**DRAFT RSM Modeling in Support of Northern Everglades Technical Plan**

**Current Base (2005)**
**Assumptions**

| **Feature** | **Entire Model Domain** |
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| **General** | • Model should reflect conditions around the year 2005 except when otherwise indicated.<br>• Period of simulation is 1970 to 2005.<br>• Model time step is daily.<br>• All elevations are in feet NGVD 29. |
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| | ***Upper Kissimmee Sub-watershed (KUB)*** |
| **General** | • Model consists on nine interconnected lakes with flows imposed for the lakes with natural creeks. The outflows from the lakes are heavily regulated. |
| **Climate** | • Climate period of record is 1970-2005. Rainfall and ET data derived from the time series developed for the SFWMM, with open water evaporation assumed for the nine lakes. |
| **Model Setup** | • The Upper Kissimmee sub-watershed model setup consists of nine lakes or Lake Management Areas (LMA). The lakes are Alligator, Myrtle, Hart, Gentry, East Toho, Toho, Cypress, Hatchineha and Kissimmee. The lakes are interconnected with canals and water control structures which are tightly regulated. |
| **Stage-Volume-Area Relationships** | • Stage-volume and stage-area relationships for the nine lake management areas are those developed as part of the KBMOS effort. |
| **Sub-watershed Inflows** | • Sub-watershed flows developed as a part of the calibration of the UKISSWIN model (PBS&J, Christ et al. 2001) were imposed as flow boundary conditions for the nine lakes. Historical flows obtained from USGS for Shingle, Boggy, Reedy and Catfish creeks were also imposed as boundary conditions for Lakes Toho, East Toho, Cypress and Hatchineha. For Shingle Creek the flow split was assumed to be 70% into Lake Hatchineha and 30% into Lake Cypress. |
| **Structure Capacity** | • The water control structures which interconnect the lakes include 6 spillways (S60, S62, S59, S61, S63 and S65), two culverts (S57 and S58) and two open channel connections (C36 and C37). The design capacities of the structures are given below:<br>S60 – 450 cfs<br>S62 – 500 cfs<br>S59 – 700 cfs<br>S61 – 2000 cfs<br>S63 – 700 cfs |

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| | S65 – 4000 cfs<br>S57 – 150 cfs<br>S58 – 130 cfs<br>Locks used for navigation at the structures are not modeled. |
| **Operations** | • The lakes and water control structures are regulated by rigid schedules as defined in the Kissimmee Basin Water Supply Plan (SFWMD, 2000). An exception is Lake Kissimmee which is simulated in the model using the Interim regulation schedule as implemented in the Phase I of the Kissimmee River Restoration Project. The flow through all structures in KUB were modeled using the daily headwater/tailwater and gate openings at the structure, as defined in the UKISS package in the District Tech Pub 86-5, and are similar to the District's Flow program. The maximum allowable gate openings for a set of headwater/tailwater conditions at the spillway were computed using the "Riprap Control" criteria mentioned in the technical publication. The flow through the open channel canals C36 and C37 connecting lakes Cypress and Hatchineha, and lakes Hatchineha and Kissimmee is modeled using a variation of the Manning's equation using stage and water surface slope as outlined in the technical publication. |
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| ***Lower Kissimmee Sub-watershed (LKB)*** | |
| **General** | • Model reflects conditions post-Phase I of the Kissimmee River Restoration (KRR) around the year 2005.<br>• It is assumed that there is no connection between Lake Istokpoga and the Kissimmee River (i.e. G-85 is assumed closed). |
| **Climate** | • The climatic period of record is 1970 to 2005.<br>• Rainfall time series were obtained from the 1914-2005 rainfall binary developed for the SFWMM. Rainfall values for the SFWMM grid cells fully contained within the LKB sub-watershed were averaged to obtain the average rainfall time series for the sub-watershed.<br>• Reference grass evapotranspiration (RET) time series (by Penman-Monteith) were obtained from the 1948-2005 binary file developed for the SFWMM. RET values for the SFWMM grid cells fully contained within the LKB sub-watershed were averaged to obtain the average RET time series for the sub-watershed. In the model it is assumed that open water evaporation from the four C-38/Kissimmee River reaches is five percent larger than RET (Kc=1.05, FAO Irrigation and Drainage paper #56). |
| **Model Setup** | • The Lower Kissimmee sub-watershed is comprised of four major basins reflecting partial (Phase I) KRR: S65A, S65BC, S65D and S65E. Only the C-38 canal, the Kissimmee River and floodplain portions of these basins are simulated as level pools: Pools A, BC, D and E. |
| **Stage-** | • Stage-volume and stage-area relationships used for the four level pools are |

