APPENDIX H

COMBINED OPERATIONAL PLAN

HYDRAULICS & HYDROLOGY

ANNEX 6
8.5 SQUARE MILE AREA EVALUATION

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H-6 8.5 SMA H&H EVALUATION

H-6.1 HISTORY AND BACKGROUND

The 8.5 Square Mile Area (8.5 SMA), also referred to as the Las Palmas Community, is an inhabited area bounded on the west by the Everglades National Park (ENP), and separated from more intensively developed urban lands to the east by the L-31N Levee and borrow canal. In 1992, a flood mitigation plan was authorized for the 8.5 SMA as part of the MWD to ENP Project. The 1992 MWD General Design Memorandum (GDM) plan included the construction of a protective levee and seepage canal around the north and west perimeter of the 8.5 SMA that would mitigate for higher stages associated with implementing the MWD Project. The GDM also included a 950 cfs pump station along L-31N to convey flood mitigation discharges from the 8.5 SMA into the L-29 Canal and the ENP Northeast Shark River Slough. The 1992 GDM plan did not provide a hydraulic connection between the MWD 8.5 SMA and the C-111 South Dade Northern Detention Area (C-111SD NDA).

In 2000, the USACE prepared the MWD General Reevaluation Report (GRR) and a Final Supplemental Environmental Impact Statement (SEIS) to assist in the selection of a Recommended Plan for providing flood mitigation to the 8.5 SMA while allowing for restoration of the Northeast Shark River Slough (NESRS) as authorized by the MWD Project. Consistent with the 1992 GDM analysis, it was a requirement of the reevaluation to analyze alternatives that provided no increase in flooding above and beyond what existed prior to the authorization of the MWD Project. The GRR recommended plan, Alternative 6D, included construction of a perimeter levee (Levee 357W [L-357W]), internal levees, an interior seepage collection canal (C-357), a new pump station (S-357), and a detention area (8.5 SMA Detention Cell) that would discharge into the proposed C-111SD NDA. The GRR/SEIS presented hydrologic modeling simulations, social impact assessments, policy analysis, real estate information, engineering design and cost analysis, environmental impact assessment, economics calculations and review of public concerns. The Record of Decision (ROD) for the 8.5 SMA GRR/SEIS stated that it would be implemented with added assurances and conditions described therein. One of those assurances and conditions is that “***periodic flooding of landowners east of the proposed levee, before and after project implementation, will remain unchanged from conditions in existence prior to implementation of the MWD Project except where flowage easements are required***.” The ROD further prescribed that: “Implementation of the Recommended Plan should not adversely impact the restoration levels of Everglades National Park's hydrology greater than that simulated through modeling of Alternative 6D” (the GRR Recommended Plan); “A monitoring, evaluation, and reporting program shall be implemented to ensure operations are consistent with these levels”; and “No deviations are intended from the operations specified in the Manual (i.e., increased pumping in the seepage canal or the inclusion of additional pumps) due to anticipated public demand for increased flood relief inside the perimeter levee of the 8.5 SMA Project.” The Hydraulic and Hydrogeologic Model Report (Appendix A) for the 2000 GRR also recognized that the final operation of the C-111 South Dade (C-111SD) pump stations and detention areas would require further study beyond the scope of the GRR effort, while also including recognition that the C-111SD components represented a large change in the local flow regime which could affect the study area.

The Corps completed construction of the 8.5 SMA features identified in the 2000 GRR in 2009. The features were operated and monitored under a testing mode, and the Corps and South Florida Water Management District (SFWMD) concluded that additional features were necessary to ensure the proper required level of mitigation is provided to the 8.5 SMA. The Corps completed construction of the final physical features of the MWD Project (Structure S-357N and Canal C-358) in February 2018. The completed MWD Project will provide additional inflows to ENP by conditionally raising the maximum operating limit of the L-29 Canal up to 8.5 feet NGVD following the acquisition of the required real estate interests along the Tamiami Trail roadway by the Corps and DOI/ENP and functional completion of the C-111SD NDA, while maintaining adherence to both the FDOT constraints for protection of the Tamiami Trail roadway and the 8.5 SMA flood mitigation constraints. Real estate acquisition along eastern Tamiami Trail was completed in August 2017. The future Combined Operational Plan (COP) study will result in a comprehensive integrated water control plan for the operation of the water management infrastructure associated with the MWD and C-111 South Dade (C-111SD) Projects.

The MWD 8.5 SMA project features, which were fully constructed and operational in February 2018, are designed to “provide mitigation for the increased water levels that will occur once the MWD project is fully implemented and the associated additional water flows are delivered to ENP. The 8.5 SMA flood mitigation features do not work independently, as full mitigation is dependent on both the MWD 8.5 SMA features and the C-111SD project features. The MWD project and the C-111SD project work together, and increased water deliveries (out of WCA 3A and into the ENP) were deferred until the C-111SD S NDA was constructed, operational, and connected to the 8.5 SMA Detention Cell to ensure no adverse impacts to private property within the 8.5 SMA. The hydraulic connection between the 8.5 SMA and the C-111SD NDA, which was envisioned by the 2000 MWD GRR/EIS for the 8.5 SMA, creates an interdependency between MWD and C-111SD project operations which affects the flood mitigation performance for the MWD 8.5 SMA components, the flood protection performance of the C-111SD project components, and the hydrologic/ecological benefits for both the MWD and C-111SD projects. Completion of C-111SD NDA components and the levee components adjacent to the 8.5 SMA included in these two contracts was integral to allowing more water to flow south into the ENP, and to ensure the 8.5 SMA features provide the flood mitigation required for the MWD project. As of August 2018, the C-111SD NDA and C-111SD South Detention Area (C-111SD SDA) were both functional, with minor additional erosion control measures planned for completion in the early portion of the 2019-2020 dry season.

The full implementation of the MWD Project cannot occur until flood mitigation is provided to the 8.5 SMA, and 8.5 SMA flood mitigation was a constraint throughout all increments of the MWD field test. With respect to operation of the L-29 Canal, the Recommended Plan for the COP includes: (1) raising of the maximum operational limit in the L-29 Canal up to 8.5 feet NGVD, subject to a 90-day annual duration limit for stages above 8.3 feet NGVD; and (2) removal of the 6.8 foot NGVD constraint at G-3273 that constrained inflows to NESRS prior to the start of the MWD incremental field test in 2015. As detailed from the analysis documented within this Annex, if the duration for L-29 Canal stages above 8.3 feet NGVD is able to be further extended following evaluation of ongoing monitoring data along the roadway or following the roadway reconstruction, an alternate constraint may be warranted as a protective measure for residential areas to the east, particularly the 8.5 SMA. Consistent with the long-term scope of the COP study, the Increment 2 field test (initiated February 2018) will continue to impose an operational constraint within the L-29 Canal, if necessary to ensure continued providence of 8.5 SMA flood mitigation requirements after functional completion of the C-111SD project while the ongoing monitoring data continues to be analyzed between the Corps and the Florida Department of Transportation (FDOT). Throughout all phases of the MWD field test and COP, USACE operations cannot cause the 8.5 SMA to endure a greater duration of high water than they would have experienced prior to construction of the MWD project and prior to MWD implementation of increased flows to ENP.

Given the nature of these constraints, raising of the L-29 Canal maximum operating limit under the Increment 2 field test was implemented incrementally with continuous monitoring of conditions both along the Tamiami Trail roadway and within the 8.5 SMA. Within the 2000 GRR, the simulated water levels within the 8.5 SMA for the Recommended Plan were shown to be at or below simulated pre-MWD water levels (referred to in the GRR as the "1983 Base"), using the 1995 rainfall as representative of wet hydrologic conditions. The "1983 Base" assumptions included no inflows from WCA 3A to the NESRS, with S-333 and S-334 only used to provide water supply deliveries to the South Dade Conveyance System. The hydrologic modeling in the GRR, which utilized the USACE MODBRANCH model, evaluated the following:

- Spatial extent of flooding across the 8.5 SMA protected area and agricultural areas located northeast of the 8.5 SMA;
- Flood duration/hydroperiod and recession rates assessed for May through September 1995 (week 21 through 37);
- Flood inundation depths, which were used to compute economic damages and flowage easement requirements (an event which approximated a Standard Project Flood event was used to assess achievement of flood mitigation – mitigation was assumed achieved if week 26 stages were below "Base 1983").

The COP development utilized regional hydrologic modeling in order to balance the ecological restoration objectives of the MWD and C-111SD projects while demonstrating compliance with the project constraints, which include requirements to maintain the mitigation for project induced flood damages in the 8.5 SMA and to maintain the level of flood damage reduction for South Dade associated with the 1994 C-111SD GRR Recommended Plan. The results from the future COP development will be used to update the flood mitigation analysis for the MWD 8.5 SMA GRR (this Annex) and to update the flood risk management analysis from the 1994 C-111SD GRR (Appendix I), which did not then identify inter-basin transfer of water from the MWD 8.5 SMA to the C-111SD Project lands. Development of the COP was informed by the MWD Increment 1, Increment 1.1/1.2 and Increment 2 field tests. Constraints included in the monitoring plans for the field tests may result in discontinuation of the field tests if adverse impacts to flood damage reduction are indicated as a result of the field test operations. The COP modeling analysis was, in part, conducted to quantitatively characterize the degree to which operational constraints for the Tamiami Trail roadway and/or the 8.5 SMA limit inflows and associated potential restoration benefits within NESRS, if applicable.

H-6.2 MODELING SELECTION AND UTILIZATION

The Miami-Dade County Regional Simulation Model (MD-RSM) model applied for the COP will replace the MODBRANCH model previously utilized by the USACE for the 8.5 SMA GRR and previous efforts to develop the MWD and C-111SD operational plan, including the 2003-2005 Combined Structural and Operational Plan (CSOP). Prior to COP, the model was under development by the SFWMD for initial application for the SFWMD C-111 Spreader Canal Project. Due to delays in the development of the model, the COP is the first application of the MD-RSM within the South Florida Ecosystem Restoration Program.

The main objective of the SFWMD MD-RSM Implementation Project was to provide a tool to simulate the hydrology and the water management operations of several basins in Miami-Dade County. The Regional Simulation Model (RSM) has been developed over the last 20 years to specifically represent the main components of the local hydrology over the full spectrum of land characteristics in south Florida, from natural areas in the west, which include the Everglades National Park and Water Conservation Areas 3A and 3B, to the highly urbanized coastal basins such as those in the eastern part of Miami-Dade County. The Miami-Dade sub-regional application of RSM is a model designed to investigate current and future operational alternatives for flood control and water supply in South Miami Dade County. MD-RSM was designed to overcome some of the limitations of the RSM-GL model to simulate at a sub-daily time-step water supply and flood control operational strategies considered in the South Dade Conveyance System and the C-111 Spreader Canal Project. Its irregular, triangular mesh is highly resolved along the East Coast Protective Levee - the interface between the ENP and the WCAs with the developed agricultural, residential and urban areas to the east.

The main purpose of MD-RSM simulations for COP is to evaluate flood risk management for the C-111 South Dade Basin and the 8.5 SMA. MD-RSM uses the same modeling engine as RSMGL with a finer mesh and time steps. The MD-RSM encompasses an area of 2,425 square miles, mostly in Miami-Dade County and the southern portion of Broward County. It spans more than 52 hydrologic basins, including the ENP, Water Conservation Areas 3A and 3B, and the Lower East Coast Service Areas (**Figure H-6.1**). The southern and eastern boundaries of the model comprise Florida Bay and the Atlantic Ocean/Biscayne Bay, which are represented in the model with time-series data of tidal stages. The model simulates all major water budget components that are relevant to South Florida, which include evaporation, transpiration, overland and groundwater flows, levee seepage, and canal flows. Also, the local-scale hydrology is simulated using a feature—Hydrologic Process Module (HPM)—that is unique to the RSM and is highly representative of the evaporation/infiltration processes in South Florida. The model includes all major canals, while some secondary and tertiary canals are simulated as Water Control District (WCD) waterbodies.

The MD-RSM domain was discretized with a mesh consisting of 28,990 triangular cells with maximum, average, and minimum cell sizes of 1,126 acres, 53 acres, and 0.82 acres, respectively. The model areas with highest mesh resolution are located along the protection levee, which separates the urban areas from the ENP and the Water Conservation Area 3B, and where some of the areas of interest for this study are located, including the 8.5 SMA and Frog Pond area. For computational purposes, the model was set up to run with a 15-minute time step, which still results in reasonable run times for simulation runs of one year. To cover different hydrologic conditions, the evaluation of alternatives using the MD-RSM model will be carried out using pre-determined dry, average, and wet years (refer to **Annex 7 of Appendix H**). The model domain is underlain by the Biscayne Aquifer, a highly transmissive unconfined aquifer that is part of the Surficial Aquifer System of south Florida. It is the primary groundwater resource for water supply in southeastern Florida. Within the MD-RSM conceptualization, the system is conceptualized as a single-layer, heterogeneous, unconfined aquifer in contact with an overlying surface water system, which includes wetlands and canals. The exchange of surface and ground water is a function of the hydraulic conductivity of the aquifer and the conductance of the canal bottom layer. These highly variable parameters are incorporated in the model using spatial interpolation methods that allow such high variability of parameter values.

A model is considered calibrated once the established goodness-of-fit metrics are within acceptable ranges and model parameters are within reasonable ranges for the area being simulated. Acceptable ranges for goodness-of-fit metrics are based on the intended use of the model and practical considerations, including the uncertainty associated with the hydrologic parameter data used to develop the model. The MD-RSM model was calibrated using historical stage and flow data for the year 2012 and data for the year 2008 for validation, including a total of 184 groundwater/marsh stage, 117 canal stage, and 50 canal flow monitoring stations. Groundwater and marsh stage data were collected at daily intervals, whereas stages, flows, and gate openings in the canals were collected at 15-minute intervals. The MD-RSM was not developed nor specifically calibrated for the COP project. A technical review of the MD-RSM was conducted by the CERP Interagency Modeling Center to confirm suitability of the modeling tool for the COP application.

Model calibration was carried out with the Parameter Estimation (PEST) software developed by Doherty (2008) by means of minimizing the differences between the observed and the computed stages. The calibration target to consider the calibration process acceptable was set up at ±0.5 ft. at all observation locations for stage bias and 0.5 ft for root mean square errors. Previous model calibration projects in South Florida also use similar error tolerances for calibration. Examples of such projects include the North Miami-Dade County MODFLOW for wetland and groundwater levels (Wilsnack, et al., 2000) the South Miami-Dade County MODFLOW (Restrepo et al., 2001), the Miami-Dade County RSM (Wilsnack, et al. 2006), the Biscayne Bay/C111 RSM Calibration (Arteaga, et al., 2007 and 2009), and more recently, the Glades/LECSA RSM (SFWMD, 2010b); all used similar error tolerances for stages. The set of parameters used in PEST for MD-RSM calibration includes: aquifer hydraulic conductivity, aquifer storage coefficient, canal conductance, canal roughness coefficients, levee seepage coefficients, ET Kveg, and overland flow roughness coefficients in some marsh areas. In this model calibration exercise, flows through control structures are computed using standard orifice and weir type equations, while the operations are represented by time series of observed gate openings imposed at each structure for the entire simulation period to compute the flows. A total of 124 water control structures, including spillways, pumps, weirs, and culverts, are included in the model, of which 50 are used for history matching.

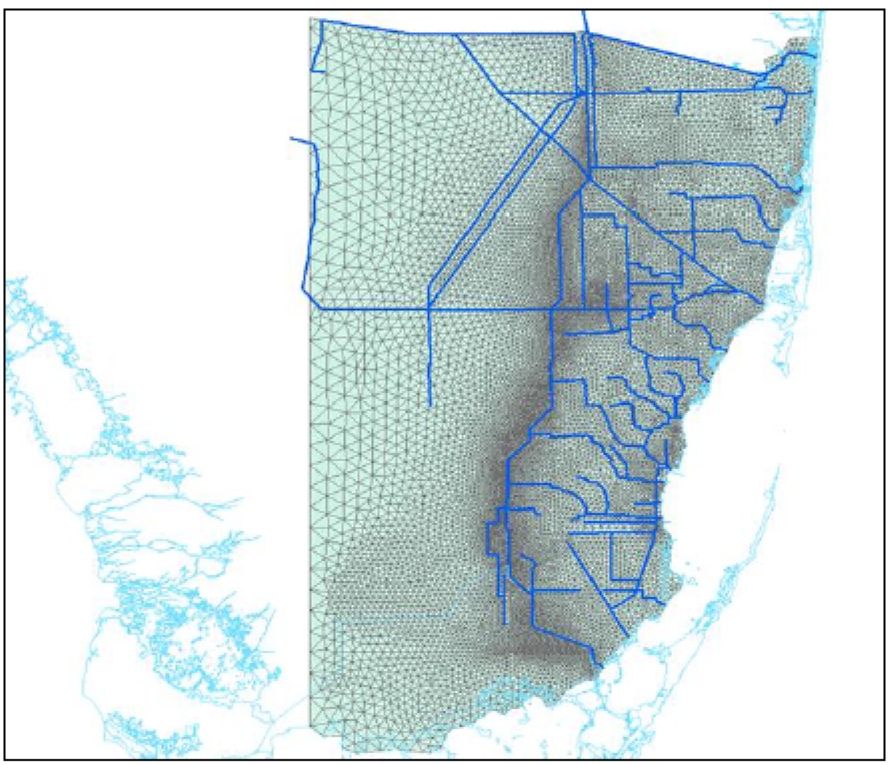


Figure H-6.1. MD-RSM Model Domain

Comprehensive documentation of the MD-RSM model development and the calibration/validation performance statistics are available in the SFWMD Calibration and Validation report completed in August

2018. The calibrated model meets the groundwater/marsh stage bias and RMSE threshold criteria at 143 of 180 (88 percent) of the gauges, and for canal stages, the criteria was met at 88 of 117 (75 percent) of the canal stage gauges. For the validation period, the bias and RMSE criteria were met at 71 percent for groundwater/marsh gauges and 58 percent of canal stage gauging stations. The calibration and validation statistics for the 8.5 SMA G-596 and G-3626 gauge locations (two 8.5 SMA gauges were used for calibration) were well within the calibration thresholds, with respective bias of 0.05-0.07 feet and RMSE of 0.39 feet. MD-RSM calibration is reasonable based on consideration of underlying parameter uncertainty and consideration of error tolerances used for other south Florida modeling applications of similar scope and scale.

The Interagency Modeling Center (IMC), under its responsibility to serve as a central point to coordinate Comprehensive Everglades Restoration Program (CERP) and CERP-related modeling activities, was consulted by the USACE COP Project Team to implement a technical review of the MD-RSM in May 2018, following SFWMD release of a draft version of the MD-RSM calibration and validation report (Arteaga, R., et al., 2018. Miami Dade County Regional Simulation Model (MDRSM) Calibration and Validation Implementation Report)**.** The purpose of the IMC technical review was to evaluate the following:

- Model objectives, conceptualization, design, and assumptions made for input data sets (e.g. topography, land use, boundary conditions, rainfall, etc.);
- Model documentation (explanation of model, data sources, and assumptions);
- Suitability of the model for its intended application with the CERP, individual CERP projects such as C-111 Spreader Canal and the CEPP and other closely-related South Florida Ecosystem Restoration planning efforts including the COP;
- Capabilities, limitations and future improvements.

The primary goals of the IMC technical review request were two-fold: (1) to ensure that the MD-RSM model was developed and implemented based on sound science and modeling principles; and (2) to determine the suitability of the MD-RSM to support formulation and evaluation of CERP, individual CERP projects such as C-111 Spreader Canal and CEPP, and other closely-related South Florida Ecosystem Restoration planning efforts including the COP.

The IMC technical review was completed in June 2018, prior to application of the MD-RSM to support the COP Round 2 formulation and subsequent hydrologic modeling. The IMC concluded that there were no major improvements needed to the MD-RSM model to support the COP project, and feedback from the IMC technical review was used to improve the documentation in the calibration and validation report, and to help inform the 8.5 SMA Robustness and Validation testing that was pursued in parallel with the COP alternative modeling application. The model appears to be adequate for evaluation of alternatives for flood mitigation, effectively simulating hydrologic effects of new structures and operational changes of existing structures for the purpose of project evaluations, and distinguishing spatial and temporal differences in surface water depths and flows from changing regulation schedule where applicable. The MD-RSM model's many strengths make it well-suited to evaluate CERP projects. Model strengths include, but are not limited to, flexible mesh allowing for high spatial resolution in areas of interest while maintaining reasonable run times, ability to represent control structure operations on a fine temporal resolution in both rules based mode and by imposing historical operations as internal boundary conditions, and the capability of simulating the full range of hydrologic conditions observed in wet, dry and in-between times. This model is a major improvement over previous regional models of the area, including the SFWMM and the RSMGL. The model weaknesses and limitations noted herein should be considered areas for potential future model refinement.

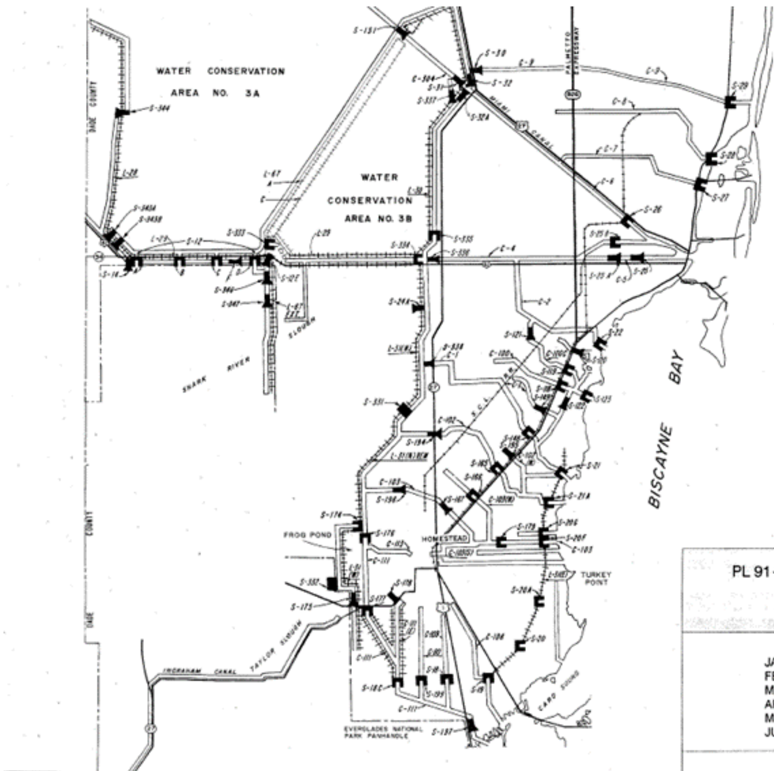
Based on recommendations from the IMC technical review and since the calibration and validation periods applied during MD-RSM development were prior to full functionality of the MWD 8.5 SMA Project following completion of the C-111 NDA, additional robustness and validation checks of the MD-RSM capability to simulate the 8.5 SMA were conducted prior to application of the MD-RSM with the COP Round 2 alternative evaluations. These additional checks are fully documented in Annex 2 of the COP EIS Hydraulics and Hydrology Appendix (Appendix H). In summary, however, the results demonstrated that the MD-RSM model can reproduce the water levels in the 8.5 SMA for the period of May 2017 to February 2018 with a bias consistent with the results of the calibrated model. The biases remain consistent with the scale of bias observed in model calibration and support our conclusion that the MDRSM provides effective representation of the 8.5 SMA for planning purposes.

H-6.3 1983 BASE CONDITION

The COP 1983 Base Condition identifies level of flood mitigation that will be maintained in the COP process. The 1983 Base Condition represents the conditions in the 8.5 SMA before MWD implementation, and is consistent with requirements from the 8.5 SMA 2000 GRR ROD. The ROD requirement that "periodic flooding of landowners east of the proposed levee, before and after project implementation, will remain unchanged ***from conditions in existence prior to implementation of the MWD Project*** except where flowage easements are required" shall be assessed by comparing the COP action alternatives against the 1983 Base Condition.

