

How dangerous is that local weir?

In July 2005 Vanessa Williams tragically drowned in a weir on the Tryweryn River in North Wales while attempting to rescue her dog which had become trapped in the weir. Unfortunately, such incidents are not rare and every year people will drown in weirs in the UK.

As well as these fatalities,

By Paul O'Sullivan and Christina McKay

there are often a significant number of people who put their lives at risk attempting to rescue people and animals trapped in weirs. For example, in addition to Vanessa Williams, her partner, one off-duty fire-fighter and two on-duty fire-fighters also entered the weir to make rescue

attempts. Thus, the scale of the tragedy that day could have been much worse.

Following this incident Rescue 3 (UK) and the Environment Agency in North Wales have worked together in order to raise people's awareness of the risk presented by weirs.

Having reviewed the incident, it became apparent that there were two key issues:

- Lack of appreciation of the risk presented by weirs to members of the public, operational staff, rescue personnel and professional river users
- No tool is available to determine the level of risk a weir presents considering hydra-

ulic conditions (i.e. how dangerous is it) and the likelihood of someone coming to harm if they ended up in a weir.

The hydrology of weirs is often such that they create very strong re-circulation currents downstream of the structure below the surface, yet produce benign looking features at the water surface. There are no large

waves, spray and perhaps noise that we'd associate with white water rapids (see diagram).

Members of the public cannot be expected to appreciate that such an apparently benign feature could be potentially lethal unless we educate them to the fact.

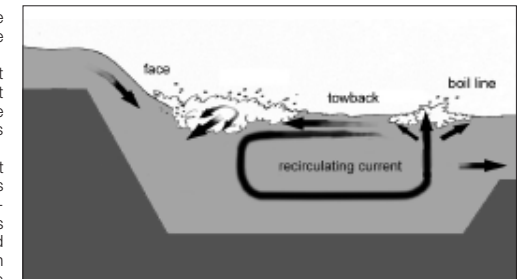
In a world of omnipresent warning signs, unless there is some base knowledge to appreciate why the warning sign exists it will potentially be ignored and seen as being the result of an overly cautious risk adverse society.

Emergency services involved in water rescue and those who operate professionally in rivers e.g rafting companies and Environment Agency operational staff also need to be educated in the potential risks weirs present.

Assessing the level of hazard, risk and difficulty of rescue from a weir will vary based upon a variety of factors including:

- The weir design and location
- The prevailing water conditions
- The nature of the river/channel upstream and downstream of the weir

The Weir Risk Assessment analyses each of these criteria in order to determine the level of risk a weir presents:



A weir in cross section reveals the hidden hazards

Water Level Considerations

As the volume of water flowing over a weir varies, so will the potential level of hazard created by the weir. At low flows the weir might only produce a weak re-circulation downstream, however, at higher flows this circulation may increase in strength.

A point may be reached where the water flow is at such a rate that the weir is 'drowned out' and no longer creates a re-circulation hazard downstream (this generally occurs at much higher flows). By risk assessing the same weir at a low, medium and high flow we are able to build

a risk profile for that weir across the full range of flows.

Weir Hazard Assessment

Knowing the hazard level that a weir presents is a key factor for anyone who needs to operate near or in a weir, be they canoeists, operational staff or rescuers. The level of hazard presented by the weir is assessed by measuring 10 key factors and scoring these on a pre-determined scale.

For example the distance of the surface tow back from the downstream boil line to the base of the weir is measured and then scored. This is repeated for all 10 factors to build up an overall hazard score for the weir. This overall score will be in a 0-40 range which is then divided into five hazard levels as shown in Table 1.

Weir Risk Assessment

While the level of hazard is an important factor, many organisations are also concerned with the level of risk which a weir will present. In order to assess risk we need to establish both the ability of a weir to cause harm (hazard) at a given water level and the chance of this harm occurring (likelihood) Table 2.



This is Weir X where Vanessa Williams drowned. It looks benign but hides dangerous currents

A weir is an overflow-type dam generally built in an open channel as a sloping or vertical wall/plate. It is used to raise the level of a river or stream, often to aid in the measurement of flow. As water flows over the drop it accelerates increasing water velocity immediately downstream of the drop. To reduce the impact of this acceleration and the potential for erosion, a basin is often constructed downstream of the weir. The stilling basin can generate re-circulation currents and/or a standing wave to reduce velocity.

