2nd Generation Asset Inspection Techniques

FRMRC / PAMS Projects Developments

Michael Wallis – HR Wallingford

- Why are inspections of flood defence assets important ?
- Why change the method/approach?
- How FRMRC work, PAMS and TE2100 projects have assisted in development of a new approach.
- The future?

Why inspect flood defence assets?

1. A primary input to the management cycle of any asset system

2. Part of a tiered suite of approaches to the assessment of the performance of assets

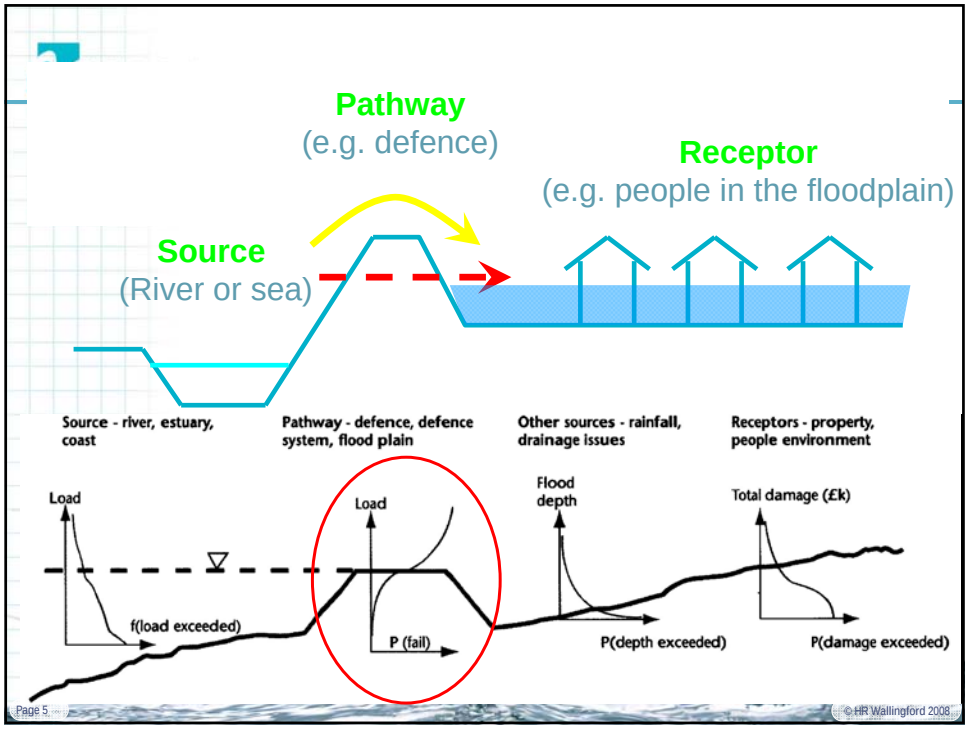
3. Condition grade is one of the parameters that influences probability of failure

Why change the approach ?

The former system:

- no explicit link of condition to likely performance*
- would not provide support to the move towards performance-focussed management of flood defence infrastructure
- could be improved to reflect best practice
- an opportunity to improve images & appendices

*Condition assessment should give information about performance of defences - condition grades are used for this purpose