The required application of the 1983 Base Condition was previously determined during the interagency CSOP coordination in 2003. The CSOP Cooperating Agencies developed an "Overview of Purposes and Objectives" (P&O) interagency agreement to define the planning process to be utilized in selecting an operating plan in accordance with the authorized project purposes, and the COP Cooperating Agencies also endorsed the approach defined in the CSOP P&O interagency agreement. The base condition described in the 1992 MWD GDM consisted of the best estimate of the physical and operational water management system that would have existed with no modification resulting from MWD project. This condition has commonly been referred to as the "Base 83 condition" (or the 1983 Base Condition). This condition included the structural features of the South Dade Conveyance System and operational policy as they existed in 1983 and water deliveries to ENP being made in accordance with the schedule specified in PL 91-282 (Minimum Delivery Schedule, 1978 Lake Okeechobee Regulation Schedule). These 1983 Base Condition scenario does not include any operational criteria for the already constructed features of the C-111SD project modifications, nor do they include additional changes in the regional system that have occurred since these project modifications were authorized -- specifically, the implementation of the WSE schedule for Lake Okeechobee or the implementation of the STA's in the EAA area. The 1983 Base Condition assumptions include the 1978 Lake Okeechobee Regulation Schedule, the 1975-1995 WCA 1 Regulation Schedule, the 1989 WCA 2A Regulation Schedule (same as the COP 2019 ECB), the 1983 Regulation Schedule for WCA-3A, and the Minimum Deliveries Schedule for inflows to Shark River Slough, Taylor Slough and the ENP Eastern Panhandle. More recent operational changes to the WCA 3A outlet structures under the 2002 Interim Operational Plan (IOP) for Protection of the Cape Sable Seaside Sparrow and the 2012 Everglades Restoration Transition Plan (ERTP) are not included in this base condition. No MWD, C-111SD Project, or CERP features are assumed in-place for the 1983 Base Condition, including flood mitigation features for the 8.5 SMA. The S-333 gated spillway is operated only in tandem with the

S-334 gated spillway to provide water supply deliveries to the South Dade Conveyance System (SDCS). The S-331 pump station, located adjacent to the 8.5 SMA, is also operated only to convey water supply to the SDCS. Refer to **Figure H-6.2** for an overview of the 1983 Base Condition infrastructure and summary of the PL-91-282 Minimum Monthly Water Deliveries requirements for ENP, excerpted from the 1992 MWD GDM.



PL 91–282 Minimum Monthly Water Deliveries to Shark River Slough (1,000 acre–feet)

JAN	22.0	JUL	7.4
FEB	9.0	AUG	12.2
MAR	4.0	SEP	39.0
APR	1.7	OCT	67.0
MAY	1.7	NOV	59.0
JUN	5.0	DEC	32.0
TOTAL = 260.0			

PL 91–282 Minimum Monthly Water Deliveries to Taylor Slough (1,000 acre–feet)

JAN	3.2	JUL	1.1
FEB	1.3	AUG	1.8
MAR	0.6	SEP	5.5
APR	0.2	OCT	9.5
MAY	0.2	NOV	8.3
JUN	0.7	DEC	4.6
TOTAL = 37.0			

PL 91–282 Minimum Monthly Water Deliveries to Eastern Panhandle (1,000 acre–feet)

JAN	1.8	JUL	0.5
FEB	0.7	AUG	1.0
MAR	0.4	SEP	2.5
APR	0.1	OCT	4.5
MAY	0.1	NOV	3.7
JUN	0.3	DEC	2.4
TOTAL = 18.0			

Figure H-6.2. 1983 Base Condition and PL 91-282 Minimum Monthly Water Deliveries Requirements

Based on the original COP schedule requirements identified from the USFWS July 2016 Biological Opinion, which specified implementation of COP by December 2019, the COP hydrologic modeling strategy (Appendix H, Annex 1) determined that the 1983 Base Condition would only be developed for the MD-RSM model, rather than also including representation of the base condition in the RSM-GL model. Since the RSM-GL model only was applied during the COP Round 1 alternative modeling (screening phase), the MD-RSM 1983 Base Condition was applied only to support the Round 2 and Round 3 alternative evaluations. With the availability of the CSOP regional hydrologic modeling 1983 Base Condition from the South Florida Water Management Model (SFWMM), SFWMM water level data from Water Conservation Area 3A (WCA 3A) was used provide upstream boundary conditions to the MD-RSM northern (I-75) and western boundary (L-28/Mullet Slough). Limitations with the SFWMM simulation period-of-record (1965-2000) required extrapolation of the boundary condition stages by the IMC using methods applied for prior CERP regional modeling applications.

The assumptions for the 1983 Base Condition, including a summary table (side-by-side comparison of key COP operational components versus the 2019 ECB and the 1994 GRR Base Condition) and a detailed structure-by-structure operational table are provided in Appendix H, Annex 3.

H-6.4 8.5 SMA Performance Metrics

Performance measures were established by the USACE to assess the flood mitigation constraint for the 8.5 SMA. Performance measures consider rainfall accumulation/durations, recession rate, inundation duration, and antecedent conditions, consistent with model-based analysis applied for MWD 2000 8.5 SMA GRR (conducted using MODBRANCH). The COP Flood Risk Evaluation Methodology Metrics and Targets (listed below) were described and coordinated with the COP Flood Risk Sub-team, and detailed in the COP Flood Risk Evaluation Methodology summary completed in June 2018, which was briefed to the COP PDT prior to the Round 1 alternative modeling.

(1) Maintain Peak Stages within 8.5 SMA

a. Metric: Change in the number of acres during a wet year (Water Year 2006) where flood mitigation is maintained at or below the 1983 Base condition wet year (Water Year 2006) peak stages. The period 20-24 June 1995 was a naturally occurring 1-in-10 year rainfall event (5-day duration) cited in the 8.5 SMA Final GRR for MODBRANCH modeling evaluations, and the period 1-7 July 1995 (week 26) had the highest ground water stages found during 1995. A comparable analysis of the Water Year 2006 rainfall time series for 8.5 SMA will be used to identify a 5-day naturally occurring rainfall event with a comparable rainfall volume for use with the MD-RSM model.

b. Target: Areas within the L-357 protective levee will not have an increase in flooding impacts as specified by the 1983 Base condition.

c. Comparison Points: Base 83 Planning Condition (Round 2), ECB2019 (Round 1, Round 2)

d. Model: RSM-GL (Round 1), MD-RSM (Round 2)

e. Notes: Evaluation period for Water Year 2006 needs to be established (Water Year 2006 was selected in late April 2018 by the MD-RSM development team); for performance screening during Round 1, peak stages during selected wet years within the RSM-GL period of record (1965-2005) will be evaluated.

(2) Maintain Hydroperiods within 8.5 SMA

a. Metric: Hydroperiod at specified indicator locations during wet (Water Year 2006), dry (Water Year 2011), and average (Water Year 2007) years.

b. Target: Indicator locations within the L-357 protective levee will not have an increase in hydroperiod as specified by the 1983 Base condition.

c. Comparison Points: Base 83 Planning Condition (Round 2), ECB2019 (Round 1, Round 2)

d. Model: RSM-GL (Round 1), MD-RSM (Round 2)

e. Notes: For performance screening during Round 1, 8.5 SMA average hydroperiods inside the L-357 protective levee will be compared for all years in the RSM-GL period of record (1965-2005).

(3) Consecutive Days of Inundation within 8.5 SMA

a. Metric: Consecutive days of inundation: number of consecutive days where the stage is above the ground surface elevation and number of days where the stage is greater than 18" above the ground surface elevation.

b. Target: Areas within the L-357 protective levee will not have an increase in consecutive days of inundation as specified by the 1983 Base condition.

c. Model Comparison: Base 83 Planning Condition (Round 2), ECB2019 (Round 1, Round 2)

d. Model: RSM-GL (Round 1), MD-RSM (Round 2)

e. Notes: For performance screening during Round 1, surface water inundation events for representative 8.5 SMA indicator cells inside the L-357 protective levee will be compared for all events in the RSM-GL period of record (1965-2005).

Each of the alternatives considered, as well as the base conditions, were simulated with the same modeling tools. The model bias and RMSE applies equivalently across the simulations, and plan selection was based on relative comparisons between the broad range of alternatives considered during Round 1 and Round 2 modeling evaluations. In addition to the screening level assessment of constraint requirements during Round 1, a full assessment of the flood risk management constraints was conducted during Round 2 evaluations (refer to **Section H-6.5**) leveraging the MD-RSM simulation results. Round 3 modeling (refer to **Section H-6.6**) was used to optimize performance of project objectives and compliance with the project constraints, based on the top-performing alternative from Round 2. COP Plan selection is based on evaluations and constraint checks conducted using both RSM-GL and MD-RSM, based on relative comparisons between the alternatives and base conditions, not based on absolute model predictions.

H-6.5 8.5 SMA Evaluations of Round 2 Alternatives

The 8.5 SMA is located approximately 7.5 miles south of the L-29 Canal that provides the primary source of COP inflows to NESRS, immediately south of the 1-mile MWD Eastern Bridge. The 8.5 SMA location and the primary flood mitigation components are shown in **Figure H-6.3** and **Figure** H-6.4.

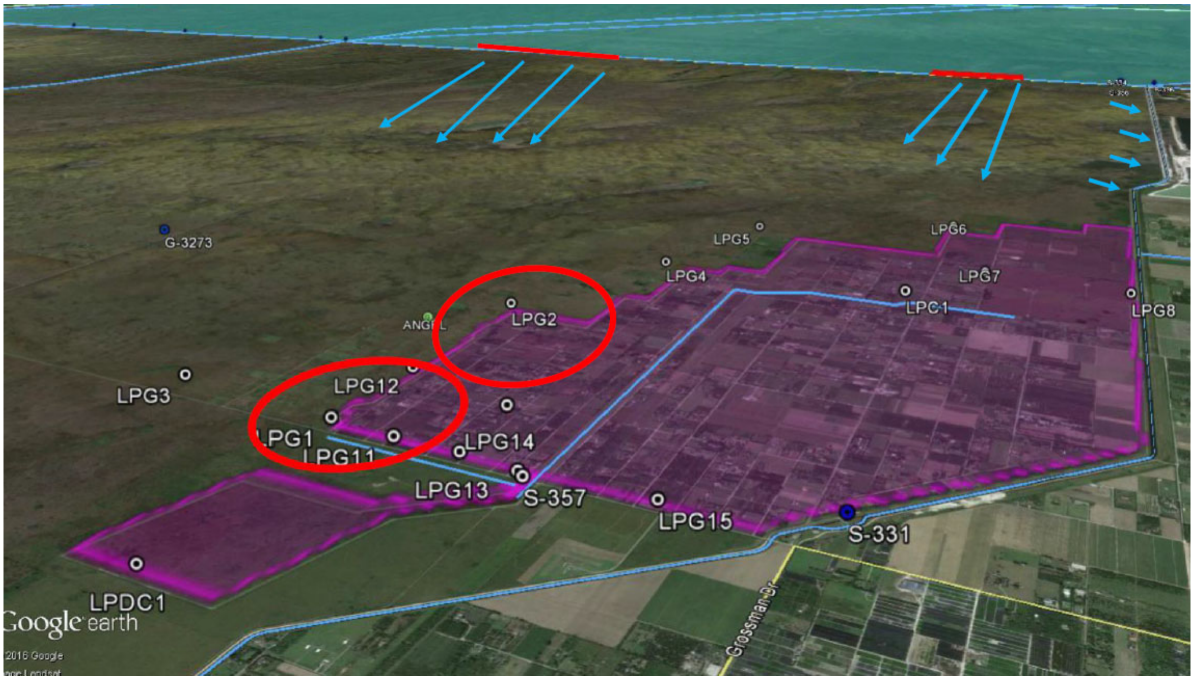


Figure H-6.3. 8.5 SMA Location Map

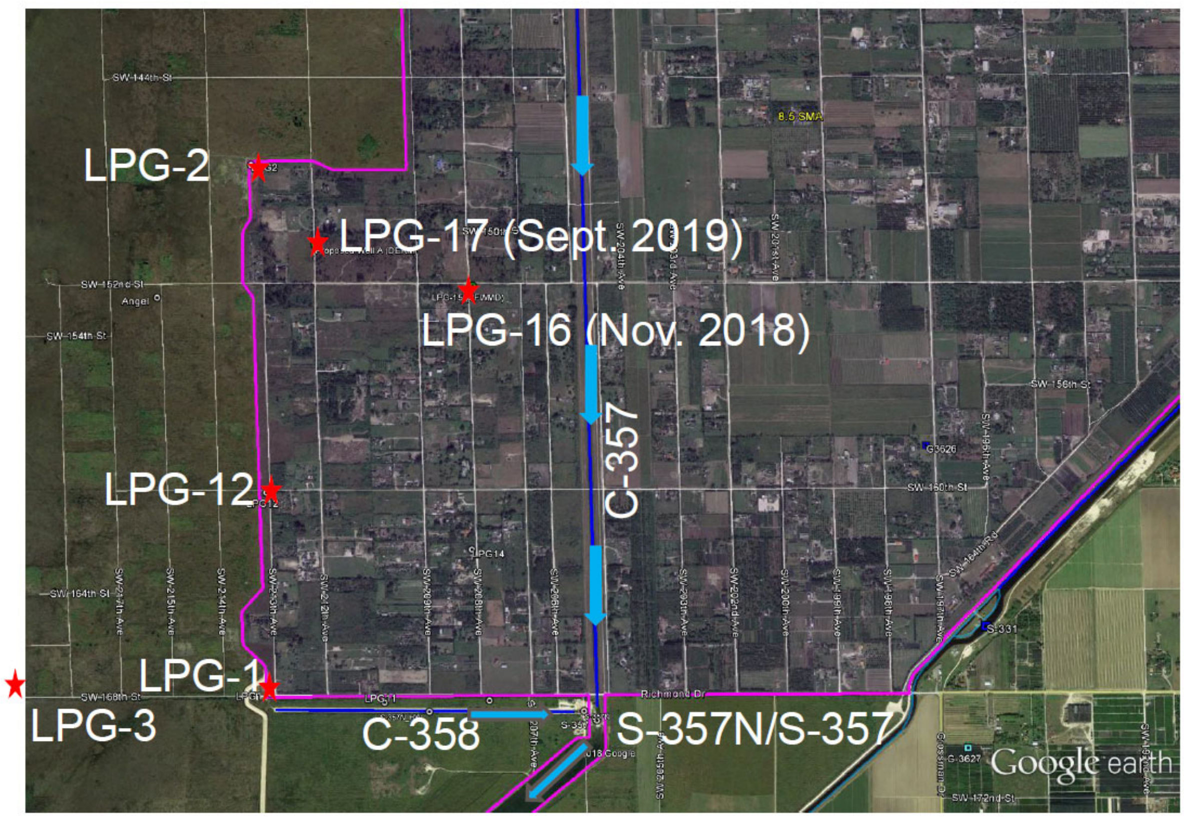


Figure H-6.4. 8.5 SMA Southwest Flood Mitigation Features Map

With the increased deliveries into NESRS, water levels within the ENP wetlands immediately west of 8.5 SMA are inundated for approximately 150 more days, or 40% of the MD-RSM wet year 2006 (Water Year extending from May 2005 through April 2006). Representative stage duration curves for Water Year 2006 are shown in **Figure H-6.5** for G-3273 (located 2.3 miles west of the 8.5 SMA), **Figure H-6.6** for LPG-3 (located 0.7 miles west of the 8.5 SMA), and **Figure H-6.7** for Angel's Monitoring Well (located 0.25 miles west of the 8.5 SMA). The hydroperiod, or total number of days with water depths above ground during a year, were computed for the wet year (Water Year 2006), dry year (Water Year 2011), and average year (Water Year 2005) for each location. In order to evaluate potential changes in groundwater depths below ground, hydroperiods were also computed for theoretical hydroperiod depths of 3 inches and 6 inches below the ground surface elevation. Hydroperiod bar graphs for the wet, dry, and average MD-RSM simulation years, including the 3 inch and 6 inch theoretical hydroperiod surfaces, are summarized on **Figure H-6.8** for LPG-3 and **Figure H-6.9** for Angel's Monitoring Well for each of the COP Base Conditions and Round 2 Alternatives. The stage hydrograph for the ENP Angel's Monitoring Well 2005-2006 wet year is shown as **Figure H-6.10,** which illustrates: (1) compared to the 1983 Base Condition, elevated water stages within NESRS associated with MWD implementation of increased inflow volumes and prolonged inflow durations (ECB 2019, ALT N2, and ALT O); (2) compared to the 1983 Base Condition, increased peak stages following significant rainfall events such as Hurricane Katrina in August 2005 (2-day rainfall amount of 9.5 inches) due to higher antecedent stage conditions and reduced groundwater storage capacity; and (3) compared to all other base conditions and Round 2 alternatives, the 1994 GRR Base Condition stages are consistently 0.5-1.25 feet higher throughout the wet season months (the 1994 GRR assumed the original 1992 MWD GDM Plan, including maximum L-29 Canal stages up to 9.7 feet NGVD and the western perimeter seepage collection canal for the 8.5 SMA).

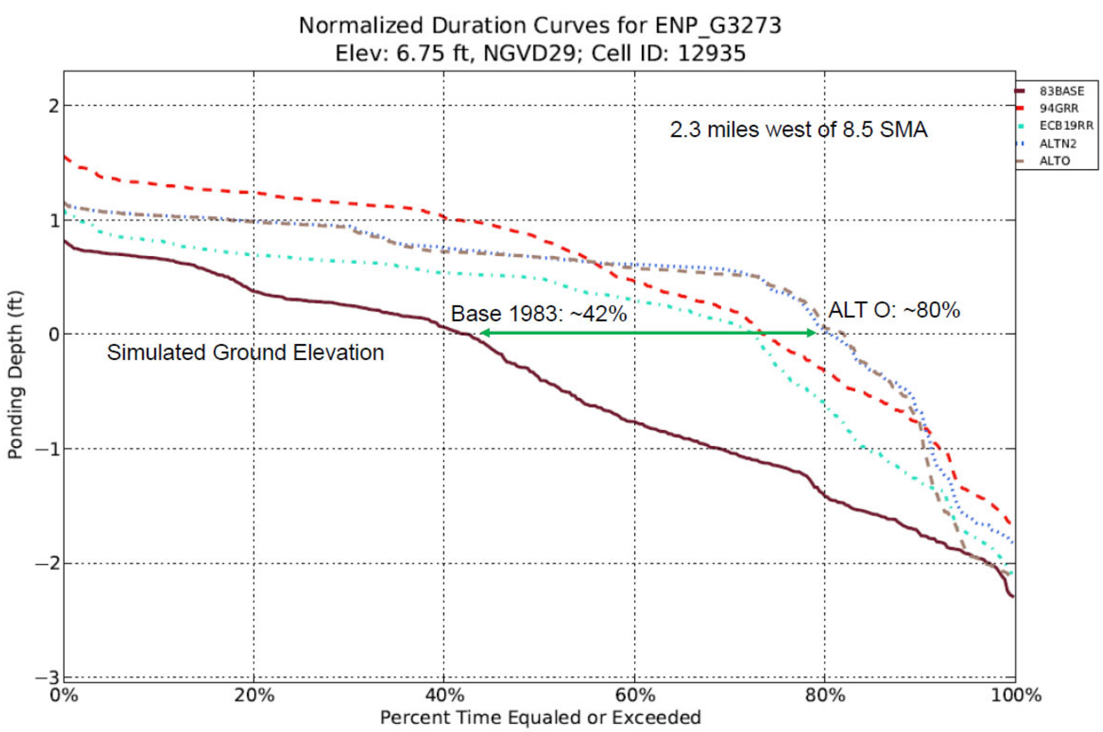


Figure H-6.5. MD-RSM Stage Duration Curves for COP Base Conditions and Round 2 Alternatives, 2005-2006 Wet Year at G-3273

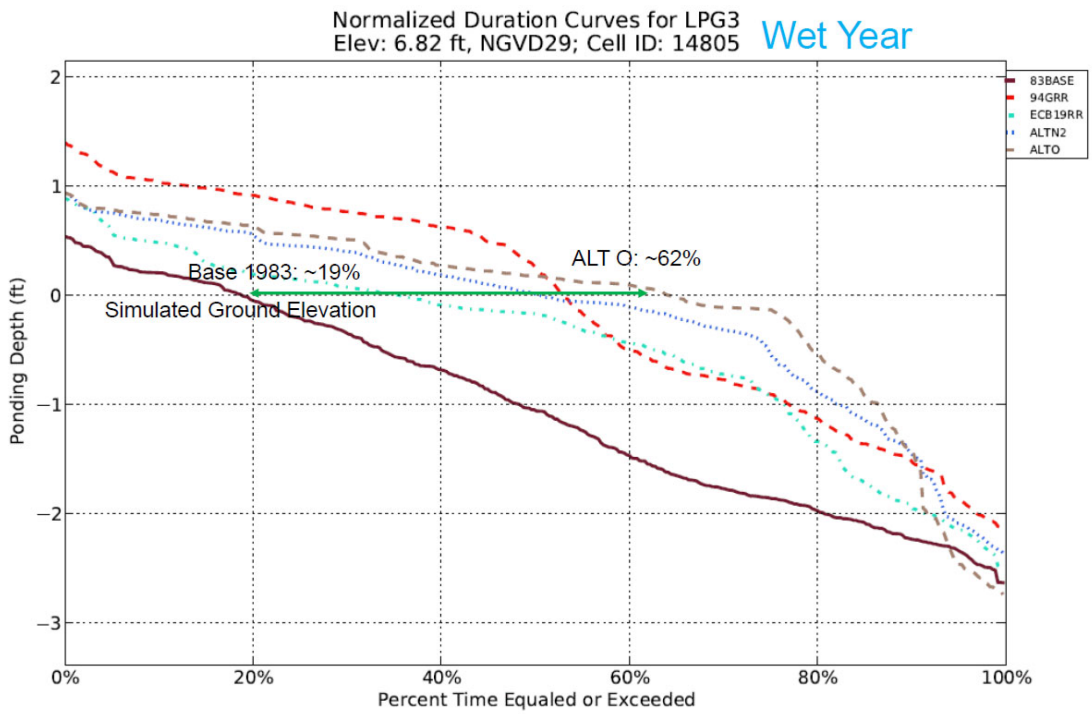


Figure H-6.6. MD-RSM Stage Duration Curves for COP Base Conditions and Round 2 Alternatives, 2005-2006 Wet Year at LPG-3

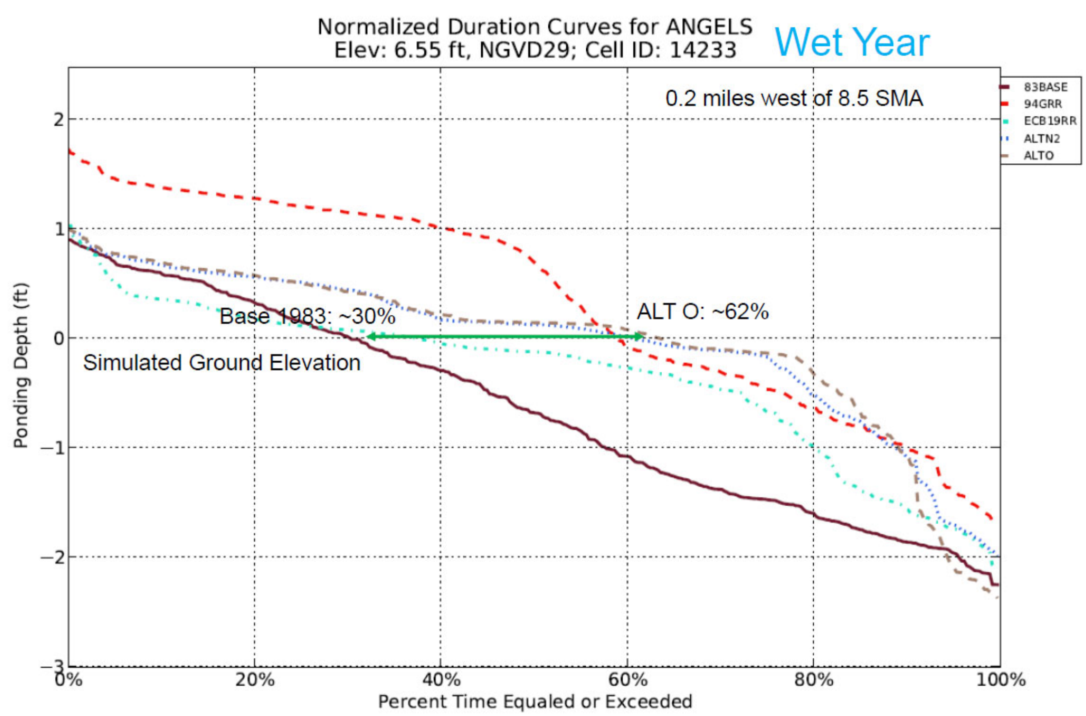


Figure H-6.7. MD-RSM Stage Duration Curves for COP Base Conditions and Round 2 Alternatives, 2005-2006 Wet Year at Angel's Well

