



MEMORANDUM

AGENDA ITEM #VII.B

DATE: MAY 15, 2023

TO: COUNCIL MEMBERS

FROM: STAFF

SUBJECT: CORRESPONDENCE AND ARTICLES

Recommendation

Information only



Executive Committee

Hon. Steve Geller, Chair
Hon. Samuel Kaufman,
1st Vice Chair
Hon. Quentin “Beam” Furr,
2nd Vice Chair
Hon. René García,
Treasurer
Hon. Michelle Lincoln,
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Mario J. Bailey,
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Jason Andreotta, DEP
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Executive Director

Isabel Cosío Carballo, MPA

Legal Counsel

Samuel S. Goren, Esq.
Goren, Cherof, Doody &
Ezrol, P.A.

April 21, 2023

Mr. Chauncey Goss
Board Chairman
South Florida Water Management District
3301 Gun Club Road
West Palm Beach, Florida 33406

Dear Chairman Goss:

At the Council’s monthly Board Meeting this week, the members of the South Florida Regional Planning Council in attendance voted unanimously to send a letter to the South Florida Water Management District’s Board (SFWMD) requesting that the Board not only levy its full millage rate, but also increase it, to fund urgently needed planning and infrastructure investments to upgrade the Central & Southern Florida Project (C&SF). These investments, in part, are identified in the SFWMD’s Sea Level Rise and Flood Resiliency Plan (September 2022) Appendix A: FPLOS Phase I Initial Project Recommendations and High-Level Estimated Costs (pages 146 – 176). Making these investments now will pay off significantly in future savings by building the infrastructure to handle costly events moving forward.

This past week’s heavy rain and flooding events clearly demonstrated, once again, South Florida’s vulnerability to extensive inland flooding and flood damage. These impacts cause great human suffering, the displacement of residents and businesses, potential adverse health impacts from water-borne disease, and substantial economic loss. With the South Florida Management Water Management District leading the way, in partnership with elected and business leaders, South Florida leaders must move forward aggressively to address C&SF Flood Control Project deficiencies and vulnerabilities and accelerate needed investment and project implementation. It is undeniable that the C&SF was not designed to address the modern-day challenges of climate change, heavy rainfall events occurring over days, king tides, and rising water and ground water levels which render flood control gates inoperable with greater frequency and overwhelm gravity-fed canal drainage systems.



Chairman Goss

April 21, 2023

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In closing, the South Florida Regional Planning Council urges the South Florida Water Management District to increase its millage rate to fast-track the planning and implementation of the infrastructure needed to provide expanded flood control and drainage in South Florida in the near term. Without this investment on an accelerated basis, South Florida will cease to be a vibrant region of opportunity for families and businesses in the future.

Thank you in advance for your consideration and assistance. Please do not hesitate to contact me (sgeller@broward.org) or Isabel Cosio Carballo (isabelc@sfrpc.com), SFRPC Executive Director, if we can provide you with additional information or otherwise be of assistance.

Sincerely,



Steve Geller

Chair, South Florida Regional Planning Council

Broward County Commissioner, District 5

Encls.

cc SFWMD Governing Board
 SFRPC Council Members
 Drew Bartlett, SFWMD Executive Director
 Isabel Cosio Carballo, SFRPC Executive Director
 Doug Bournique, Chair, TCRPC
 Tom Lanahan, TCRPC Executive Director

Excerpt from the South Florida Regional Planning Council Meeting from April 17, 2023, 12:10 pm.

Chair Geller stated that he believes that the South Florida and Treasure Coast RPCs voted at the last Joint Meeting to encourage and support the tax hike to the SFWMD and to ask the County Commissions to send a letter as well. In case this was not formally approved at the last Joint Meeting held February 17, 2023, Chair Geller accepted CM Furr's comments as a motion directing the SFRPC to send a letter requesting an increase in the millage rate to the SFWMD.

Councilmember Furr motioned to approve sending a letter to the SFWMD requesting an increase in the millage rate. Councilmember Caplan seconded the motion, which was carried by a unanimous vote of all members present.

Councilmembers in attendance:

Frank H. Caplan, *Commissioner, Village of Key Biscayne*

Joseph Corradino, *Mayor, Village of Pinecrest*

Quentin "Beam" Furr, *(Second Vice Chair), Commissioner, Broward County*

Cary Goldberg, *Governor's Appointee Broward County*

Michelle Lincoln, *(Secretary), Commissioner, Monroe County*

Greg Ross, *Mayor, Cooper City*

Senator Steve Geller, *(Chair), Commissioner, Broward County*

Craig Cates, *Mayor, Monroe County*

Denise Horland, *Commissioner, Plantation*

Samuel Kaufman, *(First Vice Chair), Vice Mayor, Key West*

Michael Udine, *Commissioner, Broward County*

Councilmembers not present:

Mario J. Bailey, *(Immediate Past Chair), Governor's Appointee Miami-Dade County*

Senator René García, *(Treasurer), Commissioner, Miami-Dade County*

Oliver G. Gilbert, III, *Chair and Commissioner, Miami-Dade County*

Kionne McGhee, *Commissioner, Miami-Dade County*

Appendix A: FPLOS Phase I – Initial Project Recommendations and High-Level Estimated Costs

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Canal Conveyance Improvements	C-8	N/A	N/A	C8_1	\$ 8,762,351	Conveyance improvements within the eastern segment of C8, downstream of its confluence with Marco Canal could help improve the current conditions FPLOS. As noted in the recent FPLOS report (Taylor, 2020), this canal segment has a number of bank exceedances, even for the more frequent (e.g., 10-year) design storm events. Dredging the C8 Canal to deepen and/or widen the cross section could reduce flood elevations and thus the frequency of bank exceedances. Although the effectiveness of this strategy would tend to diminish with increasing SLR and higher storm surge elevations, this strategy could be implemented in conjunction with mitigation strategy #2 to improve FPLOS in future SLR scenarios, which would serve to maintain manageable headwater elevations at S28.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Flood Walls and Storm Surge Barrier Downstream of S28	C-8	N/A	N/A	C8_3		<p>Mitigation strategy #3 is somewhat similar to Mitigation strategy #2 but would be more comprehensive and could potentially provide a higher level of flood protection under the more extreme SLR and storm surge scenarios. This strategy would involve construction of a storm surge barrier (i.e., a miter gate or sector gate) downstream of S28 in the vicinity of U.S Highway 1 (Biscayne Blvd), along with a flood wall to tie the surge barrier back into high ground. According to the USACE Back Bay Study (USACE, 2020), the associated flood wall would have to be continuous with a flood wall and storm surge barrier in the C7 Watershed.</p> <p>In order to be effective under the more extreme SLR scenarios, levees and/or flood walls may have to incorporate seepage barriers due to the extremely high permeability of the underlying Biscayne Aquifer. Without such barriers, the porous limestone of the Biscayne could provide a subsurface pathway for tidal waters to flow underground, seeping into the canals upstream of the floodwalls and surge barriers whenever the tides are higher than canal stages.</p> <p>Assessing the feasibility of seepage barriers will require a detailed analysis of the site(s) geology. Seepage barriers are expected to be costly in this environment. Due to the limestone geology, sheet pile walls may not be feasible. Seepage cut-off walls could possibly be constructed using a sequence of drilled shafts or specialized bedrock-cutting equipment similar to that currently employed in the rehabilitation of the Herbert Hoover Dike (Bruce, 2009). Furthermore, this strategy may require additional seepage management infrastructure (seepage collection canals and pumps) on the inland side of the seepage barriers in order to collect and discharge fresh groundwater to tide.</p> <p>Another possible refinement to this strategy would involve co-locating the surge barrier with the gated control structure (S28) and/or a forward pump station. The current plan presented in the USACE Back Bay study calls for a</p>

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
						<p>separate surge barrier some distance downstream of S28. If the surge barrier, rebuilt S28, and forward pump station could all be co-located, there may be opportunities to improve the operational flexibility of the system over the current plan, such as having the ability to pump down C-8 when the surge barrier is closed. Thus the structure could serve dual purposes of conveying rainfall-induced runoff while protecting against storm surge.</p>