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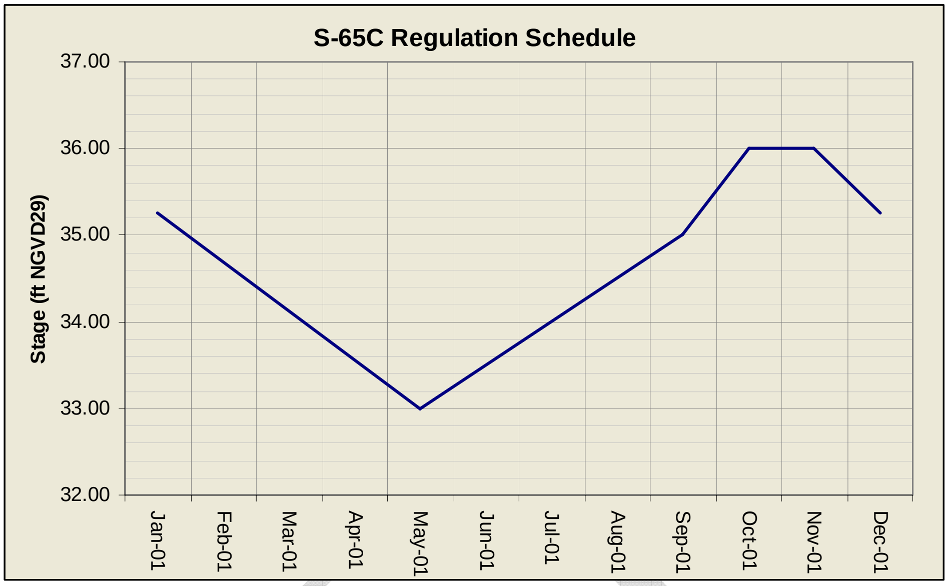
| **Volume-Area Relationships** | those developed for the KBMOS project. For Pool BC, these relationships were later manipulated to obtain stage-volume and stage-area curves for representative level-pool head. |
| **Sub-watershed Inflows** | • To be consistent with the SFWMM methodology for translating S-65 into S-65E flows, sub-watershed inflows (runoff) were estimated based on historical flow data at LKB boundary structures (S-65E – S-65 flows). Runoff was prorated based on each basin in the LKB sub-watershed and the resulting time series was imposed as boundary condition to each level pool. |
| **Structure Capacity** | • Only the major gated spillway structures in place post-Phase I of the KRR are included: S-65A, S-65C, S-65D, S-65E. Culverts and overflow weirs next to these structures are not modeled with the exception of the three broad-crested weirs at the tieback levee of S-65A which are modeled. Locks at these structures are not modeled.<br>• S-65B is not included in the simulation as it was removed as part of Phase I of the KRR.<br>• WEIRS 1, 2, 3, though still in place in 2005, are not modeled.<br>• Rating curves developed by Ansar, et al. based on dimensionless analysis were used in simulating these gated spillways (Appendix A).<br>• Gates are assumed to always be fully open.<br>• Maximum historical discharges are used to limit flow through these structures:<br>S-65A: 13,100 cfs    S-65C: 19,300 cfs<br>S-65D: 24,000 cfs    S-65E: 27,900 cfs |
| **Operations** | • The four gated spillways are operated for flood control. The regulation schedule presented in Appendix C of the 2000 KB Water Supply Plan was only implemented in real-life for S-65B (D. Anderson, pers. comm.), which was removed as part of Phase I of KRR. Therefore, a single flood control trigger stage equal to the optimum headwater stage at each structure is used to operate the structures in the model. The exception is S-65C where the schedule is used in the model as it captures the overall intent of post-Phase I operations (D. Anderson, pers. comm.). During a timestep, a structure will try to remove any volume of water stored above this flood control trigger stage, plus any basin inflow subject to the structure capacity and limited to its maximum capacity.<br>Flood control trigger stage:<br>S-65A: 46.3 ft<br>S-65D: 26.8 ft    S-65E: 21.0 ft |

