

Government of Guyana
Task Force for Infrastructure Rehabilitation

Conservancy Flood Management Modelling
Model Update Report
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1. Introduction

Discharge measurements were made by Hydromet in the approach channel to Land of Canaan Sluice in June 2005. Measurements were made 100 feet upstream of the sluice and at 1000 feet upstream of the sluice, indicating discharges of 21.72 m³/s and 25.74 m³/s respectively. The observed water level was 16.88 ft (55.38 ft GD). At the time of the measurements, the gates at Land of Canaan sluice were fully open and the downstream water level would have been of the order of 16.40 m GD (53.8 ft GD) based on tidal forecasts.

The Land of Canaan gate rating table prepared for the May 2005 modelling report indicated a discharge of the order of 45 m³/s with an upstream level of 16.88 m GD and a downstream level of 16.40 m GD. The two discharge measurements made by Hydromet are consistent, and it was considered that the most likely reason for the difference between these measurements and the discharge predicted by the gate rating table was an inaccuracy in the sill level for the sluice. The sill level originally used in the gate rating table had been determined during a field visit in November 2003.

Following identification of the discrepancy between the measured and predicted discharges at Land of Canaan, E&A Consultants carried out a level survey in August 2005 to determine the sill level of the sluice. The sill level was confirmed to be 16.07 m GD (52.73 ft GD). The level previously reported was 15.804 m GD (51.85 ft GD). The discharge capacity of the Land of Canaan sluice is therefore lower than was represented in the hydrodynamic model of the EDC set up in May 2005. This brief report outlines the implications of a change in sill level at Land of Canaan sluice on flood management in the EDC, and should lead to refinement of the procedures set up in May / June 2005. Continued refinement of models is essential as improved data becomes available.

2. The Revised Land of Canaan Gate Rating

A revised rating table for the Land of Canaan sluice has been prepared and is presented in Table 1. Figure 1 presents a comparison of the revised rating with that used previously. The coefficient of discharge on the rating had to be reduced to a value of 1.4 to re-produce the measured discharge with an upstream level of 16.88 m GD. It would clearly be very useful to have further discharge measurements at higher stage, but with the information available it was considered most appropriate to pass the rating through the observed discharge point.

Discharge through Land of Canaan sluice at any water level is lower than had been modelled previously. The impact of this will be a higher water level response to any given set of inflows to the conservancy than had been modelled previously. The impact is less significant at high water levels than at low water levels. The revised rating table produces a discharge of about 25.7 m³/s for the upstream level of 16.88 m GD.

3. Refinement of EDC Spill Characteristics for January 2005 Flood

In refining the model, the opportunity was taken to refine the spill characteristics for the January 2005 flood. The EDC embankment level distribution is shown in Figure 2. In modelling embankment spill in May 2005, a single equivalent weir was used to represent that portion of the embankment below the January 2005 flood level. This has now been modified

and a composite rating table has been produced that represents the level distribution below the January 2005 flood level in four sections, each of which is 1500 m long. The composite rating produced is given in Table 2.

