | | Rare | 4 | |
| | Receiving water hardness | Concentration of $CaCO_3$/l in receiving water | <40mg/l | 1 | 2 |
| | | | 40-<100mg/l | 2 | |
| | | | 100-<200mg/l | 3 | |
| | | | >200mg/l | 4 | |
| Ecological | Elevated temperatures in highway runoff | Change in temperature > 3ºC | Expected to occur | 1 | 2 |
| | | | May occur | 2 | |
| | | | Uncommon | 3 | |
| | | | Rare | 4 | |
| | Physiological stresses | Sensitive species / life stages | Expected to occur | 1 | 2 |
| | | | May occur | 2 | |
| | | | Uncommon | 3 | |
| | | | Rare | 4 | |

The Tables are presented in a matrix format for use as a stand-alone tool in the Appendix (see Matrices 1 and 2), and together provide a systematic, pragmatic approach to screening the relative vulnerability of receiving surface waters and groundwaters to the impacts of highway runoff.

**Table 3. Characteristics which inform the vulnerability of receiving groundwaters and an indication of how these could be benchmarked and scored**

| Criteria | Indicator | Benchmark | Score | Weighting |
|---|---|---|---|---|
| Aquifer media | Permeable (and fractured) rock materials render aquifer more vulnerable | Karst / chalk | 1 | 2 |
| | | Sand / gravel | 2 | |
| | | Metamorphic / igneous | 3 | |
| | | Clay / shale | 4 | |
| Permeability / thickness of the unsaturated zone (integrates depth to groundwater) | High permeability (e.g. sand/gravel) | 0 – 3.0m | 1 | 4 |
| | | >3.0m | 4 | |
| | Moderate permeability (e.g. Glacial till, loam) | 0 – 3.0m | 1 | |
| | | 3.0 – 10.0m | 2 | |
| | | >10.0m | 4 | |
| | Low permeability (e.g. clay silt, clay, peat) | 0 – 3.0m | 1 | |
| | | 3.0 – 5.0m | 2 | |
| | | 5.0 – 10.0m | 3 | |
| | | >10.0m | 4 | |

### 3.2 Development of an approach to interpreting receiving water vulnerability scores

Matrices 3 and 4 (see Appendix) give an overview of the range of integrated vulnerability scores (i.e. summed weighted scores) that could be derived on application of the vulnerability framework. This is achieved by completing the framework under two scenarios, selected to identify the maximum and minimum integrated vulnerability scores that could be generated for surface waters and groundwaters:

- scenario one: each indicator for a particular water body is allocated the maximum score of 4
- scenario two: each indicator for a particular water body is allocated the minimum score of 1

As can be seen from Matrices 3 and 4, integrated vulnerability scores range from:

- 18-72 for surface water (Matrix 3: the lower the value the greater the relative surface water vulnerability to highway discharges)
- 6-24 for groundwater (Matrix 4: the lower the value the greater the relative groundwater vulnerability to highway discharges)

As noted in Section 2, whilst vulnerability scores have no quantitative meaning, such scores are often interpreted using a traffic light scheme such as that provided in Table 4. Despite their widespread use, there are currently no clear guidelines on how:

- scores are segregated into discrete ranges
- different colours (e.g. the traditional red, amber, green) are allocated to identified ranges of numbers
- discrete ranges of values should be interpreted

Examples in the literature vary greatly in relation to these three aspects, indicating this is generally a value judgement (Cox, 2008; Ball and Watt, 2013). In the absence of specific guidelines, the approach shown in Table 4 is proposed with an example of how the score ranges can be interpreted is provided below:

**Table 4. An approach to interpreting integrated vulnerability score**

| **Water body type** | **Integrated vulnerability score thresholds** | | |
|---|---|---|---|
| | **High vulnerability** | **Medium vulnerability** | **Low vulnerability** |
| **Surface water** | 18-35 | 36-54 | 55-72 |
| **Groundwater** | 6-11 | 12-17 | 18-24 |

A classification of:

- high vulnerability: indicates a high probability that a receiving water will be vulnerable to the receipt of highway runoff and that therefore runoff should be treated prior to discharge.
- medium vulnerability indicates that the receiving waters may be vulnerable to highway runoff discharges and that treatment of runoff prior to discharge is therefore advised.
- low vulnerability indicates a low probably that a water body will be vulnerable to the receipt of highway discharges and therefore that treatment of runoff prior to discharge is not required.

Depending on the users ‘appetite for risk’, the ranges identified in Table 4 can be modified (i.e. thresholds varied) to alter the predefined cut-off vulnerability score at which a particular action is required. For example, a more conservative user may wish to extend the range interpreted as highly vulnerable (e.g. reclassify from 18-35 to 18-45) effectively requiring the need for detailed investigations of a greater number of waterbodies.

