Appendix C

Hydrology and Engineering

Detailed Description of Gapping of L-67 A and C (Pilot Test)

1. The L-67 Pilot Test was included as a part of the Modified Water Deliveries to Everglades National Park Project. The test involved excavation of a 1000 foot long gap in L-67A and L-67C levees separating WCA 3A from WCA 3B allowing water to flow from WCA 3A to WCA 3B. The L-67 Pilot Test began in July 1994 with completion of the two gaps and was terminated, by closing the L-67A gap in September 1994 due to high water levels in WCA 3B. In order to shift water from WCA 3A to WCA 3B, the L-67 Pilot test was re-initiated for this emergency situations.

2. In the General Design Memorandum for Water Conservation Area 3, the standard project flood stage for WCA 3B as estimated to be 8.5 feet. As a part of the Experimental Program, releases from WCA 3A to WCA 3B were to be terminated if the WCA 3B water level exceeded the design stage of 8.5 feet. This original closure criteria was set to avoid adversely impacting WCA 3B. This also applied to adjacent areas to reduce the potential of excessive seepage through L-29 and L-30 and the possibility of the levee overtopping if a major storm were to occur. Based on the time of year for this action (January through May), it is unlikely that a tropical cyclone will occur. Experience gained by closing the gap in L-67A quickly in September 1994 has reduced the uncertainty associated with the gap closure. Therefore, based on the time of year, the experience from the previous closure, and the short term emergency nature of this action, water levels at gage Site 71 will be allow to reach 9.0 feet before the gap is closed in L-67A.

3. Water levels in WCA No. 3B will be monitored and the gap will be closed using the gage Site 71 as a trigger. (see Appendix B for operating criteria). If the gap is still open by 15 May 1998, then the procedure for closing the gap as defined in the 1994 EA and FONSI on the Pilot Field Test of Gapping Levee 67 will be used.

4. Additional Actions. A second modification to the L-67 Pilot Test is the addition of culverts to L-67A gap closure. Immediately following closing the gap in the L-67A levee (if required by the closure criteria), it is recommended that gated culverts be placed in the closure area. This will provide some additional flexibility in moving water into WCA 3B in the future without re-opening the gap. A variety of gated culverts are available at the USACE South Florida Field Office, located in Clewiston, Florida. Although the flow will not be as great as the 1000 foot gap, hydraulic analysis of this action revealed that there is some benefit to adding these culverts to L-67A. However, to maximize the benefit of these culverts the invert will need to be 3.0 feet or lower and some small conveyance channels (50 ft. to 60 ft. long) will need to be constructed on the downstream side of each culvert. The table below shows the

possible flow under favorable conditions. This additional action is recommended for implementation.

Culvert Discharge (cfs)

Head across Culvert (HW-TW)	Culverts available at Clewiston Field Office Flow 1@48″	5@54″	2@72″	5@84″	Total
0.1	18	115	88	312	533
0.2	25	165	126	440	756
0.3	31	202	154	540	927
0.4	35	232	178	630	1075
0.5	40	260	198	700	1198

Note: Assumes invert of culverts at +3.0 feet.

5. Other Alternative Considered. One additional modification to the L-67 Pilot Test was considered for this emergency re-initiation. Consideration was given to closing the gap in L-67C rather than L-67A. Leaving the gap in L-67A would permit additional water to fill in the approximate 1-mile area between the L-67A and L-67C levees known as the “pocket”. However, closure of the gap in L-67C is not recommended for the following reasons:

(1) The purpose of L-67C is to reduce seepage from WCA No. 3A to WCA No. 3B. The design grade of L-67C is 12.0 feet, which is lower than the L-67A design grade of 17.0 feet. There is concern about overtopping the low design grade of L-67C.

(2) During the 1994 Pilot Test, the material excavated from L-67C was very mucky and porous. This type of material is unsuitable for withstanding higher water with the gap in L-67A remaining open. The potential for greater seepage into WCA No. 3B is too great to recommend closure of the L-67C gap.