Table 1
Revised rating table for Land of Canaan sluice

WL u/s	WL d/s																
	15.6	15.7	15.8	15.9	16	16.1	16.2	16.3	16.4	16.5	16.6	16.7	16.8	16.9	17	17.1	17.2
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.1	0.19	0.19	0.19	0.19	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.2	1.84	1.84	1.84	1.84	1.84	1.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.3	4.38	4.38	4.38	4.38	4.38	4.38	4.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.4	7.56	7.56	7.56	7.56	7.56	7.56	7.56	5.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.5	11.27	11.27	11.27	11.27	11.27	11.27	11.27	11.27	7.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.6	15.44	15.44	15.44	15.44	15.44	15.44	15.44	15.44	15.44	9.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.7	20.02	20.02	20.02	20.02	20.02	20.02	20.02	20.02	20.02	14.56	11.35	0.00	0.00	0.00	0.00	0.00	0.00
16.8	24.99	24.99	24.99	24.99	24.99	24.99	24.99	24.99	24.99	24.99	24.99	17.26	13.42	0.00	0.00	0.00	0.00
16.9	30.31	30.31	30.31	30.31	30.31	30.31	30.31	30.31	30.31	30.31	30.31	30.31	20.00	15.52	0.00	0.00	0.00
17	35.97	35.97	35.97	35.97	35.97	35.97	35.97	35.97	35.97	35.97	35.97	35.97	26.30	22.78	17.64	0.00	0.00
17.1	41.94	41.94	41.94	41.94	41.94	41.94	41.94	41.94	41.94	41.94	41.94	41.94	29.59	25.59	19.80	0.00	0.00
17.2	48.20	48.20	48.20	48.20	48.20	48.20	48.20	48.20	48.20	48.20	48.20	48.20	48.20	32.91	28.43	21.97	0.00
17.3	54.75	54.75	54.75	54.75	54.75	54.75	54.75	54.75	54.75	54.75	54.75	54.75	54.75	40.14	36.27	31.30	24.18
17.4	61.57	61.57	61.57	61.57	61.57	61.57	61.57	61.57	61.57	61.57	61.57	61.57	61.57	43.92	39.66	34.20	27.00
17.5	68.66	68.66	68.66	68.66	68.66	68.66	68.66	68.66	68.66	68.66	68.66	68.66	68.66	68.66	68.66	68.66	68.66
17.6	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00	76.00
17.7	83.58	83.58	83.58	83.58	83.58	83.58	83.58	83.58	83.58	83.58	83.58	83.58	83.58	83.58	83.58	83.58	83.58
17.8	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39
17.9	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44	99.44
18	107.71	107.71	107.71	107.71	107.71	107.71	107.71	107.71	107.71	107.71	107.71	107.71	107.71	107.71	107.71	107.71	107.71
18.1	116.20	116.20	116.20	116.20	116.20	116.20	116.20	116.20	116.20	116.20	116.20	116.20	116.20	116.20	116.20	116.20	116.20
18.2	124.90	124.90	124.90	124.90	124.90	124.90	124.90	124.90	124.90	124.90	124.90	124.90	124.90	124.90	124.90	124.90	124.90
18.3	133.81	133.81	133.81	133.81	133.81	133.81	133.81	133.81	133.81	133.81	133.81	133.81	133.81	133.81	133.81	133.81	133.81
18.4	142.92	142.92	142.92	142.92	142.92	142.92	142.92	142.92	142.92	142.92	142.92	142.92	142.92	142.92	142.92	142.92	142.92
18.5	152.22	152.22	152.22	152.22	152.22	152.22	152.22	152.22	152.22	152.22	152.22	152.22	152.22	152.22	152.22	152.22	152.22