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Raise levees along C-8 canal and add gates / pumps on the secondary branches	C-8	N/A	N/A	C8_4	\$248,791,563	If, in the future SLR scenarios, it is no longer feasible or cost effective to maintain stages in the primary canals at acceptable levels, it may be necessary to consider raising the levees along the primary canals and constructing new gated structures and/or pumps on the secondary canals to achieve an acceptable level of flood protection. The FPLOS report shows the flood depth differences for the 25-year event with no mitigation measures (3-foot SLR minus current conditions), along with conceptual locations of potential new gated structures and pump stations on existing secondary canals at their confluence with the primary canals. Also shown on this report are areas that currently drain directly to the primary canals. Because these areas would not be protected by improvements on secondary branches, they would require modifications to the stormwater collection system to either (a) re-route the drainage to a nearby secondary branch, or (b) re-route the drainage to new municipal pump stations (not shown). Although the extensive drainage modifications this would require may render this strategy infeasible basin-wide, this option was included for completeness or as an option to be considered for targeted areas. Initial Cost estimates include adding pump stations for the Miami-Dade Co. tributary canals to the C8 Canal
Connect Western Mine Pits South of C9 Canal to the C9 Canal	C-9	N/A	N/A	C9_1	\$92,401,883	Connect Western Mine Pits South of C9 Canal to the C9 Canal. Construction of a 1000 cfs immediately west of SW 173rd Ave. Construct backup generator power for C9 Lake Belt forward Pump Station
Oleta River Storm Surge Barrier	C-9	N/A	N/A	C9_2	\$14,576,015	This strategy would include a surge barrier on the Oleta River to the north of S29. The Oleta River barrier would cut off a potential pathway for storm surge to bypass the S29 and enter the C9 basin from the north and west through a swath of urbanized lowlands. A more comprehensive (and more costly) version of this strategy that would provide a higher level of flood protection could also be considered for the C9 Basin. This would be similar to the strategy of flood walls and surge barriers discussed as Mitigation Strategy #3 for the C8 Basin.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Raise levees along C-9 Canal and add gates / pumps on the secondary branches	C-9	N/A	N/A	C9_3	\$322,493,438	This strategy is similar to mitigation strategy #4 in the C-8 basin. If, in the future SLR scenarios, it is no longer feasible or cost effective to maintain stages in the primary canals at acceptable levels, it may be necessary to consider raising the levees along the primary canals and constructing new gated structures and/or pumps on the secondary canals to achieve an acceptable level of flood protection. Conceptual locations of potential new gated structures and pump stations on existing secondary canals at their confluence with C-9. As in C-8, areas draining directly to C-9 would not be protected by improvements on secondary branches, and would require additional modifications to the stormwater collection systems to either (a) re-route the drainage to a nearby secondary branch, or (b) re-route the drainage to new municipal pump stations (not shown). Although the extensive drainage modifications this would require may render this strategy infeasible basin-wide, this option was included for completeness or as an option to be considered for targeted areas. Initial cost Estimates include only new pumps to secondary branches (Station estimate based on \$50k/cfs incl all dewatering, structure const, site work, elec., I&C, and mechanical.) and not raising canal banks.
Increase Connectivity Between C-9 and C-11	C-9	N/A	N/A	C9_4		This strategy was identified by the South Broward Drainage District (SBDD) as a way to increase operational flexibility. In particular, enlarging the Silver Lake Control Structure would facilitate the movement of water into C-11 Basin from SBDD S5 Basin or vice versa depending on relative water levels within the two canals.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Structure S-37B improvements	Broward County	C-14 Basin	The C-14 West Basin has been assigned a 5-year FPLOS rating for SLR1 and less than 5-year FPLOS rating for SLR2 and SLR3. For all return period design storm and sea level rise scenarios simulated, the first FPLOS deficiency that is predicted to occur is flooding of a gravity-drained area that has topographic elevation lower than the peak stage in the C-14 Canal. As return period and sea level rise increases, other deficiencies are predicted to occur such as bank exceedance. Much of the C-14 West Basin is drained by pumps or is	BC_2.1		Although Structure S-37B is not a tidal structure, it is expected to be impacted by sea level rise. As storm surge and sea level rise propagate upstream of Structure S-37A, higher tailwater levels will be seen at Structure S-37B. Higher tailwater levels at Structure S-37B result in decreased discharge and higher stages in the C-14 Canal. One possible improvement to S-37B is the addition of a pump station. However, this addition would only be feasible with major modifications to Structure S-37A also, otherwise it would worsen downstream flooding between S-37B and S-37A. Structural or operational modifications to structure S-37B alone would not be beneficial as Structure S-37B is not predicted to be overtopped and maintains positive head differential during the simulated sea level rise scenarios. Structure improvements at S-37B may be avoidable with a combination of modifications to Structure S-37A, which will be needed anyway, and secondary system improvements, which later studies may determine to be more cost effective as the FPLOS deficiencies are very localized and not widespread.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Add gates / pumps on the secondary system	Broward County		protected by the embankments along the C-14 Canal.	BC_2.2	\$129,800,461	As part of the PM #5 analysis presented in Deliverable 4.2A, Taylor Engineering compared peak canal stages with land surface topography elevations. A significant area of the C-14 West Basin has topographic elevations that are lower than the simulated peak canal stages, however, much of it is drained by pumps (areas such as Coral Springs and Tamarac). Areas drained by pumps can continue to discharge when downstream water levels are higher (unless required by permit to stop when the downstream stages exceed a threshold stage), so they are of less significance for the purposes of the PM #5 evaluation. However, areas that are drained by gravity are unable to drain whenever downstream water levels are higher than the land surface elevation. In the C-14 West Basin, one area in particular was identified as being drained by gravity and having land surface elevations lower than the peak stage where it drains to the C-14 Canal. This area, mainly roads in North Lauderdale, between N University Dr and S State Road 7 (Hwy 441), would benefit from the addition of operable structure(s), whether it be to actively drain when downstream water levels are elevated or to prevent the elevated C-14 Canal from backing up into secondary system. The FPLOS report shows conceptual locations of potential new gated structures or pump stations on existing secondary canals at their confluence with the primary canals. Cost estimates include: Replace the existing control structure for flows into the WCA-2 with a 2000 cfs gated spillway and Construction of a 2000 cfs immediately east of the Sawgrass Expy, including backup generator