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| ***Taylor Creek/Nubbin Slough Sub-watershed (TCNS)*** | |
| **General** | • A flow-pass-through method is implemented for this area. The historical flow from this area into LOK is imposed as flow boundary condition. Then the flow would pass through the sub-watershed and outlet directly into LOK. |
| **Climate** | • The climatic period of record is 1970 to 2005.<br>• For flow pass-through method, RF and ET are not needed in the simulation. |
| **Model Setup** | • The whole sub-watershed is divided into three basins: TCNS (S191+S133), S154 (S154+S154C), and S135. Outflows from these basins into LOK are: TCNSQ (S191+S133), S154, and S135 respectively. |
| **Stage-Volume-Area Relationships** | • For flow pass-through method, stage-volume relationships will not be used. |
| **Sub-watershed Inflows** | • The sub-watershed inflows are assumed to produce historical outflows from the sub-watershed into LOK which are imposed as flow boundary conditions. These flows: TCNSQ, S154 and S135, are from DBHYDRO database. |
| **Structure Capacity** | • Design capacity: S191 7440cfs; S133 625cfs; S154 1000cfs; S135 500cfs.<br>• Since flow pass-through method is implemented for this area, the design capacity does not impact the simulation. |
| **Operations** | • Historically, structure S191 is operated on headwater elevation, and maximum gate opening. S135 and S133 are pump stations, operated according to headwater elevation.<br>• For flow pass-through method, the structures are assumed to have been |

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| | operated as was done historically. |
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| ***Lake Istokpoga Sub-watershed*** | |
| **General** | • A flow pass-through method is implemented for this area. The historical flow from this area into LOK is imposed as flow boundary condition. Then the flow would pass through the sub-watershed and outlet directly into LOK. The sub-watershed is assumed to be cutoff from Lower Kissimmee with the structure G85 closed all the time. |
| **Climate** | • The climatic period of record is 1970 to 2005.<br>• For flow pass-through method, RF and ET are not needed in the simulation. |
| **Model Setup** | • The Istokpoga model is setup such that historical outflows are assumed to pass through the sub-watershed. Outflows into Lake Okeechobee (through S71, S72, S84, S127, S129 and S131) are assumed to be lumped into a single quantity. |
| **Stage-Volume-Area Relationships** | • For flow pass-through method, stage-volume relationships will not be used. |
| **Sub-watershed Inflows** | • The sub-watershed inflows are assumed to produce historical outflows from the sub-watershed into LOK which are imposed as flow boundary conditions. |
| **Structure Capacity** | • From the structure books, the major gated spillway structures design capacities are shown in parenthesis: S68 (3000 cfs), S70 (5000 cfs), S71 (6000 cfs), S72 (3000 cfs), S75 (1150 cfs), S84 (6000 cfs), S127 (625 cfs), S129 (375 cfs) and S131 (375 cfs).<br>• Since flow pass-through method is implemented for this area, the design capacities do not impact the simulation. |
| **Operations** | • For flow pass-through method, the structures are assumed to have been operated as was done historically. |
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| ***Fisheating Creek Sub-watershed*** | |
| **General** | • This sub-watershed is modeled as a flow pass-through. The historical outflow from Fisheating Creek into LOK is imposed as an inflow to the sub-watershed as a boundary condition and allowed to flow into LOK. |
| **Climate** | • The climatic period of record is 1970 to 2005.<br>• For flow pass-through method, RF and ET are not needed in the simulation. |
| **Model Setup** | • The entire Fisheating Creek area is modeled as a single basin. |
| **Stage-Volume-Area Relationships** | • For flow pass-through method, stage-volume relationships will not be used. |
| **Sub-** | • Since this sub-watershed is modeled as a flow pass-through, sub-watershed |