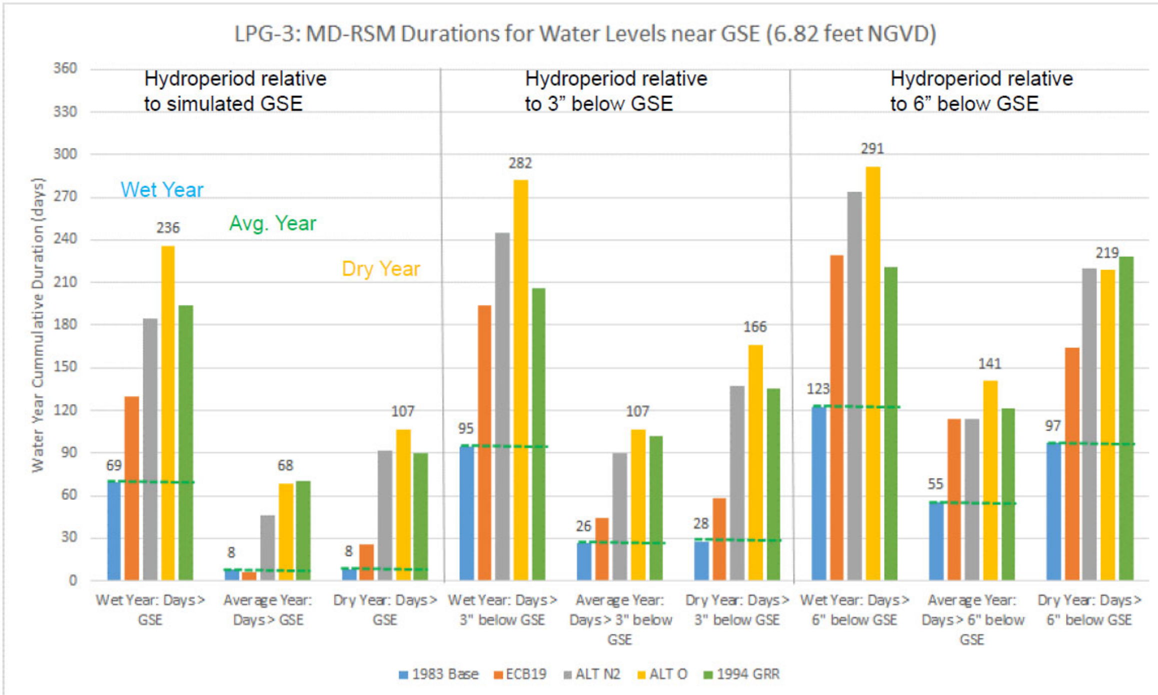


Figure H-6.8. Hydroperiod bar graphs for the wet, dry, and average MD-RSM simulation years for the COP Base Conditions and Round 2 Alternatives at LPG-3, including hydroperiod referenced against ground surface elevation and the 3 inch and 6 inch theoretical hydroperiod surfaces

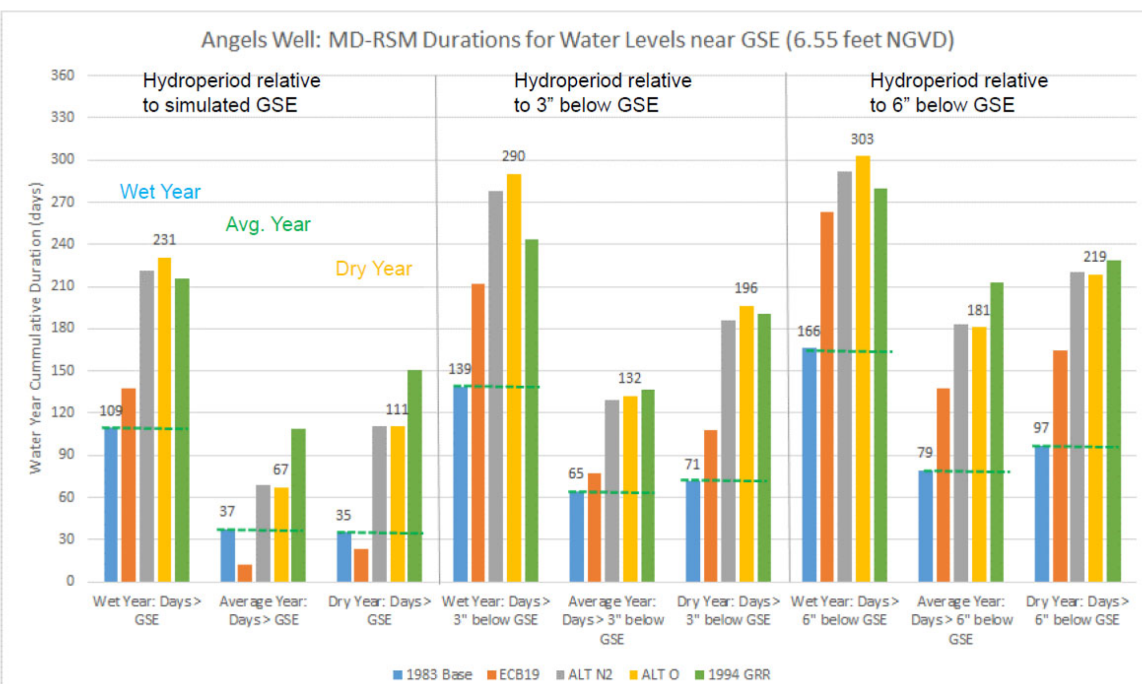


Figure H-6.9. Hydroperiod bar graphs for the wet, dry, and average MD-RSM simulation years for the COP Base Conditions and Round 2 Alternatives at Angel's Well, including hydroperiod referenced against ground surface elevation and the 3 inch and 6 inch theoretical hydroperiod surfaces

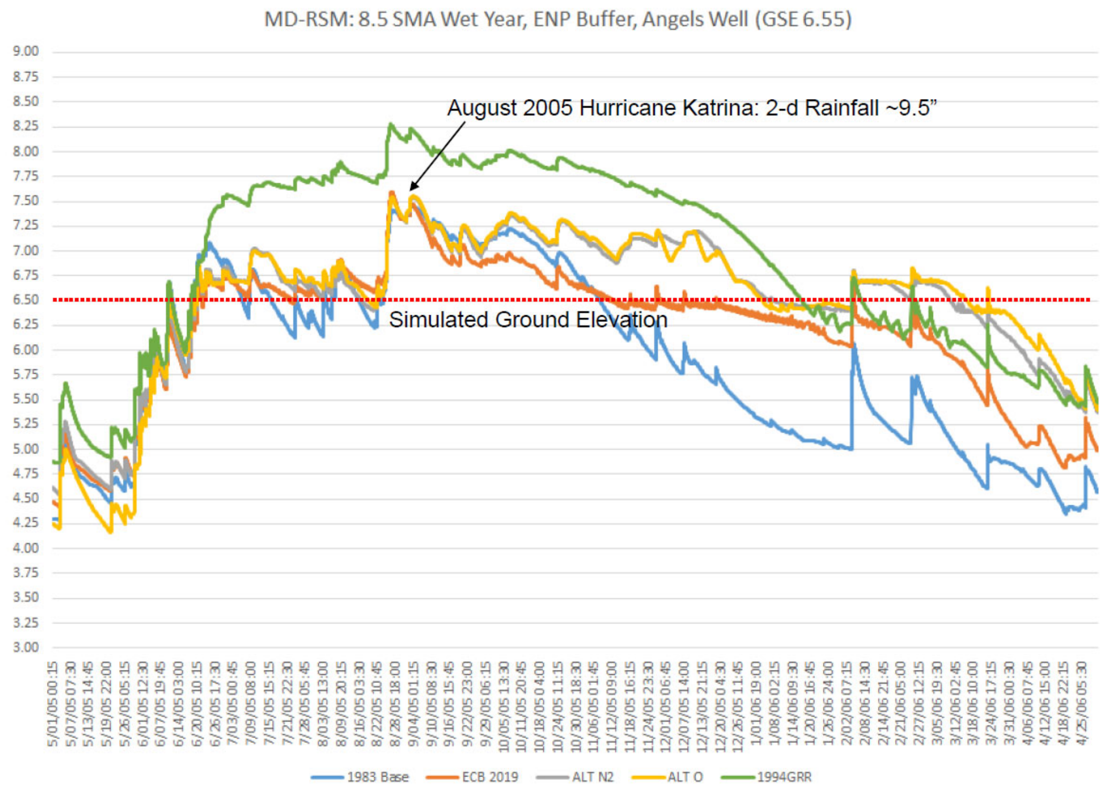


Figure H-6.10. MD-RSM Stage Hydrographs for COP Base Conditions and Round 2 Alternatives, 2005-2006 Wet Year at Angel's Well

Based on the 2000 8.5 SMA GRR ROD requirement that "periodic flooding of landowners east of the proposed levee, before and after project implementation, will remain unchanged ***from conditions in existence prior to implementation of the MWD Project*** except where flowage easements are required," all 8.5 SMA locations within the interior of the 8.5 SMA flood mitigation levee are assessed by comparing the COP action alternatives against the 1983 Base Condition. The existing groundwater monitoring wells located east of the C-357 western perimeter levee are shown on **Figure H-6.3** and **Figure** H-6.4.

Similar to the evaluation approach used with MODBRANCH during development of the 2000 8.5 SMA GRR Plan and repeated during the CSOP evaluations, a performance measure was developed to display the MD-RSM peak stages across all model grid cells within the 8.5 SMA interior mitigation area. The 8.5 SMA interior mitigation area was divided into five sub-areas based on the location of the 8.5 SMA interior C-357 Canal and land use: (1) Flowage Easement, North of the C-357 Canal (publicly-owned lands with no limitation of inundation depth and duration, shown in purple); (2) North of C-357 Canal (shown in dark blue); (3) West of C-357 Canal (including LPG-1, LPG-2, LPG-12, LPG-16, and LPG-17, shown in orange); (4) C-357 Canal (grid cells which include the C-357 Canal, shown in green); and (5) East of C-357 Canal (lands between the C-357 Canal and the L-31N Canal, which receive flood mitigation benefits from both the S-357 and S-331 pump stations). For each MD-RSM simulation water year (wet, dry, or average), the annual peak stage is computed for each interior mitigation area grid cell (with an associated grid cell acreage), compared against the LiDAR-based average grid cell elevation, and classified into a depth bin ranging in 0.1 foot increments from >0.1 feet to >1.0 feet. The sub-areas within the 8.5 SMA interior mitigation area are shown in **Figure H-6.11**, which included a side-by-side comparison of the sub-areas used for the Pennsuco-Dade-Monroe (PDM) MODBRANCH application (top panel) and the COP MD-RSM application (bottom panel). The 8.5 SMA peak stage performance measure results for the Round 2 alternatives (ALT N2; ALT O) during the 2005-2006 wet year, including comparison versus the 2019 ECB (ECB19RR), 1983 Base Condition (83Base), and the 1994 GRR Base Condition (94GRR) are shown in the following figures for each sub-area: **Figure H-6.12** (flowage easement), **Figure H-6.13** (North of C-357), **Figure H-6.14** (West of C-357), **Figure H-6.15** (C-357 Canal), and **Figure H-6.16** (East of C-357). The initial evaluations of the Round 2 alternatives indicated that the peak stages within the 8.5 interior flood mitigation area for both COP action alternatives were consistently lower than the 1983 Base Condition for all depth classifications across all sub-areas, except for within the Flowage Easement sub-area that is not constrained by flood mitigation performance requirements as this area is already publicly-owned.

Stage duration curves within the sub-area West of C-357 are shown in **Figure H-6.17** for LPG-2, **Figure H-6.18** for LPG-12, and **Figure H-6.19** for LPG-17, as these areas warranted a detailed evaluation given the recurrent water management challenges observed within this sub-area during the MWD Incremental field test operations. The hydroperiod, or total number of days with water depths above ground during a year, were computed for the wet year (Water Year 2006), dry year (Water Year 2011), and average year (Water Year 2005) for each location. In order to evaluate potential changes in groundwater depths below ground, hydroperiods were also computed for theoretical hydroperiod depths of 3 inches and 6 inches below the ground surface elevation. Hydroperiod bar graphs for the wet, dry, and average MD-RSM simulation years, including the 3 inch and 6 inch theoretical hydroperiod surfaces, are summarized on **Figure H-6.20** for LPG-2 and **Figure H-6.21** for LPG-17 for each of the COP Base Conditions and Round 2 Alternatives. The figures indicate compliance with the 8.5 SMA flood mitigation constraint for hydroperiod duration (water year duration less than the 1983 Base Condition) at both locations, but the figures also show the Round 2 alternatives as having increased frequency of groundwater conditions within 3 inches (LPG-2) and 6 inches of ground surface elevation (LPG-2 and LPG-17). The stage hydrograph for the LPG-2 2005-2006 wet year is shown as **Figure H-6.22**, which illustrates: (1) compared to the 1983 Base Condition, elevated water stages at LPG-2 associated with MWD implementation of increased inflow volumes and prolonged inflow durations (ECB 2019, ALT N2, and ALT O); (2) compared to the 1983 Base Condition, a slight increase in peak stages following significant rainfall events such as Hurricane Katrina in August 2005 (2-day rainfall amount of 9.5 inches); (3) Compared to the 1983 Base Condition, the COP Round 2 alternatives and the 2019 ECB demonstrate a significant increased drainage rate and a significantly reduced duration with stages above ground given the ability to leverage the C-357/C-358 Canals and use of the S-357 pump station; (4) the COP Round 2 alternatives experience secondary events later in the wet season, where water levels temporarily rise above ground in response to moderate rainfall events due to the persistently higher groundwater stages with COP implementation; and (5) compared to all other base conditions and Round 2 alternatives, the 1994 GRR Base Condition stages are consistently 0.5-1.0 feet lower at LPG-2 throughout the wet season months due to the assumed western perimeter seepage collection canal for the 8.5 SMA and the larger S-357 pump station assumed to discharge directly in the L-31N Canal. Throughout the hydrologic monitoring with the MWD Incremental field test, the use of the LPG-2 ground surface elevation (approximately 6.7 feet NGVD) as a flood mitigation metric for 8.5 SMA inundation duration has been recognized by the USACE as a conservative criteria since the aerial topographic survey indicates this location as approximately 0.25-0.50 feet lower than most of the adjacent developed property (refer to Figure H-6.23). During the field test, USACE installed two additional monitoring wells at LPG-16 and LPG-17 to supplement the previously available groundwater data at LPG-2 and LPG-12 (refer to the maps on **Figure H-6.3** and **Figure** H-6.4); the new monitoring locations were fully instrumented and ground-surveyed in September 2019, although the data is not available in real-time (monthly downloads only). With the continued monitoring under the Increment 2 field test, the USACE will continue to consider adjustments to the flood mitigation criteria at LPG-2, such as using a hydroperiod duration criteria relative to a more representative elevation for this portion of the 8.5 SMA interior mitigation area.

The 1994 GRR assumed infrastructure is shown in **Figure H-6.24**, for reference; additional details regarding the 1994 GRR assumptions are provided in Appendix H, Annex 3.

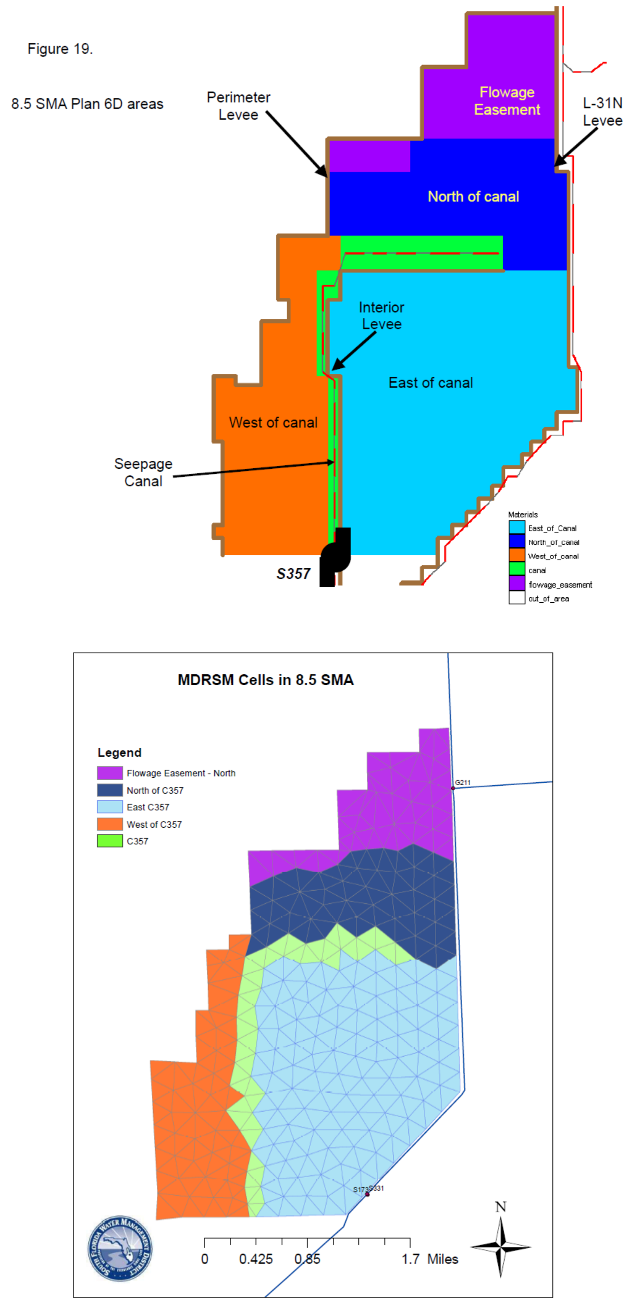


Figure H-6.11. MD-RSM Model Element Resolution for 8.5 SMA, with 8.5 SMA Basin Sub-Areas Delineated for Flowage Easement (purple), North of C-357 (dark blue), West of C-357 (orange), East of C-357 (light blue), and adjacent to C-357 (green). MODBRANCH model 8.5 SMA Basin Sub-Areas are Indicated on the Top Panel, for Reference.

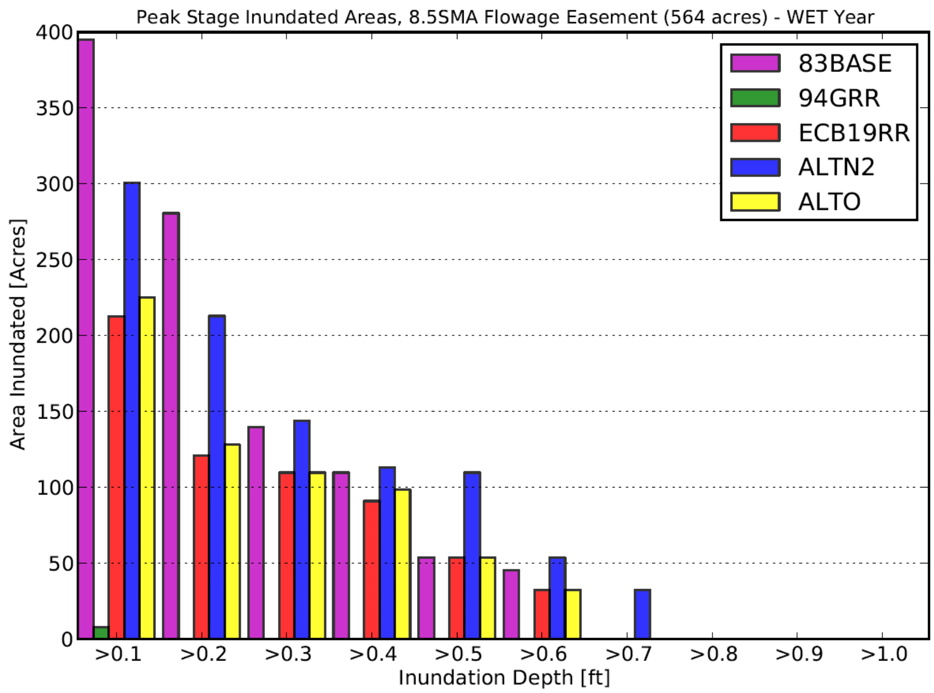


Figure H-6.12. MD-RSM Peak Stage Inundation Areas for 8.5 SMA Flowage Easement Sub-Basin with Depth Classifications Ranging from Greater than 0.1 feet up to Greater than 1.0 feet (0.1 foot Increments), COP Base Conditions and Round 2 Alternatives in the 2005-2006 Wet Year

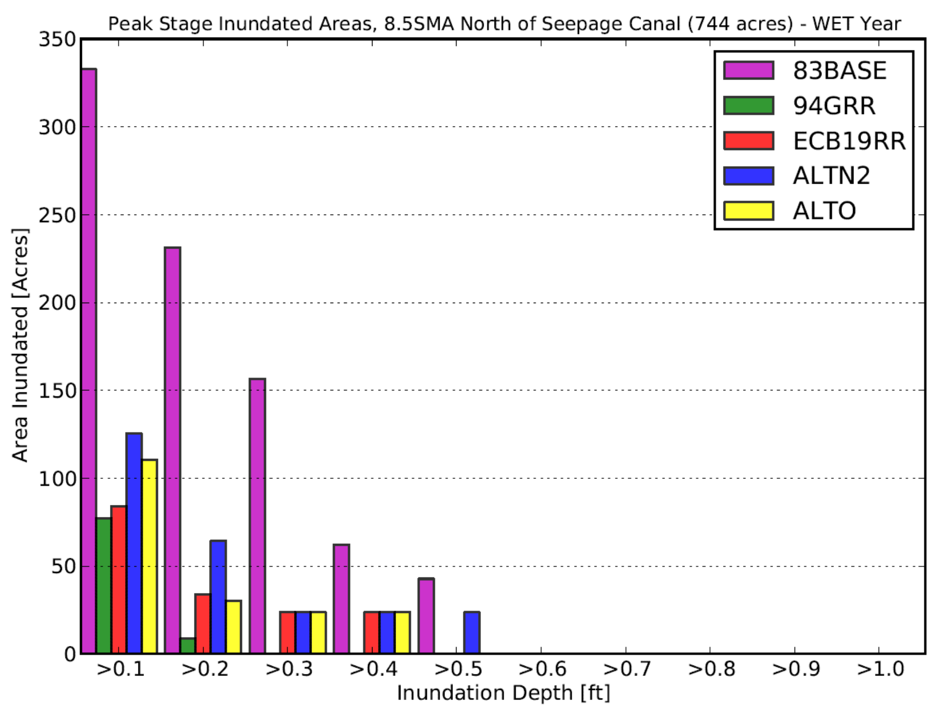


Figure H-6.13. MD-RSM Peak Stage Inundation Areas for 8.5 SMA North of C-357 Sub-Basin with Depth Classifications Ranging from Greater than 0.1 feet up to Greater than 1.0 feet (0.1 foot Increments), COP Base Conditions and Round 2 Alternatives in the 2005-2006 Wet Year

