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The study of cooling water discharge into British Waterways canal

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Aim

To develop a 3D interactive mathematical model to ensure safe and effective use of a natural resource.



The problem

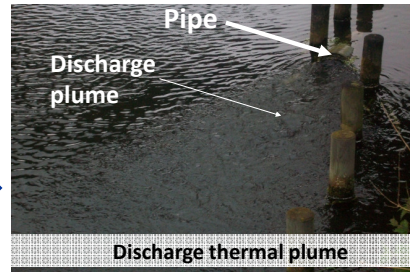
Excessive increase in ambient water temperature reduces the dissolved oxygen in the water which threatens aquatic life.

Advantages of British Waterways canal water cooling system

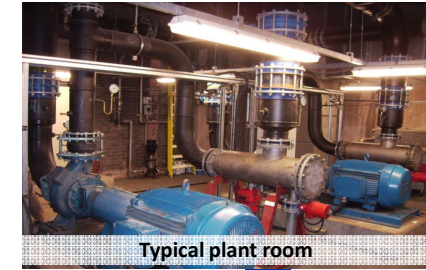
- Using British Waterways canals for cooling systems can save **£100 million** on energy bills
- Reduce carbon emissions by **one million tonnes**.



Cooling water discharge into British Waterways canal



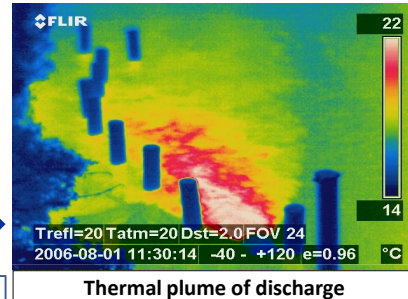
What size is the plume?



Cooling water discharge into British Waterways canal



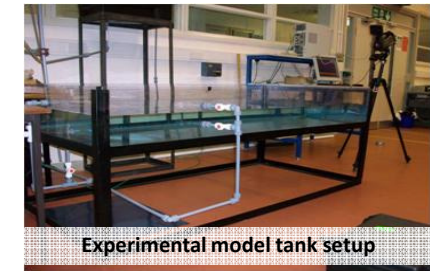
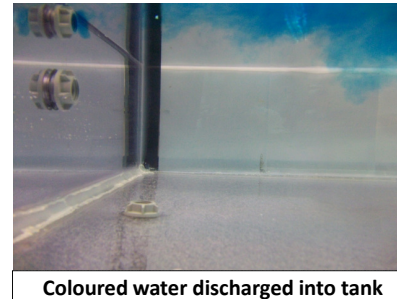
Thermal camera used to predict the heat distribution on the surface



On-site measurements

Laboratory Testing

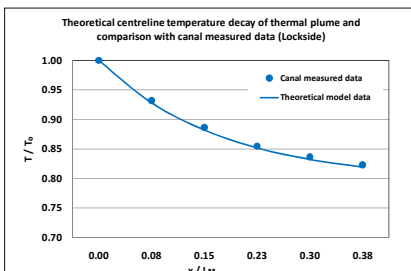
Combine



Coloured water shows the vertical extension of the plume

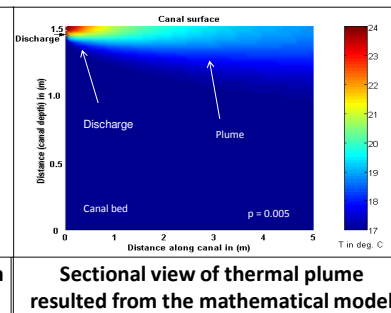
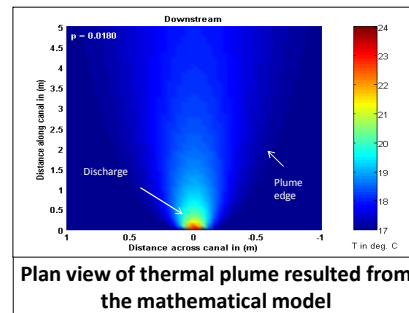
Results

The final predictive model has been applied to existing canal sites where the results compare very favourably with the measured on-site results. It is now complete for national use on canal waters and lakes.



$$T(x, y) = \left(\frac{T_0 - T_a}{2} \right) \left(\operatorname{erf} \frac{b - z}{2 \sqrt{p_1 \cdot x}} + \operatorname{erf} \frac{b + z}{2 \sqrt{p_1 \cdot x}} \right) + T_a$$

T₀, T_a: Discharge and Ambient Temperature, b: Nozzle Radius, z: Depth, p₁: (U)velocity/(D)Turbulent Diffusivity



Conclusion

The work results in an interactive model that can be used to maximise use of canal water and lakes without prejudice to aquatic life. Environmental Agency approval is now being sought for its use on a national scale.