Pathway
(e.g. defence)
Receptor
(e.g. people in the floodplain)
Source
(River or sea)
Source - river, estuary, coast
Pathway - defence, defence system, flood plain
Other sources - rainfall, drainage issues
Receptors - property, people environment
Load
f(load exceeded)
Load
P (fail)
Flood depth
P(depth exceeded)
Total damage (£k)
P(damage exceeded)
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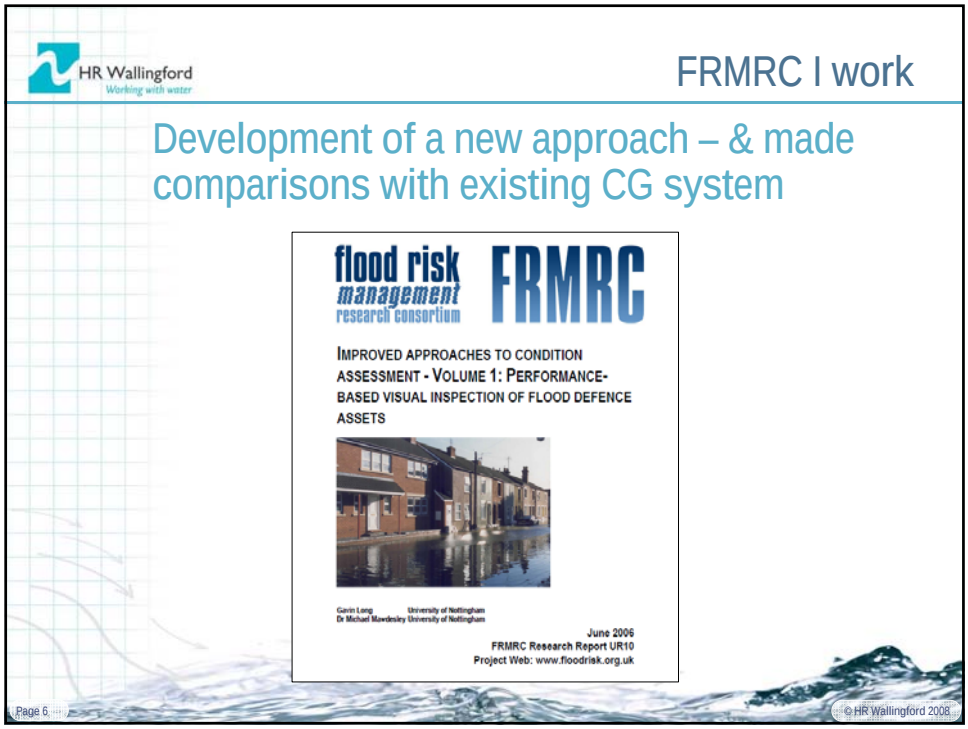
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FRMRC I work
Development of a new approach – & made comparisons with existing CG system
flood risk management research consortium
FRMRC
IMPROVED APPROACHES TO CONDITION ASSESSMENT - VOLUME 1: PERFORMANCE-BASED VISUAL INSPECTION OF FLOOD DEFENCE ASSETS
Gavin Long University of Nottingham
Dr Michael Mawdesley University of Nottingham
June 2006
FRMRC Research Report UR10
Project Web: www.floodrisk.org.uk
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FRMRC research

Looked at:

- Performance based asset monitoring and inspection
- Best practice across other industries
- Performance models & modelling for flood defence structures

The current method found not to provide required detail to produce an adequate assessment of performance

FRMRC Research

Developed a revised visual inspection method 'Condition Indexing', which provides an assessment of the asset's likely performance in terms of its flood defence function.

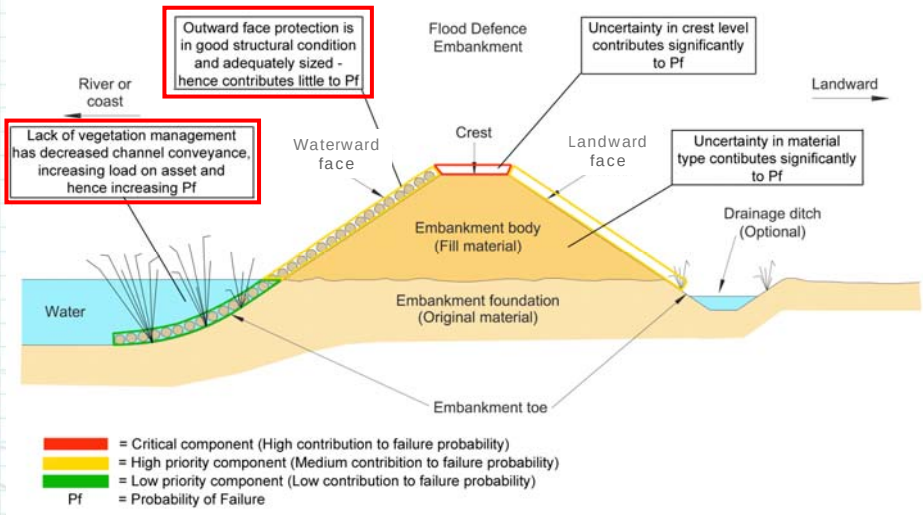
Involves:

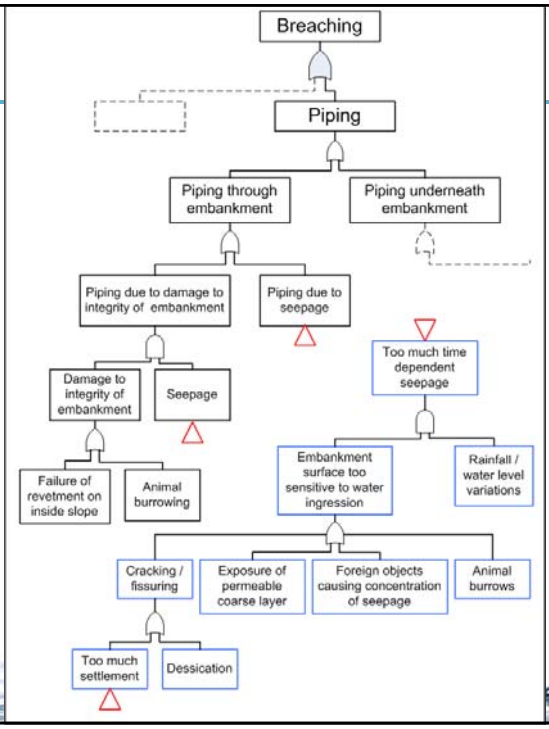
- assessment of 'performance features'
- confidence scoring associated with the assessment
- contribution of performance features to predefined failure modes (by expert judgement).

Performance features

PF's are the basis of the CI process. They represent the features of an asset to be inspected to produce the CI and must:

- be related to at least one failure mode
- be visible in order to be assessed
- be gradable visually (across the CG range)
- be mutually exclusive (ideally!)