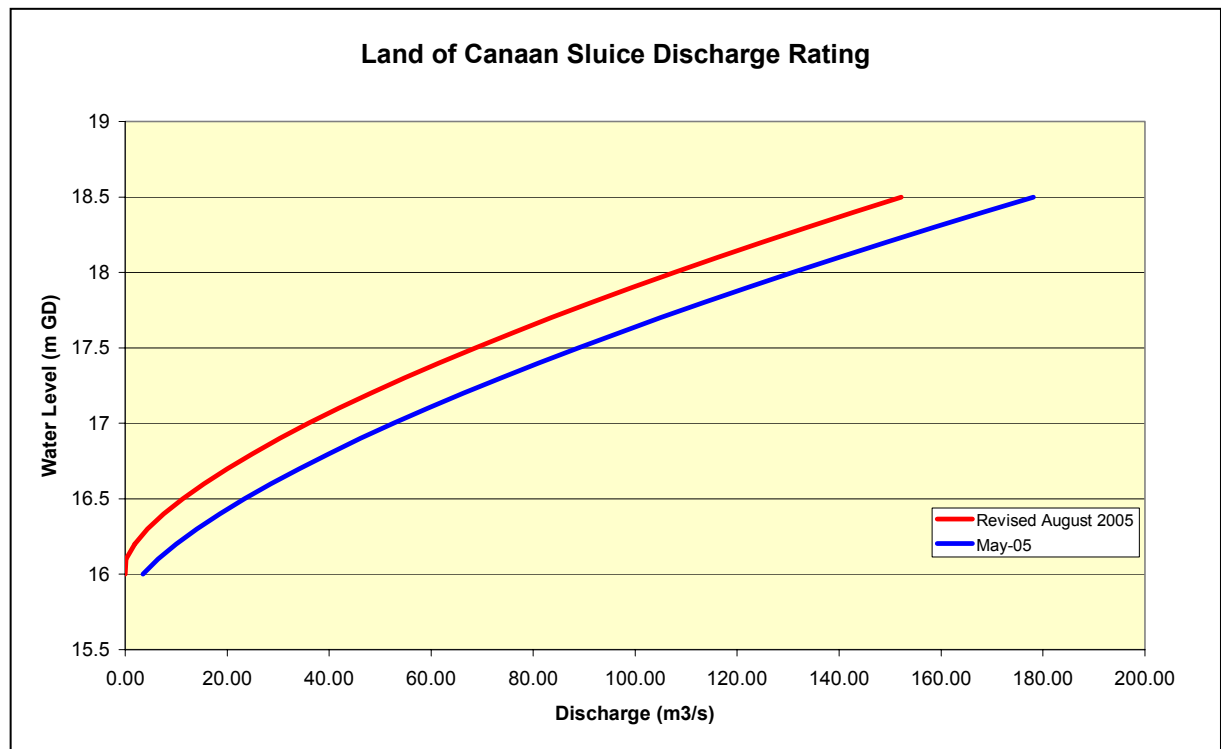


Figure 1 Revised discharge rating for Land of Canaan sluice

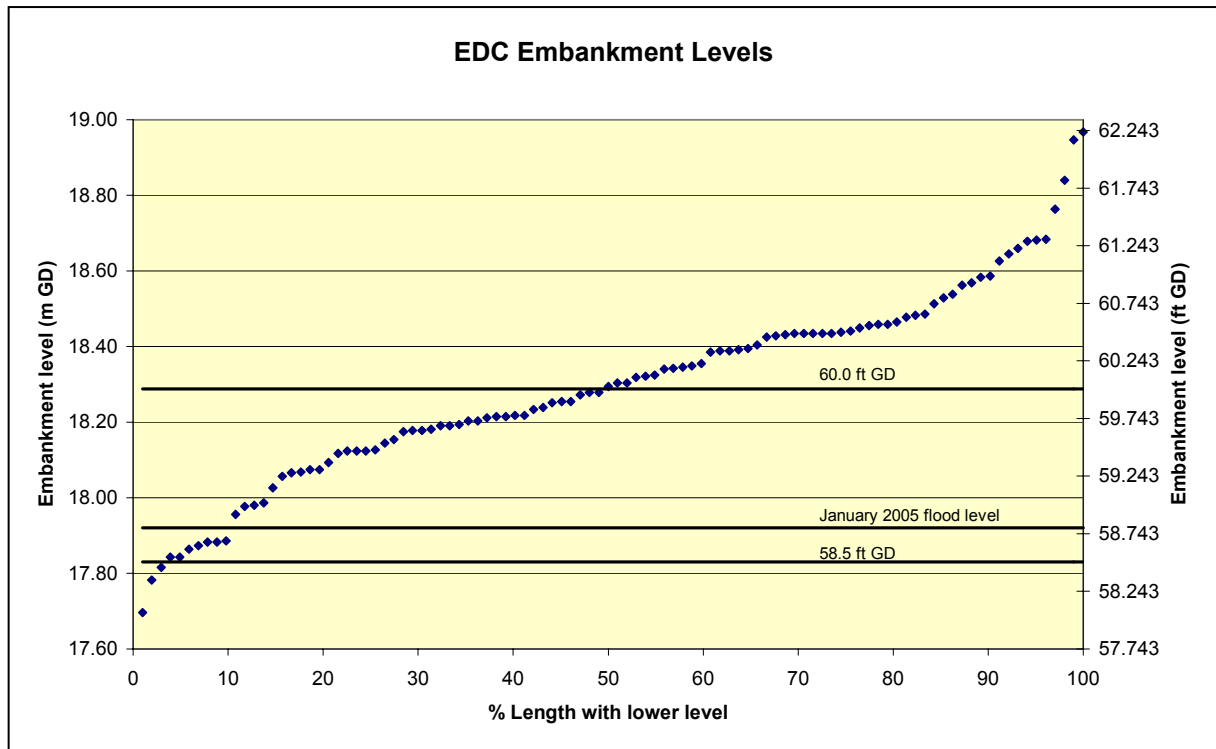


Figure 2 EDC embankment crest levels post January 2005 flood

Table 2
EDC embankment spill rating table for January 2005 flood

WL u/s	WL d/s																	
	15.6	15.7	15.8	15.9	16	16.1	16.2	16.3	16.4	16.5	16.6	16.7	16.8	16.9	17	17.1	17.2	
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.8	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
17.9	82.80	82.80	82.80	82.80	82.80	82.80	82.80	82.80	82.80	82.80	82.80	82.80	82.80	82.80	82.80	82.80	82.80	82.80
18	307.33	307.33	307.33	307.33	307.33	307.33	307.33	307.33	307.33	307.33	307.33	307.33	307.33	307.33	307.33	307.33	307.33	307.33
18.1	713.11	713.11	713.11	713.11	713.11	713.11	713.11	713.11	713.11	713.11	713.11	713.11	713.11	713.11	713.11	713.11	713.11	713.11
18.2	1321.10	1321.10	1321.10	1321.10	1321.10	1321.10	1321.10	1321.10	1321.10	1321.10	1321.10	1321.10	1321.10	1321.10	1321.10	1321.10	1321.10	1321.10
18.3	2071.08	2071.08	2071.08	2071.08	2071.08	2071.08	2071.08	2071.08	2071.08	2071.08	2071.08	2071.08	2071.08	2071.08	2071.08	2071.08	2071.08	2071.08
18.4	2936.69	2936.69	2936.69	2936.69	2936.69	2936.69	2936.69	2936.69	2936.69	2936.69	2936.69	2936.69	2936.69	2936.69	2936.69	2936.69	2936.69	2936.69
18.5	3903.22	3903.22	3903.22	3903.22	3903.22	3903.22	3903.22	3903.22	3903.22	3903.22	3903.22	3903.22	3903.22	3903.22	3903.22	3903.22	3903.22	3903.22

4. Simulation of the January 2005 Flood

The HYDRO-1D model of the EDC was re-configured to include the revised rating for the Land of Canaan sluice, and the refined rating for EDC embankment spill. Gate operations and model boundary conditions were exactly the same as had been modelled in May 2005.

Figure 3 shows the simulation of January 2005 EDC levels with the revised Land of Canaan sluice rating. The simulation produced in May 2005 is included for comparison. As might be expected, the revised rating for Land of Canaan sluice results in an earlier and higher rise in water levels than was produced previously. In overall terms, the simulation is still acceptable, although the indication is that the model may be more conservative than before. The model treats the EDC as a level pool, and there is no attenuation or lag of the flood as it passes through the conservancy. It is to be expected therefore that the model would simulate a rise in flood levels earlier than observed in the prototype, and that simulated peak levels would be higher than observed. Another issue that was highlighted in the May 2005 report was that there may have been flow round the south-eastern end of the EDC. The recession of the flood levels is reasonably well represented and it is considered that the revised model is a valid representation of the EDC and its' flood discharge characteristics. The revised model will, however, produce higher flood levels than reported in May 2005 for the same sets of boundary conditions.