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Raise levees at selected locations on the C-14 Canal	Broward County			BC_2.3		As part of the PM #1 analysis presented in Deliverable 4.2A, Taylor Engineering compared peak canal stages with canal bank elevations. Although the C-14 Canal is predicted to mostly contain the 100-year return period design storm within its banks for all three sea level rise scenarios simulated, there are a few localized locations of exceedance. Of the three locations with significant bank exceedance levels, only one is predicted to directly result in inundation of developed lands, which was the metric used to identify deficiencies in this study. The FPLOS Report shows the location proposed for canal bank improvements. The proposed bank improvement would involve raising about 1200 linear ft of the 1700 ft section shown on the north side of the canal to form a more elevated continuous embankment.
Canal dredging in areas with significant head loss	Broward County			BC_2.4		One potential way to reduce stages in the C-14 Canal would be to dredge the canal in areas with significant head loss. The canal bottom profile can be compared to the canal design bottom elevation to identify areas with sediment accumulation. Based on the 25-year design storm simulation results, there is a predicted head loss of about 0.60 ft to 0.74 ft (decreasing as SLR increases) over the 9400 ft stretch of canal between the Sunshine WCD PS1 outfall and South State Road 7, and 1.0 ft to 1.23 ft (decreasing as SLR increases) over the 13500 ft stretch of canal between South State Road 7 and Structure S-37B. These areas could benefit from dredging if the existing canal conditions have deteriorated compared to the design conditions. Regardless of whether the existing canal conditions in these areas have deteriorated compared to design, it is possible that deepening the canal to improve conveyance could reduce peak canal stages.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Raise levees on the Cypress Creek Canal	Broward County	C-14 East Basin	The C-14 East Basin has been assigned a 10-year FPLOS rating for SLR1 and less than 5-year FPLOS rating for SLR2 and SLR3. Under SLR1 scenario, the 25-year design storm is predicted to produce peak canal stages that exceed bank elevations and inhibit gravity-driven drainage. Under SLR2 and SLR3 scenarios, the 5-year design storm is predicted to produce peak canal stages that exceed bank elevations and inhibit gravity-driven drainage. As return period and sea level rise increases, so does the predicted occurrences of bank exceedance as well as the area and duration of flooding. The C-14 East Basin is drained by gravity and is therefore sensitive to stage in the Cypress Creek Canal. To reduce flooding and increase the level of service provided for the C-14 East Basin, Taylor Engineering recommends evaluation of the following two potential flood mitigation projects:	BC_3.2		If, in the future SLR scenarios, it is no longer feasible or cost effective to maintain stages in the primary canals at acceptable levels, it may be necessary to consider raising the levees along the primary canal to reduce overland flooding as a result of bank exceedance. However, this strategy alone would not reduce flooding as a result of elevated stages in the primary canal inhibiting gravity-driven discharge from the secondary system. Therefore, this mitigation strategy could be implemented as necessary in select locations that would still experience bank exceedance after Structure S-37A Improvements (mitigation strategy 1) have been implemented, which can be determined through future model simulations.
Canal dredging in areas with significant head loss	Broward County			BC_3.3		One potential way to reduce stages in the Cypress Creek Canal would be to dredge the canal in areas with significant head loss. The canal bottom profile can be compared to the canal design bottom elevation to identify areas with sediment accumulation. Based on the 10-year design storm simulation results, there is a predicted head loss of about 0.3 ft over the 1 mile stretch of canal between W Palm Aire Drive and FL-845 (Powerline Road) and 0.2 ft over the 3500 ft stretch of canal between FL-845 and the Train Tracks Bridge.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Culvert Modification	Broward County		The Pompano Basin has been assigned a less than 5-year FPLOS rating for all SLR scenarios simulated. The Pompano Canal is predicted to contain the 100-year SLR3 design storm event within its banks with no instances of bank exceedance. However, the canal stage resulting from even the 5-year SLR1 scenario is predicted to result in water backing up and spilling out of the secondary system, as well as inhibiting gravity-driven drainage of developed areas in some localized areas. The Pompano Basin is drained by gravity and model simulations indicate that it would be sensitive to extremely sensitive to sea level rise. As return period and sea level rise increases, so does the overland flood depth and duration in many areas. To reduce flooding and increase the level of service provided for the Pompano Basin, Taylor Engineering recommends evaluation of the following three potential flood mitigation projects:	BC_4.1		The results of the future conditions FPLOS assessment indicate that the culvert immediately upstream of G-57 is at least partially responsible for the elevated stages in the Pompano Canal. This 10 ft diameter culvert, which is approximately 1450 ft in length, is predicted to have approximately 1.5 to 4.0 ft of head loss depending on the specific return period and sea level rise scenario. Depending on the specific scenario, this head loss is more significant than the effects of sea level rise. Therefore, although Structure G-57 experiences overtopping / bypass, improving the conveyance capacity of this section of the canal may prove to have more impact than G-57 improvements alone. However, to maximize flood protection improvement, modification of this culvert could be done in conjunction with Structure G-57 improvements.
Divert Water Through C-14 West / C-14 East Basin	Broward County	POMPANO BASIN	<ul style="list-style-type: none"> • Culvert modification: Increase the conveyance capacity / decrease the head loss through the culvert immediately upstream of 	BC_4.3		If, in the future SLR scenarios, it is no longer feasible or cost effective to maintain stages in the primary canal at acceptable levels, it may be necessary to consider diverting water from the Pompano Basin to the C-14 West Basin, which will ultimately pass through the C-14 East Basin to tide. However, as the C-14 West Basin and the C-14 East Basin are predicted to be affected by sea level rise, diverting water to them would likely only be feasible after structure improvements at S-37B and S-37A are implemented. It may be more effective to divert water through Structure S-37B and Structure S-37A, which will both likely need improvements anyway to protect the large area they serve, than to perform some level of improvement at Structure G-57 and the culvert immediately upstream in addition to the C-14 Basin projects. These potential strategies should be further investigated and analyzed in future studies.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
			Structure G-57 • Structure G-57 improvements • Divert water through C-14 West / C-14 East Basin			
Raise levees along the C-13 Canal and add gates / pumps on secondary branches	Broward County	C-13 WEST BASIN	The C-13 West Basin has been assigned a 25-year FPLOS rating for SLR1, 10-year rating for the SLR2, and less than 5-year rating for SLR3. Under SLR1 scenario, the 100-year design storm is predicted to produce peak canal stages that exceed bank elevations and inhibit gravity-driven drainage. Under SLR2, the 25-year design storm is predicted to produce peak canal stages that exceed bank elevations and inhibit gravity-driven drainage. Under SLR3, the 5-year design storm is predicted to produce peak canal stages near the tidal structure that are higher than larger return periods storms under smaller sea level rise, which highlights the C-13 West Basin's sensitivity to sea level rise.	BC_5.2		If, in the future SLR scenarios, it is no longer feasible or cost effective to maintain stages in the primary canals at acceptable levels, it may be necessary to consider raising the levees along the C-13 Canal and constructing new gated structures and/or pumps on the secondary canals to achieve an acceptable level of flood protection. The FPLOS report presents conceptual locations of potential new gated structures and pump stations on existing secondary canals at their confluence with the primary canals. Gravity structures such as gated culverts, sluice gates, or flap gates are different types of structures that could be considered to prevent flood water from propagating upstream.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
			Per District operational criteria, the S-36 tidal structure closes whenever the tailwater elevation comes within 0.1 ft of the headwater elevation. Due to the increased tailwater elevation associated with sea level rise, the S-36 structure is predicted to close often to prevent storm surge from propagating upstream. Although this prevents storm surge from propagating upstream, it does not completely prevent increased stages upstream, as the C-13 Canal stage will increase due to being unable to discharge to tide when the Structure S-36 is closed.			
Structure Operation Modification	Broward County	NORTH NEW RIVER WEST BASIN	The North New River West Basin has been assigned a 100-year FPLOS rating for SLR1, 25-year for SLR2, and 10-year for SLR3. North New River is predicted to contain the 100-year SLR1, 25-year SLR2, and 10-year SLR3 storm events within its banks with no instances of bank exceedance and little to no overland flooding resulting directly from the elevated canal stages. The 100-year SLR2 and 25-year SLR3 design storms are almost completely contained within bank, however, there is one localized area where	BC_7.1		Based on District-provided structure operations (SFWMD H&H Bureau, 2020), Structure G-54 opens when the headwater elevation exceeds 4.5 ft NGVD29 and does not close until the headwater falls below 3.5 ft NGVD29. As such, once the structure is opened, it remains open when downstream water levels are higher than upstream water levels as long as the upstream water levels have not fallen below 3.5 ft NGVD29, which only occurs for the SLR1 scenarios. It is possible that peak upstream canal stages can be reduced by changing the standard operating criteria. One potential modification that should be further analyzed is closing the gate whenever the downstream elevation is within 0.1 ft of the headwater elevation, as is done with other District tidal outfall structures in Broward County. This operation or a similar set of operating criteria relating to closing the structure if tailwater exceeds headwater would be necessary if a pump station is added, as discussed in Section 8.2. In addition, if structure operations are modified so that the structure closes, the