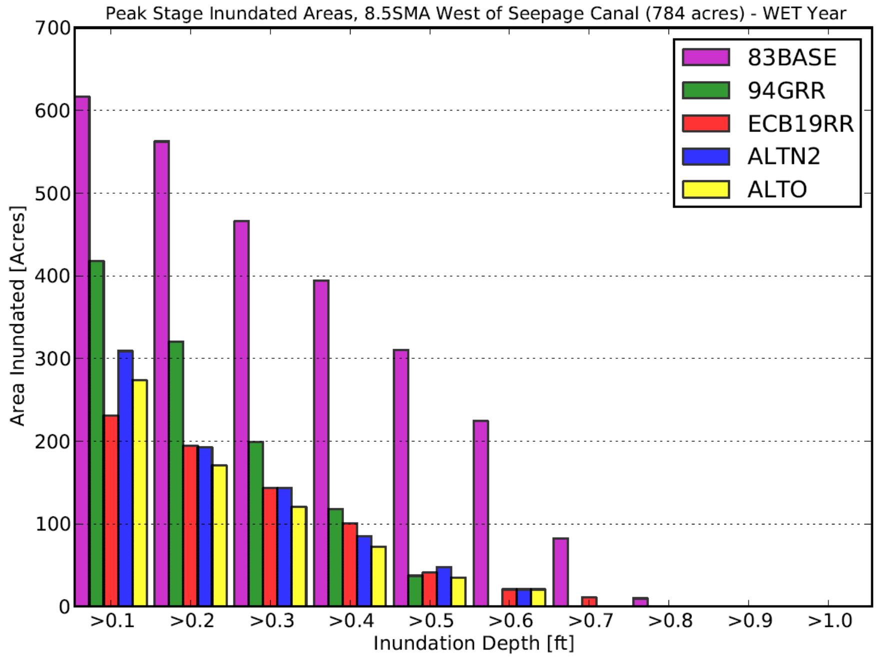


Figure H-6.14. MD-RSM Peak Stage Inundation Areas for 8.5 SMA West of C-357 Sub-Basin with Depth Classifications Ranging from Greater than 0.1 feet up to Greater than 1.0 feet (0.1 foot Increments), COP Base Conditions and Round 2 Alternatives in the 2005-2006 Wet Year

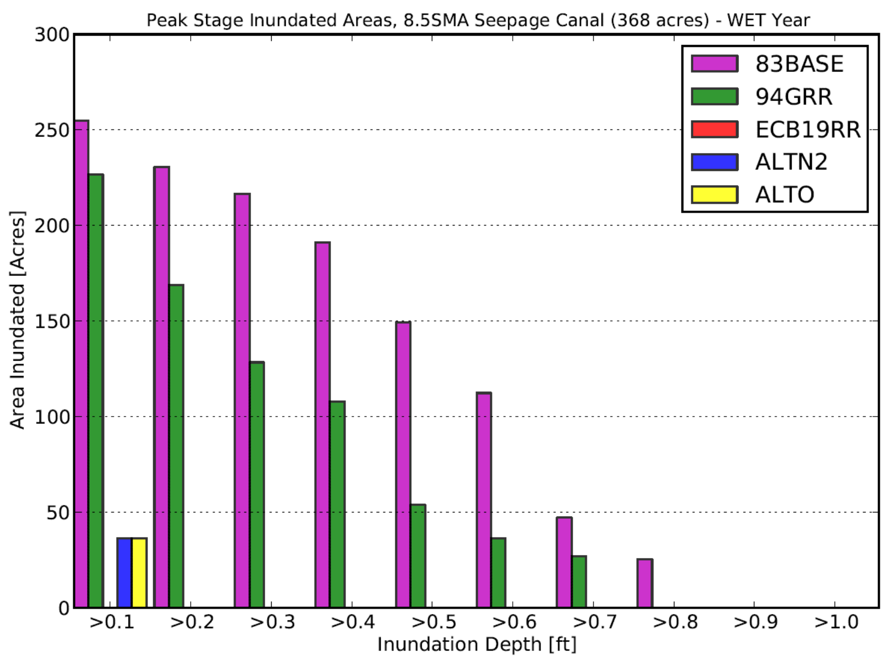


Figure H-6.15. MD-RSM Peak Stage Inundation Areas for 8.5 SMA C-357 Canal Sub-Basin with Depth Classifications Ranging from Greater than 0.1 feet up to Greater than 1.0 feet (0.1 foot Increments), COP Base Conditions and Round 2 Alternatives in the 2005-2006 Wet Year

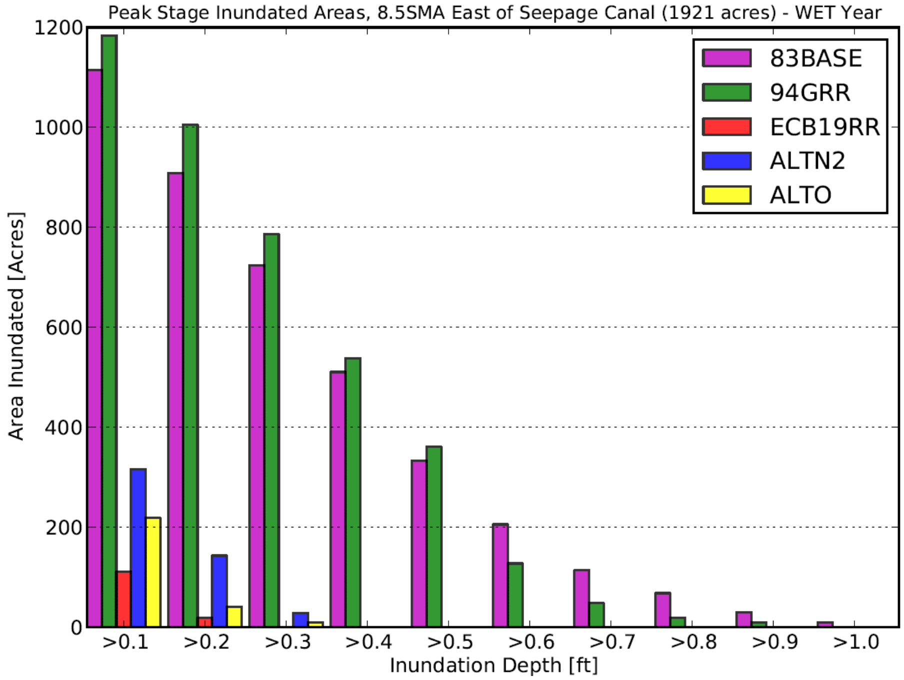


Figure H-6.16. MD-RSM Peak Stage Inundation Areas for 8.5 SMA East of C-357 Sub-Basin with Depth Classifications Ranging from Greater than 0.1 feet up to Greater than 1.0 feet (0.1 foot Increments), COP Base Conditions and Round 2 Alternatives in the 2005-2006 Wet Year

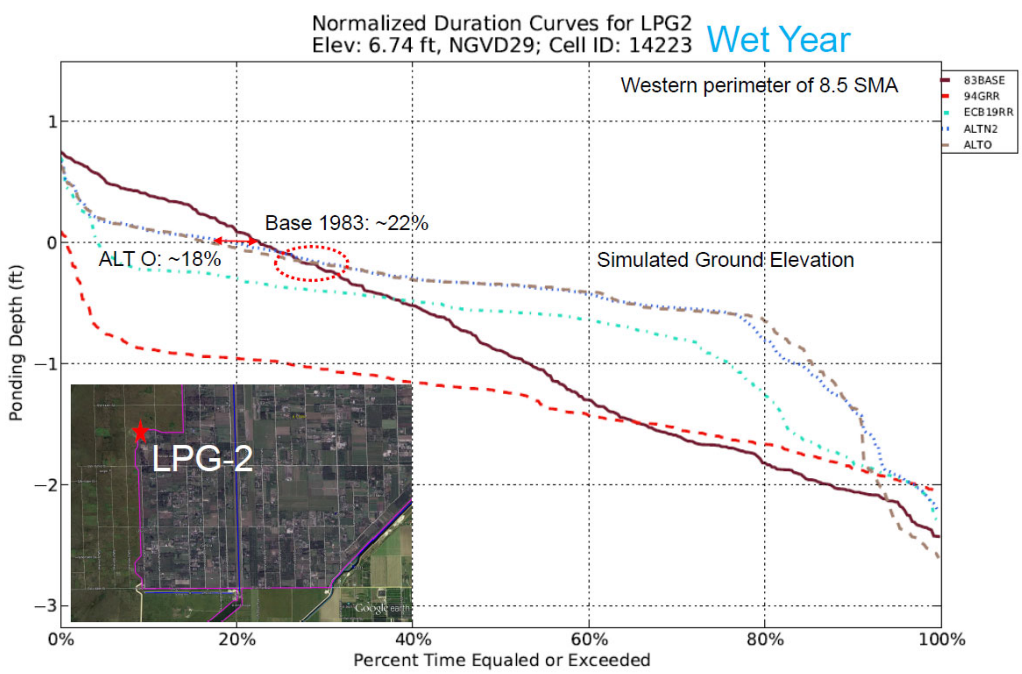


Figure H-6.17. MD-RSM Stage Duration Curves for COP Base Conditions and Round 2 Alternatives, 2005-2006 Wet Year at LPG-2

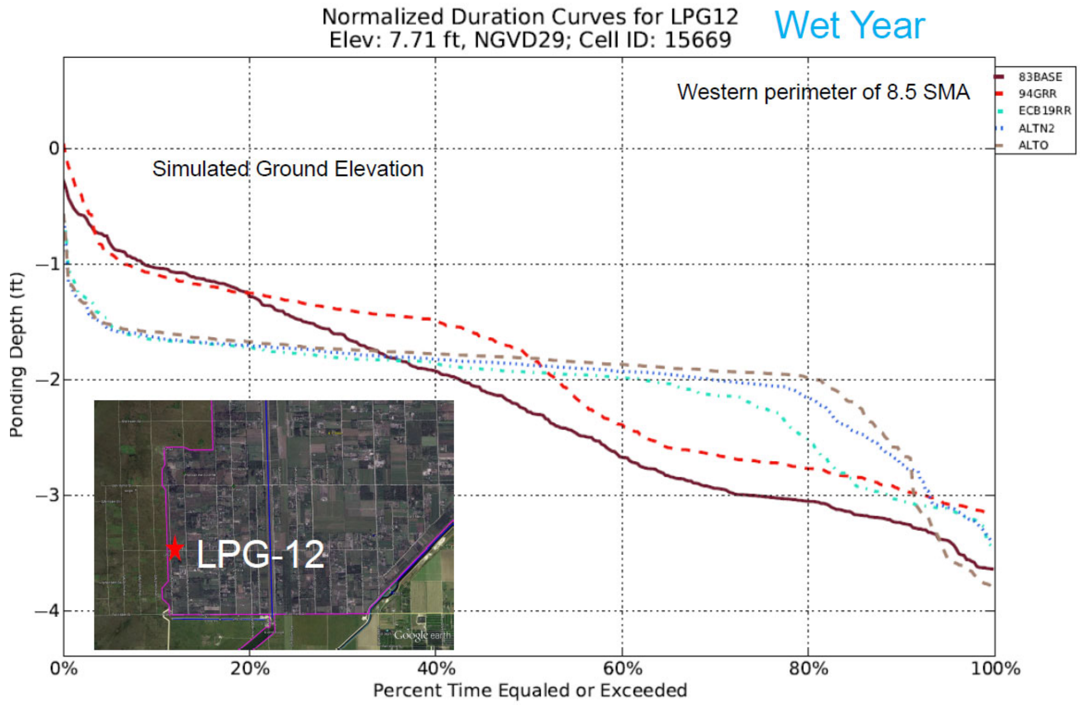


Figure H-6.18. MD-RSM Stage Duration Curves for COP Base Conditions and Round 2 Alternatives, 2005-2006 Wet Year at LPG-12

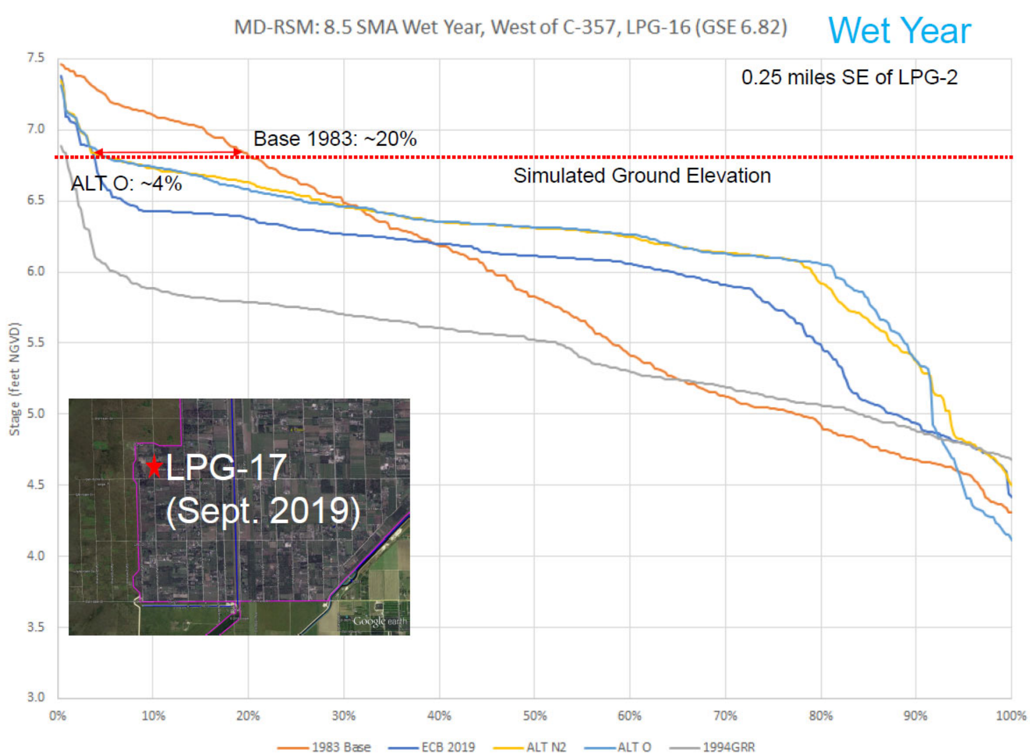


Figure H-6.19. MD-RSM Stage Duration Curves for COP Base Conditions and Round 2 Alternatives, 2005-2006 Wet Year at LPG-17

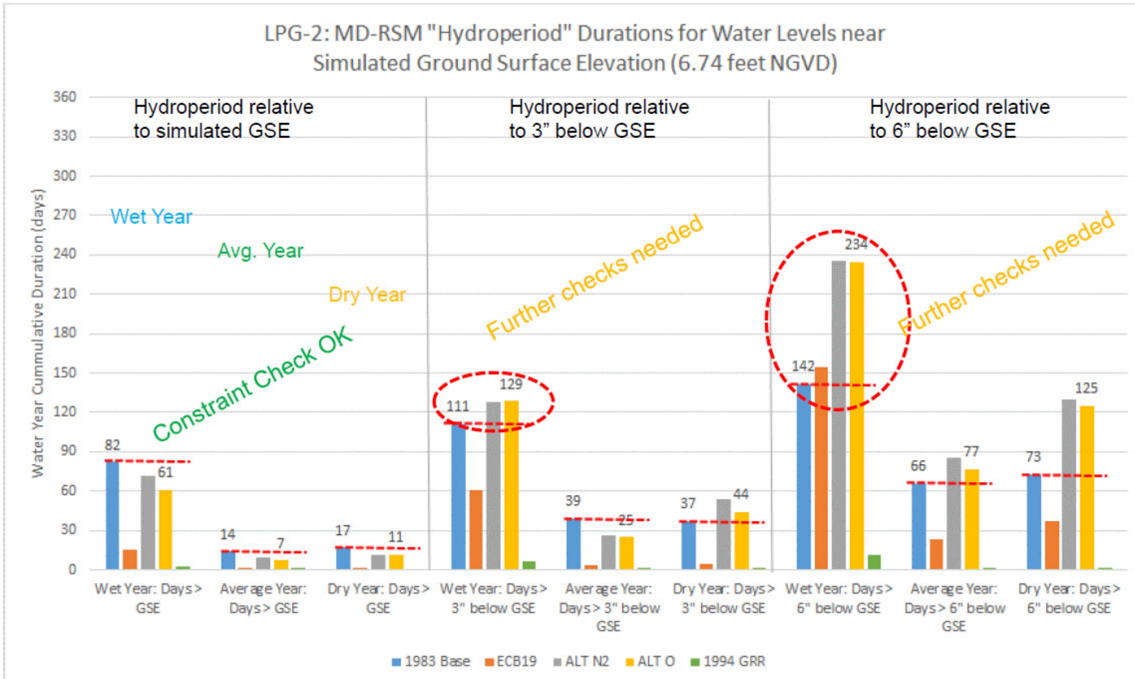


Figure H-6.20. Hydroperiod bar graphs for the wet, dry, and average MD-RSM simulation years for the COP Base Conditions and Round 2 Alternatives at LPG-2, including hydroperiod referenced against ground surface elevation and the 3 inch and 6 inch theoretical hydroperiod surfaces

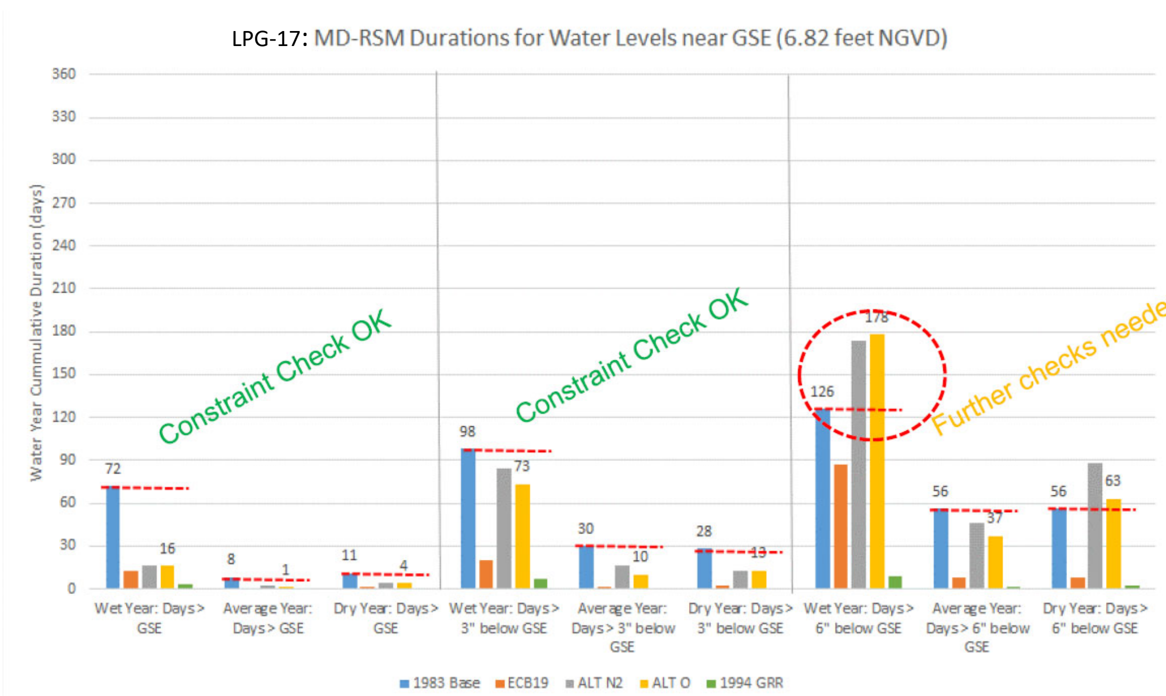


Figure H-6.21. Hydroperiod bar graphs for the wet, dry, and average MD-RSM simulation years for the COP Base Conditions and Round 2 Alternatives at LPG-17, including hydroperiod referenced against ground surface elevation and the 3 inch and 6 inch theoretical hydroperiod surfaces

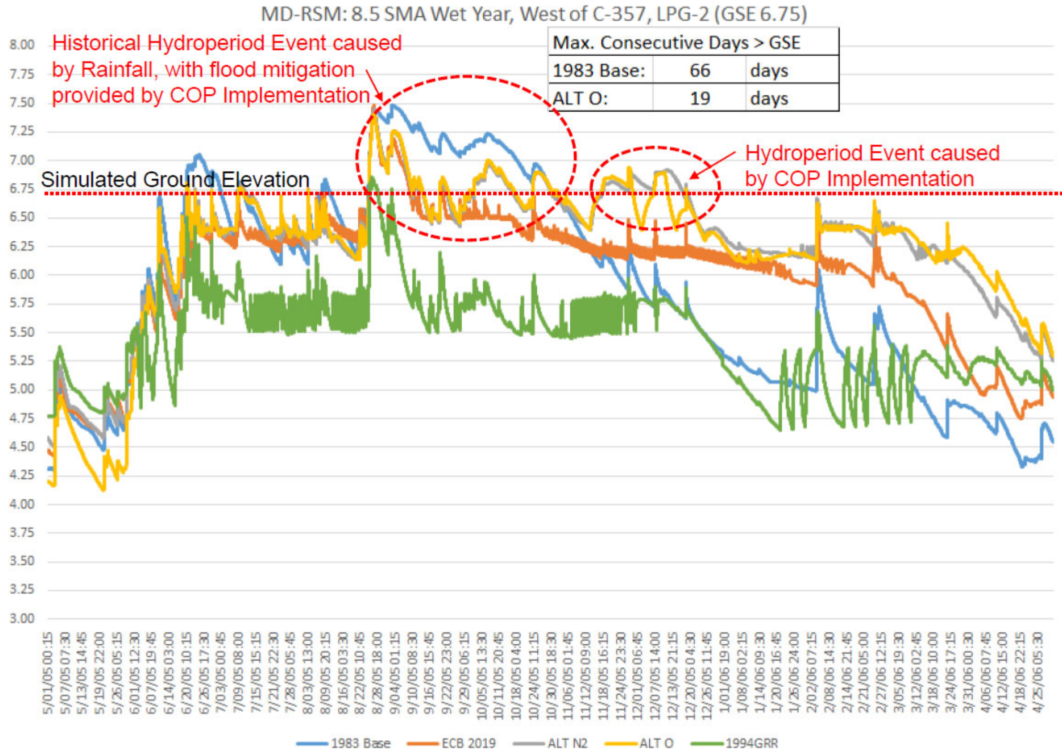


Figure H-6.22. MD-RSM Stage Hydrographs for COP Base Conditions and Round 2 Alternatives, 2005-2006 Wet Year at LPG-2