(3) Logistically, closing the L-67C gap would be very difficult. The crown of the L-67C levee is much narrower than the crown of L-67A and would cause problems for the construction equipment and crews. In addition, suitable material to close the L-67C gap would have to hauled in from a yet unidentified borrow site. During construction of the gap in 1994, the levee became very soft under the construction equipment and further damage to L-67C is a major concern. In addition the staging areas from the 1994 Test are already in place and permitted at the L-67A gap.

Hydrologic Modeling

The South Florida Water Management Model (The 2X2 model) has been utilized to estimate the potential impacts of the emergency re-initiation L-67 Pilot Test and modified SDSC

structure operating criteria to handle seepage from WCA-3B via L-30. The 2X2 model uses the period of record rainfall data from 1965 through 1995 and calculates water levels on 4 square mile grids (2 miles by 2 miles) using the different structure operating criteria. This analysis used the period of record years 1965 through 1995 to compare the alternatives. Two scenarios were modeled for this emergency action. The first is labeled "Test7.1" which represents the current approved operating criteria under Test 7, Phase 1 and the second is labeled "Test7.1_SDCS". The "Test7.1_SDCS" used the WCA-3A regulation schedule labeled "Alternative 1" (Plate 3) which limited the S-12C and D discharge to 1,000 cfs from 1 January through 15 March up to elevation 10.90 ft, Zone A2, then transitioned to the existing WCA-3A regulation schedule by 1 June, and used a maximum gate opening for S-12C and D from 1 January through 15 April up to elevation 11.0 ft, Zone A1, then transitioned to the existing WCA-3A regulation schedule, by 1 June. This scenario also used the temporary deviations to WCA 1 and WCA 2A regulation schedule which limit discharge through the S-10 and S-11 structures during the spring. A 1000-foot weir in L-67A and L-67C at elevation 7.0 ft, was used to simulate the gaps that are open as part of the emergency action to pass water from WCA 3A to WCA 3B. The S-333 tailwater constraint of 7.5 ft in L-29 and the trigger criteria of 6.8 ft at G-3273 remained in place. The culvert, G-69, which discharges from WCA-3B to the L-29 canal was operated with up to 460 cfs discharge when the S-333 tailwater was less than 7.5 ft.

Limitations of the model results based on the assumptions used in this model are discussed below. Any interpretation of the model results should be made with this information in mind. Using models to estimate actual field conditions is an iterative process. There was not sufficient time to review the model and make changes before this document was to go out, changes will be made to the model input to more accurately represent actual field conditions and the model will be re-run.

a. The model, using a fixed weir for the L-67 A & C gap (S-345) with a tailwater constraint of 9.0’, resulted in flows in excess of what would actually occur. This has been confirmed by field observations and measurements taken by the USGS during the 1994 Pilot Field test. In addition, the gap in L-67A is separated from the gap in L-67C by almost a mile of marsh, this further reduces the relationship between the flow through L-67A, which is dependent on the stage in WCA 3A, and the flow through the gap in L-67C.

b. The overestimation of flow through the L-67 A & C gap results in higher stages in WCA 3B and increased seepage in L-29 and L-30. At the same time, this results in an underestimation of the storage and stage in WCA 3A.

c. The resulting overestimation in seepage in L-30 results in an increase in conveyance through L-31N, which estimates higher stages in areas to the east of L-31N.

d. Flows of 460 cfs through G-69 (S-355) are probably in excess of actual field capacity which is limited by upstream conditions.

e. The proposed temporary deviation to the WCA 3A regulation schedule shown in Plate 4, has been replaced by the temporary deviation to the WCA 3A regulation schedule shown in Plate 3. This regulation schedule will allow stages in WCA 3A to rise to 11.25 feet before opening all S-12 structures.