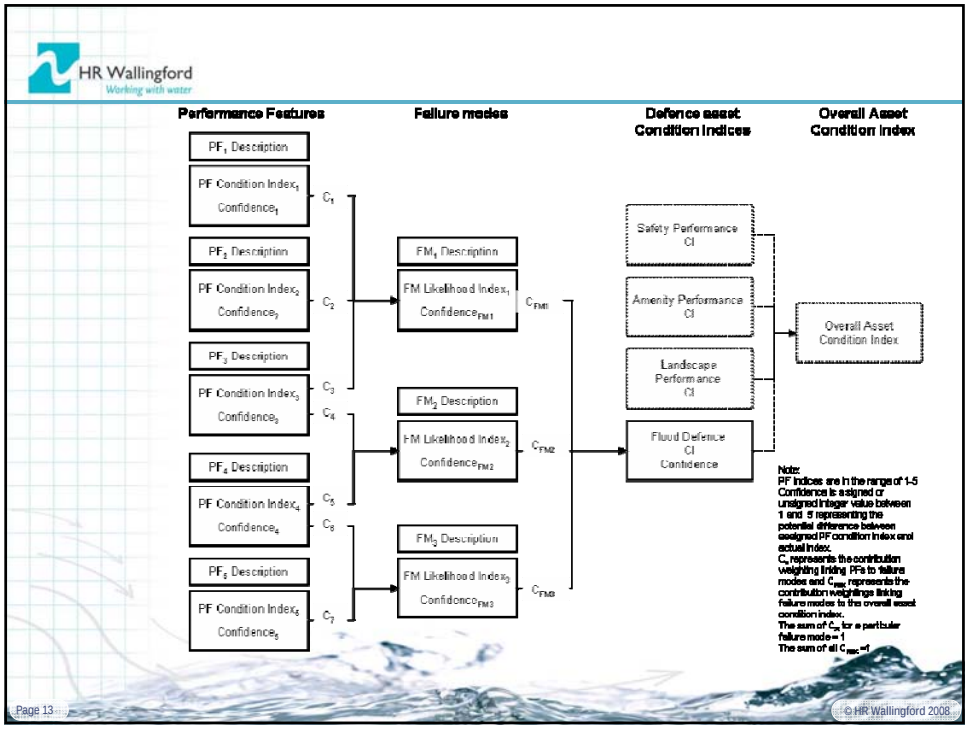




PF grading

Table 4.2 Performance feature assessment for asset component 3b (embankment)

Performance Features	Condition	Confidence	Condition Max	Condition Min
1. Animal burrowing/vermin infestation	1	0	1	1
2. Foreign objects in the crest or rear slope concentrating the erosion process	1	0	1	1
3. Cracking and /or fissuring	4	+1	5	4
4. Third party damage (cattle, vehicles etc)	1	0	1	1
5. Direct evidence of seepage or piping	1	0	1	1
6. Visible deformation of cross-section caused by slope instability	4	+1	5	4
7. Erosion of cross section	1	0	1	1
8. Vegetation condition (outer slope)	1	+1	2	1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Performance Features
Failure modes
Defence asset Condition Indices
Overall Asset Condition Index
PF1 Description
PF Condition Index1
Confidence1
C1
PF2 Description
PF Condition Index2
Confidence2
C2
PF3 Description
PF Condition Index3
Confidence3
C3
C4
PF4 Description
PF Condition Index4
Confidence4
C5
C6
PF5 Description
PF Condition Index5
Confidence5
C7
FM1 Description
FM Likelihood Index1
Confidence FM1
CFM1
FM2 Description
FM Likelihood Index2
Confidence FM2
CFM2
FM3 Description
FM Likelihood Index3
Confidence FM3
CFM3
Safety Performance CI
Amenity Performance CI
Landscape Performance CI
Fluvd Defence CI Confidence
Overall Asset Condition Index
Note:
PF indices are in the range of 1-5
Confidence is assigned or unsigned integer value between 1 and 5 representing the potential difference between assigned PF condition index and actual index.
Cm represents the contribution weighting linking PFs to failure modes and Cmac represents the contribution weightings linking failure modes to the overall asset condition index.
The sum of Cm for a particular failure mode = 1
The sum of all Cmac=1
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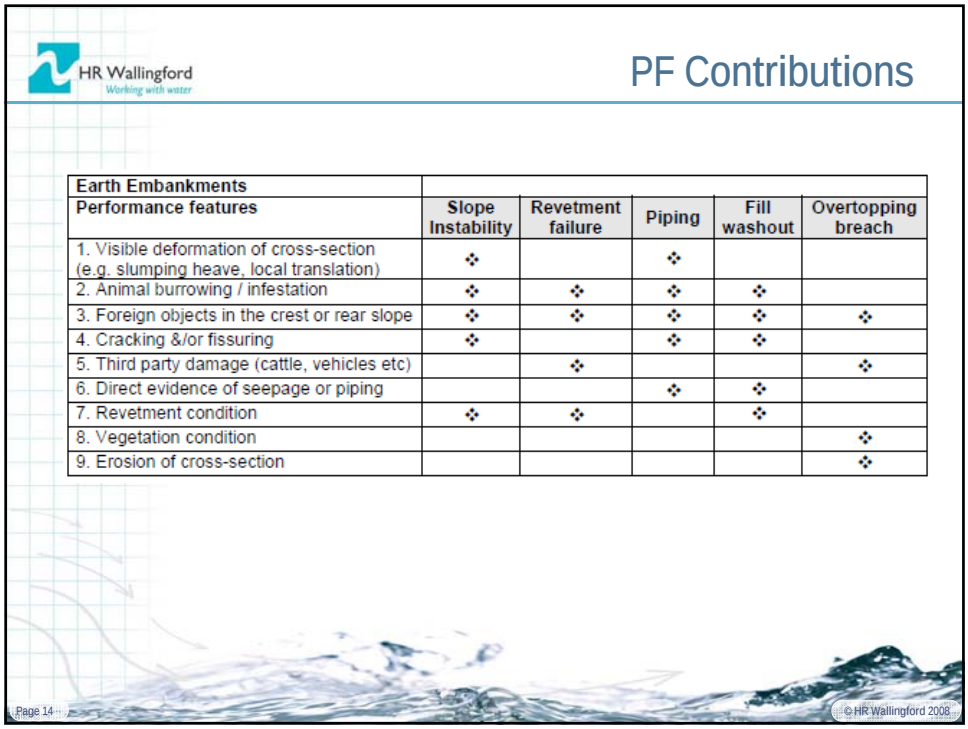
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PF Contributions
Earth Embankments
Performance features
Slope Instability
Revetment failure
Piping
Fill washout
Overtopping breach
1. Visible deformation of cross-section (e.g. slumping heave, local translation)
2. Animal burrowing / infestation
3. Foreign objects in the crest or rear slope
4. Cracking &/or fissuring
5. Third party damage (cattle, vehicles etc)
6. Direct evidence of seepage or piping
7. Revetment condition
8. Vegetation condition
9. Erosion of cross-section
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PAMS work