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
			even the small exceedance would contribute to overland flooding of developed areas. Per District operational criteria listed in the Water Control Operations Atlas for Eastern Broward County (SFWMD H&H Bureau, 2020), the G-54 tidal structure opens whenever the headwater elevation is greater than 4.5 ft NGVD29 and does not close when the downstream water level is elevated. This simulated operation results in elevated upstream water levels and instances of flow reversal. It is possible that closing the structure when downstream levels are within 0.1 ft of the headwater elevation would have similar results to current conclusions as storm surge would overtop Structure G-54, but it should be further analyzed.			gated structure would need modification, which is also discussed in Section 8.2.
Raise Levees at Select Location(s)	Broward County			BC_7.3		If, in the future SLR scenarios, it is no longer feasible or cost effective to maintain stages in the primary canal at acceptable levels, it may be necessary to consider raising the canal levees to reduce overland flooding as a result of bank exceedance. For the North New River Canal, only one instance of bank exceedance was predicted during the future condition simulations (upstream and downstream 124th Ave (N Flamingo Rd)), which was the primary deficiency that impacts the assigned flood protection level of service. Raising the segment of canal embankment identified in Deliverable 4.2B would increase the level of service and is likely a very feasible project to implement. The proposed bank improvement would involve raising about 2800 linear ft of the 3600 ft section shown on the north side of the canal to form a more elevated continuous embankment. It is possible that this strategy would not be required if Structure G-54 follows salinity control operations discussed in Section 8.1, which future modeling simulations can address.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Canal dredging in areas with significant head loss	Broward County			BC_7.4		One potential way to reduce stages in the North New River Canal would be to dredge the canal in areas with significant head loss. The canal bottom profile can be compared to the canal design bottom elevation to identify areas with sediment accumulation. Based on the 25-year design storm simulation results, there is a predicted head loss of about 0.3 ft to 0.83 ft (decreasing as SLR increases) over the 3 mile stretch of canal between Hiatus Rd and N University Dr (FL-817), and 0.14 to 0.46 ft (decreasing as SLR increases) over the 7000 ft stretch of canal between N University Dr and Structure G-54. These areas could benefit from dredging if the existing canal conditions have deteriorated compared to the design conditions. The head loss through the North New River Canal should be analyzed again after the salinity control operations discussed in Section 8.1 have been included in future model simulations. Dredging in areas with significant head loss may eliminate the need to raise the embankment, which could be analyzed in the next phase of this FPLOS study.
Lower water control elevation of primary canal	Broward County	C-11 WEST BASIN	The C-11 West Basin has been assigned a 10-year FPLOS rating for all SLR scenarios. Although the C-11 Canal is expected to contain the 100-year storm event within its banks with no instances of bank exceedance, the elevated canal stage would decrease the gravity drainage ability of the secondary system, contributing to flooding of	BC_8.1		The C-11 West Basin is controlled at a water elevation of 4.0 ft NGVD29. Lowering the control water level in the western segment of the C-11 Canal (upstream / west of Structure S-13AW) may help buffer the peak rainfall and result in overall lower stages in the primary system. As this basin is drained by pumps at the western end of the C-11 Canal, lowering the control elevation would need to be implemented with modification to the standard operating procedure, otherwise the primary canal system would fill back up prior to peak rainfall. However, lowering the control elevation and maintaining the lower stages pre-storm with the pumps may reduce flooding to some extent.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Improve C-11 conveyance capacity / operation modification	Broward County		<p>developed areas. To reduce flooding and increase the level of service provided for the C-11 West Basin, Taylor Engineering recommends evaluation of the following four potential flood mitigation projects:</p> <ul style="list-style-type: none"> • Lower water control elevation of primary canal • Improve C-11 conveyance capacity / operation modification • Add gates / pumps to the secondary system • Use the existing inter-basin connection with C-11 East <p>Although there is a large pump station already draining the C-11 West Basin, it is already at maximum capacity in accordance with the non-Everglades Construction Project permit (SFWMD H&H Bureau, 2020).</p>	BC_8.2		<p>One potential way to reduce the duration of flooding is to increase the conveyance capacity of the C-11 Canal so that the pump has less “down-time”. Based on standard operating criteria, the S-9/S-9A Pump Station reduces discharge when the headwater drops below 1.0 ft NGVD29 and may turn off completely if the water elevation drops below 0.0 ft NGVD29 until the minimum pool elevation is re-established. Increasing channel conveyance capacity could increase the water level upstream of the pumps which would allow them to stay at peak discharge longer, as well as reducing upstream water levels. One potential way of improving canal conveyance is to dredge the primary canal (back to design condition in areas with significant head loss of sediment deposition) or deepen the canal beyond design conditions. Based on the future condition simulations, this strategy would not likely reduce peak flood depths as the pumps are at peak capacity during those times. However, it could reduce the duration that the primary canal is elevated, ultimately reducing the duration of flooding.</p>
Add gates / pumps to the secondary system	Broward County		<p>Therefore, instead of increasing the capacity of the pump station, a potential flood mitigation project would be to provide it more opportunity to discharge at its maximum capacity, either by improving channel conveyance capacity or by modifying the</p>	BC_8.3		<p>If, in the future SLR scenarios, it is no longer feasible or cost effective to maintain stages in the primary canals at acceptable levels, it may be necessary to consider constructing new gated structures and/or pumps on the secondary canals to achieve an acceptable level of flood protection. Due to the large number of connection points between the primary and secondary system, it is likely not feasible to add a pump station to each one. However, it is possible that some strategic combination of gates and pumps could be implemented to reduce flooding and increase the level of service. Adding gates to the secondary canals at their confluence with the primary canals would prevent water from backing up into the secondary system during times of peak stage and pump stations placed on secondary canals with the most connectivity could actively drain the secondary system.</p>

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Use the existing inter-basin connection with C-11 East	Broward County		standard operation criteria. These are further discussed in Section 9.2.	BC_8.4		Between the C-11 West Basin and the C-11 East Basin exists Structure S-13AW, which is an inter-basin connection. For the purposes of the FPLOS design storms, this structure remained closed. The intended purpose of this structure is to discharge excess water from the C-11 West Basin to tide when capacity is available in the C-11 East Basin. One potential way to reduce flooding in the C-11 West Basin is to divert some flood water to tide through the C-11 East Basin. However, this would only be feasible if structure modifications were implemented to increase the discharge potential of the C-11 East Basin tidal structure. As the maximum discharge capacity of the S-9/S-9A pump station is limited, the most obvious way to remove flood water from the C-11 West Basin is to discharge it to tide by increasing the maximum capacity of the S-13 tidal structure. However, modifications to the S-13 structure alone may not be sufficient enough and the primary canal conveyance may need to be improved through dredging (back to design condition) or deepening in some sections. Improvements to the S-13 structure are further discussed in Section 10.2.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Structure S-13 Improvements Option 1	Broward County	C-11 EAST BASIN	The C-11 East Basin has been assigned a 5-year FPLOS rating for all SLR scenarios. Although the C-11 Canal is expected to contain the 100-year storm event within its banks with no instances of bank exceedance, the elevated canal stage would decrease the gravity drainage ability of the secondary system, contributing to flooding of developed areas.	BC_9.1		Structure S-13 is the tidal outfall structure for the C-11 East Basin and is composed of a pump station and an underflow gate. Regardless of gate position, water will bypass this structure at an elevation of 8.0 ft NGVD29 (SFWMD H&H Bureau, 2020), which was not predicted to occur based on District-provided storm surge data. However, the S-13 peak tailwater used for the 100-year SLR3 scenario is within 0.04 ft of bypassing/overtopping the structure. The S-13 underflow gate closes whenever the tailwater elevation gets within 0.1 ft of the headwater elevation. Under future condition sea level rise, the S-13 tailwater stage will often exceed the headwater stage, which forces the underflow gate to remain closed, which significantly reduces the discharge. Structure improvements would involve re-building or modifying the S-13 structure to include more (or larger) forward pumps and increase the heights of the platform to reduce the potential for overtopping/bypass. Due to the low elevation of the C-11 East Basin, sea level rise will likely make a gravity structure such as the S-13 underflow gate impractical. Although the gate is still able to discharge at times during the simulated sea level rise design storms, it does so with upstream water level elevations that cause flooding. Therefore, to reduce flooding and increase FPLOS, increased pump capacity is required.
Structure S-13 Improvements Option 2	Broward County	C-11 EAST BASIN	The C-11 East Basin has been assigned a 5-year FPLOS rating for all SLR scenarios. Although the C-11 Canal is expected to contain the 100-year storm event within its banks with no instances of bank exceedance, the elevated canal stage would decrease the gravity drainage ability of the secondary system, contributing to flooding of developed areas.	BC_9.2		Structure S-13 improvement option 1 involves sizing the upgraded/modified pump station to handle the needs of the C-11 East Basin alone. S-13 improvement option 2 involves sizing the upgraded/modified pump station to handle not just the needs of the C-11 East Basin, but also some needs of the C-11 West Basin. The discharge out of the C-11 West Basin through the S-9/S-9A pump station is limited based on the non-Everglades Construction Project permit. However, discharge to tide is only limited to what the infrastructure can handle. As modifying Structure S-13 is likely required to protect the C-11 East Basin from sea level rise, it may be possible to also increase the level of service for the C-11 West Basin at the same time with one project.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Add Gates / Pumps to the Secondary System	Broward County			BC_9.3		<p>If, in the future SLR scenarios, it is no longer feasible or cost effective to maintain stages in the primary canals at acceptable levels, it may be necessary to consider constructing new gated structures and/or pumps on the secondary canals to achieve an acceptable level of flood protection. Due to the large number of connection points between the primary and secondary system, it is likely not feasible to add a pump station to each one. However, it is possible that some strategic combination of gates and pumps could be implemented to reduce flooding and increase the level of service. Adding gates to the secondary canals at their confluence with the primary canals would prevent water from backing up into the secondary system during times of peak stage and pump stations placed on secondary canals with the most connectivity could actively drain the secondary system. In the C-11 East Basin, the secondary system is mostly composed of north/south drainage canals and does not have many east/west canals connecting them. Therefore, increased connectivity and conveyance between the secondary system would be needed to minimize the number of secondary system pump stations.</p>