The model results are discussed below for the following areas: WCA 3A and 3B, areas east of WCA 3A and 3B, areas south of WCA 3A and 3B, and structures in the SDCS.

a. Interior WCA 3A and 3B. In WCA-3A, interior stages and duration are relieved by the emergency gap through the L-67 A+C levee, which show flows greater than 2000 cfs based on a weir length of 1000 ft and crest elevation 7.0 ft. Likewise, in WCA-3B, interior stages are higher because of the gap. Overall, above ground durations are unchanged, except for ponding in the lower southeast corner. Note that this weir design in the model overestimates actual field flows.

b. Western colony of CSSS. The area southwest of WCA 3A, represented by gage NP-205 show a decrease in above ground duration of 17.0% and decrease in above ground stages of 4.0 inches.

c. Shark River Slough colony of CSSS. The area south of the L-67 ext., represented by a cell located south west of NP-206, shows a 12% shorter duration of above ground ponding and decrease in average stage of 4.0 inches.

d. L-30. Structure S-335, was set to open when the headwater was greater than or equal to 7.0 ft. to move seepage water from WCA 3B via L-30 and L-31N. High wet season stages averaged about 7.5 ft. with peaks going as high as 8.0 ft, and early dry season stages (through March) where between 7.0 and 7.5 ft. The flow durations was longer and discharge increased by up 400 cfs.

e. Structures in the SDCS. S-331 discharge increased 13.0% of the time with an average discharge increase of up to 100 cfs. S-176 shows a corresponding increase of 100 cfs but no increase in duration.

f. Bird Drive Basin. Areas east of L-31N, represented by the cell at Bird Drive (G-3439), shows very little increase in stage or duration. The area represented by Krome (G-978), shows increased duration and wet season stages are increased 0.75 ft.

g. 8.5 Square mile area. Cells in the 8.5 sq area could increase the above ground duration between 0.0 and 4.0%. For example, at Angels well, stages above ground stages may increase up to 1.5 inches.

Determination of Maximum Safe Water Level in WCA 3A.

In Part I, Supplement 33 General Design Memorandum for Conservation Area No. 3 (1960), it was noted one of the factors for establishing the regulation schedule and levee heights was the retention of marsh vegetation that would prevent large wind tides and waves from developing during hurricanes. It was determined that a marsh vegetation that could prevent wind tides could be retained with a seasonal regulation schedule varying between 9 to 11 feet. After consideration of other factors such as water supply and fish and wildlife resources, a seasonal regulation schedule varying from 9.5 to 10.5 feet was selected. Since 1985 the 9.5-10.5 foot WCA 3A regulation schedule was modified to include some additional zones. The regulation schedule varies from a high stages in the winter (dry season) to low stages in the beginning of the summer (wet season). Based on the assumption of marsh vegetation preventing wind tides, the levee design criteria in the GDM was to provide 2.5 feet of freeboard above the Standard Project Flood (SPF) profile, and about 4 feet above the period of record stage at that time. Rapid removal of flood storage in the WCA's is limited due to the slow movement of water in the densely vegetated WCA's. The relatively flat ground slopes and dense vegetation often lead to sloping pool conditions in the WCA's, and backwater effects.

Based on the Sloping Pool Storage curve for WCA 3A, there is about 525,000 acre-feet of storage available between the three station average WCA 3A stages of 11.25 to 10.00 feet. Between April 1st and May 31st, it would require about 4,300 cfs/day of outflow to remove 525,000 acre-feet of water stored in WCA 3A, not including any other inflows or direct rainfall. USGS flow data for the S-12s for the last 4 years indicate that, for an S-12 tailwater stage of 11 feet, a discharge of about 1500 cfs is possible at S-12D, about 1200 cfs at S-12C, about 700 cfs at S-12B, and about 900 cfs at S-12A. The Corps also reviewed as-built drawings for levees and structures in WCA 3A. Thus, based on this quick review of available data, the Corps' best engineering judgement at this time is that the proposed WCA 3A regulation schedule deviation shown in Plate 3 would not pose an unacceptable risk of failure of levees and structures in WCA 3A.