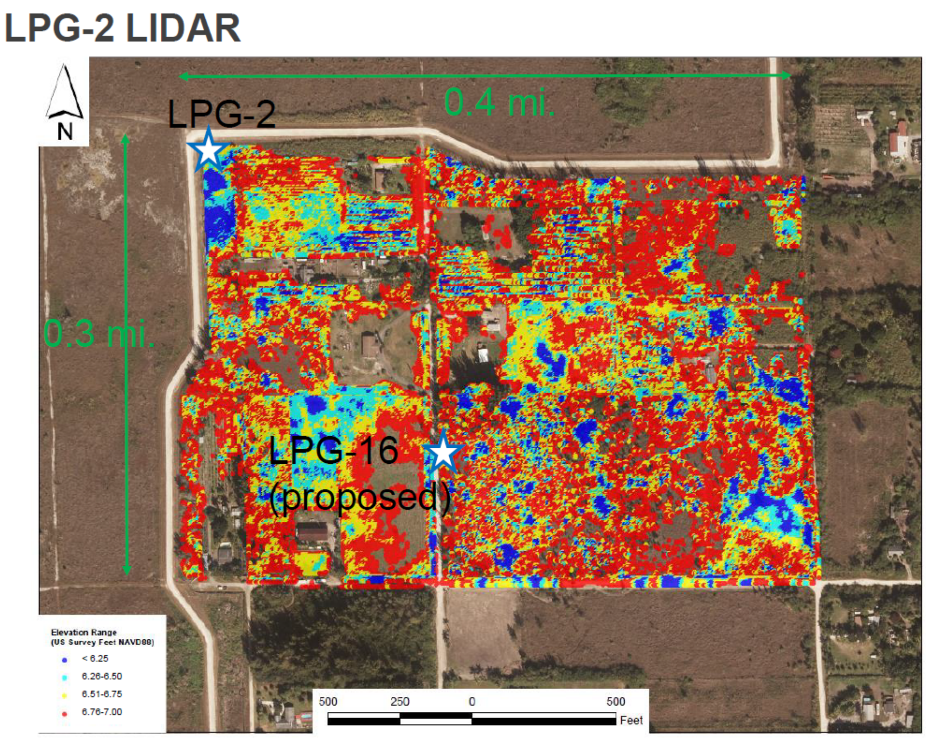


Figure H-6.23. 8.5 SMA LiDAR Survey Ground Elevations Proximal to LPG-2

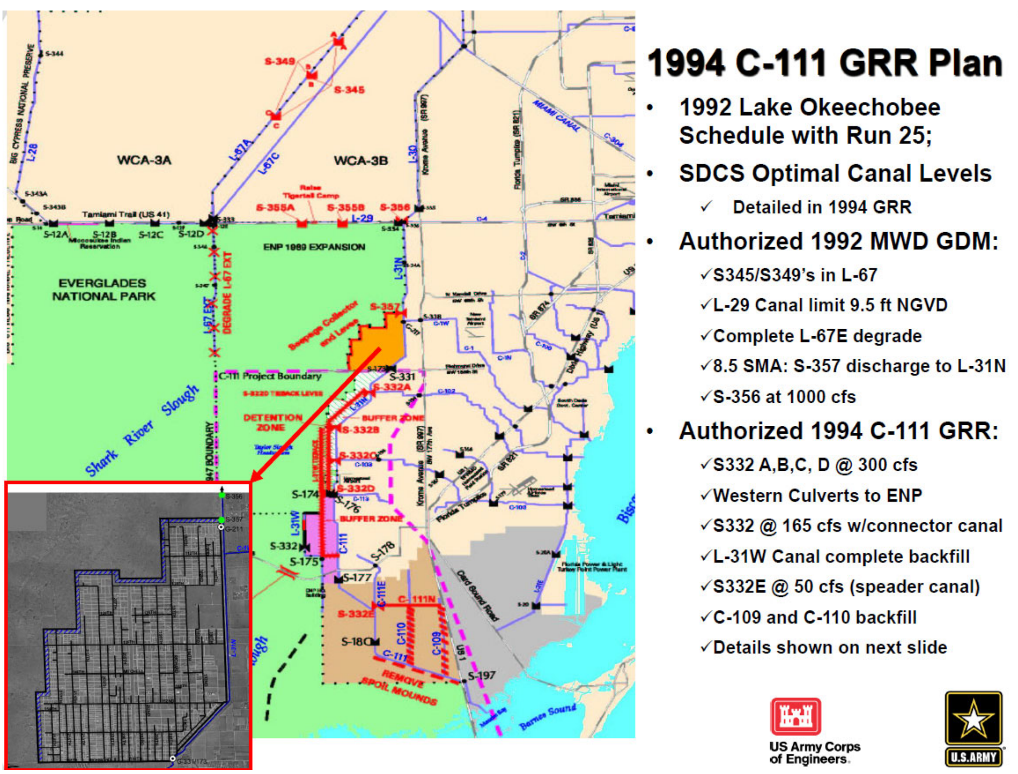


Figure H-6.24. Feature Map for 1994 C-111 South Dade GRR Base Condition, showing 1992 MWD GDM and 1994 C-111 SD GRR components

Based on review of the COP Round 2 alternatives and following the COP PDT recommendation of Alternative O as the top-performing alternative to carry forward for further optimization during Round 3 modeling, the following conclusions summarize the performance of Alternative O with respect to the 8.5 SMA flood mitigation constraint:

- 8.5 SMA Congressionally-authorized Flood Mitigation constraint compliance is achieved for all interior 8.5 SMA locations, consistent with methodology applied for the 2000 GRR
    - Peak stage acreage < 1983 Base Condition Peak Stage acreage for all depth classes
    - Hydro-periods above ground surface elevation < 1983 Base Condition for wet, average, dry years
    - Consecutive inundation duration < 1983 Base Condition for wet, average, dry years
- Significant hydro-period extensions are evidenced at ENP and buffer locations immediately west of the 8.5 SMA
- Uncertainty with MD-RSM model predictions and topography (note that typical MD-RSM model elements within the western 8.5 SMA are 10-12 acres in size) warranted further constraint checks at LPG-2 (e.g. consideration of flood mitigation performance at the proximal LPG-16 and LPG-17 locations)
    - LPG-2 is 0.25-0.50 feet below average adjacent ground elevations and is not representative of the road and housepad elevations on the adjacent parcels.
    - Average First-Floor Elevations in 8.5 SMA ~2.0 ft above Base Flood Elev.(8.0 ft NGVD)

Continued assessment was planned for the Round 3 modeling and concurrent Water Control Plan development activities, including consideration of the following:

- Sensitivity to L-29 Canal constraint (8.5 feet NGVD limited to OCT-JAN during Round 2 alternatives)
- PDT proposals for adjusted operations at S-357 or S-331 with Round 3 modeling
- Further refinement of real-time flood mitigation tracking metrics for COP SOM, derived from 1983 Base Condition MD-RSM modeling and 2017-2018 system operations with C-111 NDA
- Continued efforts to monitor LPG-16 (pending ground survey) and future installation of LPG-17.

The MD-RSM wet year operations for Alternative O and the 1983 Base Condition, including C-357 canal stages (ALT O only), L-31N Canal stages at the adjacent S-331 Headwater (1983 Base Condition and ALT O), and S-357 pump operations, are shown in **Figure H-6.25** to illustrate the suite of information available from the MD-RSM modeling to aid with concurrent refinement of the COP Water Control Plan operational criteria.

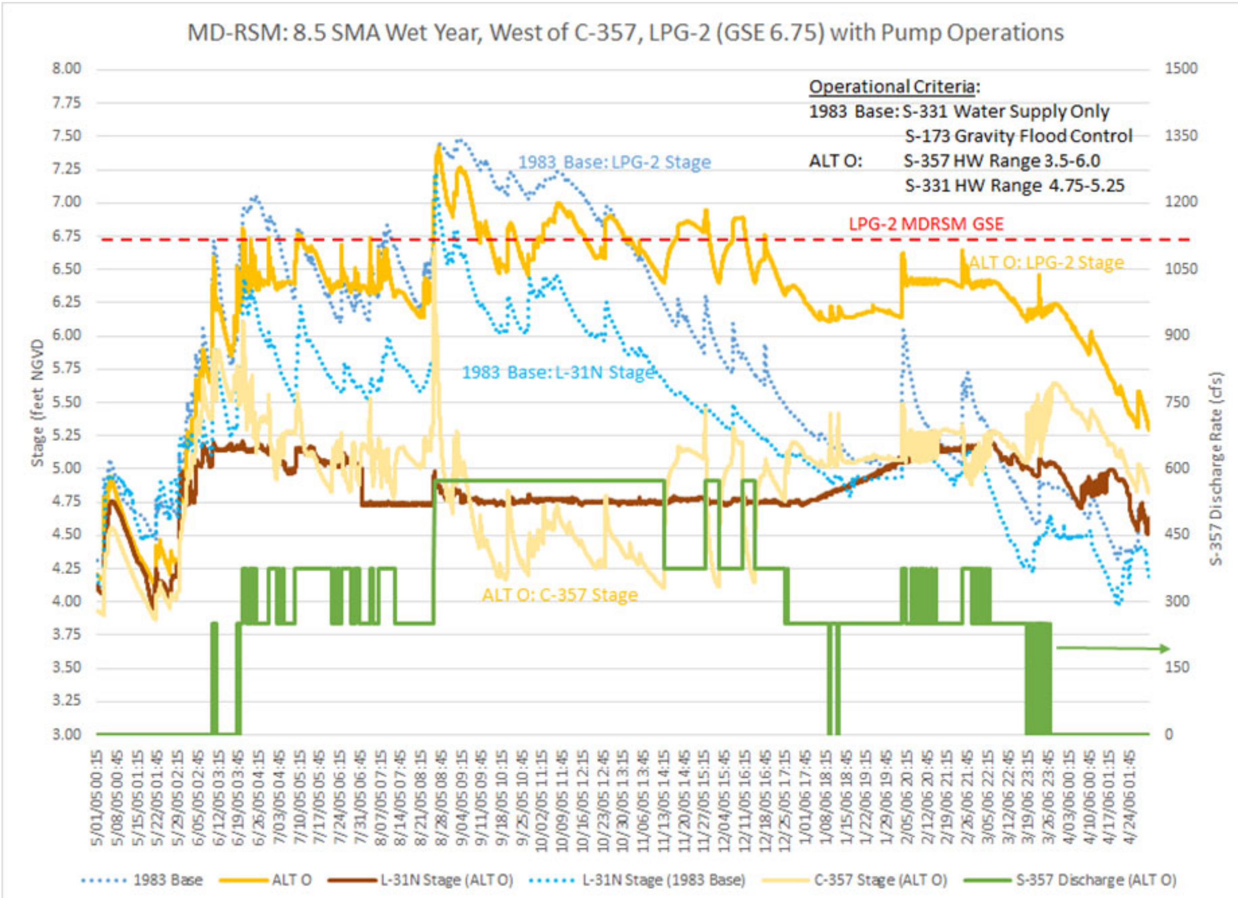


Figure H-6.25. MD-RSM Stage Hydrographs for 1983 Base Condition and Round 2 Alternative O at LPG-2 and L-31N Canal (S-331 Headwater Stage), 2005-2006 Wet Year. Canal C-357 Stage Hydrographs and S-357 Pump Daily Flow Rates are also displayed for the same period for Alternative O.

H-6.6 8.5 SMA Evaluations of Round 3 Alternatives

The COP Round 3 alternative modeling for Alternative Q was principally derived from Round 2 Alternative O. Alternative Q incorporates a “real-time” Tamiami Trail Flow Formula (TTFF) to identify weekly operational target flows in place of previous Rainfall Plan (Current) and iModel targets used to drive flow targets across Tamiami Trail during the Round 2 modeling. Alternative Q operated the L-29 Canal per the FDOT constraint of up to 90 days above 8.3 feet NGVD per water year, consistent with 2008 Tamiami Trail LRR requirements and MWD Increment 2 field test. To aid with review of the effect of this constraint, the COP modeling assumptions (Round 1, Round 2, and Round 3) used the 8.5 feet NGVD constraint for October through January (~120 days). The COP modeling assumptions used an 8.25 feet NGVD constraint for remainder of the year (including August 2005, coincident with Hurricane Katrina). Alternative Q incorporates the WCA 3A Extreme High Water Line that was evaluated with Alternative N2 in Round 2, while retaining the WCA 3A Regulation Schedule Zone A and elimination of regulatory Zones D and E1 consistent with Alternative O. Water supply sub-team evaluations of the Round 2 alternatives resulted in Alternative Q including an update to the WCA 3A floor to incorporate use of the 3-69W gauge as envisioned in the Central Everglades Project. As detailed in the COP main EIS, Alternative Q also incorporates operational changes to S-332C and S-18C as recommended by public feedback and incorporates operational modifications to promote flow to Biscayne Bay consistent with Round 2 Sensitivity Run 4. The RSM-GL Round 3 modeling also corrected an incorrect closure criteria applied to S-12C in the Round 2 Alternative O scenario, although this error was not included in the Round 2 MD-RSM modeling. The USACE determined that the error correction would not alter the PDT recommendation to carry forward Alternative O as the base for the Round 3 formulation, and therefore Alternative O was not re-run with the RSM-GL.

However, the COP Round 3 alternative modeling for Alternative Q also identified an error with the MD-RSM modeling that was previously described in **Section H-6.5**. During the Round 2 alternative modeling, only the WCA 3A associated with the Tamiami Trail Flow Formula (TTFF) were delivered into NESRS via the S-333 gated spillway. WCA 3A Regulatory discharges, which supplement the TTFF environmental deliveries when WCA 3A stages exceed Zone A of the Regulation Schedule, were included in the RSM-GL Round 2 modeling but these supplemental inflows to NESRS were not included in the MD-RSM modeling of the Round 2 alternatives. The result of this error correction was an average stage increase of approximately 0.3 feet for NESRS across the entire 2005-2006 wet year, with a more localized increase of approximately 0.5 feet within the L-29 Canal prior to the significant rainfall event associated with Hurricane Katrina in late August 2005; the effect of this error correction is shown in **Figure H-6.26** for the L-29 Canal and **Figure H-6.27** for the LPG-2 monitoring location for the 8.5 SMA interior mitigation area.

The MD-RSM Round 3 modeling also included minor changes to the 1983 Base Condition and the 2019 ECB simulations from Round 2. Minor changes were included for the 2019 ECB and Alternative Q to represent ramp-up pumping operations at S-199 and S-200 and minor updates were also incorporated to the bottom elevations of the C-111 South Dade NDA and SDA Detention Areas. The MD-RSM 1983 Base Condition was also updated to include removal of the full 9 mile length of the L-67 Extension, consistent with the previously identified assumptions (the prior 1983 Base Condition used for Round 2 evaluations included the existing ~5.5 miles that are included in the ECB and COP alternatives).

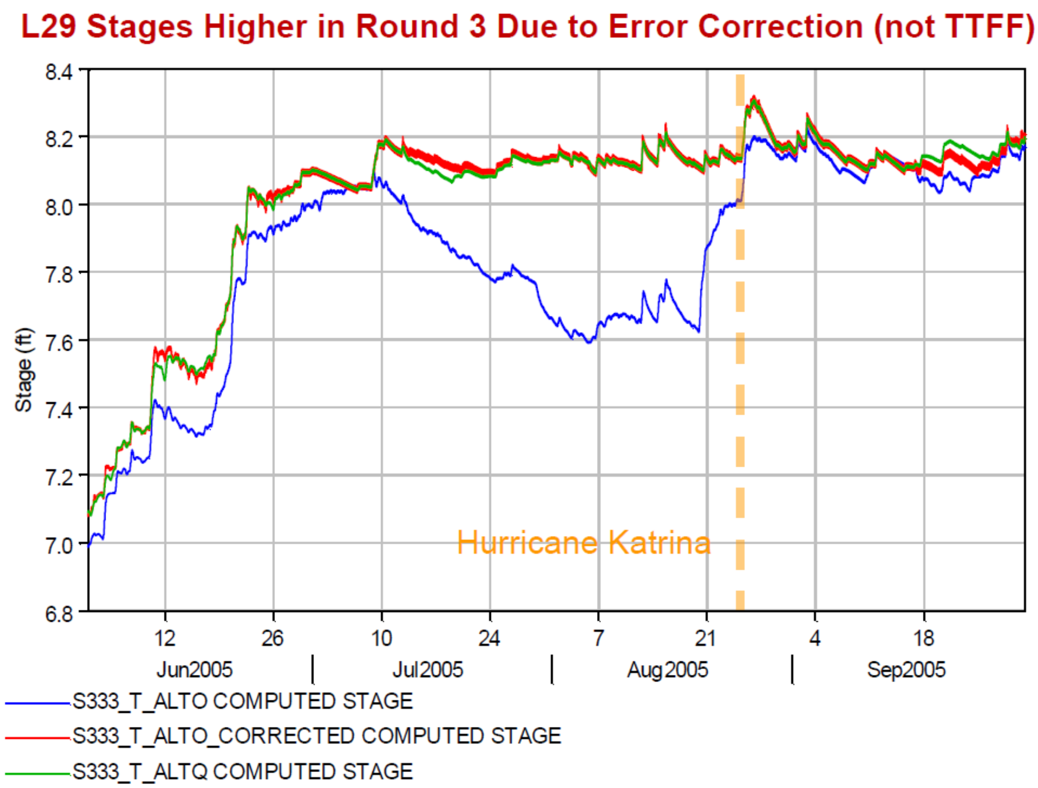


Figure H-6.26. MD-RSM Stage Hydrographs for L-29 Canal with Original and Error Correction for Round 2 Alternative O and Resultant Round 3 Alternative Q, 2005-2006 Wet Year

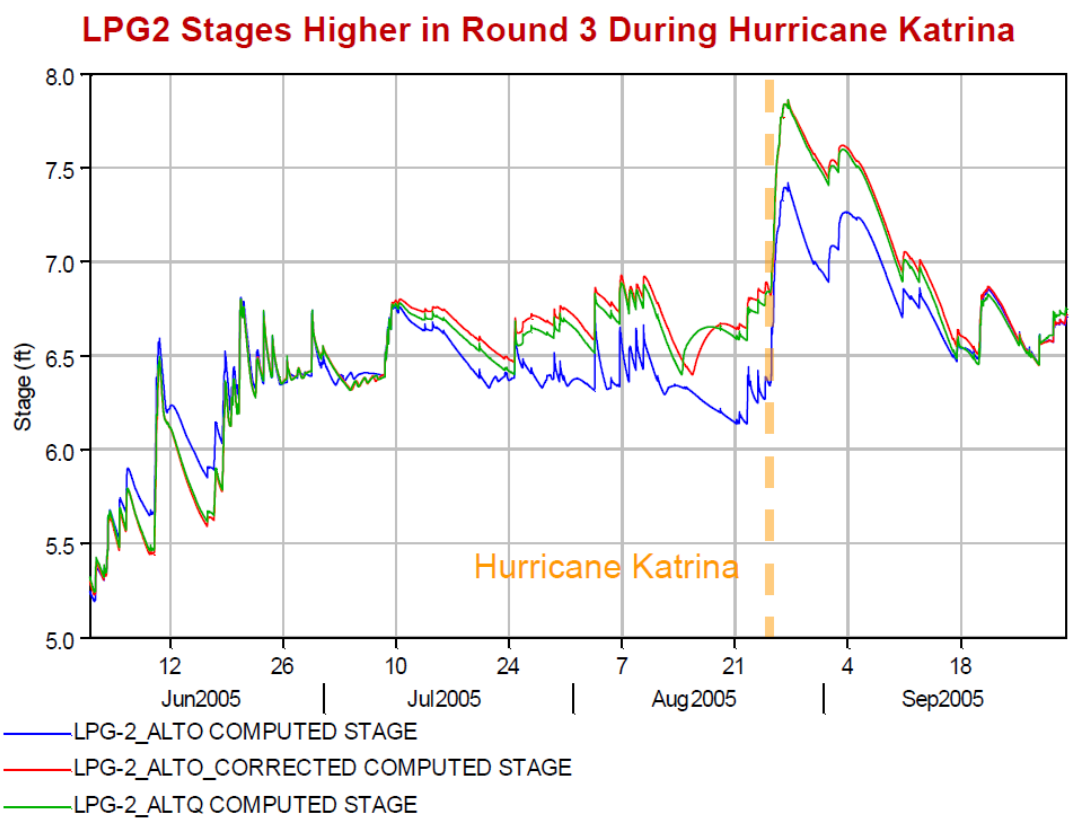


Figure H-6.27. MD-RSM Stage Hydrographs for L-29 Canal with Original and Error Correction for Round 2 Alternative O and Resultant Round 3 Alternative Q, August 2005 Hurricane Katrina Event

The initial Alternative Q simulation did not include use of S-357 and S-331 to minimum range when G-3273 > 7.5 feet NGVD and LPG-2 > 6.7 feet NGVD; although these event-driven operations were included in Alternative Q documentation developed by the project formulation team, as informed from real-time operations during the MWD Incremental field test, these operations had not previously been included in the COP MD-RSM modeling since the Round 2 performance evaluations indicated compliance with the 8.5 SMA flood mitigation constraints. Following the completion of the Round 3 Alternative Q modeling (with the NESRS inflow error correction detailed previously) and presentation of the results to the COP PDT on 21 May 2019, initial review of the results by the USACE indicated that non-inclusion of these operations would result in non-compliance with the COP 8.5 SMA Flood Mitigation Criteria. This initial assessment led to additional informational modeling coordinated by COP modeling team concurrent with PDT review of Alternative Q, with the latest simulation runs completed on 31 May 2019.

A sequential progression of MD-RSM simulation was coordinated with the COP interagency modeling sub-team to more completely represent Alternative Q operations during high water conditions within NESRS, adjacent to 8.5 SMA (S-357/S-331 floor ops), with the additional effort required to confirm the capability of COP Alternative Q to meet 8.5 SMA constraint. The sequential modeling assumptions are detailed below:

A. Alternative Q6 (also QS6; preliminary results 05-21-19)

- Simulation includes use of S-357 to minimum range when G-3273 > 7.5 feet NGVD and LPG-2 > 6.7 feet NGVD (included in Alternative Q documentation shared with PDT)

   - When G-3273 > 7.5 feet NGVD and LPG2 is ABOVE 6.7 feet NGVD, S-357 Headwater (HW) stage will be lowered to 2.3 to 3.0 feet NGVD until LPG2 can be lowered to 6.2 ft NGVD. Operated at Maximum capacity 575 cfs (match FDEP ops permit issued to SFWMD). [NOTE: Alternative Q documentation indicates exit criteria when "LPG-2 can be maintained between 6.2-6.6 ft NGVD"; simulation reflects maximum duration for S-357 criteria]
   - Five days prior to Katrina, pre-storm operations force all four S357 pumps to turn on until the storm passes.
- Simulation does not include use of S-331 to minimum range when G-3273 > 7.5 feet NGVD and LPG-2 > 6.7 feet NGVD (included in Alternative Q documentation shared with PDT)

B. Alternative Qm (Q modified; preliminary results 05-31-19)

- Simulation includes use of S-357 to minimum range (2.3-3.0 ft NGVD) when G-3273 > 7.5 feet NGVD and LPG-2 > 6.7 feet NGVD (included in Alternative Q documentation shared with PDT)
   - Ops same as Alternative Q6, including pre-storm operations denoted above
- Simulation include use of S-331 to minimum range (2.8-3.5 ft NGVD) when G-3273 > 7.5 feet NGVD and LPG-2 > 6.7 feet NGVD (included in Alternative Q documentation shared with PDT)
   - When G-3273 > 7.5 feet NGVD and LPG2 is ABOVE 6.7 feet NGVD, S-331 Headwater (HW) stage will be lowered to 2.8 to 3.5 feet NGVD until LPG2 can be lowered to 6.2 NGVD. [NOTE: Alternative Q documentation indicates exit criteria when "LPG-2 can be maintained between 6.2-6.6 ft NGVD"; simulation reflects maximum duration for S-331 criteria]
- Expected COP operations of Alternative Q would be bracketed by the MD-RSM simulations of ALT Q6 and ALT Qm, with the potential need for S-331 operations evaluated for each specific rainfall event and forecasted peak stage and recession rate (due to the limited resolution with the RSM-GL, this bracketed range is collectively evaluated with only the Alternative Q simulation)

C. Sensitivity Run SR Qm1 (preliminary results 05-31-19)

- Simulation allows L-29 Canal to be operated up to 8.5 feet NGVD any time of the year
   - Comparable to PDT-requested RSM-GL sensitivity simulation SRQ1
- Simulation includes use of S-357 and S-331 to minimum ranges when G-3273 > 7.5 feet NGVD and LPG-2 > 6.7 feet NGVD (included in Alternative Q documentation shared with PDT)
   - Ops same as Alternative Qm denoted above

The evaluation methodology previously detailed for the Round 2 alternatives in **Section H-6.5** was replicated for the Round 3 alternatives, including Alternative Q, the modified Alternative Q (Alternative Qm), and the L-29 Canal sensitivity scenario with removal of the FDOT constraint (Alternative SR Qm1). Due to the unplanned nature of the modeling for scenarios A and B for 8.5 SMA event-based operations, a full suite of MD-RSM performance measure graphical outputs was not generated for these scenarios.