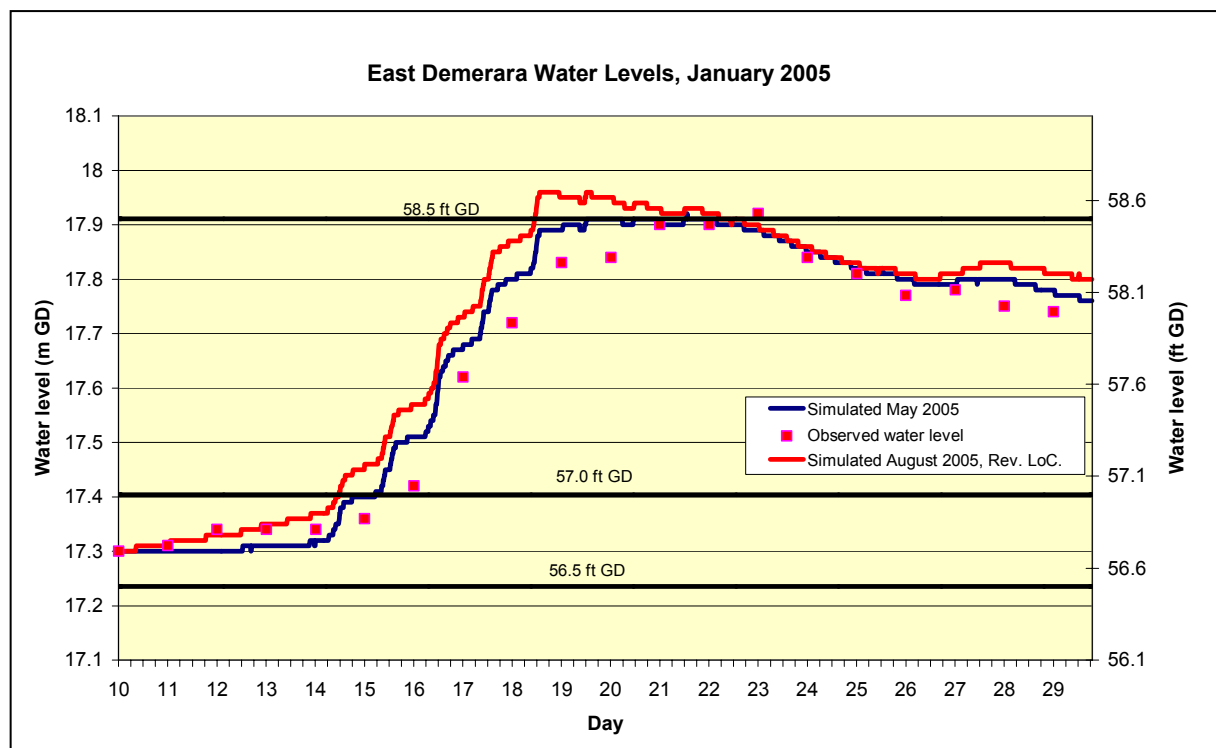


Figure 3 Simulation of January 2005 flood with revised Land of Canaan sluice rating

5. Analysis of EDC Gate Operations in Design Events

A schedule for gate operations was prepared by the SEEC committee in May 2005. These are presented in Table 3.

Table 3
SEEC Committee schedule for gate operations

Water level at Maduni (ft GD)	Gate Status					
	Land of Canaan	Maduni	Lama Big	Lama Small	Cunha	Kofi
55.50	Closed	Closed	Closed	Closed	Closed	Closed
56.00	Open	Closed	Closed	Closed	Closed	Closed
56.25	Open	Open	Closed	Closed	Open	Open
57.00	Open	Open	Closed	Closed	Open	Open
57.50	Open	Open	Closed	Closed	Open	Open
58.00	Open	Open	Open	Closed	Open	Open
58.25	Open	Open	Open	Open	Open	Open

Figure 4 presents the simulated water levels for 10 day 1000 year and 10000 year floods with the gate operations indicated above in Table 3. Also included in Figure 4 is the simulation of the 1000 year flood prior to refinement of the Land of Canaan gate rating. With the revised rating for Land of Canaan sluice, and the gate schedule given above the 1000 year flood peaks at just above the level of 58.5 ft GD, and is of course higher than the equivalent simulation carried out in May 2005.

