FRMRC flood risk management research consortium

Estimating blockage potential at culvert trash screens

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The problem

- Culverts represent pinch-points in the river system which often have trash screens installed to prevent internal blockage.
- However these can be a flood hazard in themselves if not cleared and maintained at an appropriate inspection interval.
- Material delivered into the river system includes natural (organic) debris and also anthropogenic trash.

Current guidance

Trash and Security Screen Guide

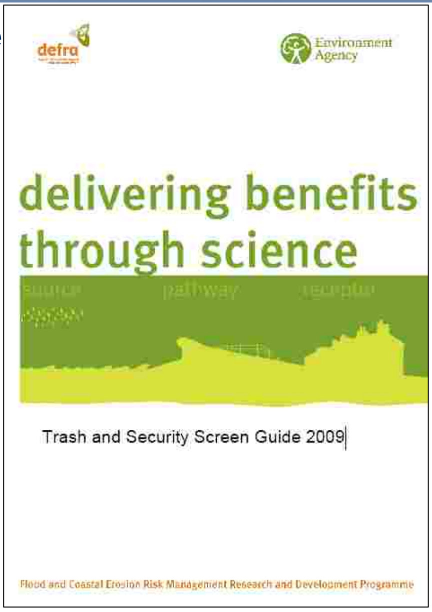
(TSSG) (EA, 2009)

<available EA website>

Culvert Design and Operation Guide

(CDOG) (CIRIA, 2010)

<commercial publication>



WP 4.1 Research Aims

Build on the current scientific knowledge base regarding trash screen blockage:

- Determine key variables driving delivery and blockage.
- Examine possible temporal trends.
- Develop potential predictive equations to estimate the:

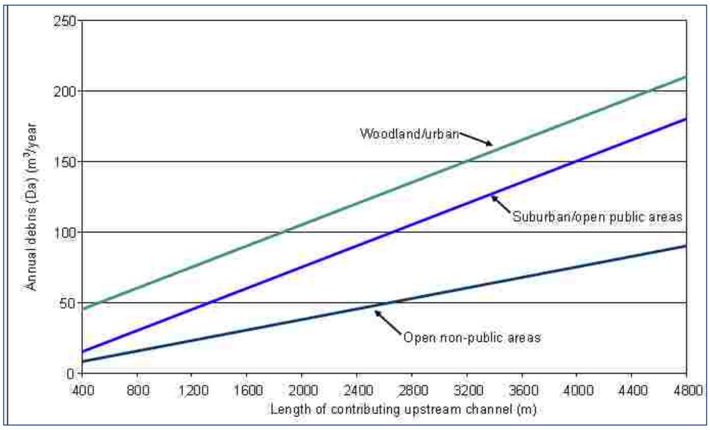
Probability of debris load delivery to screens

Potential screen area likely to block (blind)

- Assess their validity and applicability.
- Make recommendations for decision support and update best-practice guidance.

Estimating blockage extent

Current best-practice methodology for estimating potential screen blockage (CDOG and TSSG).



Analysis approach

- Used detailed inspection records (25,000 observations) from 140 screens located in Belfast (supplied by NIRA) to determined the probability of delivery of significant debris loads **(P_d)** and average screen area likely to block **(Sa_b)**.

- Related these two parameters to hypothesised driving variables using multiple regression analysis to generate predictive equations :-

P_d / Sa_b = *f* { channel, flow, (screen), landuse, social dep. } → **predictive equations**

Driving variables

SA_b= function of(NL, SL, Q, R, AG, SO, SU, U, ID, S, A)

- NL = upstream contributing river length.
- SL = upstream slope.
- Q = flow with ‘x’ year return period.
- % landuse cover:
  - R = rural
  - A = agricultural
  - SU = suburban
  - SO = suburban open
  - U = urban
- ID = income domain (social deprivation).
- S = screen bar spacing.
- A = screen angle.

Significant variables

SA_b= function of (~~L~~, SL, ~~Q~~, R, ~~AG~~, SO, SU, ~~U~~, ID, S, A)

Rank	variable
1	A
2	S
3	ID
4	R
5	SO

While the equations have weak statistical significance they have highlighted the key parameters that influences screen blockage.