This re-circulation can at times have sufficient power to trap people should they enter the weir. Unlike natural drops in rivers, weirs can be designed to be both very efficient and uniform, both of which can increase their ability to trap debris, including people.

Table 1 Weir Hazard Level

Hazard Score	0-10	11-15	16-20	21-30	31-40
Hazard Level	Very Low (1)	Low (2)	Medium (3)	High (4)	Very High (5)

Weir safety

How safe is that weir?

Table 2 Weir Likelihood of Causing Harm Level

Likelihood Score	0-1	>1-2	>2-3	>3-4	>4-5
Likelihood Level	Very Unlikely (1)	Unlikely (2)	Likely (3)	Very Likely (4)	Almost Certain (5)

Table 3 Weir Risk Rating

Hazard	1	2	3	4	5
Likelihood	Very low	Low	Medium	High	Very high
1 Very unlikely	1	2	3	4	5
2 Unlikely	2	4	6	8	10
3 Likely	3	6	9	12	15
4 Very Likely	4	8	12	16	20
5 Almost certain	5	10	15	20	25

Score	Priority	Action
1 - 5	LOW	Action required to reduce the risk, although low priority. Time, effort and cost should be proportional to the risk.
6 - 10	MEDIUM	Action required soon to control. Interim measures may be necessary in the short term.
12 - 25	HIGH	Action required to control the risks. Further resources may be needed.

The hazard level is scored as explained above. Likelihood is calculated using a different set of criteria. These factors focus on the amount of public/professional access to the weir from both land and water and any existing control measures in place. These factors are measured and scored to produce a 'likelihood of caus-

Table 4 Weir Rescue Difficulty Level

Rescue Difficulty Score	<20	20-25	>25
Rescue Difficulty Level	Low (1)	Medium (2)	High (3)

matrix can be used to obtain a 0-25 risk score for the weir (see Table 3). This then produces a

allow rescuers to assess the level of difficulty to undertake such an

operation. A series of criteria which determine the complexity of a rescue e.g. level of access to banks, shape of the weir etc, are assessed and scored. This produces a rescue difficulty score for the weir categorised as: Low, medium and high as in Table 4:

Implementation

The risk assessment was initially tested on numerous weirs on the Rivers Dee, Trent and Thames in 2006/7. Application and development of the system since then by Rescue 3(UK) and the Environment Agency in North Wales and a number of fire and rescue services is producing excellent results. It is proving to be both a useful tool for developing risk profiles for weirs across a full range of river flows and determining comparative level of risk between weirs. Fire and rescue service feedback has confirmed that the system is an excellent foundation upon which they can develop operational pre-plans and make pre-determined attendance decisions.

The assessment document is available for download at: www.rescue3.co.uk

- Paul O'Sullivan is managing director of Rescue 3 (UK) based at the National Whitewater Centre, North Wales. Rescue 3 (UK) is the country's leading swiftwater and flood rescue training provider. www.rescue3.co.uk

Christina McKay is the North Wales team leader for hydro-metry and telemetry with Environment Agency Wales which is responsible for protecting communities from the risk of flooding and managing water resources. www.environment-agency.gov.uk

The system is an excellent foundation upon which to develop operational pre-plans

ing harm' score of between 0 and 5 which is then transferred to a likelihood level as shown above:

Once levels have been established for 'Hazard' and 'Likelihood of Causing Harm' a standard hazard x likelihood risk

low, medium or high risk rating for the weir at a particular flow.

Rescue Difficulty Assessment

Due to the potential risks to personnel undertaking rescues from weirs, it was decided to incorporate a tool that would

RoSPA conference workshop

Paul and Christina are delivering a Weir Risk Assessment workshop at the RoSPA national water safety conference in Cardiff on November 9. This workshop will look at the risks presented by weirs, explain the Environment Agency/Rescue 3 (UK) Weir Assessment System and will include a site visit for practical application of the risk assessment. For more information see www.rospa.com/events