With the increased deliveries into NESRS, water levels within the ENP wetlands immediately west of 8.5 SMA are inundated for approximately 150 more days, or 40% of the MD-RSM wet year 2006 (Water Year extending from May 2005 through April 2006). Representative stage duration curves for Water Year 2006 are shown in **Figure H-6.28** for G-3273 (located 2.3 miles west of the 8.5 SMA), **Figure H-6.29** for LPG-3 (located 0.7 miles west of the 8.5 SMA), and **Figure H-6.30** for Angel's Monitoring Well (located 0.25 miles west of the 8.5 SMA). The hydroperiod, or total number of days with water depths above ground during a year, were computed for the wet year (Water Year 2006), dry year (Water Year 2011), and average year (Water Year 2005) for each location. In order to evaluate potential changes in groundwater depths below ground, hydroperiods were also computed for theoretical hydroperiod depths of 3 inches and 6 inches below the ground surface elevation. Hydroperiod bar graphs for the wet, dry, and average MD-RSM simulation years, including the 3 inch and 6 inch theoretical hydroperiod surfaces, are summarized on **Figure H-6.31** for LPG-3 and **Figure H-6.32** for Angels' Monitoring Well for each of the COP Base Conditions (with minor updates subsequent to the Round 2 results detailed previously), Round 3 Alternative Q, and the Round 3 sequenced operational scenarios for 8.5 SMA flood mitigation. These figures illustrate that hydroperiod durations and water stages west of the 8.5 SMA are not adversely diminished by event-based operations at S-357 and/or S-331 during NESRS high-water conditions. The stage hydrograph for the ENP Angel's Monitoring Well 2005-2006 wet year is shown as **Figure H-6.33**, which illustrates: (1) compared to the 1983 Base Condition, elevated water stages within NESRS associated with MWD implementation of increased inflow volumes and prolonged inflow durations (ECB 2019, ALT Q, ALT Q6, ALT Qm, and SR Qm1); and (2) compared to the 1983 Base Condition, increased peak stages following significant rainfall events such as Hurricane Katrina in August 2005 (2-day rainfall amount of 9.5 inches) due to higher antecedent stage conditions and reduced groundwater storage capacity.

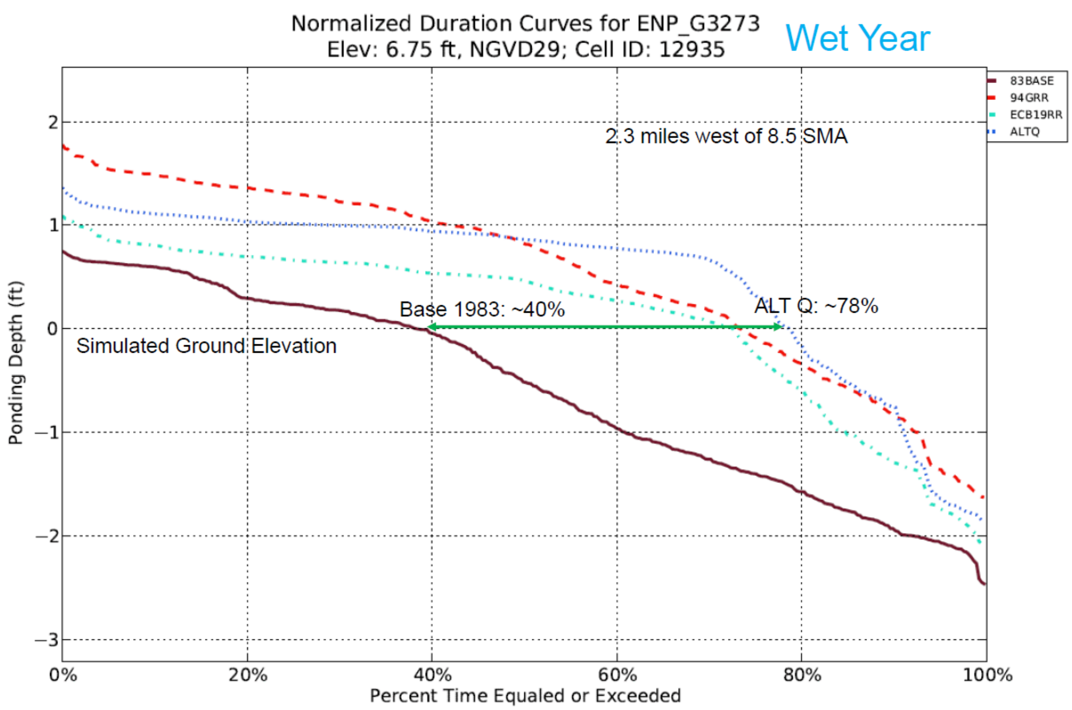


Figure H-6.28. MD-RSM Stage Duration Curves for COP Base Conditions and Round 3 Alternative Q, 2005-2006 Wet Year at G-3273

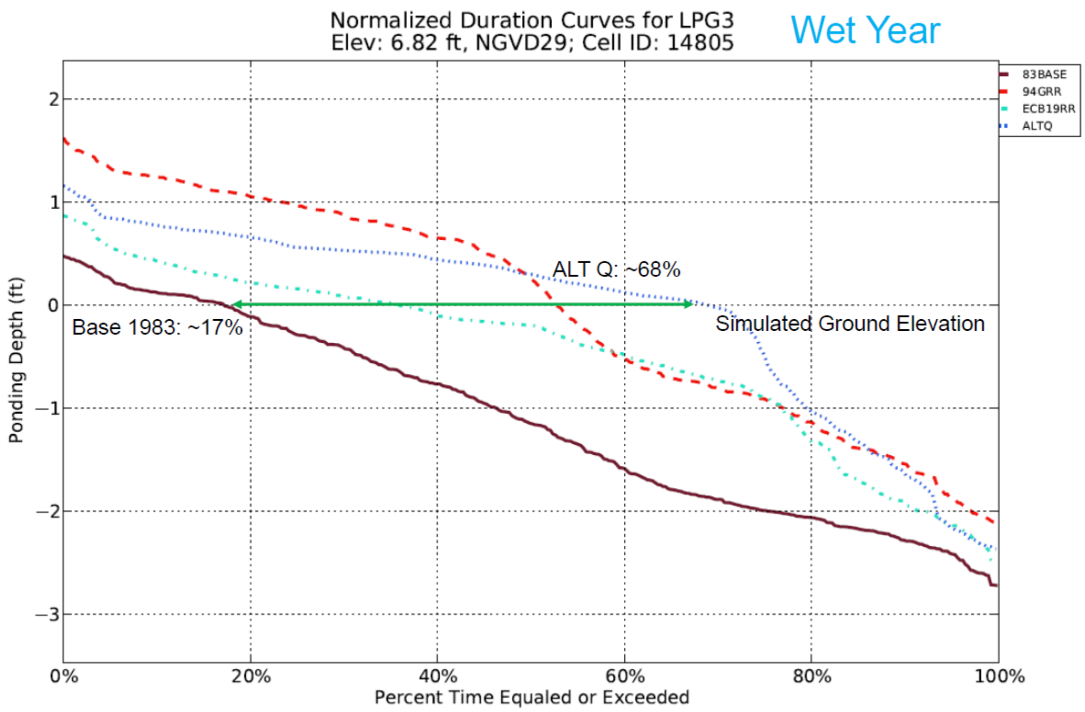


Figure H-6.29. MD-RSM Stage Duration Curves for COP Base Conditions and Round 3 Alternative Q, 2005-2006 Wet Year at LPG-3

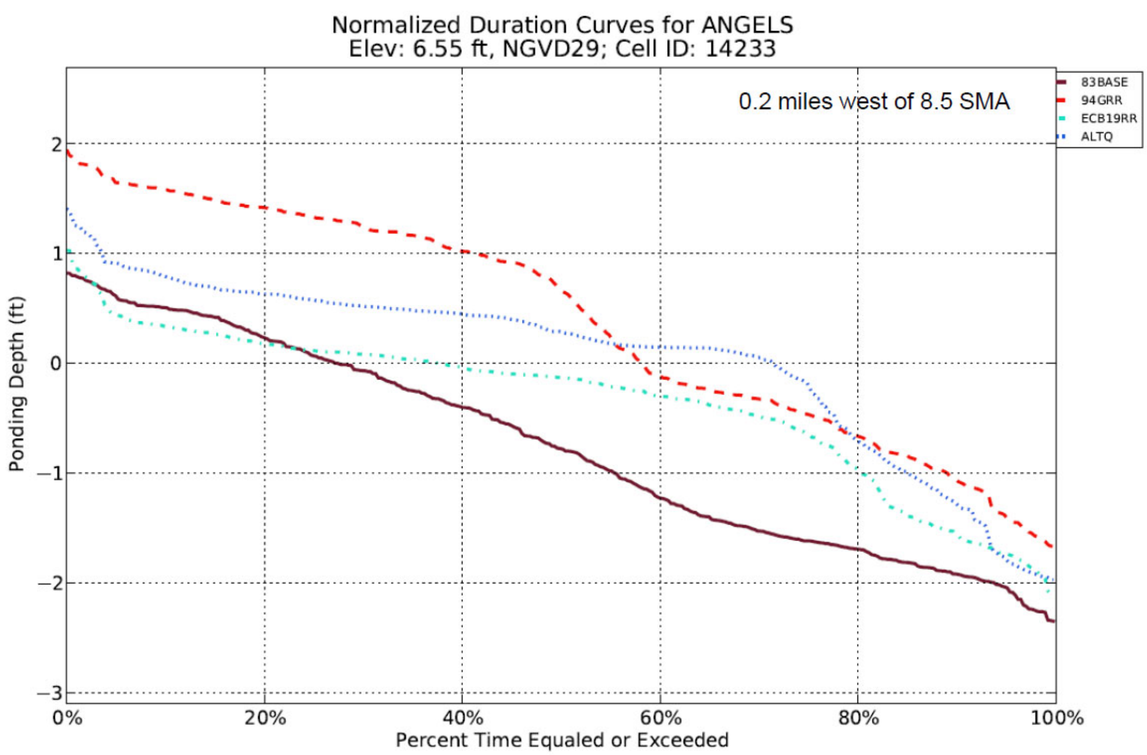


Figure H-6.30. MD-RSM Stage Duration Curves for COP Base Conditions and Round 3 Alternative Q, 2005-2006 Wet Year at Angel's Well

8.5 SMA BUFFER TO ENP: LPG-3

Modeling indicates hydroperiod durations
and water stages west of 8.5 SMA
are not adversely diminished
by event-based 8.5 SMA operations
during NESRS high-water conditions

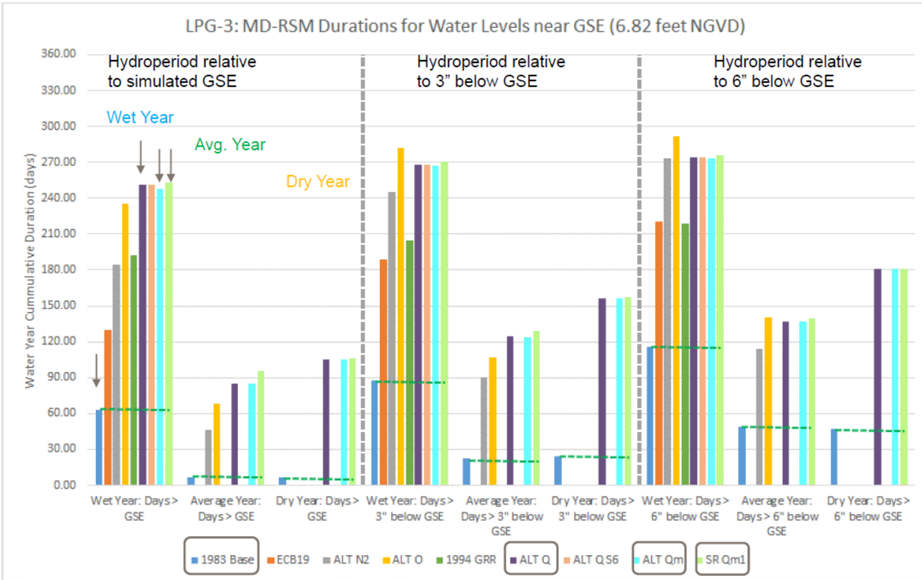


Figure H-6.31. Hydroperiod bar graphs for the wet, dry, and average MD-RSM simulation years for the COP Base Conditions and Round 3 Alternative Q at LPG-3, including hydroperiod referenced against ground surface elevation and the 3 inch and 6 inch theoretical hydroperiod surfaces

8.5 SMA BUFFER TO ENP: ANGEL'S WELL

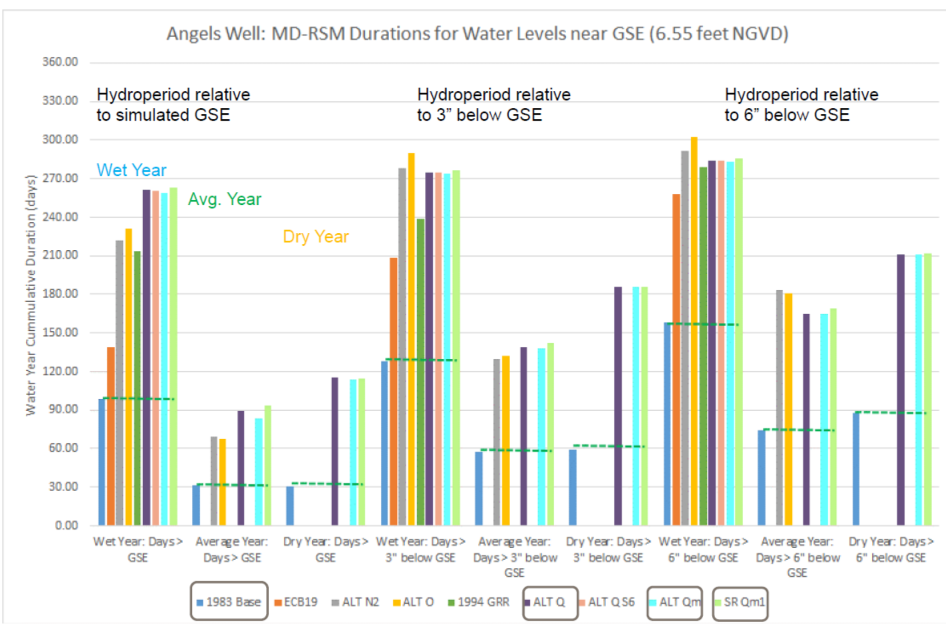


Figure H-6.32. Hydroperiod bar graphs for the wet, dry, and average MD-RSM simulation years for the COP Base Conditions and Round 3 Alternative Q at Angel's Well, including hydroperiod referenced against ground surface elevation and the 3 inch and 6 inch theoretical hydroperiod surfaces

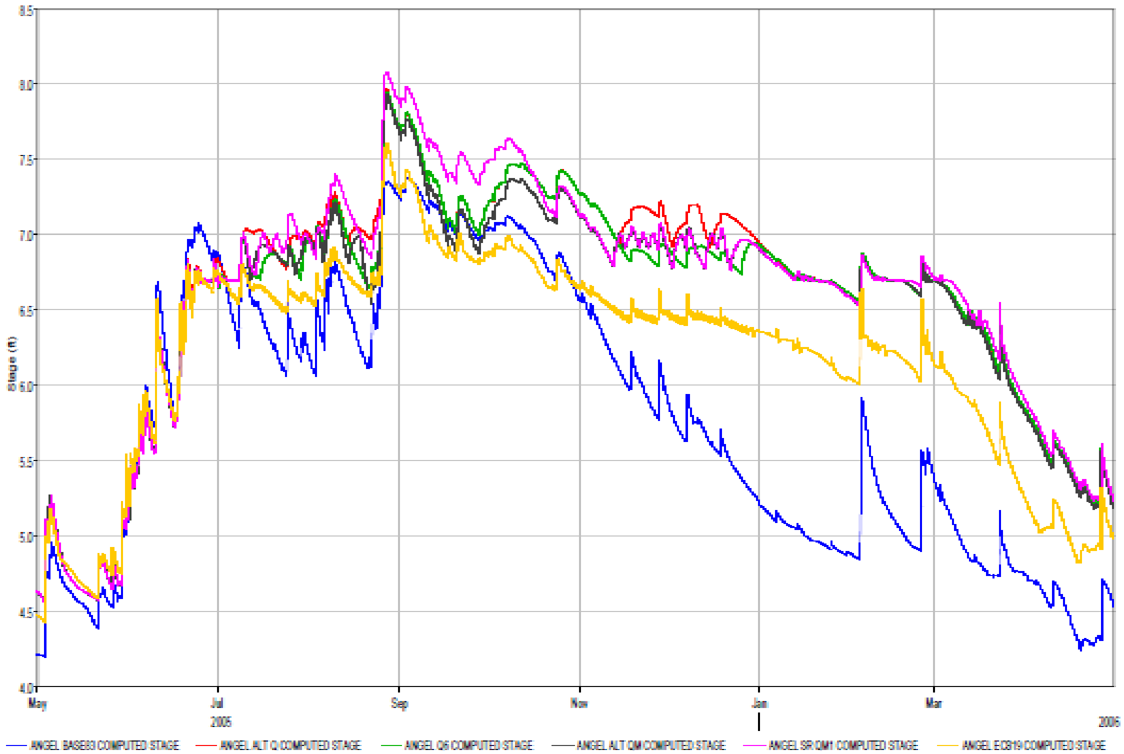


Figure H-6.33. MD-RSM Stage Hydrographs for 1983 Base Condition and Sequential 8.5 SMA Test Operations for Round 3 Alternative Q, 2005-2006 Wet Year at Angel's Well

Based on the 2000 8.5 SMA GRR ROD requirement that "periodic flooding of landowners east of the proposed levee, before and after project implementation, will remain unchanged ***from conditions in existence prior to implementation of the MWD Project*** except where flowage easements are required," all 8.5 SMA locations within the interior of the 8.5 SMA flood mitigation levee are assessed by comparing the COP Round 3 alternatives, including the scenarios for 8.5 SMA event-based operations, against the 1983 Base Condition. The existing groundwater monitoring wells located east of the C-357 western perimeter levee are shown on **Figure H-6.3** and **Figure** H-6.4.

Initial screening of the 8.5 SMA flood mitigation performance for Alternative Q indicated that peak stages along the southwestern portion of 8.5 SMA were elevated compared to the 1983 Base Condition during the 2005-2006 wet year and the 2010-2011 dry year in the MD-RSM simulations. Peak stage difference maps comparing Alternative Q, Alternative Qm, and Alternative SR Qm1 against the 1983 Base Condition are displayed in **Figure H-6.34** (wet year), **Figure H-6.35** (average year), and **Figure H-6.36** (dry year). Only the privately-owned parcels within the 8.5 SMA interior flood mitigation area are color-coded as green (peak stage reduced compared to the 1983 Base Condition), yellow (peak stage increase by 0.01-0.25 feet compared to the 1983 Base Condition), or red (peak stage increase by 0.26-0.50 feet compared to the 1983 Base Condition). Similar to the evaluation approach used with MODBRANCH during development of the 2000 8.5 SMA GRR Plan and repeated during the CSOP evaluations, a performance measure was developed to display the MD-RSM peak stages across all model grid cells within the 8.5 SMA interior mitigation area; the performance measure is described in further detail in **Section H-6.5**. The 8.5 SMA peak stage performance measure results for the Round 3 alternatives (ALT Q; ALT Qm; ALT SR Qm1) during the 2005-2006 wet year, including comparison versus the 2019 ECB (ECB19RR; minor updates post Round 2), 1983 Base Condition (83Base; minor updates post Round 2) are shown in the following figures for each sub-area: **Figure H-6.37** (flowage easement), **Figure H-6.38** (North of C-357), **Figure H-6.39** (West of C-357), **Figure H-6.40** (C-357 Canal), and **Figure H-6.41** (East of C-357); the ALT Q6 simulation results with 8.5 SMA event-based operations at S-357 only, without supplemental use of S-331, are not displayed based on the USACE preliminary performance assessment which indicated the scenario to be insufficient to address the 8.5 SMA flood mitigation constraint. The initial evaluations of the Round 3 alternatives indicated that the peak stages within the 8.5 interior flood mitigation area for both COP action alternatives were significantly lower than the 1983 Base Condition for all depth classifications across the C-357 Canal and East of C-357 sub-areas; as detailed in the Round 2 assessment section, water levels within the Flowage Easement sub-area are not constrained by flood mitigation performance requirements as this area is already publicly-owned. However, consistent with the peak stage difference map displayed in **Figure H-6.34**, the 8.5 SMA flood mitigation performance measure that Alternative Q peak stages exceeded the 1983 Base Condition flood mitigation constraint for depth classifications >0.4 feet for the sub-area North of the C-357 and for depth classifications >0.7 feet for the sub-area West of the C-357; the total acreage with increased peak stages compared to the 1983 Base Condition totaled 236 acres within the 8.5 SMA interior flood mitigation area. With the explicit inclusion of 8.5 SMA event-based operations at S-357 and S-331 in ALT Qm, peak stages exceeded the 1983 Base Condition flood mitigation constraint for depth classifications >0.6 feet for the sub-area North of the C-357 and for depth classifications >0.8 feet for the sub-area West of the C-357; the total acreage with increased peak stages compared to the 1983 Base Condition totaled 91 acres within the 8.5 SMA interior flood mitigation area (35 acres North of C-357; 56 acres West of C-357). With the explicit inclusion of 8.5 SMA event-based operations at S-357 and S-331, with the additional removal of the L-29 Canal FDOT constraint (assumed 120 day limit) in SR Qm1, peak stages exceeded the 1983 Base Condition flood mitigation constraint for depth classifications >0.5 feet for the sub-area North of the C-357 and for depth classifications >0.7 feet for the sub-area West of the C-357; the total acreage with increased peak stages compared to the 1983 Base Condition totaled 208 acres within the 8.5 SMA interior flood mitigation area (63 acres North of C-357; 145 acres West of C-357).

Stage duration curves within the sub-area West of C-357 are shown in **Figure H-6.42** for LPG-2, **Figure H-6.43** for LPG-12, and **Figure H-6.44** for LPG-17 , as these areas necessitated a detailed evaluation due to the peak stage increases within the West of C-357 sub-area and given consideration of the recurrent water management challenges observed within this sub-area during the MWD Incremental field test operations. The hydroperiod, or total number of days with water depths above ground during a year, were computed for the wet year (Water Year 2006), dry year (Water Year 2011), and average year (Water Year 2005) for each location. In order to evaluate potential changes in groundwater depths below ground, hydroperiods were also computed for theoretical hydroperiod depths of 3 inches and 6 inches below the ground surface elevation. Hydroperiod bar graphs for the wet, dry, and average MD-RSM simulation years, including the 3 inch and 6 inch theoretical hydroperiod surfaces, are summarized on **Figure H-6.45** for LPG-2 and **Figure H-6.46** for LPG-17 for each of the COP Base Conditions and Round 2 Alternatives. The wet year 2005-2005 stage hydrographs at LPG-2 and LPG-17 are displayed in **Figure H-6.47** and **Figure H-6.48** , respectively, including a zoomed-in portion of the hydrographs around the Hurricane Katrina event in late August; the wet year peak stages are summarized as follows, as shown on the hydrographs: for LPG-2, peak stages (feet NGVD) are 7.41 for the 1983 Base Condition, 7.48 for the 2019 ECB, 7.86 for ALT Q, 7.82 for ALT Qm, and 7.95 for SR Qm1; for LPG-17, peak stages (feet NGVD) are 7.40 for the 1983 Base Condition, 7.40 for the 2019 ECB, 7.76 for ALT Q, 7.71 for ALT Qm, and 7.84 for SR Qm1. **Figure H-6.45** through **Figure H-6.48** indicate Alternative Q as non-compliant with the 8.5 SMA flood mitigation constraint for hydroperiod duration (water year duration less than the 1983 Base Condition) at LPG-2, and the figures also show the Alternative Q as having increased frequency of groundwater conditions within 3 inches (LPG-2) and 6 inches of ground surface elevation (LPG-2 and LPG-17).