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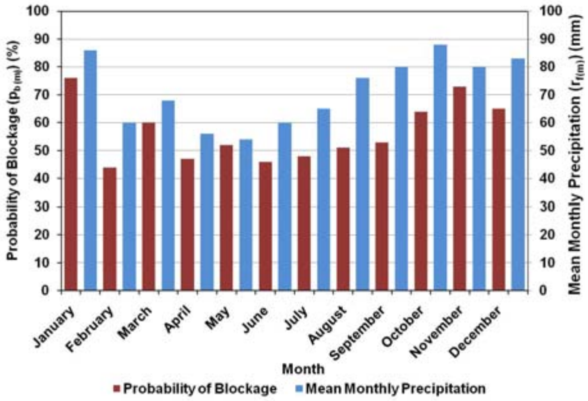
Temporal variation in blockage

Precipitation



Asset management staff should be aware that blockage extent can vary with time of year. Consequently it may be prudent to assess worst case conditions when estimating associated risk.

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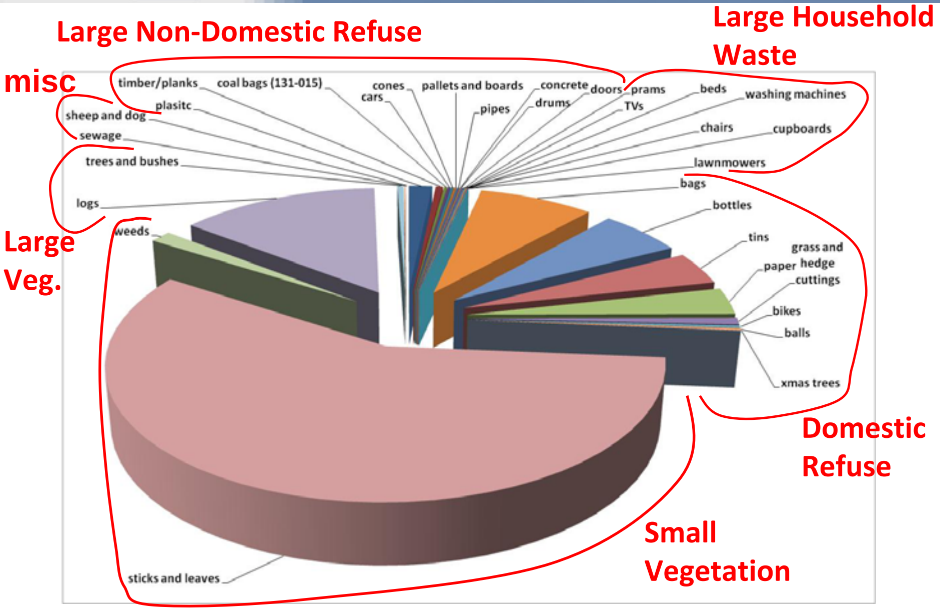
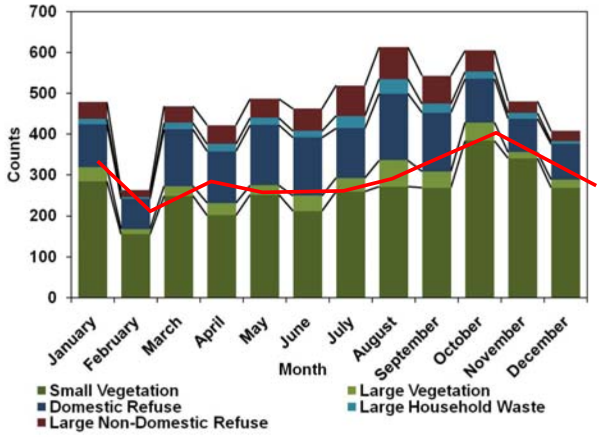
Debris composition



