Todmorden Flood Alleviation Scheme

As part of the Todmorden Flood Alleviation Scheme (FAS) it is proposed to build storage basins to safely contain flood water during periods of excessively high river flow. During storm conditions when the river flow rate exceeds a certain value, part of the flow will be diverted into these basins. This reduces the flow rate further downstream, increasing the capacity of the river to cope with further inflow and reducing the risk of flooding to properties and services downstream. When the river flow returns to normal, the storage tanks can be emptied at a controlled rate back into the river to ready the facility for the next storm.
The project is part of a major scheme undertaken by a number of contractors including Halcrow for the Environment Agency, with a total capital cost of £41 Million. Further details on the scheme are available on the module web site (www.efm.leeds.ac.uk/CIVE/FluidsLevel1/CaseStudies)

Design Brief

The design of these storage areas forms a major part of the capital cost of the project and is crucial to the success of the FAS. Two sites have been identified, Centre Vale Park and Millwood.

Site 1: Centre Vale Park

The location of the basin is Centre Vale Park park, just next to the River Calder just upstream of the Todmorden town centre, as shown in Figure 1. River flow above the flood condition will automatically trigger a pen-stock gate to open that diverts part of the river flow down a culvert to the inlet structure and into the park.

The maximum level in the park must not exceed 127.4 mAOD. The usable area of the park is 13500m^2, of which 2500m^2 forms a stilling basin: an area which floods initially and ensures that the flow into the rest of the storage area is in a controlled manner. In the stilling basin the ground level is 126.0 mAOD. There is a weir of height 1.05 m above the bed of the stilling basin. On the downstream side of the weir the level in the park is 127.0mAOD. The park then drops in level to 126.65m at the outlet pipe of diameter 900mm. At the downstream end of the outlet pipe is a flap gate.

The inlet structure has allows flow into the park through two culverts of area 0.656m^2 each. For design purposes a constant inflow of 3.61m^3/s can be used to determine the time required to fill the storage area.

Using the geographical and flow data given above you are required to determine the following aspects to allow geotechnical and structural engineers to draw up a detailed design:

1. The maximum velocity into the stilling basin cannot exceed 3.0m/s. Is this satisfied by the above design figures?
2. At the far side of the stilling basin the width is 35m. What will the velocity have reduced to at this point assuming maximum depth?
3. How long will the stilling basin take to fill?
4. How long will the whole park take to fill?
5. How long will the park take to empty assuming a velocity in the pipe of 0.5m/s?
6. If the river level just covers the outlet flap gate, and the level in the park is 1.0m above the top of the gate, will this cause the gate to open if there is closing moment on the gate of 500Nm?