## 4. **Conclusions**

Irrespective of incomplete data sets, policy-makers, National Road Administrations and environmental protection agencies are increasingly required to make decisions on how, when and where highway runoff should be treated. As a contribution to addressing this need, a qualitative framework to support the systematic identification of receiving water vulnerability to polluted discharges, which is this report relates to highway traffic pollution, has been developed. Viewed as an extension of risk assessment, the developed approach qualitatively considers the differential impact of an identified hazard (i.e. highway runoff) within a local environment (the receiving water body). Through consideration of the co-identification of criteria combining a review of the research literature and stakeholder discussions, the nature and type of influence of a range of parameters has been defined. An approach to benchmarking and scoring indicators is provided and default weightings are developed. Alternatively the user can identify their own weightings, for example, based on site specific knowledge / concerns. An approach to interpreting categorising and interpreting integrated vulnerability scores is presented. The results of this process will be integrated within the PROPER Deliverable 3.3 (Decision support tool (DST) to support users to identify the most appropriate sustainable drainage system under various conditions), and its practical application will be addressed within PROPER Deliverable 3.6 (Application of the PROPER DST to real world case studies).

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**Appendix**

**Matrix A1. The PROPER framework to support the systematic identification of receiving surface waters vulnerable to highway traffic pollution**

| | | | | | | Water body 1 | | Water body 2 | | Water body 3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Criteria** | **Indicator** | **Descriptor** | **Benchmark** | **Score** | **Weighting** | **Score** | **Score x weighting** | **Score** | **Score x weighting** | **Score** | **Score x weighting** |
| Hydro-logical | Dilution capacity | >8:1 dilution | Expected to occur | 1 | 3 | | | | | | |
| | | | May occur | 2 | | | | | | | |
| | | | Uncommon | 3 | | | | | | | |
| | | | Rare | 4 | | | | | | | |
| | Scouring of basal sediments | Blanketing of basal substrates | Expected to occur | 1 | 2 | | | | | | |
| | | | May occur | 2 | | | | | | | |
| | | | Uncommon | 3 | | | | | | | |
| | | | Rare | 4 | | | | | | | |
| | First flush effect | Elevated concentrations at start of event | Expected to occur | 1 | 3 | | | | | | |
| | | | May occur | 2 | | | | | | | |
| | | | Uncommon | 3 | | | | | | | |
| | | | Rare | 4 | | | | | | | |
| Chemical | Elevated sodium chloride levels | Frequency of winter maintenance activities | Expected to occur | 1 | 4 | | | | | | |
| | | | May occur | 2 | | | | | | | |
| | | | Uncommon | 3 | | | | | | | |
| | | | Rare | 4 | | | | | | | |
| | Receiving water hardness | Concentration of $CaCO_3$/l in receiving water | <40mg/l | 1 | 2 | | | | | | |
| | | | 40-<100mg/l | 2 | | | | | | | |
| | | | 100-<200mg/l | 3 | | | | | | | |
| | | | >200mg/l | 4 | | | | | | | |
| Ecological | Elevated temperature in highway runoff | Change in temperature > 3°C | Expected to occur | 1 | 2 | | | | | | |
| | | | May occur | 2 | | | | | | | |
| | | | Uncommon | 3 | | | | | | | |
| | | | Rare | 4 | | | | | | | |
| | Physiological stresses | Sensitive species / life stages | Expected to occur | 1 | 2 | | | | | | |
| | | | May occur | 2 | | | | | | | |
| | | | Uncommon | 3 | | | | | | | |
| | | | Rare | 4 | | | | | | | |
| **Summed weighted scores per water body** | | | | | | | | | | | |

**Matrix A2. The PROPER framework to support the systematic identification of receiving groundwaters vulnerable to highway traffic pollution**

| | | | Score | Weighting | Water body 1 | | Water body 2 | | Water body 3 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Indicator** | **Descriptor** | **Benchmark** | | | **Score** | **Score x weighting** | **Score** | **Score x weighting** | **Score** | **Score x weighting** |
| Aquifer media | Substrate type | Karst / chalk | 1 | 2 | | | | | | |
| | | Sand / gravel | 2 | | | | | | | |
| | | Metamorphic / igneous | 3 | | | | | | | |
| | | Clay / shale | 4 | | | | | | | |
| Permeability/ thickness of vadose zone | High permeability | 0 – 3.0m | 1 | 4 | | | | | | |
| | | >3.0m | 4 | | | | | | | |
| | Moderate permeability | 0 – 3.0m | 1 | | | | | | | |
| | | 3.0 – 10.0m | 2 | | | | | | | |
| | | >10.0m | 4 | | | | | | | |
| | Low permeability | 0 – 3.0m | 1 | | | | | | | |
| | | 3.0 – 5.0m | 2 | | | | | | | |
| | | 5.0 – 10.0m | 3 | | | | | | | |
| | | >10.0m | 4 | | | | | | | |
| **Summed weighted scores per water body** | | | | | | | | | | |