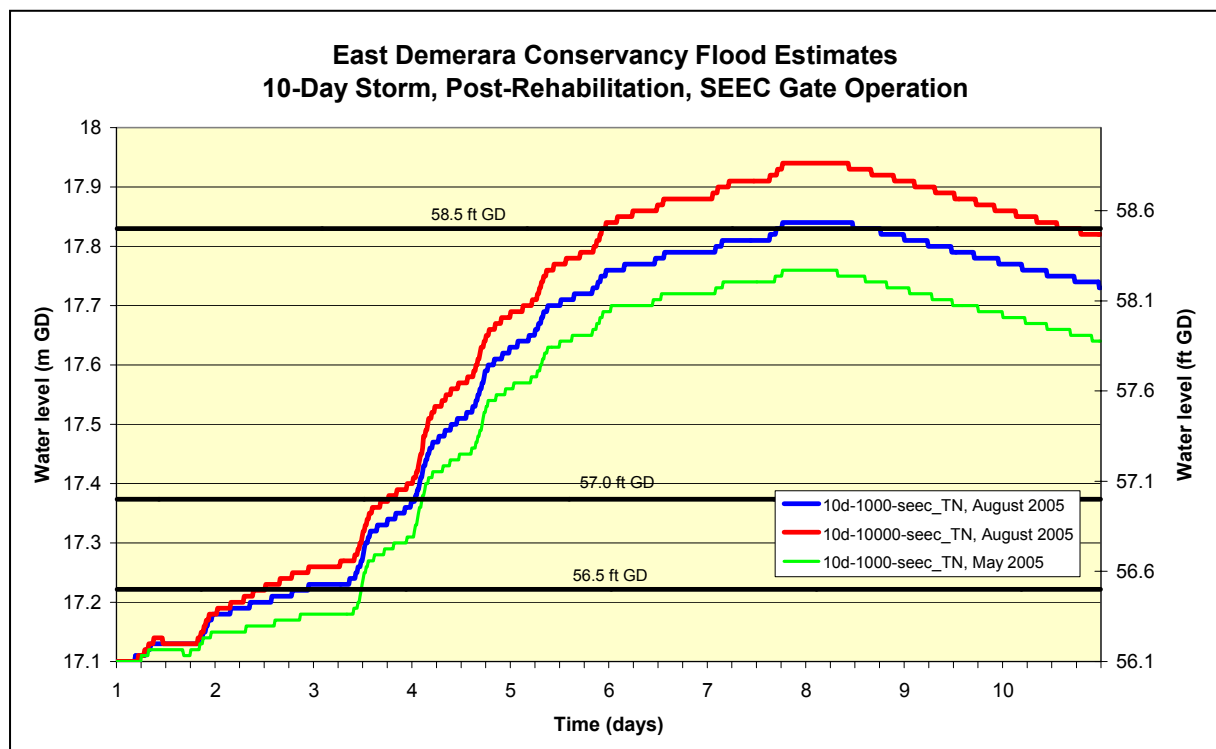


Figure 4 Simulated EDC levels with SEEC committee schedule for gate operations

Further model runs have been carried out for the 1000 year flood, with slight modifications to the SEEC schedule for Land of Canaan Sluice. Figure 5 shows the impact of delaying opening of Land of Canaan sluice until levels of 17.22 m GD (56.5 ft) and 17.37 m GD (57.0 ft). The 1000 year flood levels exceed the desirable maximum level of 17.80 m GD (58.5 ft). If in the short term it is considered that a 1000 year design standard is appropriate, there could be an argument for delaying opening Land of Canaan Sluice until a level of 17.22 m GD (56.5 ft), as the desirable maximum level is only exceeded for a short period of time.