In order to demonstrate compliance with the 8.5 SMA interior flood mitigation metrics, the Round 3 modeling was updated to explicitly include the event-based criteria for S-357 and S-331; although not explicitly modeled with the initial Alternative Q simulation, based on the preliminary Round 2 performance evaluations, these criteria were always included as features of Alternative Q resultant from the lessons learned from real-time water management under the Increment 2 field test. The composite summary of these figures illustrates: (1) compared to the 1983 Base Condition, elevated water stages at LPG-2 associated with MWD implementation of increased inflow volumes and prolonged inflow durations (ECB 2019, ALT Q, ALT Qm, and SR Qm1, collectively the COP Round 3 alternatives); (2) compared to the 1983 Base Condition, a moderate increase in peak stages by 0.4-0.5 feet following significant rainfall events such as Hurricane Katrina in August 2005 (2-day rainfall amount of 9.5 inches); (3) Compared to the 1983 Base Condition, the COP Round 3 alternatives and the 2019 ECB demonstrate a significant increased drainage rate and a significantly reduced duration with stages above ground given the ability to leverage the C-357/C-358 Canals and use of the S-357 pump station; (4) the COP Round 3 alternatives experience secondary events later in the wet season, where water levels temporarily rise above ground in response to moderate rainfall events due to the persistently higher groundwater stages with COP implementation – particularly apparent with Alternative Q without use of the event-based operations for S-357 and/or S-331; (5) compared to Alternative Q, Alternative Qm (event-based operations at S-357 and S-331) reduced cumulative duration with hydroperiod above ground surface elevation at LPG-2 (88 to 33 days; 1983 Base Condition at 74 days) and LPG-17 (33 to 14 days; 1983 Base Condition at 63 days); and (6) compared to Alternative Q, Alternative Qm (event-based operations at S-357 and S-331) reduced the longest consecutive duration with hydroperiod above ground surface elevation at LPG-2 (22 to 19 days; 1983 Base Condition at 56 days) and LPG-17 (18 to 14 days; 1983 Base Condition at 54 days). Similar comparisons were also conducted for the MD-RSM 2004-2005 average year and the MD-RSM 2010-2011 dry year. Table 1 and Table 2 provide a composite summary of the 8.5 SMA interior flood mitigation performance metrics for hydroperiod (measured relative to ground surface elevation only, consistent with the 2000 GRR metrics) and event duration for LPG-2 and LPG-17, respectively. The tables are color-coded to distinguish metrics which are improved relative to the 1983 Base Condition (green), metrics which are impaired relative to the 1983 Base Condition (red), and metrics which are similar, but slightly improved, to the 1983 Base Condition (yellow).

Throughout the hydrologic monitoring with the MWD Incremental field test, the use of the LPG-2 ground surface elevation (approximately 6.7 feet NGVD) as a flood mitigation metric for 8.5 SMA inundation duration has been recognized by the USACE as a conservative criteria since the aerial topographic survey indicates this location as approximately 0.25-0.50 feet lower than most of the adjacent developed property (refer to **Figure H-6.23**). During the field test, USACE installed two additional monitoring wells at LPG-16 and LPG-17 to supplement the previously available groundwater data at LPG-2 and LPG-12 (refer to the maps on **Figure H-6.3** and **Figure** H-6.4); the new monitoring locations were fully instrumented and ground-surveyed in September 2019, although the data is not available in real-time (monthly downloads only). With the continued monitoring under the Increment 2 field test, the USACE will continue to consider adjustments to the flood mitigation criteria at LPG-2, such as using a hydroperiod duration criteria relative to a more representative elevation for this portion of the 8.5 SMA interior mitigation area.

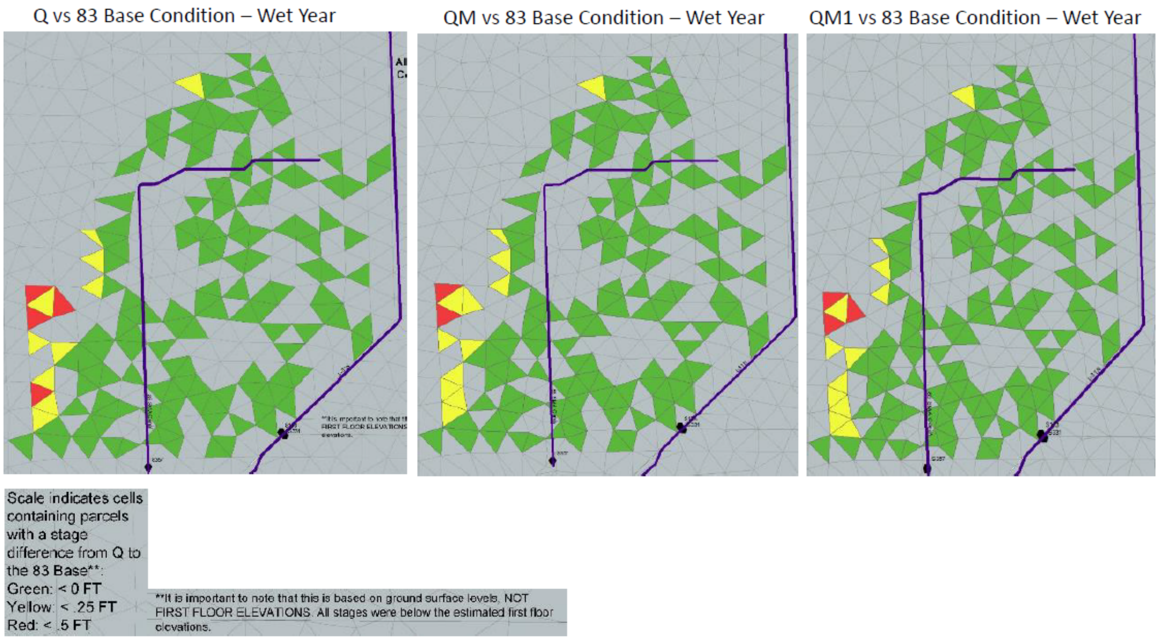


Figure H-6.34. Comparison of 8.5 SMA MD-RSM Peak Stages between Sequential 8.5 SMA Test Operations for Round 3 Alternative Q and COP 1983 Base Condition, 2005-2006 Wet Year. Cells are Green if Peak Stages are Lower than the 1983 Base Condition, Yellow if Higher than the 1983 Base Condition by Less than 0.25 feet, and Red if Higher than the 1983 Base Condition by Greater than 0.25 feet and Less than 0.50 feet.

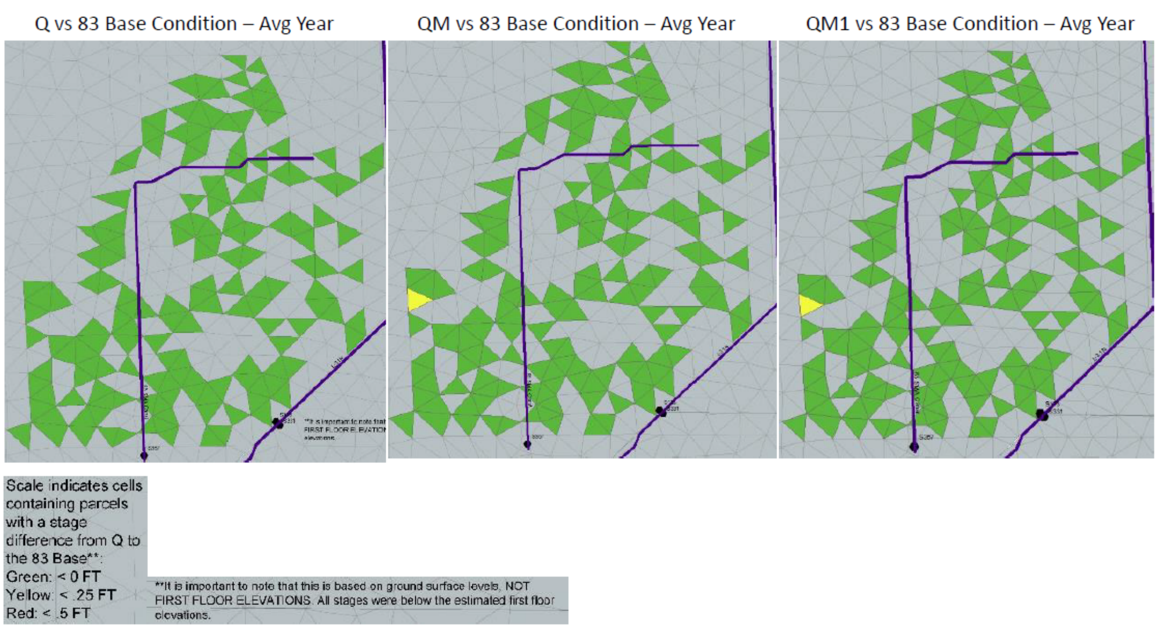


Figure H-6.35. Comparison of 8.5 SMA MD-RSM Peak Stages between Sequential 8.5 SMA Test Operations for Round 3 Alternative Q and COP 1983 Base Condition, 2004-2005 Average Year. Cells are Green if Peak Stages are Lower than the 1983 Base Condition, Yellow if Higher than the 1983 Base Condition by Less than 0.25 feet, and Red if Higher than the 1983 Base Condition by Greater than 0.25 feet and Less than 0.50 feet.

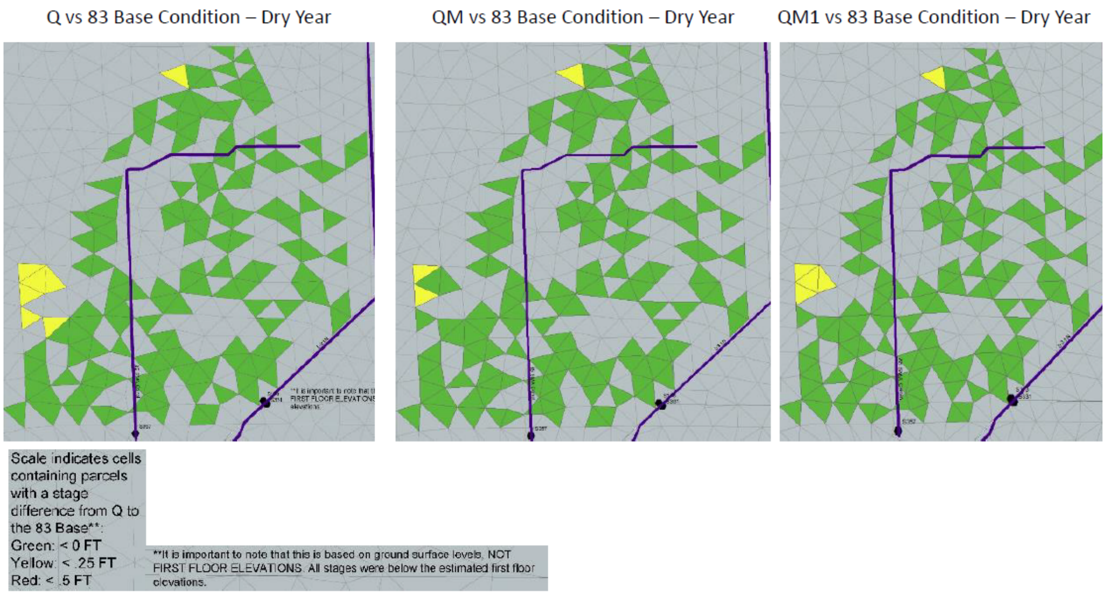


Figure H-6.36. Comparison of 8.5 SMA MD-RSM Peak Stages between Sequential 8.5 SMA Test Operations for Round 3 Alternative Q and COP 1983 Base Condition, 2010-2011 Wet Year. Cells are Green if Peak Stages are Lower than the 1983 Base Condition, Yellow if Higher than the 1983 Base Condition by Less than 0.25 feet, and Red if Higher than the 1983 Base Condition by Greater than 0.25 feet and Less than 0.50 feet.

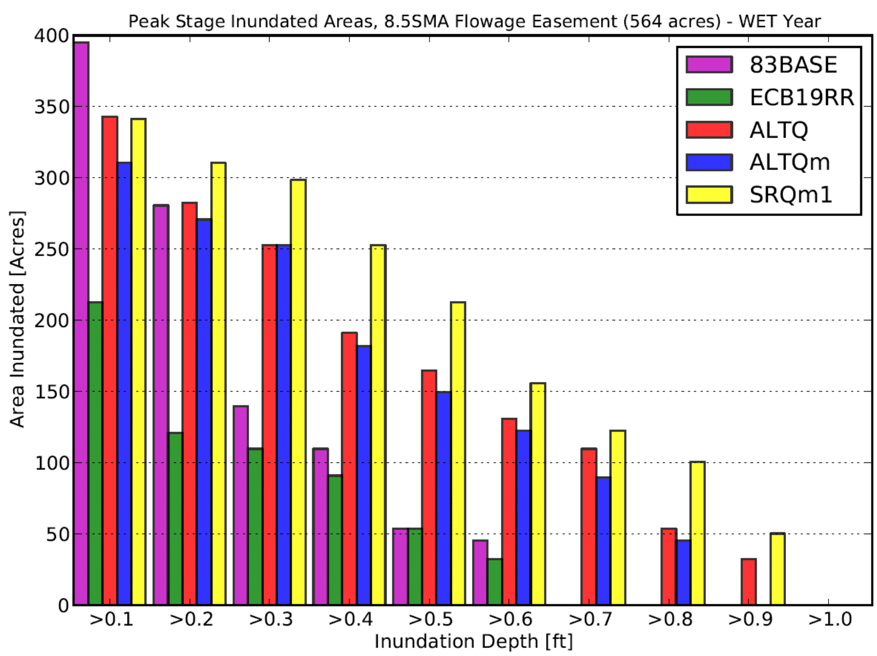


Figure H-6.37. MD-RSM Peak Stage Inundation Areas for 8.5 SMA Flowage Easement Sub-Basin with Depth Classifications Ranging from Greater than 0.1 feet up to Greater than 1.0 feet (0.1 foot Increments), COP Base Conditions and Round 3 Alternative Q Bracket Simulations in the 2005-2006 Wet Year

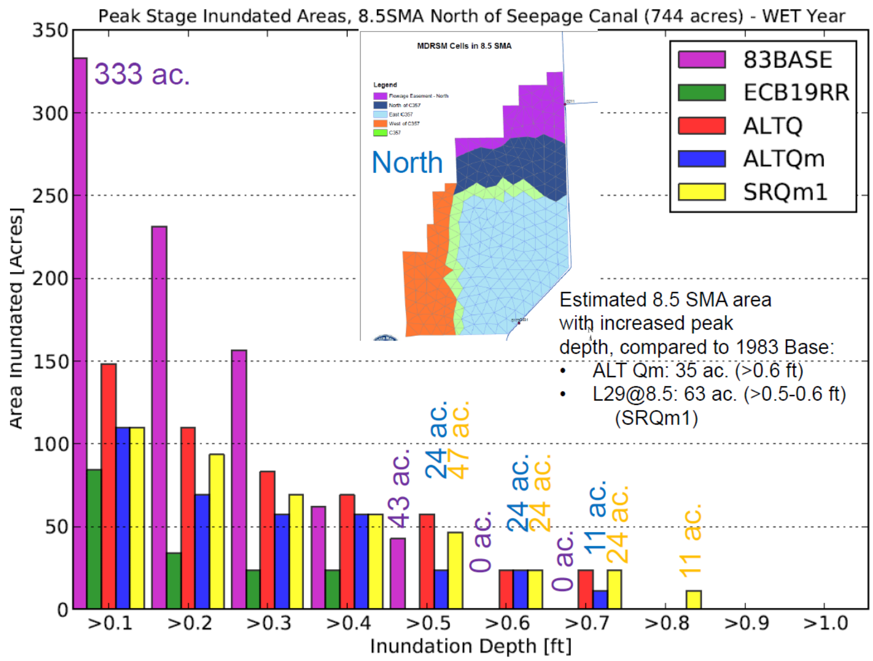


Figure H-6.38. MD-RSM Peak Stage Inundation Areas for 8.5 SMA North of C-357 Sub-Basin with Depth Classifications Ranging from Greater than 0.1 feet up to Greater than 1.0 feet (0.1 foot Increments), COP Base Conditions and Round 3 Alternative Q Bracket Simulations in the 2005-2006 Wet Year

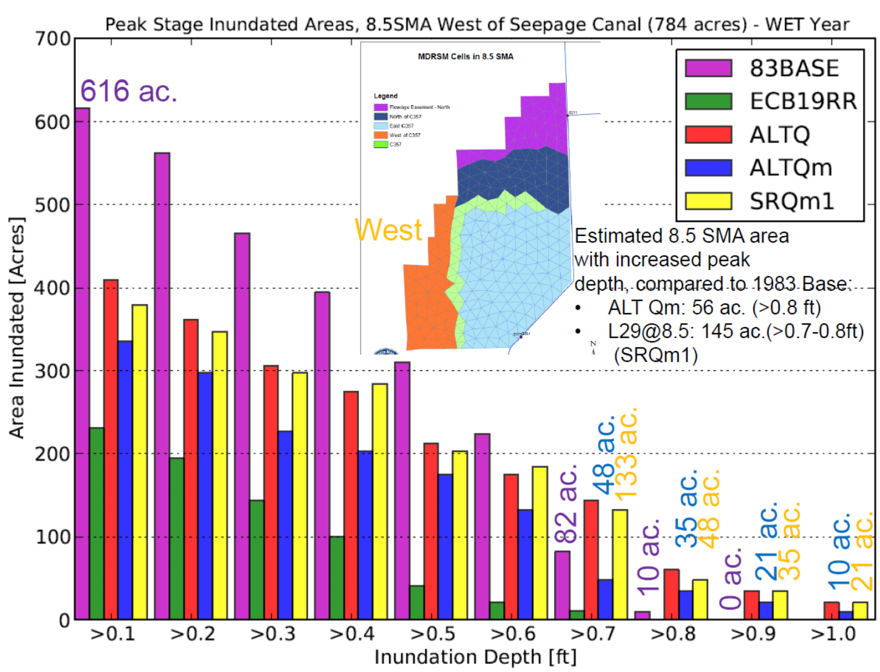


Figure H-6.39. MD-RSM Peak Stage Inundation Areas for 8.5 SMA West of C-357 Sub-Basin with Depth Classifications Ranging from Greater than 0.1 feet up to Greater than 1.0 feet (0.1 foot Increments), COP Base Conditions and Round 3 Alternative Q Bracket Simulations in the 2005-2006 Wet Year

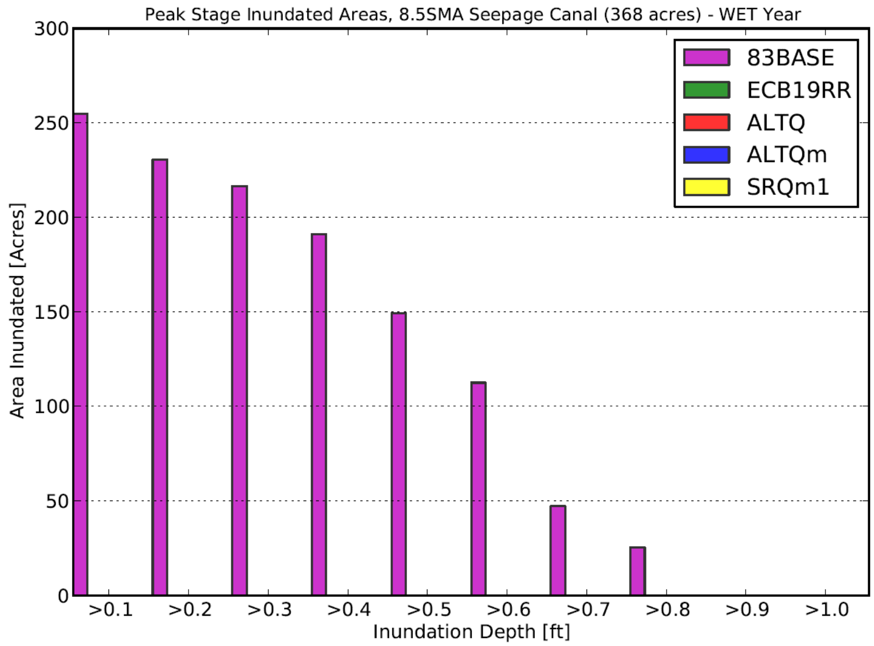


Figure H-6.40. MD-RSM Peak Stage Inundation Areas for 8.5 SMA C-357 Canal Sub-Basin with Depth Classifications Ranging from Greater than 0.1 feet up to Greater than 1.0 feet (0.1 foot Increments), COP Base Conditions and Round 3 Alternative Q Bracket Simulations in the 2005-2006 Wet Year

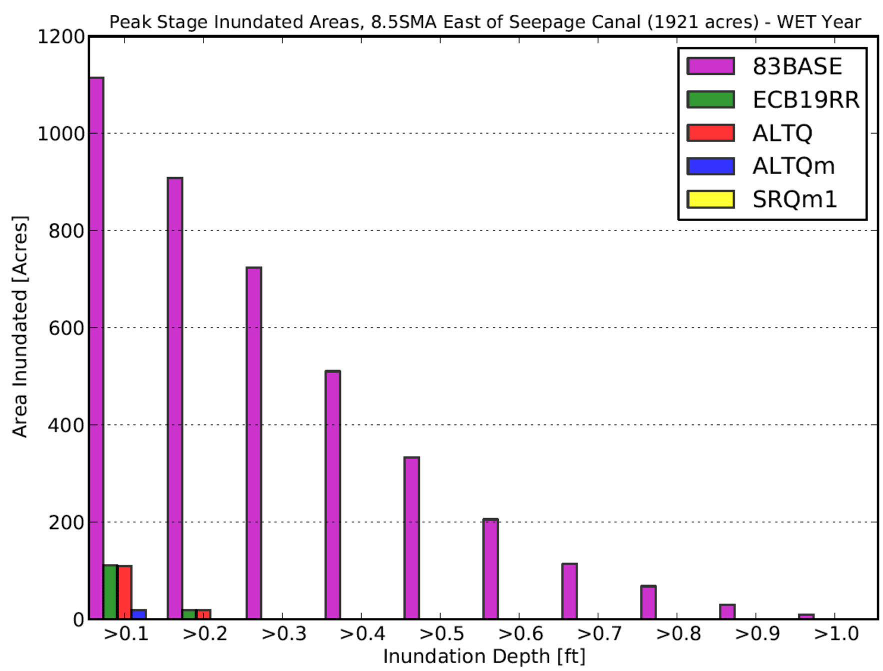


Figure H-6.41. MD-RSM Peak Stage Inundation Areas for 8.5 SMA East of C-357 Sub-Basin with Depth Classifications Ranging from Greater than 0.1 feet up to Greater than 1.0 feet (0.1 foot Increments), COP Base Conditions and Round 3 Alternative Q Bracket Simulations in the 2005-2006 Wet Year

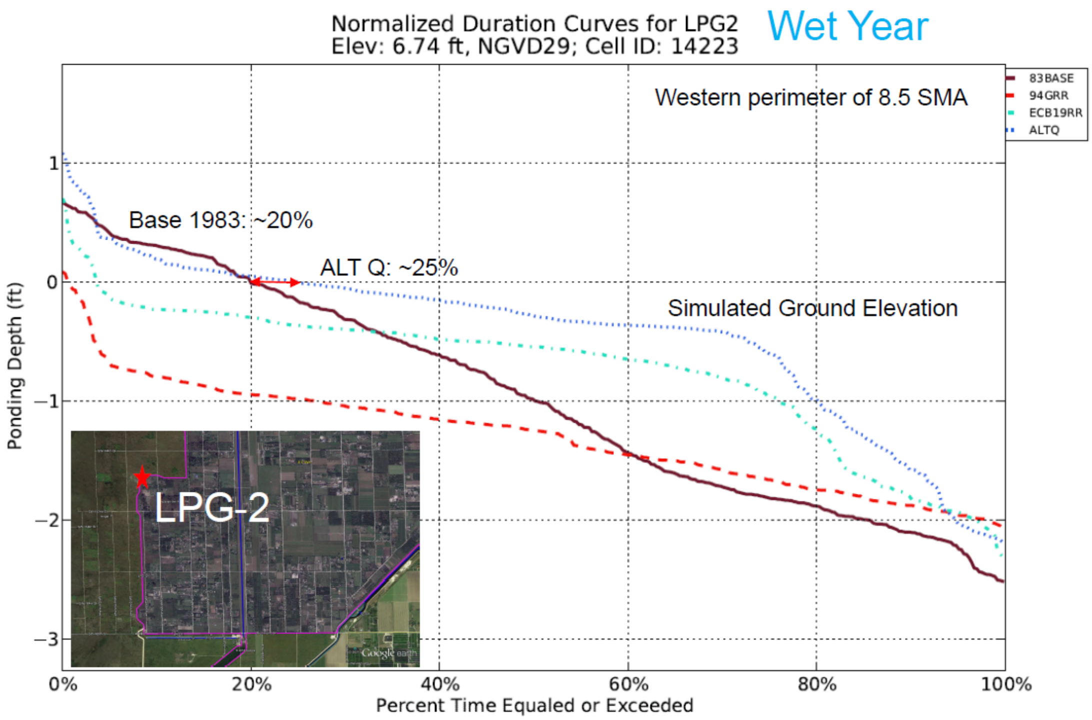


Figure H-6.42. MD-RSM Stage Duration Curves for COP Base Conditions and Round 3 Alternative Q, 2005-2006 Wet Year at LPG-2