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Improvements in Primary Canals C-1W and C-1	South Miami-Dade	Watershed C-1	<p>The C-1 Watershed has been assigned a 10-year FPLOS rating for SLR0 and SLR1 and 5-year FPLOS rating for SLR2 and SLR3. The primary reason for rating the watershed as a 10-yr and 5-yr LOS is due to canal bank exceedance. The following infrastructure projects are suggested to maintain and improve the LOS of watershed C-1:</p> <ol style="list-style-type: none"> 1. Improvements in Primary Canals C-1W and C-1. 2. Upgrades of coastal structure S21 and potential new tidal structure at the Goulds Canal outfall to Biscayne Bay. 3. Upgrades of inland structures S148 and S149. 4. Installation of backflow prevention measures and devices. 5. Installation of control structure at the crossing of Cutler Wetland C-1 Flow Way and the eastern levee. 6. Improvements to elevation requirements of levees at the eastern boundary of the C-1 watershed. 7. Development of local flood mitigation projects in collaboration with Miami-Dade County. <p>The numerical model can be</p>	SMD_2.1		<p>The improvements in Primary Canals C-1W and C-1 may include maintenance and dredging to provide an even bottom gradient from the west to the east and an upgrade of canal bank top elevations to eliminate overtopping. An example of the canal profiles and the deficiencies along the canals for 25-yr design event and SLR 0, 1, 2 and 3 is provided in the Report.</p> <p>The canal profiles show exceedance of canal banks on multiple locations for design events with a return period greater than 5-yr and 10-yr and an increase of SLR. In addition, the report shows that there is a water divide in canal C-1W at approximate chainage 5.5 which suggests that the cross sections of the C-1W may require widening to allow flow to the west (to canal L-31N). Structure S-338 closes depending on the flooding conditions downstream in the C-1 basin. Opening of the structure may cause additional flooding. Any changes for flood operations to this structure will be dependent on downstream flood conditions, therefore additional analysis is recommended to provide a better understanding of effects of redirecting flow to the west.</p> <p>Improvements in Canals C-1W and C-1 will involve:</p> <ul style="list-style-type: none"> • Increase of canal bank elevation above the stage of the 25-yr 3-day design event within the Urban Development Boundary and at locations where flooding damages may occur as result of overtopping of the canal banks. • Maintenance of canals C-1W and C-1, and potential dredging to improve the canal bottom gradient and minimize hydraulic losses <p>Considering that dredging and changing the elevations of the original canal bottom profiles could be prohibitively expensive for the entire canal, additional hydrographic surveys of the C-1N and C-1 canals and cross sections are recommended (C-1W canal already has a detailed cross section survey which has been implemented in the model). The new hydrographic surveys will be used to update the model cross sections, and additional simulation are suggested to determine locations where the canal bottom profile or cross section configurations may cause head</p>

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
			extended to provide analysis of the suggested projects and evaluate the effect of each project on the LOS for current and future conditions.			losses due to constriction or sedimentation and determine canal sections that may require deepening or widening.
New tidal structure at the Goulds Canal outfall to Biscayne Bay	South Miami-Dade	Watershed C-1		SMD_2.3	\$14,140,467	Additional consideration should be given to future urbanization of the agricultural areas which are in the vicinity of Goulds Canal. Future land use which is marked as Agriculture. If the agricultural areas become developed, significant runoff contribution will be expected into Goulds Canal, which may additionally require a tidal structure to accommodate discharges from urbanized areas.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Upgrades of inland structures S148 and S149	South Miami-Dade	Watershed C-1		SMD_2.4		The inland structures will require: <ul style="list-style-type: none"> • Increase of conveyance capacity of Canal C-1N by increasing the capacity of Structure S149 (currently 400 cfs), considering that flooding and canal overtopping has been observed upstream of S149 in canal C-1N. • Upgrade heights of the S149 platform and gates. Currently stages of 7.5 NGVD 29 (6.0 ft NAVD) can bypass the structure. • Upgrade heights of the S148 platform and gates. Currently stages of 9.0 NGVD 29 (7.5 ft NAVD) can bypass the structure.
Installation of backflow prevention measures and devices		Watershed C-1		SMD_2.5		Installation of backflow prevention devices to protect the secondary and tertiary system from backflow from the primary canal system particularly for increased SLR and storm surge conditions which can create high stages in the primary canals.
Installation of control structure at the crossing of Cutler Wetland C-1 Flow Way and the eastern levee.	South Miami-Dade	Watershed C-1		SMD_2.6		The planned Cutler Wetland C-1 Flow Way will require a control structure to avoid backflow during storm surge as discussed in the analysis of Future Conditions (Task 5.2, Section 3.1.4). Proposed structures may include a set of gated box culverts with parameters which will be based on additional analysis of flow rates and stages determined from selected design events and SLR scenario.
Improvements to elevation requirements of levees at the eastern boundary of the C-1 watershed.		Watershed C-1		SMD_2.7		Levee overtopping caused by storm surge can result in significant backflow in the C-1 watershed and increased upstream flood potential. Therefore, raising the top of the levees up to the 25-yr 3-day design event storm elevation at locations on the C-1 Watershed Canal within the Urban Development Boundary would be necessary. Elevation improvements of all levees at the eastern boundary of the C-1 watershed to 7.5 ft (NAVD 88) plus the necessary freeboard would be required. For example, near Goulds Canal, the levee will require an upgrade with a recommended top of the levee of 7.5 ft. (NAVD 88) plus required freeboard (based on the peak stages for the 100-yr event and +3 ft SLR).

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Development of local flood mitigation projects in collaboration with Miami-Dade County.	South Miami-Dade	Watershed C-1		SMD_2.8		<p>The proposed mitigation areas are based on the flood depth greater than 1.0 ft for the 25-yr 3-day design event and flood depth greater than 2.5 ft for the 25-yr 3-day design event.</p> <p>Based on the Flood Extent and Duration Maps (PM5 and PM6) for the 25-yr 3-day storm event and +3 ft SLR, the C-1 Watershed areas within the Urban Boundary Line will require flood mitigation.</p> <p>To analyze the impacts of SLR on the urban drainage, the difference of the flood rasters for SLR 3 and SLR 0 were used to determine the greatest impact of SLR within the watershed. The SLR 0 depth raster depth was subtracted from the SLR 3 depth raster and differences were classified into 3 categories: i) less than 1 ft SLR impact, ii) SLR impact between 1 and 2 feet and SLR impact greater than 2 feet. The FPLOS report shows the areas impacted by SLR change from +0 to +3 ft. The major impacts are within the wetland areas which are interconnected within the drainage system and more specifically the primary canals. The figure shows that the SLR impacts for most of the urban areas (except for the areas highlighted with yellow and red colors) is not expected to be significant for a SLR change from 0 to 3. The FPLOS Report additionally shows the locations within watershed C-1 which will experience increased flooding with SLR and will require drainage improvements.</p>

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Improvements in Primary Canals C-100, C-100A, C-100B.		Watershed C-100	<p>The C-100 Watershed has been assigned a 5-year FPLOS rating for SLR0 and SLR1 and less than 5-year FPLOS rating for SLR2 and SLR3. The primary reason for these ratings is due to canal bank exceedance along several locations along the C-100 Canal. The following projects are recommended for evaluation as potential flood mitigation projects:</p> <ol style="list-style-type: none"> 1. Improvements in Primary Canals C-100, C-100A, C-100B. 2. Upgrades of coastal Structure S123. 3. Backflow prevention. 4. Increase in elevation of all levees at the eastern boundary of the C-100 watershed. 5. Development of local 	SMD_3.1		<p>Considering that changing the original canal bottom profile design could be prohibitively expensive for the entire canal, additional hydrographic surveys of the cross sections are recommended. The hydrographic surveys can be used to update the model cross sections, and additional simulation are suggested to determine locations where the canal bottom profile may cause head losses due to constriction or sedimentation.</p> <p>Improvements in Canals C-100, C-100A and C-100B involve:</p> <ul style="list-style-type: none"> • Increase of C-100B canal bank elevation above the peak stage of the 25-yr 3-day design event within the Urban Development Boundary and at locations where flooding damages may occur as result of overtopping of the canal banks. • Maintenance and dredging of canals C-100A and C-100B for selected locations to improve the canal bottom gradient at locations which potentially have negative bottom gradient or higher hydraulic losses than average • An example of the canal profiles is provided in the report. <p>The canal profiles show exceedance of canal banks on multiple locations of canal banks of C-100A and C-100B within the Urban Development Boundary of Miami-Dade County.</p>