**Matrix A3. The PROPER framework to support the systematic identification of receiving surface waters vulnerable to highway traffic pollution**

| | | | | | | Scenario 1: allocation of maximum score | | Scenario 2: allocation of minimum score | | Scenario 3: allocation of intermediate scores | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Water body 1 | | Water body 2 | | Water body 3 | |
| **Criteria** | **Indicator** | **Descriptor** | **Benchmark** | **Score** | **Weighting** | **Score** | **Score x weighting** | **Score** | **Score x weighting** | **Score** | **Score x weighting** |
| Hydro-logical | Dilution capacity | >8:1 dilution | Expected to occur | 1 | 3 | 4 | 12 | 1 | 3 | 2 | 6 |
| | | | May occur | 2 | | | | | | | |
| | | | Uncommon | 3 | | | | | | | |
| | | | Rare | 4 | | | | | | | |
| | Scouring of basal sediments | Blanketing of basal substrates | Expected to occur | 1 | 2 | 4 | 8 | 1 | 2 | 2 | 4 |
| | | | May occur | 2 | | | | | | | |
| | | | Uncommon | 3 | | | | | | | |
| | | | Rare | 4 | | | | | | | |
| | First flush effect | Elevated concentrations at start of event | Expected to occur | 1 | 3 | 4 | 12 | 1 | 3 | 2 | 6 |
| | | | May occur | 2 | | | | | | | |
| | | | Uncommon | 3 | | | | | | | |
| | | | Rare | 4 | | | | | | | |
| Chemical | Elevated sodium chloride levels | Frequency of winter maintenance activities | Expected to occur | 1 | 4 | 4 | 16 | 1 | 4 | 2 | 8 |
| | | | May occur | 2 | | | | | | | |
| | | | Uncommon | 3 | | | | | | | |
| | | | Rare | 4 | | | | | | | |
| | Receiving water hardness | Concentration of $CaCO_3$/l in receiving water | <40mg/l | 1 | 2 | 4 | 8 | 1 | 2 | 2 | 4 |
| | | | 40-<100mg/l | 2 | | | | | | | |
| | | | 100-<200mg/l | 3 | | | | | | | |
| | | | >200mg/l | 4 | | | | | | | |
| Ecological | Elevated temperature in highway runoff | Change in temperature > 3°C | Expected to occur | 1 | 2 | 4 | 8 | 1 | 2 | 2 | 4 |
| | | | May occur | 2 | | | | | | | |
| | | | Uncommon | 3 | | | | | | | |
| | | | Rare | 4 | | | | | | | |
| | Physiological stresses | Sensitive species / life stages | Expected to occur | 1 | 2 | 4 | 8 | 1 | 2 | 2 | 4 |
| | | | May occur | 2 | | | | | | | |
| | | | Uncommon | 3 | | | | | | | |
| | | | Rare | 4 | | | | | | | |
| **Integrated vulnerability scores (i.e. summed weighted scores per water body)** | | | | | | | 72 | | 18 | | 36 |

**Matrix A4. The PROPER framework to support the systematic identification of receiving groundwaters vulnerable to highway traffic pollution**

| | | | | | Scenario 1: allocation of maximum score | | Scenario 2: allocation of minimum score | | Scenario 3: allocation of intermediate scores | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Water body 1 | | Water body 2 | | Water body 3 | |
| **Indicator** | **Descriptor** | **Benchmark** | **Score** | **Weighting** | **Score** | **Score x weighting** | **Score** | **Score x weighting** | **Score** | **Score x weighting** |
| Aquifer media | Substrate type | Karst / chalk | 1 | 2 | 4 | 8 | 1 | 2 | 2 | 4 |
| | | Sand / gravel | 2 | | | | | | | |
| | | Metamorphic / igneous | 3 | | | | | | | |
| | | Clay / shale | 4 | | | | | | | |
| Permeability / thickness of vadose zone | High permeability | 0 – 3.0m | 1 | 4 | 4 | 16 | 1 | 4 | 2 | 8 |
| | | >3.0m | 4 | | | | | | | |
| | Moderate permeability | 0 – 3.0m | 1 | | | | | | | |
| | | 3.0 – 10.0m | 2 | | | | | | | |
| | | >10.0m | 4 | | | | | | | |
| | Low permeability | 0 – 3.0m | 1 | | | | | | | |
| | | 3.0 – 5.0m | 2 | | | | | | | |
| | | 5.0 – 10.0m | 3 | | | | | | | |
| | | >10.0m | 4 | | | | | | | |
| **Integrated vulnerability scores (i.e. summed weighted scores per water body)** | | | | | | 24 | | 6 | | 12 |