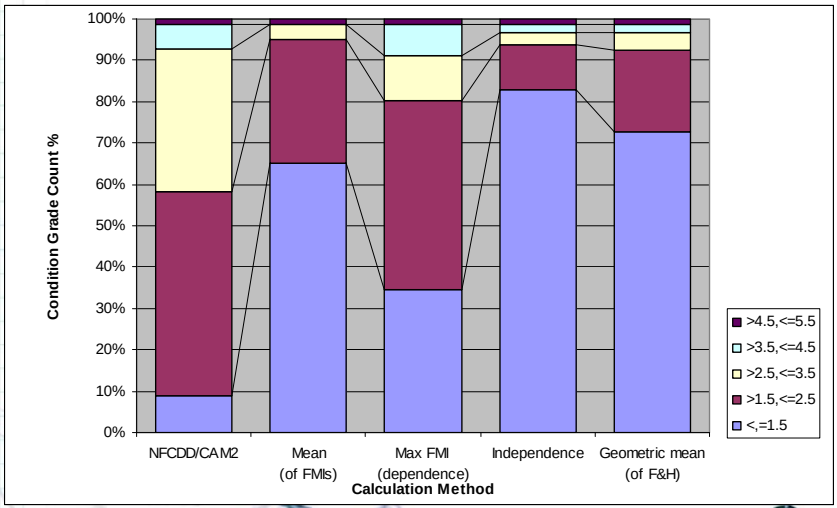
Testing of the method on different types of FD assets including;