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Upgrades of coastal Structure S123.	South Miami-Dade	Watershed C-100	flood mitigation projects in collaboration with Miami-Dade County. The numerical model can be extended to provide an analysis of the suggested projects and evaluate the effects of each project on the LOS for the current and future conditions. The improvements in Primary Canals C-100, C-100A, C-100B may include maintenance and dredging to provide an even bottom gradient from west to east and an increase of the canal bank elevations to eliminate overtopping.	SMD_3.2		Structure S123 is a two-gate spillway structure with a design flow of 2,300 cfs at 40% SPF, for a 0.5 ft head differential and a tailwater at 1.5 ft (0.0 ft NAVD 88). The major deficiency of this structure for SLR and storm surge conditions is the low by-pass level which is listed as 8.0 ft NGVD 29 (approximately 6.5 NAVD 88). For example, the structure will be by-passed for the 25-yr and 100-yr Storm events for SLR 2 and 3. Figure 17 shows the computed headwater elevations at Structure S123 for the 25-yr and 100-yr events and SLR 0, 1, 2 and 3 ft. Figure 18 illustrates the locations of the C-100 canal banks which have an elevation deficiency and will allow overtopping of the canal. The structure is rated at 5,000 cfs at 100% SPF with head differential of 0.8 ft at tailwater of 2.0 ft NGVD 29 (0.5 NAVD 88) and may require increased peak flow capacity for future SLR and storm surge conditions, and to maintain the peak headwater to design conditions (1.3 ft NAVD). The upgrades of structure S123 include: <ul style="list-style-type: none"> • Installation of a new pump facility which will require additional analysis to optimize flow rates, pump location, downstream effects, funding, local conditions, selected return period of design events, criteria for SLR, freeboard and storm surge elevations. • Increase the heights of the platform and gates above 7.5 ft NAVD plus freeboard. • Improvements to the levees north and south of the structure to be above 7.5 ft (currently the lowest points are 6.03 ft. (NAVD) and potential overtopping can occur).
Backflow prevention.		Watershed C-100		SMD_3.3		Installation of backflow prevention devices are necessary to protect the secondary and tertiary system from backflow from the primary canal system, particularly for increased SLR and storm surge conditions, which can create high stages in the primary canals.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Development of local flood mitigation projects in collaboration with Miami-Dade County.	South Miami-Dade	Watershed C-100		SMD_3.4		Based on the Flood Extent and Duration Maps, the C-100 Watershed areas within the Urban Boundary Line which will require flood mitigation, based on the flood depth greater than 1.0 ft and 2.5 ft for the 25-yr 3-day design event, are depicted in the yellow colored areas. Additionally, the difference of the flood rasters for SLR 3 and SLR 0 were used to determine the greatest impact of SLR within the watershed. The SLR 0 depth raster depth was subtracted from the SLR 3 depth raster. The differences were classified into 3 categories: i) less than 1 ft impact, ii) impact between 1 and 2 feet and iii) impact greater than 2 feet. The FPLOS report also shows that the SLR impacts for most of the urban areas (except for the areas highlighted with yellow and red colors) is not expected to be significant for SLR change from 0 to 3. The locations within watershed C-100 which will experience increased flooding with increasing SLR and will require drainage improvements are detailed in the report.
Improvements in Primary Canals C-102 and C-102N		Watershed C-102	The C-102 Watershed has been assigned a 5-year FPLOS rating for SLR0 and SLR1 and less than 5-year FPLOS rating for SLR2 and SLR3. The primary reason for rating the watershed as 5-yr and less than 5-yr is due to canal bank exceedance. The following projects are recommended for evaluation as potential flood mitigation projects: 1. Improvements in Primary Canals C-102 and C-102N. 2. Upgrades of coastal structure S21A. 3. Backflow prevention devices. 4. Installation of a control	SMD_4.1		Improvements in Primary Canals C-102 and C-102N may require maintenance and dredging to provide an even bottom gradient from west to east and an increase of canal bank elevations to eliminate overtopping. Considering that changing the original canal bottom profile design could be prohibitively expensive for the entire canal, additional hydrographic surveys of the cross sections are recommended. The hydrographic surveys can be used to update the model cross sections, and additional simulations are suggested to determine locations where canal bottom profile may cause head losses due to constriction or sedimentation. Improvements in Canals C-102 and C-102N involve: • Increase of canal bank elevation above the stage of the 25-yr 3-day design event within the Urban Development Boundary and at locations where flooding damages may occur as a result of overtopping of the canal banks. • Maintenance of Canals C-102 and C-102N to ensure a consistent canal bottom gradient which will minimize the hydraulic losses.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
			structure at the eastern levee crossing of conveyances. 5. Improved elevation of all levees at the eastern boundary of the C-102 watershed. 6. Development of local flood mitigation projects in collaboration with Miami-Dade County. The numerical model can be extended to provide an analysis of the suggested projects and evaluate the effects of each project on the LOS for current and future conditions.			An example of the canal profiles and the deficiencies along the canals C-102 and C-102N is provided in the report.
Backflow Prevention	South Miami-Dade	Watershed C-102		SMD_4.3		Installation of backflow prevention devices will be necessary to protect the secondary and tertiary system from backflow from the primary canal system particularly for increased SLR and storm surge conditions which can create high stages in the primary canals.
Installation of control structures at Levee L31E	South Miami-Dade	Watershed C-102		SMD_4.4		Information from SFWMD suggests that 10 culverts and 5 pump stations will be constructed on Levee L-31E for future planned water deliveries to the wetlands east of the levee. All culverts will require controlled gates to prevent backflow from Biscayne Bay during tidal and storm surge events.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Retrofitting Levees		Watershed C-102		SMD_4.5		The top elevation of the L-31E levee between Structures S20G and S21A. The profile shows that the levee elevation can be overtopped at multiple locations for peak stages greater than 5.5-6.0 ft. Overtopping of Levee L-31E can result in significant backflow in the C-102 watershed, increased flooding potential upstream and considerably slower drainage of the flooded areas. Therefore, upgrading the levee to 7.5 ft NAVD plus required freeboard is recommended (7.5 ft NAVD is based on the headwater peak stages for the 100-yr design event and SLR +3.0 ft).
Local Mitigation projects	South Miami-Dade	Watershed C-102		SMD_4.6		Based on the Flood Extent and Duration Maps (reported in PM5 and PM6), the C-102 Watershed areas within the Urban Boundary Line which will require flood mitigation, based on the flood depth greater than 1.0 ft for the 25-yr 3-day design event and flood depth greater than 2.5 ft for the 25-yr 3-day design event. Additionally, the difference of the flood depth rasters for SLR +3 and SLR +0 were used to determine the greatest impact of SLR within the watershed. The SLR 0 depth raster depth was subtracted from the SLR 3 depth raster and differences were classified into 3 categories: i) less than 1 ft SLR impact, ii) SLR impact between 1 and 2 feet and SLR impact greater than 2 feet. The report shows the areas impacted by SLR from 0 to 3 ft. The major impacts are within the wetland areas which are interconnected with the drainage system. The FPLOS report shows that the SLR impacts on the urban areas is not expected to be significant for SLR from 0 to 3, however there are multiple locations within the watershed which experience flooding and which will require mitigation such as conveyance improvements, coastal structure upgrades, and backflow prevention. FPLOS report shows the locations within watershed C-102 which will experience increased flooding with increasing SLR and will require drainage improvements.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Improvements in Primary Canals C-103 and C-103N	South Miami-Dade	Watershed C-103	The C-103 Watershed has been assigned a 5-year FPLOS rating for SLR0 and SLR1 and less than 5-year FPLOS rating for SLR2 and SLR3. The primary reason for rating the watershed as 5-yr and less than 5-yr is due to canal bank exceedance. The following projects are recommended for evaluation as potential flood mitigation projects: 1. Improvements in Primary Canals C-103 and C103N. 2. Upgrades of coastal structures S20F and S20G. 3. Backflow prevention devices. 4. Installation of a control structure at levee L-31E. 5. Improved elevation of all levees at the eastern boundary of the C-103 watershed.	SMD_5.1		The improvements in Primary Canals C-103 and C-103N considers improved maintenance and dredging at locations with high head losses to provide an even bottom gradient from west to east, and upgrades of the canal banks to eliminate overtopping. <ul style="list-style-type: none"> • An increase of C-103 canal bank elevation above the stage of the 25-yr 3-day design event, within the Urban Development Boundary and at locations where flooding damages may occur as a result of overtopping of the canal banks. • Maintenance of canals C-103 and C-103N to ensure consistent canal bottom gradient which will minimize the hydraulic losses. • An example of the canal profiles is provided in the FPLOS report Considering that dredging of the original canal bottom profile design could be prohibitively expensive for the entire canal, additional hydrographic surveys of the cross sections are recommended. The hydrographic surveys can be used to update the model cross sections, and additional simulation are suggested to determine locations where the canal bottom profile may cause head losses due to constriction or sedimentation
Backflow Prevention		Watershed C-103	6. Development of local flood mitigation projects in collaboration with Miami-Dade County.	SMD_5.3		Installation of backflow prevention devices are necessary to protect the secondary and tertiary system from backflow from the primary canal system particularly for increased SLR and storm surge conditions which can create high stages in the primary canals.
Installation of Control Structures at Levee L31E		Watershed C-103	The numerical model can be extended to provide an analysis of the suggested projects and evaluate the effect of each project on the	SMD_5.4		Information from SFWMD suggests that 10 culverts and 5 pump stations will be constructed on Levee L-31E for future planned water deliveries to the wetlands east of the levee. All culverts will require controlled gates to prevent backflow from Biscayne Bay during tidal and storm surge events.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Retrofitting Levees	South Miami-Dade	Watershed C-103	LOS for current and future conditions.	SMD_5.5		Overtopping of the levee can result in significant backflow in the C-103 watershed which will also result in considerably slower drainage and increased upstream flood potential. Therefore, upgrading the levee to 7.5 ft NAVD plus required freeboard are recommended. The top elevation of the L-31E levee between structure S20G and Florida City Canal. The profile shows that the levee elevation can be overtopped at multiple locations for peak stages greater than 5.0-6.0 ft.
Local Mitigation projects		Watershed C-103		SMD_5.6		Based on the Flood Extent and Duration Maps (reported in PM5 and PM6), the C-103 Watershed areas within the Urban Boundary Line which will require flood mitigation based on the flood depth greater than 1.0 ft for the 25-yr 3-day design event and flood depth greater than 2.5 ft for the 25-yr 3-day design event. There are multiple locations within the watershed which experience flooding and which will require mitigation such as conveyance improvements, coastal structure upgrades and backflow prevention. Additionally, the difference of the flood depth rasters for SLR +3 and SLR +0 were used to determine the greatest impact of SLR within the watershed. The SLR 0 depth raster depth was subtracted from the SLR 3 depth raster and differences were classified into 3 categories: i) less than 1 ft SLR impact, ii) SLR impact between 1 and 2 feet and iii) SLR impact greater than 2 feet. FPLOS Report shows the areas impacted by SLR from 0 to 3 ft and the locations within watershed C-103 which will experience increased flooding with increasing SLR and will require drainage improvements.

