science summary

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Accumulation and dispersal of suspended solids in watercourses

Science Summary SC020048

A novel risk assessment procedure to prioritise sites likely to be affected by highway-derived sediment is outlined in a new report. A five-year research programme jointly funded by the Highways Agency and the Environment Agency included three projects which assessed the ecological impacts of highway storm runoff,

- *Effects of insoluble pollutants on the ecology of receiving waters*
- *Improved determination of pollutants in highway runoff*
- *Effects of soluble pollutants on the ecology of receiving waters*

This project, on insoluble pollutants, identifies the scenarios under which contaminated sediment in runoff would be likely to have a negative impact on receiving-water ecology.

Key findings and recommendations of the report:

- Total mass of sediment discharged during the monitoring programme was highly variable between sites.
- The concentration of contaminants in runoff sediment samples did not vary greatly between different field sites.
- Damage to biological communities was observed downstream of some runoff outfalls and highway-derived contamination was measured in animal tissue.
- Highway-derived sediment that had accumulated in a receiving watercourse was toxic to selected invertebrates in lab tests.
- Sites at which the receiving watercourse flowed too slowly to disperse sediment were particularly prone to negative ecological impacts.

Risk assessment procedures should therefore take account of the mass of sediment discharged annually as well as the concentration of contaminants associated with that sediment. Most importantly though, the propensity of the receiving watercourse to accumulate or disperse sediment must be assessed.

In the study, the effects of sediment in runoff were investigated at six highway outfalls using both field and laboratory investigations. Native invertebrate communities were monitored upstream and downstream of each outfall. Sediment toxicity was assessed in both laboratory and field “in situ” tests with five species of aquatic invertebrate. The field sites were selected from a potential pool of approximately 1,800 known sites and were short-listed according to desirable characteristics including: a traffic flow greater than 30,000 vehicles per day, a relatively diverse watercourse community and minimal or no treatment of highway runoff. Field sites were restricted to relatively small receiving watercourses. The overall approach was to represent realistic worst case conditions. Site selection was done in 2003.

The six field sites were Penrith (M6/River Petteril), Newton Aycliffe (A1/River Skerne), Sheffield (M1/Pigeon Bridge Brook), Birmingham (M5/River Salwarpe and M42/River Arrow) and Stowmarket (A14/River Sapiston trib). Receiving watercourses at three sites were fast-flowing and dispersed sediment away from the point of discharge (M6, M5 and A14). The remaining three sites were slow-flowing and accumulated sediment. Field investigations were carried out every three months for a period of two years (2004 and 2005) and laboratory investigations were completed by the end of 2006.

As well as intensive monitoring and investigation of impacts at field sites, the inputs of sediment material and the quality of that sediment were assessed during ten storm events at each site. Properties such as contaminant loading and particle size distribution were compared between samples of storm runoff and samples of accumulated bed sediment. Rainfall and river depth/velocity were continuously monitored by data loggers at each site during 2005 and 2006.

Following the field and laboratory investigations, a risk assessment procedure for insoluble contaminants was developed in 2007. This uses predictions of contaminant concentrations resulting from a separate modelling project. (Crabtree, B. "Improved Determination of Pollutants in Highway Runoff - Phase 2: Final Report" WRc Report UC7697, 2008). Predicted sediment contamination is compared to trigger values at which toxicity is expected (derived from extensive literature review). Subsequently, the prediction of toxicity may be refined by considering local conditions that may remove toxicity (binding phases in sediment that can sequester contaminants). If sediment is predicted to be hazardous, the ability of the receiving watercourse to disperse sediment is assessed. Finally, at sites that are predicted to accumulate sediment, the potential extent of annual sediment coverage is estimated.

After designing the risk assessment procedure, it was applied to a further six field sites and the outcomes were compared to actual field conditions. These sites incorporated three watercourses that were predicted to disperse sediment (Penrith M6/Gill Beck, Leeming Bar A1/Bedale Beck and Lockerbie M74/Dryfe water) and three that were predicted to accumulate sediment (Sheffield M1/Rockley Dike, Worcester M5/Spetchley Brook and an unnamed watercourse crossing the A14 at Huntingdon).

At all sites, highway-derived particulate material was predicted to exceed the trigger values at which toxicity is expected. The risk assessment procedure successfully identified sites that dispersed and accumulated sediment. Assessment of ecological impact was complicated by the extensive flooding that occurred in 2007, and dramatic changes in the habitats at all sediment-accumulating sites were observed. Nevertheless, it proved possible to use data collected during the 2003 site selection procedure as a comparator. Overall, the sites predicted to be impacted by accumulated sediment were observed to be impacted. But some evidence of community impacts were also found at two of the dispersing sites (M6/Gill Beck and M74 Dryfe Water). Observed impacts may therefore be a result of soluble contaminants present in the water column and this highlights the need for separate assessment of soluble contamination. (reported in: Johnson, I and Crabtree, B. "Effects of Soluble Pollutants on the Ecology of Receiving Waters - Final Report" WRc Report UC7486/2, 2008).

This report is relevant to highway designers and environmental regulators responsible for the assessment, design and management of highways.

The Highways Agency's research programme (Crabtree et al, 2006) identified that some aspects of its guidance for assessing the impacts of highway runoff was based on data that may not be representative of the pollutants and concentrations currently found in highway runoff under UK conditions. The focus of the Highways Agency's ongoing research programme, in partnership with the Environment Agency, is to collect data to better understand the nature and impacts of pollutants in highway runoff.

The key aims of this research programme are to develop a model to predict pollutant concentrations in highway runoff and to develop ecologically based standards for receiving waters in order to control the impact of soluble and insoluble pollutants in highway runoff. The research outputs will be taken into consideration by the Highways Agency in future revisions of the Design Manual for Roads and Bridges, specifically HA216 *Road Drainage and the Water Environment*.

This summary relates to information from Science Project SC020048 reported in detail in the following output(s):

Science Report produced by the Highways Agency: Y91925, May 2008

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