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| **watershed Inflows** | outflow time series is imposed as inflow boundary conditions.<br>• Since there is no flow monitoring sites close to LOK, the inflow time series is developed based on historical data at the Palmdale station. Palmdale station is the most downstream "natural" station which is located on the upper Fisheating Creek sub-watershed, several miles upstream of the confluence of the creek to the LOK. The assumption is the runoff downstream of Palmdale is included in MDS term. |
| **Structure Capacity** | • No structures exist in this sub-watershed. Fisheating Creek has open connection with Lake Okeechobee through the creek. A dummy structure is assumed with very high capacity to allow passing the sub-watershed inflow to LOK. |
| **Operations** | • N/A |
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| ***Lake Okeechobee Sub-watershed*** | |
| **General** | • Current base simulation as in SFWMM 2005 base run |
| **Climate** | • The climatic period of record is 1970 to 2005. |
| **Model Setup** | • Lake Okeechobee modeled as a “lake” in the Regional Simulation model with established stage-area and stage-volume relationships. Rainfall is part of the MDS term. ET simulated using the same methodology as in the SFWMM. |
| **Stage-Volume-Area Relationships** | • Same as in SFWMM |
| **Sub-watershed Inflows** | • Historical flows are applied for the Fisheating Creek, Lake Istokpoga and Taylor Creek/Nubbin Slough sub-watersheds. Backflows coming from the east, west and south of Lake Okeechobee as simulated in the SFWMM will be input as boundary conditions in RSM. S65E flows into Lake Okeechobee will be simulated. |
| **Structure Capacity** | • Same as in SFWMM |
| **Operations** | • Regulatory releases to the estuaries and to the WCAs are simulated based on the WSE schedule. Based on the SFWMM equivalent run, regulatory releases through S-352 and S-351 Hillsboro Canal are zero. Regulatory releases through C-10A are also simulated.<br>• Individual LOSA basin demands are boundary conditions. Water management cutback scheme is simulated based on hybrid LOWSM operations. EAA conveyance cutbacks are not currently simulated but fixed based on SFWMM output.<br>• NETP sub-watersheds which are simulated in the model establish inflows into Lake Okeechobee.<br>• All other inflows and outflows are fixed boundary conditions. |
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**Appendix A**

**Table 1** - Spillway equations based on dimensional analysis
From "Dimensionless Flow Ratings at Kissimmee River Gated Spillways" Tech Pub SHDM report, Operations and Hydro Data Management Division, SFWMD (M. Ansar, Z. Cheng, J. A. Gonzalez & M. J. Chen)

| Flow Condition | Equation | Restriction | Remarks |
|---|---|---|---|
| Controlled Submerged (CS) | $Q = L\sqrt{g{y_c}^3}$<br>$y_c = aG_o\left(\frac{H-h}{G_o}\right)^b$<br>$a$ = 1.04, $b$ = 0.30 | $\frac{h}{G_o} \geq 1.0$ | Also known as submerged orifice |
| Controlled Free (CF) | $Q = L\sqrt{g{y_c}^3}$<br>$y_c = aG_o\left(\frac{H}{G_o}\right)^b$<br>$a$ = 0.86, $b$ = 0.35 | $\frac{h}{G_o} < 1.0 \ \& \ \frac{H}{G_o} \geq \frac{1}{K}$<br>$K = 2/3$ | Also known as free orifice |
| Uncontrolled Submerged (US) | $Q = L\sqrt{g{y_c}^3}$<br>$y_c = aH(1-\frac{h}{H})^b$<br>$a$ = 0.838, $b$ = 0.167 | $\frac{h}{G_o} < 1.0, \frac{H}{G_o} < \frac{1}{K}, \& \frac{h}{H} \geq K$<br>$K = 2/3$ | Also known as submerged weir |
| Uncontrolled Free (UF) | $Q = L\sqrt{g{y_c}^3}$<br>$y_c = aH$<br>$a$ = 0.7 | $\frac{h}{G_o} < 1.0, \frac{H}{G_o} < \frac{1}{K}, \& \frac{h}{H} < K$<br>$K = 2/3$ | Also known as free weir |
| Transitional Flow | No transition region | | |

In the table, the flow equation coefficients for the Kissimmee River spillways are shown.

$H$: head water above CEL (ft) = HW-CEL;
$h$: tail water above CEL (ft) = TW-CEL;
$g$: gravitational acceleration, 32.2 ft^2/s;
$G_o$: gate opening (ft); $L$: spillway width (ft);
$y_c$: critical depth (ft); $Q$: computed discharge (cfs)

Note: Coefficients a and b only apply to Kissimmee River gated spillways.