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
Downstream C-7 Basin OBS: These projects were detailed back in 2018 and associated cost estimates are now outdated.	C-7	N/A	N/A	C7_1		<p>Measures include the following: ID; Measure; Unit Cost; Dimensiones M1; Total Costs; Remarks A- Flood walls; \$1500 per linear foot; 36568 feet; \$54,852,000; Assuming 30 feet depth B- Exfiltration trenches; \$1500 per linear foot; 170,293 feet; \$25,543,950 C- Backflow preventers; \$70,000 per piece; 16 pieces; \$1,120,000; Range of \$10,000 to \$100,000 D- Pumps; \$30,000 per cfs; 3,300 cfs; \$99,000,000; Range of 3>0 to 30,000 per CFS</p> <p>Total: \$180,515,950</p> <p>Note: For the M1 scenario, it was assumed that 3,300 cfs pump capacity would be needed. In practice this was less, as about 3,137 cfs maximum capacity was simulated. However, the 3,300 cfs was used for the cost calculation. Only construction costs are considered; operation and maintenance costs for the pumps are not included.</p>
Elevation to 6 feet (NGDV29) for all buildings and roads OBS: These projects were detailed back in 2018 and associated cost estimates are now outdated.	C-7	N/A	N/A	C7_3.1		<p>ID; Unit Costs of Elevation; Dimensions; Total Costs A- Buildings; \$50,000 per building; 736; \$36,800,000 B- Roads; \$500 per linear foot elevation; 240,156; \$120,078,206</p> <p>Total: \$156,878,206</p>
Elevation to 7 feet for all buildings and roads OBS: These projects were detailed back in 2018 and associated cost	C-7	N/A	N/A	C7_3.2		<p>ID; Unit Costs of Elevation; Dimensions; Total Costs A- Buildings; \$50,000 per building; 1,730; \$86,500,000 B- Roads; \$500 per linear foot elevation; 367,964; \$183,982,245</p> <p>Total: \$270,482,245</p>

Project Name	Basin	Sub-Basin	Sub-Basin Current FPLOS Condition	Mitigation Strategy ID	Total Cost	Comment
estimates are now outdated.						
Elevation to 8 feet for all buildings and roads OBS: These projects were detailed back in 2018 and associated cost estimates are now outdated.	C-7	N/A	N/A	C7_3.3		ID; Unit Costs of Elevation; Dimensions; Total Costs A- Buildings; \$50,000 per building; 3,432; \$171,600,000 B- Roads; \$500 per linear foot elevation; 474,458; \$237,229,000 Total: \$408,829,000
All buildings elevated to the maximum 100-year flood levels under scenario SLR3, and all roads to the 10-year flood level under scenario SLR3 (scenario M3(x)). OBS: These projects were detailed back in 2018 and associated cost estimates are now outdated.	C-7	N/A	N/A	C7_3.4		ID; Unit Costs of Elevation; Dimensions; Total Costs A- Buildings; \$50,000 per building; 2,932; \$146,600,000 B- Roads; \$500 per linear foot elevation; 284,197; \$142,098,530 Total: \$288,698,530

Flood insurance costs will soar in Florida. See the expected increases in your ZIP code

BY NICOLAS RIVERO



Leon rides his bike down a flooded street in the Edgewood neighborhood on Thursday, April 13, 2023, in Fort Lauderdale, Fla. A torrential downpour severely flooded streets partially submerging houses and cars across South Florida. MATIAS J. OCNER / mocner@miamiherald.com

Brace for a few years of flood insurance rate hikes, South Florida. And they're going to be steep — doubling, even tripling for thousands of homeowners.

FEMA has changed the way it calculates flood insurance prices. Instead of relying on old flood zone maps covering broad areas, it's now [basing premium prices on a wider range of factors](#), like an individual property's distance from the ocean, rainfall levels and the cost to rebuild a home.

Last month, for the first time, FEMA shared estimates for what that will mean for the average flood insurance premium by ZIP code. For the worst-hit ZIP code in South Florida — 33469, a stretch of coastal Palm Beach County that covers parts of Jupiter and Tequesta — that will mean a 342% premium increase, on average.

In the most expensive ZIP code for flood insurance in South Florida — 33149, which covers Key Biscayne — average premiums will rise north of \$7,000 a year.

Some important qualifiers: The premium hikes won't hit all at once for existing policyholders, and not everyone will see an increase. FEMA estimates that about 20% of Florida policyholders will actually see their premiums drop under the new pricing regime, known as Risk Rating 2.0.

For those with current federal flood policies, the good news is that the rate won't immediately skyrocket. Congress has capped price hikes at 18% per year. The bad news is, you might see that flood insurance premium go up 18% every year for several years until it reaches the new Risk Rating 2.0 calculation for your home.

If you're buying a new flood insurance policy, however, you'll get hit with the new premium all at once. Since April 2022, new policyholders have had to enroll at the full Risk Rating 2.0 price.

FEMA says the new premiums reflect the reality of Florida’s increasing flood risk, as people continue to build homes in flood-prone areas and climate change raises sea levels and makes “rain bomb” events, like the 1,000-year floods that [recently inundated Fort Lauderdale](#), more common.

The agency also argues that the new premium regime is more fair. “The new methodology allows FEMA to equitably distribute premiums across all policyholders based on the value of their home and the unique flood risk of their property. Currently, many policyholders with lower-value homes are paying more than they should and policyholders with higher-value homes are paying less than they should,” FEMA wrote in an [April 2021 press release](#) announcing the change.