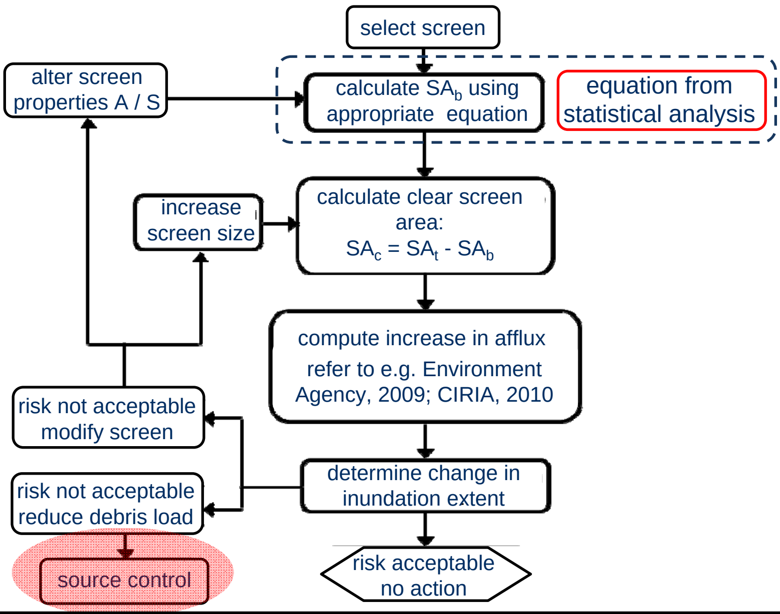
Temporal variation in blockage

Debris type



Greater loads of organic matter during autumn – compounds affect of precipitation

Scheme for decision support



Source control

• **Legislation**

• fly-tipping legislation: UK Government (1990).

• equivalent for business: ENCAMS (2006).

• Forestry Commission regulations: Forestry Commission (2003).

• EA (2007): channel-side landowner legislation.

Restriction of access

Stakeholder engagement

• stewardship schemes (education, litter clearing: need incentives).

• financial incentives for farmers to dispose of agricultural waste efficiently.

Day-lighting

Summary

- A large empirical dataset has been used to assess factors driving screen blockage.
- The probability of debris delivery and screen area likely to block were related to key driving variables using regression analysis.
- These equations have very low statistical significance but do highlight the key influencing variables.
- Screen properties had the greatest influence when considering blockage.

Summary

•The most important driver common to both measure was social deprivation which has implications for source control.

•Debris delivery and blockage was found to vary according to time of year. This may be controlled by precipitation and organic material availability.

•A scheme has been presented that forms the basis for a screen management decision support tool.

•The equations and schemes developed indicate potential approaches: they are not fit-for-purpose, and cannot be promoted as best-practice at present.

Outputs

Guidance

- **FRMRC WP4.1 Final Science Report.**
- **Technical note to accompany CDOG.**
- **Report on integration of science outputs with FRM.**
- **Report on trash screen research needs.**

Books

Wallerstein N. & Arthur S. (accepted) Trash Screens at Culverts. In: Flood Defence Design and Analysis Methods. ICE publication.

Papers

Wallerstein N. & Arthur S. (accepted) Improved methods for predicting trash delivery to culverts protected by trash screens. Journal of Flood Risk Management.

Wallerstein N. & Arthur S. (in review) A new method for predicting trash screen blockage extent. ICE Water Management.

Streftarais G., Wallerstein N., Gibson G. & Arthur S. (in review) Modeling the probability of blockage at culvert trash screens using a Bayesian approach. Water Resources Research.

Wallerstein NP. Arthur S. 2010. Improved methods for predicting trash loading at culverts and trash screens. Proceedings of the Flood and Coastal Risk Management Conference 2010. Telford. 29th June - 1st July.

Wallerstein NP. Arthur S. 2010. Development of equations for prediction of blockage at trash screens. Proceedings of First European Congress of the IAHR. Edinburgh. 4th 6th May 2010.

Wallerstein NP. Arthur S. Sisinngghi D. 2010. Towards predicting flood risk associated with debris at structures. Proceedings of the IAHR APD conference 2010. Auckland, New Zealand.

Wallerstein NP. Arthur S. Sisinngghi D. 2009. Relationship between river discharge and debris blockage at culverts with trash screens. Proceedings of the final conference of COST action C22 Urban Flood Management. Paris, France. 25th - 27th November 2009.

Acknowledgement

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