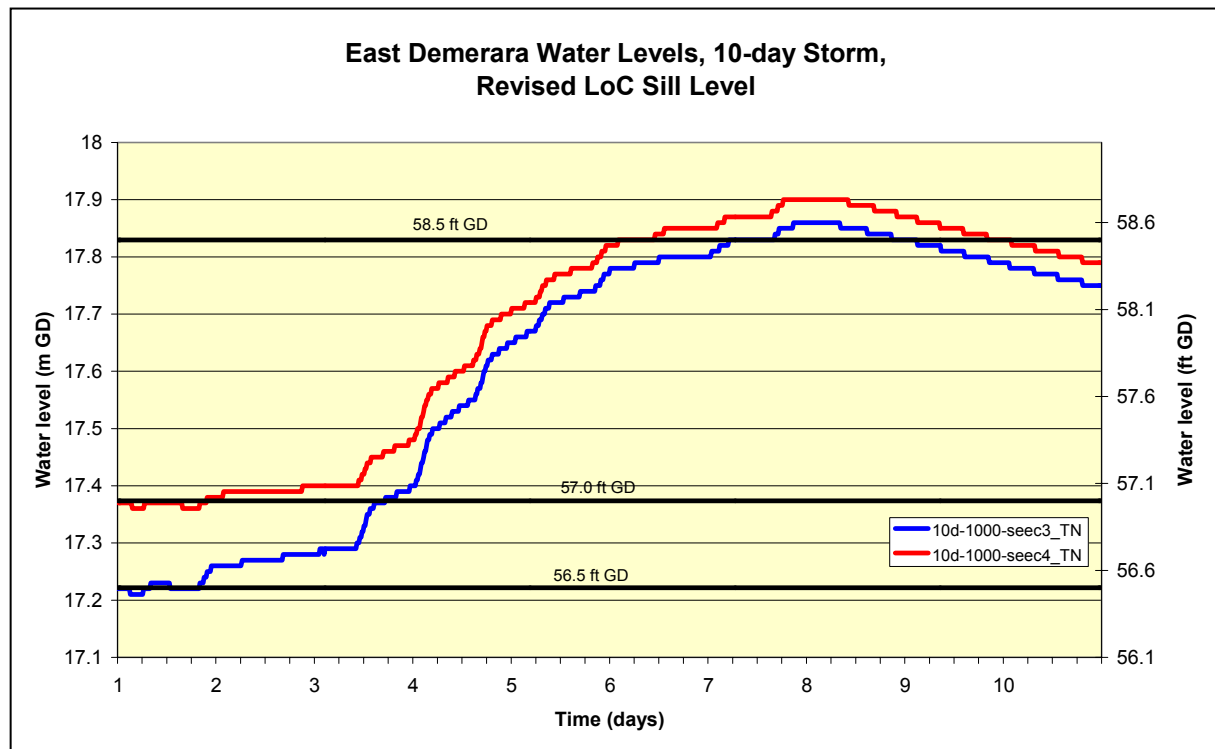


Figure 5 Simulated EDC water levels with modified opening levels for Land of Canaan sluice.

6. Conclusions and Recommendations

The Land of Canaan discharge rating table has been revised, and as a result, it is now considered that there is less flexibility in the operation of EDC than had been indicated in the May 2005 modelling report. Operating the gates in accordance with the schedule given in Table 3 will give a reasonable margin of safety in a 1000 year flood. This margin will be slightly reduced if Land of Canaan sluice opening is delayed until a level of 17.22 m GD (56.5 ft).

An appropriate margin of safety cannot be assured for a 10,000 year flood with the present outlet works. An additional outlet must be provided as soon as possible.

It is important that hydrographic survey of both conservancies be carried out, and that modelling be taken to a pseudo two-dimensional mode. The present model may, on the one hand, over-estimate the rate of rise of flood levels and underestimate attenuation, but on the other hand is not capable simulating the movement of a flood wave through the conservancy. It is possible that higher levels than simulated could occur locally.

The SEEC committee should reconsider decisions made in May 2005 with regard to the schedule of gate operations, in the light of the new simulations reported on in this report, and identify any further modelling runs that they would like to have done. These could be carried out very quickly.