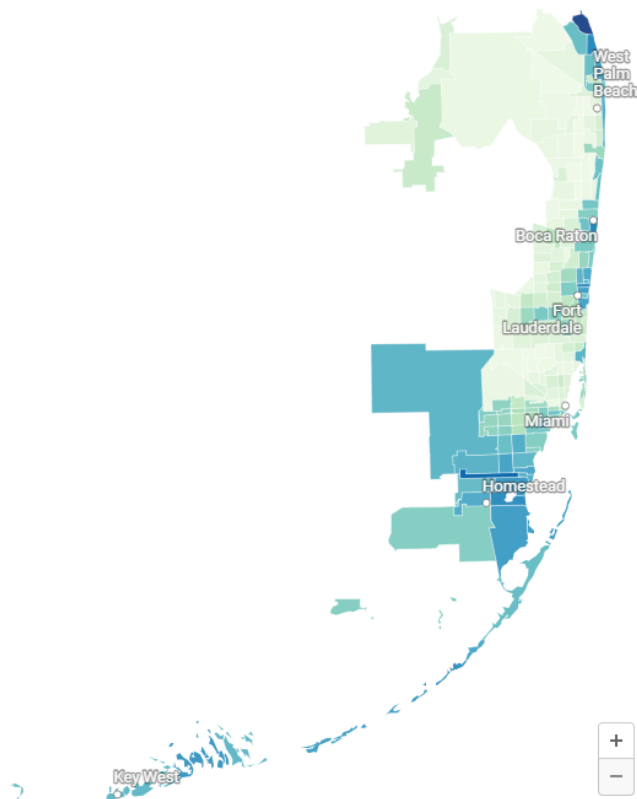
Mortgage lenders and banks often require that home and property owners get federal flood insurance. Although Florida has the highest number of policies in the country, [roughly 4 out of 5 Florida homes](#) aren’t covered. Emergency management experts warn that just about anyone in a state vulnerable to hurricanes and heavy rains [should get it](#).

The number of Florida flood insurance policies is likely to rise. This year, Florida lawmakers [passed a bill](#) requiring anyone with hurricane and wind policies from Citizens Insurance to also get flood insurance. That affects 1.2 million Citizens policyholders in the state.

Across South Florida, the biggest premium hikes will go to policyholders in the Keys, South Miami-Dade and coastal Broward and Palm Beach counties. Rates will remain relatively stable in North Dade and inland Broward and Palm Beach.

Big changes coming to flood insurance rates

New changes to the national flood insurance program could be bringing steep increases to flood insurance bills across South Florida.



Map: Nicolás Rivero • Source: U.S. Federal Emergency Management Agency • Map data: © Esri, TomTom North America, Inc., United States Postal Service • [Get the data](#) • Created with [Datawrapper](#)

The 10 biggest premium hikes in South Florida affect ZIP codes up and down the coastline from Summerland Key to Jupiter — and three ZIP codes in inland Miami-Dade County.

Those hikes will eventually lead to average increases in annual insurance bills as high as \$4,056 in ZIP code 33036, which covers Islamorada. But the increases will phase in gradually. In ZIP code 33469, which covers parts of Jupiter and Tequesta, the average policyholder will see eight straight years of 18% insurance hikes before their premiums stabilize at the new Risk Rating 2.0 level.

South Florida ZIP codes with the biggest flood insurance premium hikes under Risk Rating 2.0

	County	ZIP code	Average premium hike	Impact on annual insurance bill
1	Palm Beach	33469	342%	+\$2,669
2	Miami-Dade	33170	287%	+\$1,609
3	Palm Beach	33432	229%	+\$2,178
4	Palm Beach	33477	226%	+\$1,705
5	Monroe	33001	222%	+\$3,044
6	Miami-Dade	33033	217%	+\$1,544
7	Miami-Dade	33146	214%	+\$1,580
8	Broward	33305	209%	+\$2,301
9	Monroe	33036	207%	+\$4,056
10	Monroe	33042	198%	+\$2,996

Table: Nicolás Rivero • Source: U.S. Federal Emergency Management Agency • Get the data • Created with Datawrapper

Under the new risk rating regime, the highest average premiums in South Florida will all be in ZIP codes in Miami-Dade and Monroe counties. Key Biscayne, Islamorada, Marathon, Miami Beach, North Bay Village, Bal Harbor, Surfside, and Sunny Isles will be among the most expensive areas to insure against flooding in South Florida. Key Biscayne will have the sixth highest insurance premiums of any ZIP code in the state.

South Florida ZIP codes with the highest average flood insurance premiums under Risk Rating 2.0

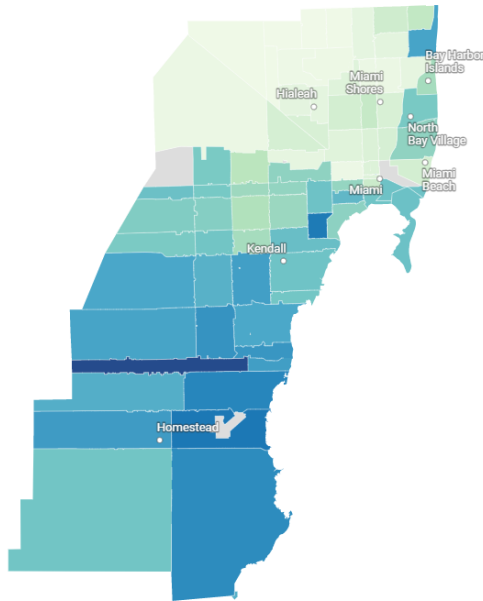
	County	ZIP code	Average flood insurance premium
1	Miami-Dade	33149	\$7,097
2	Monroe	33036	\$6,016
3	Monroe	33051	\$5,938
4	Monroe	33050	\$5,666
5	Miami-Dade	33141	\$5,422
6	Miami-Dade	33140	\$5,373
7	Miami-Dade	33160	\$5,077
8	Miami-Dade	33154	\$4,888
9	Monroe	33070	\$4,690
10	Monroe	33042	\$4,510

Table: Nicolás Rivero • Source: U.S. Federal Emergency Management Agency • Get the data • Created with Datawrapper

In Miami-Dade, the biggest premium increases are coming in the southern part of the county, in ZIP codes where home prices are particularly high (33146, i.e. Coral Gables) or where premiums have been historically low (33033, i.e. Leisure City and 33170, which runs west from Goulds to the Everglades).

Big changes coming to flood insurance rates

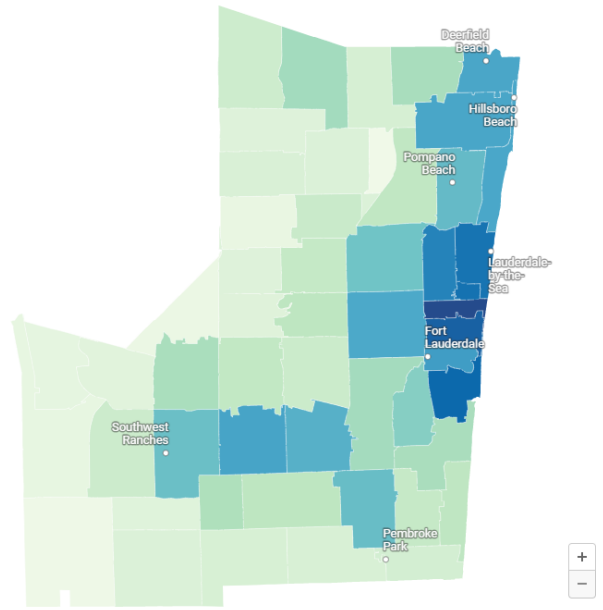
New changes to the national flood insurance program could be bringing steep increases to flood insurance bills across Miami-Dade County.



Source: U.S. Federal Emergency Management Agency • [Get the data](#) • Created with [Datawrapper](#)

Big changes coming to flood insurance rates

New changes to the national flood insurance program could be bringing steep increases to flood insurance bills across Broward County.



Source: U.S. Federal Emergency Management Agency • [Get the data](#) • Created with [Datawrapper](#)

In Broward, the biggest premium increases are concentrated on the coast, especially in ZIP codes surrounding Fort Lauderdale. ZIP code 33315, which covers Edgewood, one of the [worst-hit neighborhoods](#) in the Fort Lauderdale floods, will see a relatively modest 64% premium hike. But a few miles north in ZIP code 33305, premiums are expected to double on average.

This climate report is funded by [Florida International University](#), the Knight Foundation and the [David and Christina Martin Family Foundation](#) in partnership with Journalism Funding Partners. The Miami Herald retains editorial control of all content.

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