Figure 1: Centre Vale Park

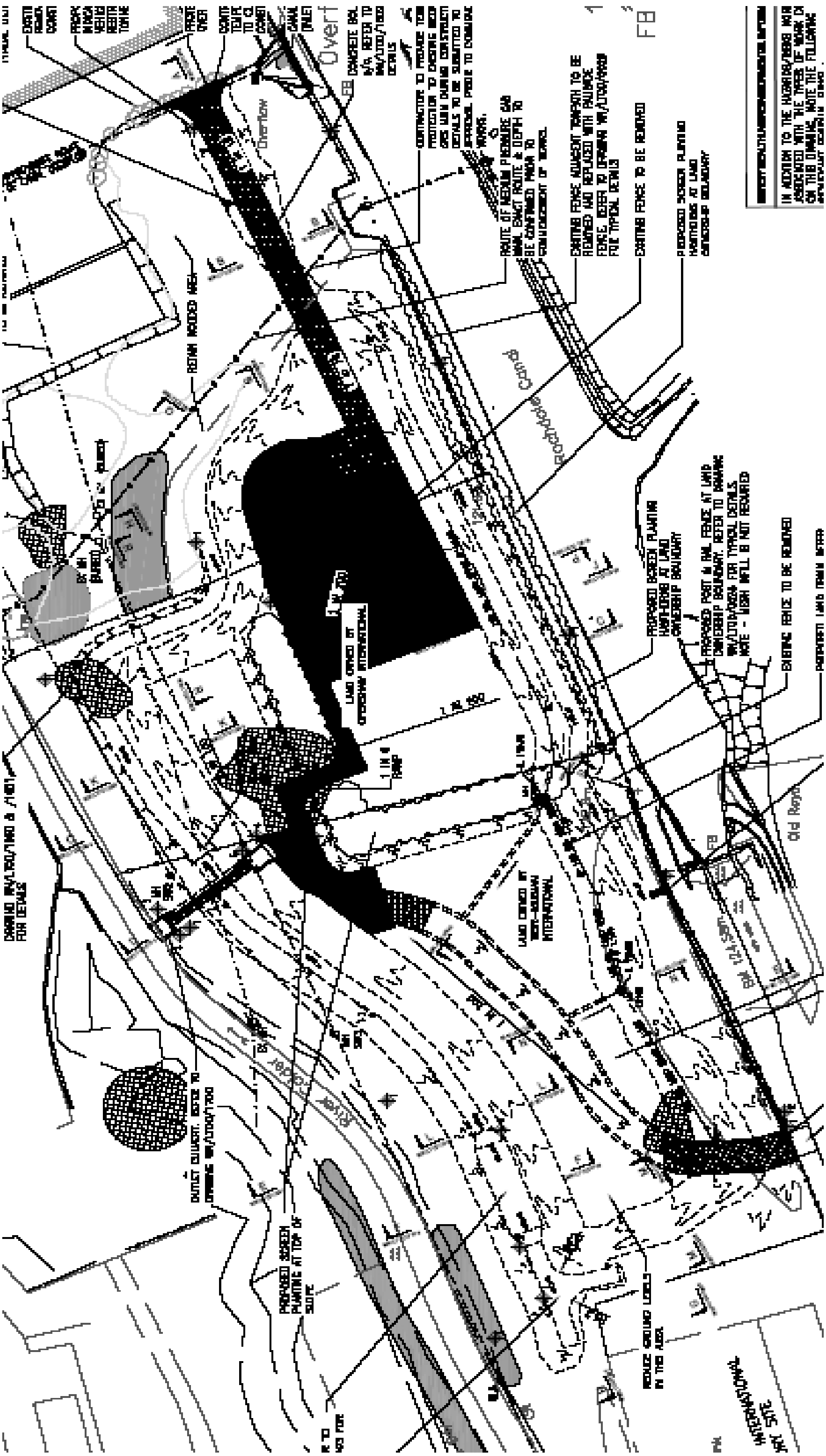
Site 2: Millwood

The location of Millwood is just downstream of Todmorden town centre, see Figure 2, but near an area of industrial units which have often flooded in the past.

The Millwood storage area covers an area of 4000m^2. It has 3 levels, 10% has a level of 102.0mAOD, 20% has a level of 101.0mAOD and the rest is at 100.0mAOD. Water enters this storage area when the river level exceeds the height of an inflow weir. The crest of the inflow weir is at 104.0mAOD. A flow rate of 162 litres/s may be used for design purposes. Outflow is via a single 900m diameter pipe at a level of 100mAOD, the downstream end of this is fitted with a flap gate to prevent back flow from the river.

1. Is the volume sufficient to store a 1 in 10 year event of volume 13500m^3?
2. How long will the area take to fill?
3. To prevent erosion on the bank of the inlet weir the velocity of flow entering the storage area must be less than 0.8m/s. If the flood level for the design flow is expected to be 15cm above the weir, using continuity, what will be the minimum length of weir to ensure the velocity is within the design criteria.
4. What is the moment on the flap gate when the level in the storage area is a maximum and the river is below the gate?
5. Assuming an outflow velocity of 0.6m/s how long will it take to empty?

Figure 2


Overflow
Rochdale Canal
LAND OWNED BY OPENSHAW INTERNATIONAL
1 IN 500
EXISTING FENCE TO BE REMOVED
Old Royd