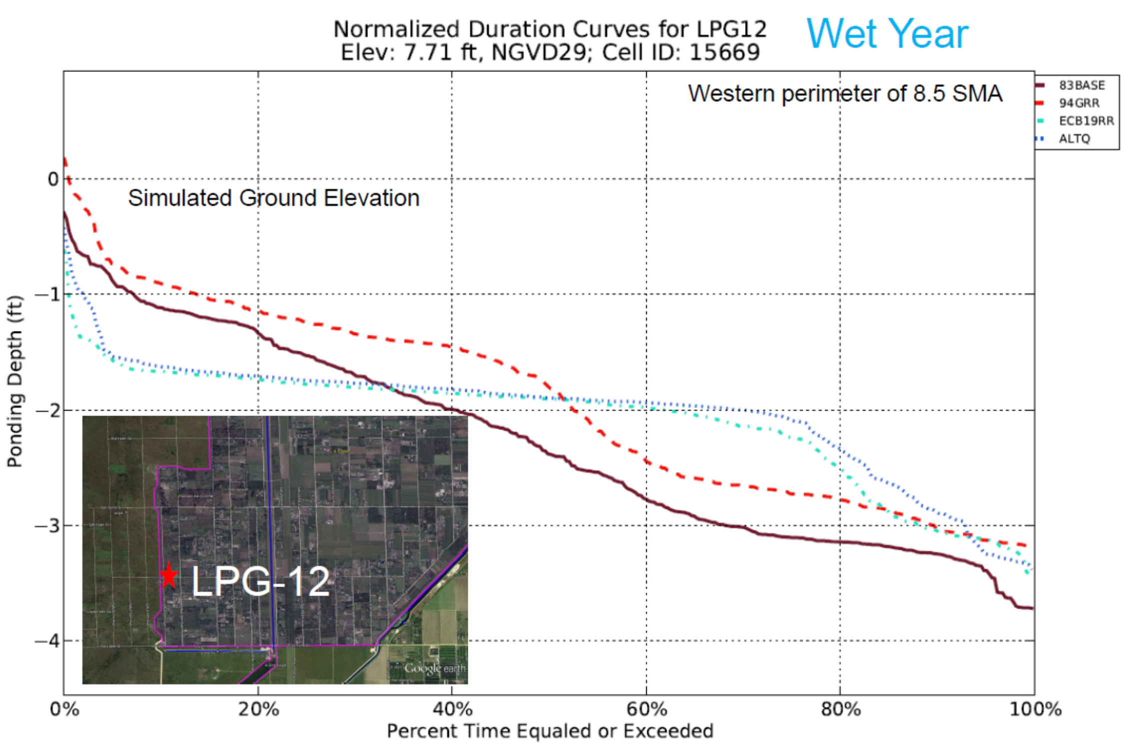


Figure H-6.43. MD-RSM Stage Duration Curves for COP Base Conditions and Round 3 Alternative Q, 2005-2006 Wet Year at LPG-12

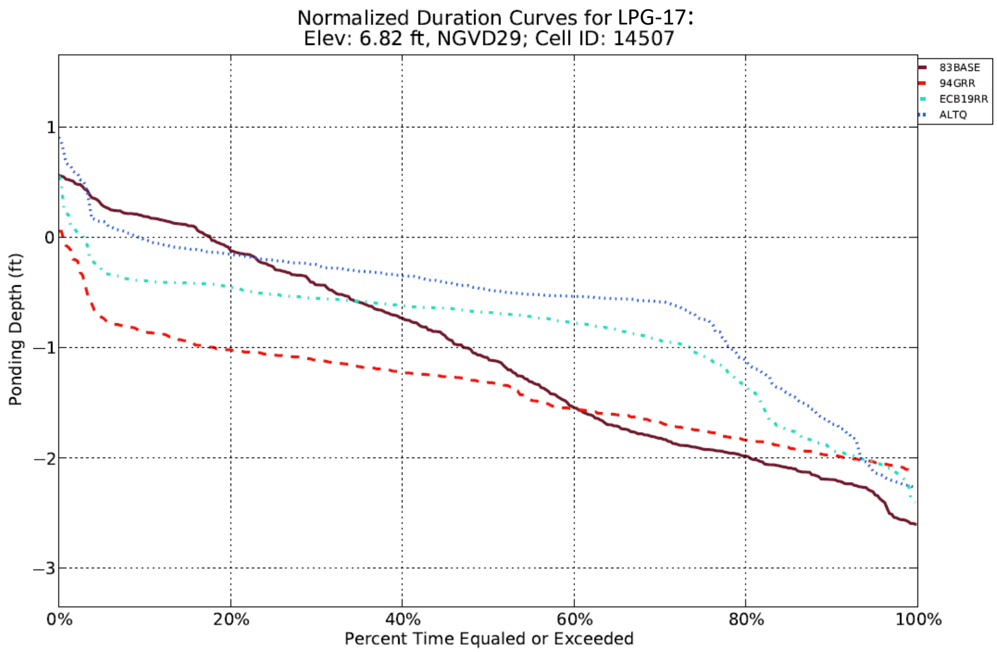


Figure H-6.44. MD-RSM Stage Duration Curves for COP Base Conditions and Round 3 Alternative Q, 2005-2006 Wet Year at LPG-17 (note: title is mis-labeled to gauge name on maps)

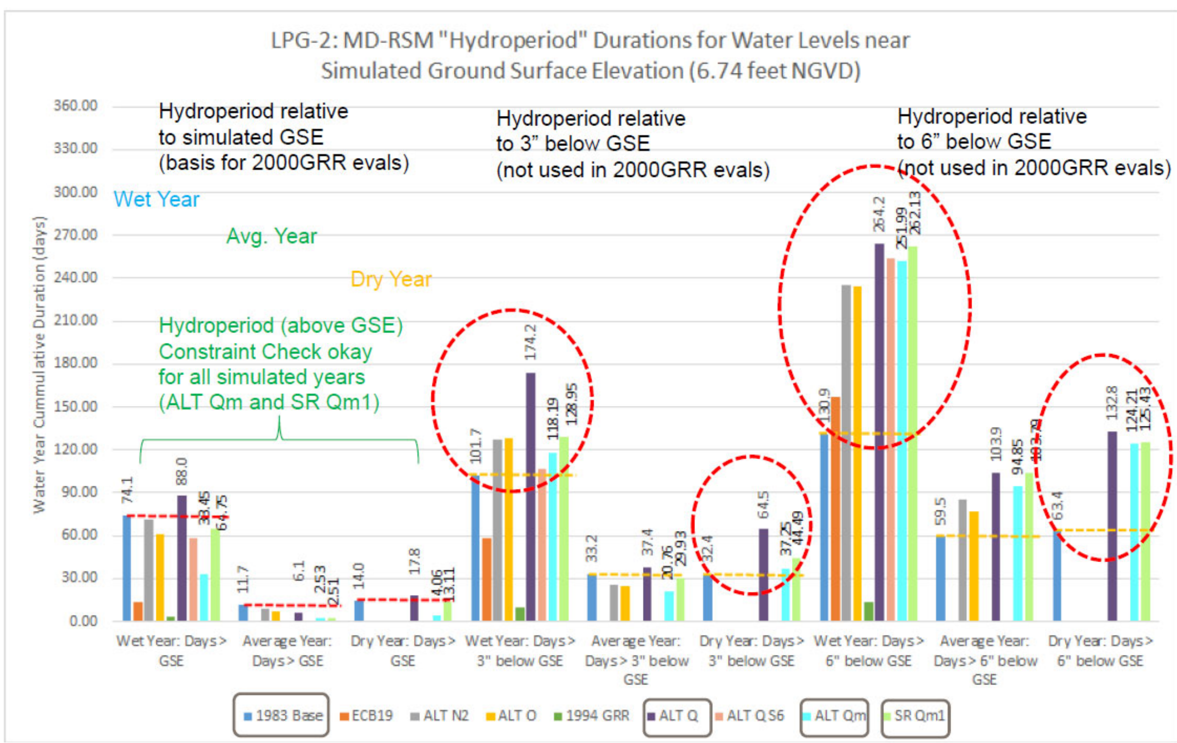


Figure H-6.45. Hydroperiod bar graphs for the wet, dry, and average MD-RSM simulation years for the COP Base Conditions and Round 3 Alternative Q at LPG-2, including hydroperiod referenced against ground surface elevation and the 3 inch and 6 inch theoretical hydroperiod surfaces

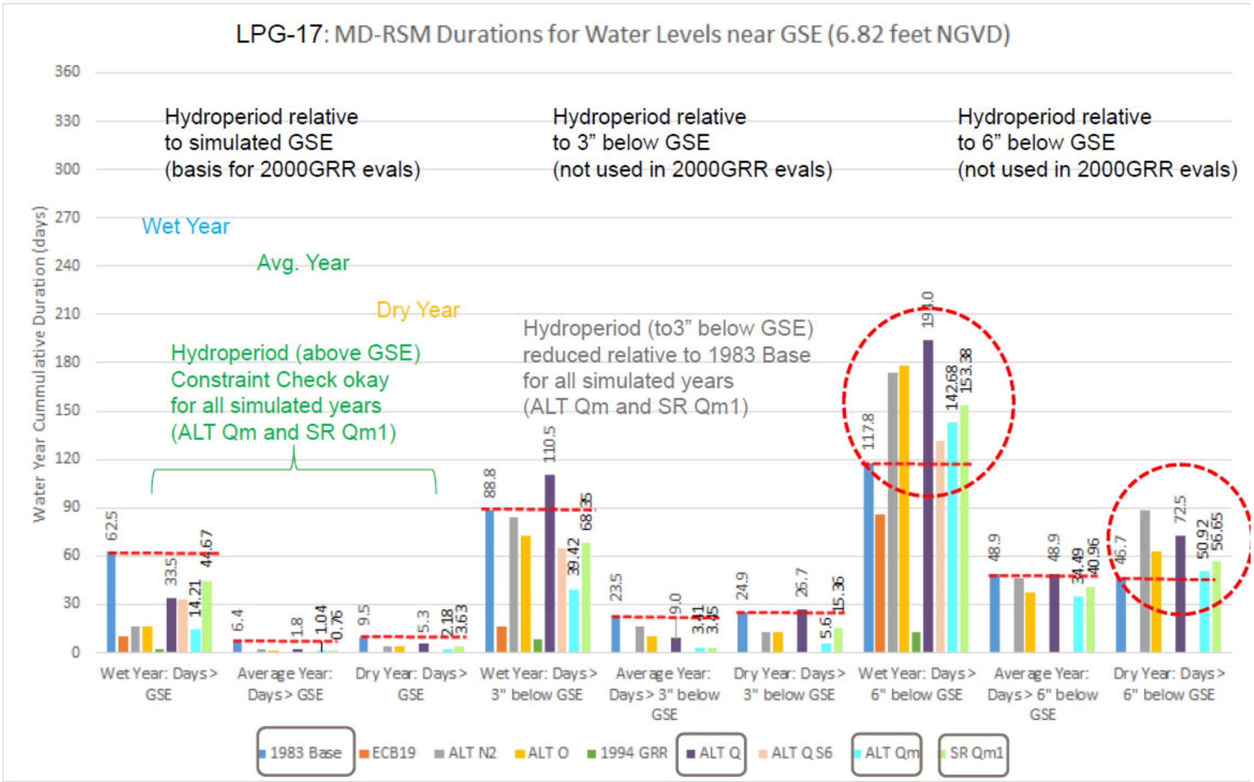


Figure H-6.46. Hydroperiod bar graphs for the wet, dry, and average MD-RSM simulation years for the COP Base Conditions and Round 3 Alternative Q at LPG-17, including hydroperiod referenced against ground surface elevation and the 3 inch and 6 inch theoretical hydroperiod surfaces

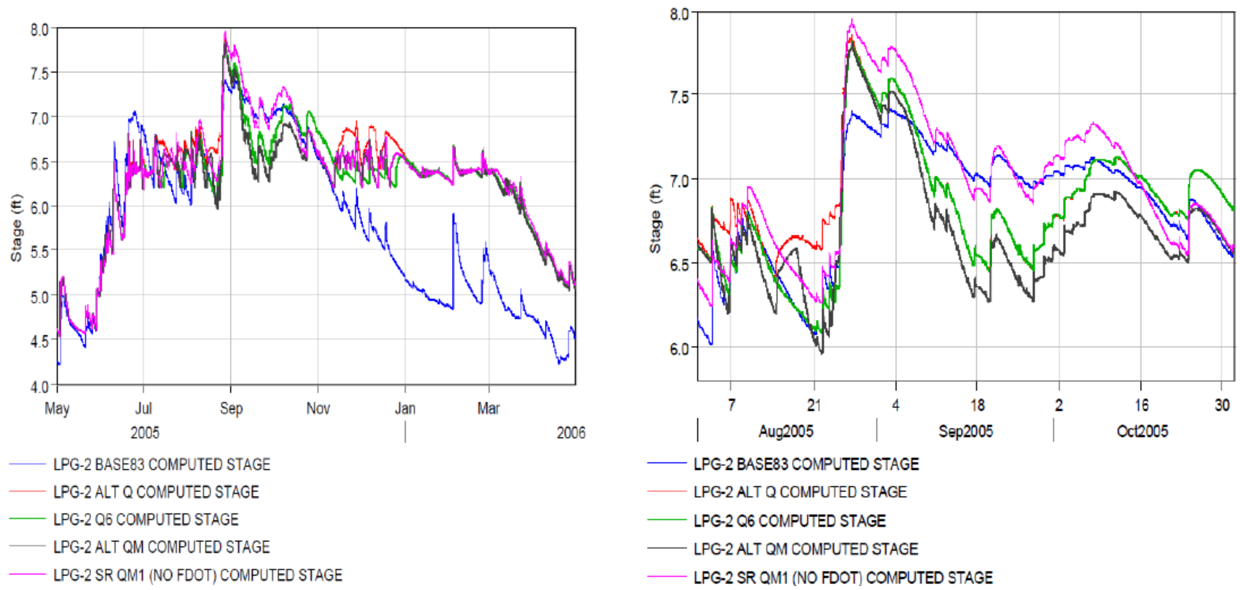


Figure H-6.47. MD-RSM Stage Hydrographs for 1983 Base Condition and Sequential 8.5 SMA Test Operations for Round 3 Alternative Q, 2005-2006 Wet Year at LPG-2. Left Panel Displays the Entire Water Year and the Right Panel Displays the August 2005 Hurricane Katrina Rainfall Event and Post-Event Recession.

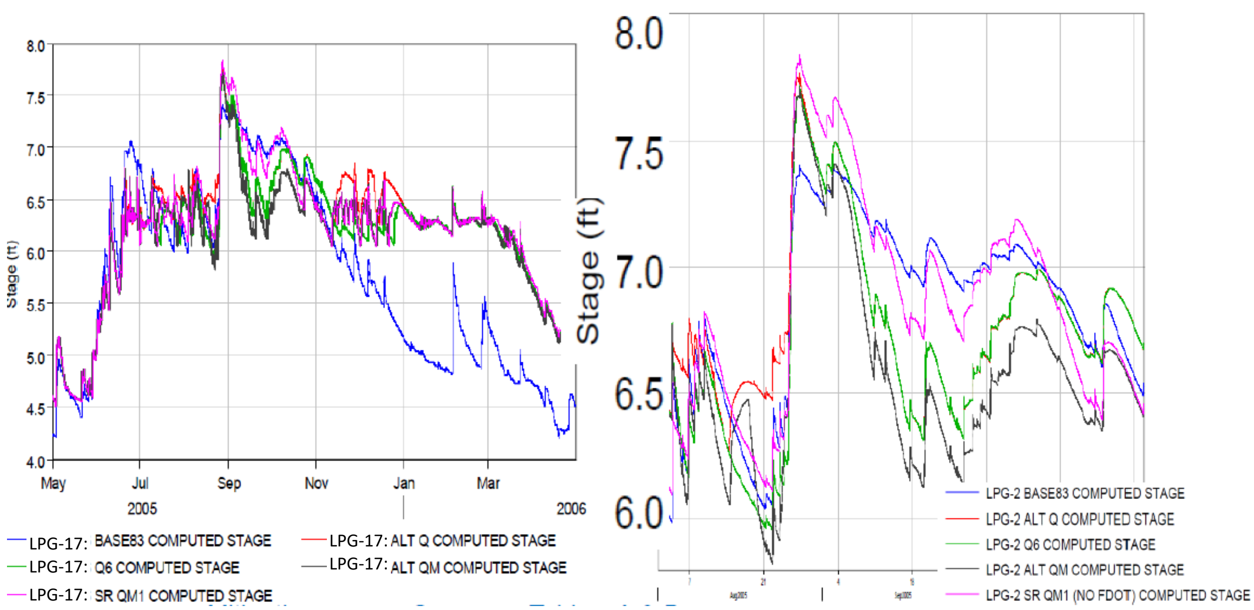


Figure H-6.48. MD-RSM Stage Hydrographs for 1983 Base Condition and Sequential 8.5 SMA Test Operations for Round 3 Alternative Q, 2005-2006 Wet Year at LPG-17. Left Panel Displays the Entire Water Year and the Right Panel Displays the August 2005 Hurricane Katrina Rainfall Event and Post-Event Recession.

Table H-6.1. Summary of 8.5 SMA Accumulated Duration above Ground Surface Elevation at LPG-2 for MD-RSM Wet, Dry, and Average Years and Consecutive Inundation Duration in Wet Year, comparing COP Base Conditions and Sequential 8.5 SMA Test Operations

LPG-2	1983 Base	ECB19	ALT Q	ALT Qm	SR Qm1
Wet Year: Cumm. Days > GSE	74.13	13.51	88.02	33.45	64.75
Average Year: Cumm. Days > GSE	11.65	0.00	6.05	2.53	2.51
Dry Year: Cumm. Days > GSE	14.03	0.00	17.80	4.06	13.11
Wet Year: Consecutive Days > GSE	56.24	13.26	22.30	18.67	54.83

Improved compared to 1983 Base
Impaired compared to 1983 Base
Similar to 1983 Base (slightly improved)

Table H-6.2. Summary of 8.5 SMA Accumulated Duration above Ground Surface Elevation at LPG-17 for MD-RSM Wet, Dry, and Average Years and Consecutive Inundation Duration in Wet Year, comparing COP Base Conditions and Sequential 8.5 SMA Test Operations

LPG-17:	1983 Base	ECB19	ALT Q	ALT Qm	SR Qm1
Wet Year: Cumm. Days > GSE	62.52	10.45	33.48	14.21	44.67
Average Year: Cumm. Days > GSE	6.43	0.00	1.79	1.04	0.76
Dry Year: Cumm. Days > GSE	9.49	0.00	5.34	2.18	3.63
Wet Year: Consecutive Days > GSE	53.63	11.55	17.61	14.21	*45.35

*Total 'Event' Hydroperiod = 21.7d wet, 2.7d dry, 5.1d wet, 3.3d dry, 17.3d wet

Improved compared to 1983 Base
Impaired compared to 1983 Base
Similar to 1983 Base (slightly improved)

H-6.7 8.5 SMA Flood Mitigation Conclusions and Water Control Plan Recommendations

Based on review of the COP Round 3 alternatives, the following conclusions summarize the performance of Alternative Q, the modified Alternative Q with event-based operations at S-357 and S-331 (Alternative Qm), and the potential Alternative Q scenario if the FDOT constraint for the L-29 Canal is removed (SR Qm1, which includes the event-based operations at S-357 and S-331) with respect to the 8.5 SMA flood mitigation constraint. Alternative Qm is the most appropriate MD-RSM modeling representation of the COP Recommended Plan (Alternative Q Plus) following the COP PDT Round 3 technical evaluations.

- 8.5 SMA Congressionally-authorized Flood Mitigation constraint compliance is achieved for all interior 8.5 SMA locations, consistent with methodology applied for the 2000 GRR
    - Hydrologic conditions are not unchanged for all areas, but circumstances are globally improved

        - 61% of 8.5 SMA Leveed Area (6.0 mi^2, excluding flowage easement areas) indicated periodic surface inundation for the modeled 1983 Base (wet year)
        - 12% of 8.5 SMA Leveed Area (6.0 mi^2) indicated periodic surface inundation for the modeled ALT Q (wet year)
    - Hydro-period durations above ground surface elevation < 1983 Base for wet, average, dry years
    - Maximum consecutive days of inundation duration < 1983 Base for wet, average, dry years
    - Peak stage < 1983 Base Peak stage for all depth classes over 98-99% of the 8.5 SMA Leveed Area
        - 1-2% of the 8.5 SMA Protected Area indicates a temporary increase in peak stage (up to 0.4 ft.), with these locations receiving a reduction in inundation duration of 66-74% (LPG-2/LPG-17)
        - Uncertainty with MD-RSM model predictions and topography (note that typical MD-RSM model elements within the western 8.5 SMA are 10-12 acres in size) warranted further constraint checks at LPG-2 (e.g. consideration of flood mitigation performance at the proximal LPG-16 and LPG-17 locations); LPG-2 is 0.25-0.50 feet below average adjacent ground elevations and is not representative of the road and housepad elevations on the adjacent parcels.
        - Simulated peak stages of 7.8 feet NGVD remain > 2.0 feet lower than Average First-Floor Elevations in 8.5 SMA (estimated ~2.0-2.5 feet above the Base Flood Elev. of 8.0 ft NGVD, based on available data)
        - 2018 Miami-Dade County LiDAR survey information was also reviewed to confirm the ingress/egress and elevations adjacent to each parcel where short-term increased peak stage levels were indicated.
- Significant hydro-period extensions are evidenced at ENP and buffer locations immediately west of the 8.5 SMA
    - Ecological effects observed from COP alternatives have assumed retention of the L-29 FDOT constraint throughout Round 1, Round 2 and Round 3 modeling
    - Modeling indicates hydroperiod durations and water stages west of 8.5 SMA are not adversely diminished by event-based 8.5 SMA operations during NESRS high-water conditions
- Further assessment was conducted for the Round 3 modeling and concurrent Water Control Plan development activities, including consideration of the following:
    - SR Q1 with annual operation of the L-29 Canal up to 8.5 ft NGVD does not demonstrate compliance with the complete suite of 8.5 SMA flood mitigation constraint metrics for all interior locations
        - 2-3% of the 8.5 SMA Protected Area indicates a temporary increase in peak stage (up to 0.5 ft.), with these locations receiving no significant reduction in inundation duration

- SR Q1 may be partially or fully implementable if the 8.5 SMA effectiveness is both under-estimated in the COP modeling and the L-29 Canal FDOT constraints are revised or later removed (e.g. TTNS)
  - COP Water Control Plan will incorporate Real-time monitoring in an effort to further increase the frequency and duration of L-29 Canal operations above 8.25 feet NGVD, while continuing to balance system-wide performance and maintaining compliance with constraints
- Continued utilization of real-time flood mitigation tracking metrics will be included in the COP Water Control Plan, informed by 2017-2019 field test operations and the 1983 Base Condition MD-RSM modeling, to provide additional assurances for adherence to the flood mitigation constraint
  - Continued efforts to monitor LPG-16 and LPG-17, which were fully instrumented in September 2019 following completion of the COP Round 3 modeling.

H-6.8 References

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