# Reducing Uncertainty in Initial PICs with Simple Hydraulic Models

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## Background

The introduction of the 2022 Dam Safety Regulations has required initial Potential Impact Classification (PIC) assessments for small to medium-sized irrigation and municipal dams.

Traditionally, these assessments have relied on qualitative evaluations based on engineering judgement of likely breach flow paths, derived from on-site observations or desktop topographic analysis.

Without some form of quantitative validation, there is a risk that these qualitatively estimated breach paths could exclude crucial assets from a consequence assessment, resulting in “false negative” classifications, where medium or high consequence dams are incorrectly classified as low.

To reduce the possibility of false negative classification, we propose simple hydraulic dam breach models be used as a validation tool to ensure initial PIC assessments are based on representative qualitative breach flow paths.

## Objective

- Initial PIC assessments play a crucial role in dam safety, yet conventional qualitative approaches may lack the necessary rigor to reliably determine breach flow paths, particularly in areas with complex downstream conditions.
- This poster explores how simple hydraulic models can be used as a validation tool to enhance the accuracy of engineering judgment in initial PIC assessments, reducing uncertainty and minimizing the risk of misclassification.

## Model Setup

- Fig 1. shows the setup of a simple hydraulic model in HEC-RAS using an inflow boundary condition representing dam breach flows into a 2D mesh area downstream.
- The model is not intended as a definitive output to inform consequence assessments. Instead, it should be used as a check to ensure an engineer’s qualitative estimate of the inundation is appropriate.

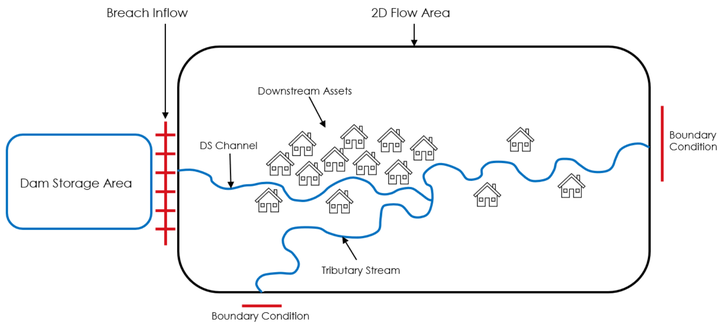


**Fig 1.** Simplified Schematic of Model.

## Dam Breach Hydrograph

- Rather than breaching the model directly in HEC-RAS, an inflow hydrograph for the model is constructed using widely known empirical formulas outlined in HR Wallingford (2018) to determine breach characteristics (Fig 2.).
- Hydraulic routing of the breach is estimated using the derived characteristics, and physically based weir and orifice equations.
- This process can be easily automated, enabling fast preparation of the hydrograph and model as is necessary for initial assessments.

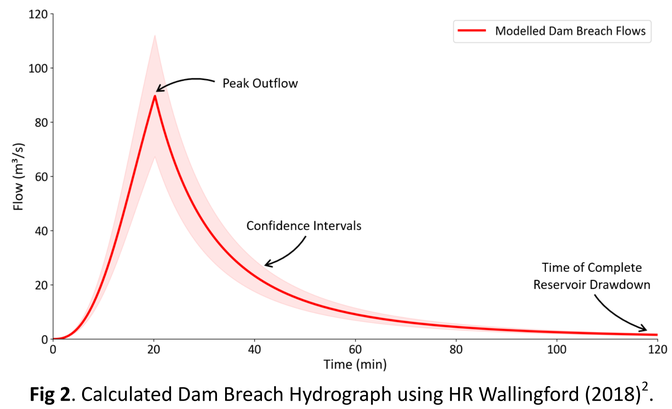


**Fig 2**. Calculated Dam Breach Hydrograph using HR Wallingford (2018)[2].

## Simulation & Results

### Simulation

- The model is built using bare earth DEM LiDAR to represent the topography downstream from the dam. Approximately 80% of NZ has publicly available LiDAR (Fig 3.).
- The developed breach hydrograph is simulated over the topography.
- Assumptions of a default Manning’s n and computationally efficient time steps are used to ensure efficiency and conservatism.
- Should intermediate or comprehensive modelling be required, the simple model can be adapted and refined.

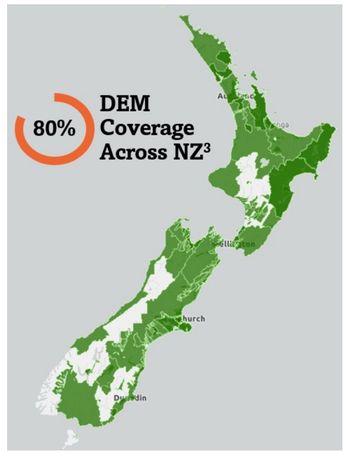


**Fig 3.** 2024 LINZ LiDAR Coverage of NZ[3].

### Results

Fig 4. shows a representative case where a simple breach model highlights potential misclassification. For small irrigation dams located on complex flow topographies such as the Canterbury Plains, unvalidated qualitative estimates can be unreliable.

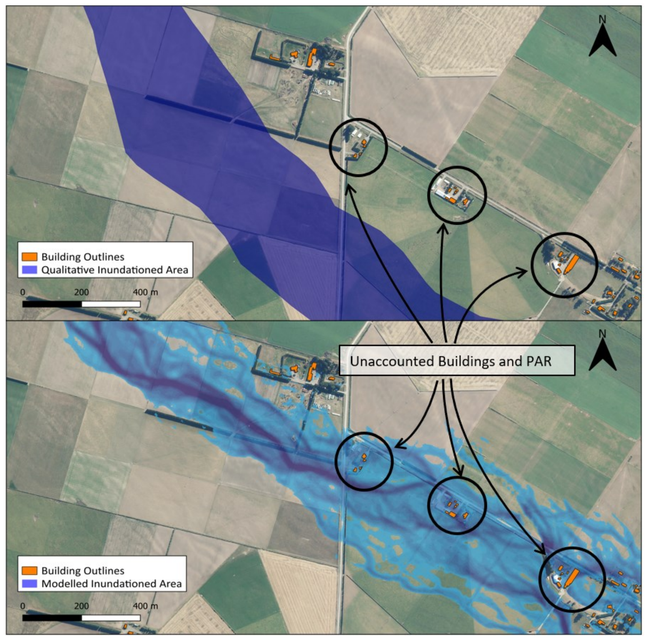


**Fig 4.** Example qualitative inundation estimation (above) vs inundation area using a slimmed down model (below) for an initial PIC.

- The simple hydraulic model using 1 m resolution LiDAR shows that the qualitative flow estimate, which is based on 20 m topo map contours, misses several potentially impacted buildings.
- This result suggests that an initial assessment is insufficient, and further detailed modelling should be conducted to quantify the depth and velocity hazard posed to the downstream community.

## Conclusions & Limitations

- NZSOLD and MBIE guidance for qualitative initial assessments do not provide instruction for semi-quantitative validation and instead advocate user caution.
- Without validation, there is a risk of false “negative” classifications, where medium or high consequence dams are incorrectly classified as low.
- High-level breach models can be used as a validation of engineering judgement in initial assessments without sacrificing time and cost to small dam owners.
- This model is semi-quantitative and is only intended to serve as a validation check on qualitative initial assessments. If results suggest complex downstream conditions, intermediate/comprehensive assessments should be completed.

## References

1. NZ Government (2022). *Building (Dam Safety) Regulations 2022.*
2. HR Wallingford (2018). *A Guide to Breach Prediction*.
3. LINZ (2024). *NZ LiDAR Elevation Availability*.