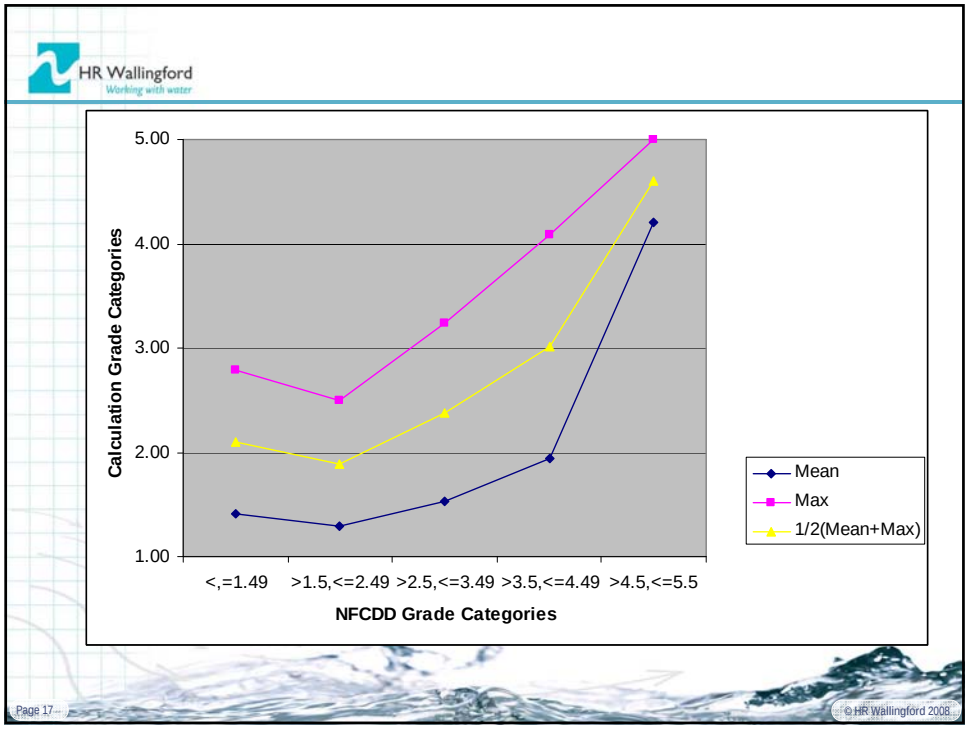
- testing and validating the method of calculating the condition grade by comparing different ways of combining the performance feature scores,
- validating the method against grades recorded in NFCDD.
- Testing of condition assessment flow charts

(157 defences)

Embankments	53	Anchored sheet piled walls	16
Earth retaining gravity walls	54	Cantilevered sheet piled walls	11
Free standing gravity walls	14	Beaches	9

Piloting results

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5.00
4.00
3.00
2.00
1.00
Calculation Grade Categories
<,=1.49
>1.5,<=2.49
>2.5,<=3.49
>3.5,<=4.49
>4.5,<=5.5
NFCDD Grade Categories
Mean
Max
1/2(Mean+Max)
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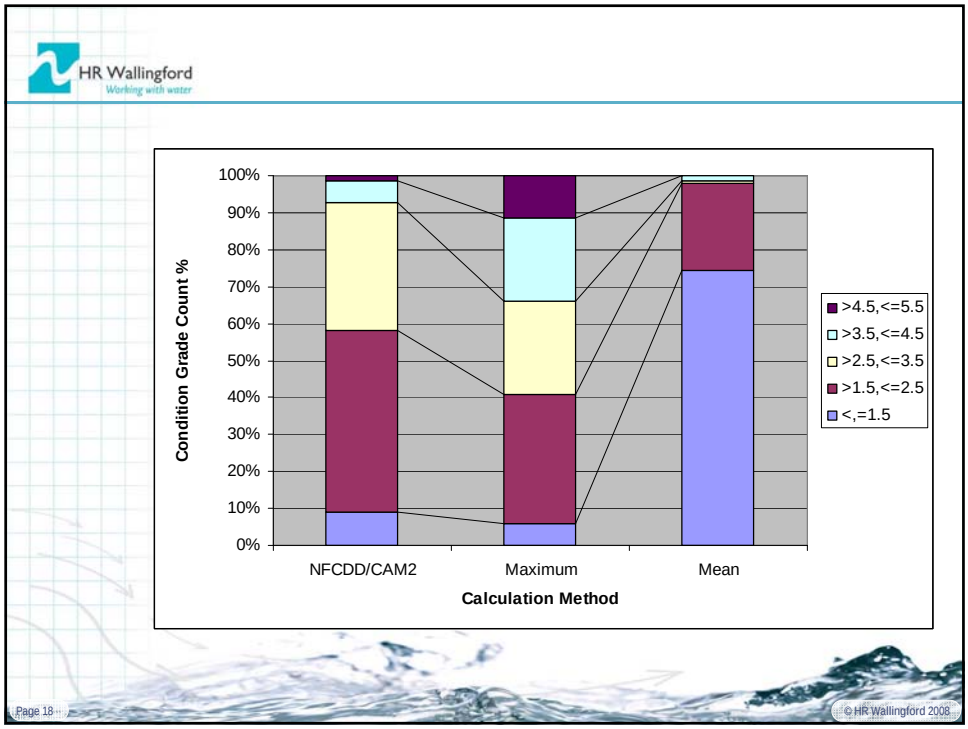
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100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Condition Grade Count %
NFCDD/CAM2
Maximum
Mean
Calculation Method
>4.5,<=5.5
>3.5,<=4.5
>2.5,<=3.5
>1.5,<=2.5
<,=1.5
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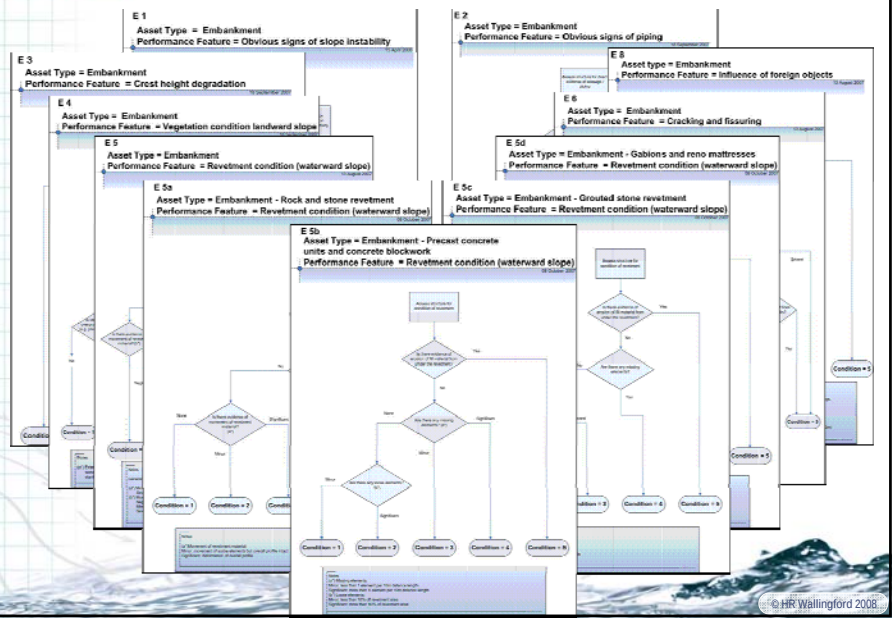
Condition assessment flow charts



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Measured Steps Forwards

Measured Steps Forward;

- Update of the CAM – images and modification of the guidance language to align with performance-based assessment.
- Introduced inspection of channels for Conveyance & Blockage into the CAM

Summary

PAMS & FRMRC work has

- reassessed visual inspection and condition grading methodology
- proposed methodological options, and tested and examined suitability
- reviewed and updated existing guidance
- made recommendations & proposed new guidance and tools for further development

Future development ?

Work on integrating visual inspection and quantitative survey measurements has been undertaken by the University of Nottingham under FRMRC SWP 4.2, and

Proposals for further developments in condition inspection will be taken forward in the Asset Performance Tools scoping. (Environment Agency report SC090038/R)

Useful links / references

Long *et al*, (2008). Asset condition assessment using visual inspection. FRMRC UFMO UR10.

Defra/Environment Agency (2009). PAMS (Performance-based Asset Management System) – Phase 2 Outcome Summary Report. SC040018/R1. Environment Agency, Rio House, Bristol.

Defra/Environment Agency (2011). Asset Performance Tools. SC090038. Environment Agency, Rio House, Bristol.

http://www.floodrisk.org.uk/