APPENDIX B:
ENGINEERING

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FINAL FOUR ALTERNATIVES:

The final four alternatives are 2.2.2a, 2.2.2.b, 3.2.2a and 3.2.2b. The alternative descriptions are in the paragraphs below. The schedule for these alternatives is based on the time to get the design modifications complete, real estate, contracting, and required permits. The schedule for each alternative is as follows:

Alternative 2.2.2a – Add 1-mile eastern bridge and mitigate road to accommodate a canal elevation of 8.0 feet NGVD has construction duration of 3 years. The start date for the construction is October 2008.

Alternative 2.2.2b – Add 1-mile western bridge and mitigate road to accommodate a canal elevation of 8.0 feet NGVD has construction duration of 3.5 years. The start date for the construction is August 2010.

Alternative 3.2.2a – Add 1-mile eastern bridge and mitigate road to accommodate a canal elevation of 8.5 feet NGVD has construction duration of 3 years. The start date for the construction is October 2008.

Alternative 3.2.2b – Add 1-mile western bridge and mitigate road to accommodate a canal elevation of 8.5 feet NGVD has construction duration of 3.5 years. The start date for the construction is August 2010.

On December 14 FDOT provided pavement design guidelines for roadways that do not have the standard design clearance between the design high water elevation and the lime rock base. Based on this information the design for each alternative is as follows:

For the 8 foot elevation:

If the road is above 11.41, mill off 3 inches of asphalt and replace with 3 inches of asphalt.

If the road is between 11.41 and 10.41, mill off 3 inches of asphalt and replace with 5 inches of asphalt.

If the road is below 10.41, reconstruct the road to so that the black base is 1 foot above the design high water elevation of 8 feet. This gives a crown of 10.54.

For the 8.5 foot elevation:

If the road is above 11.91, mill off 3 inches of asphalt and replace with 3 inches of asphalt.

If the road is between 11.91 and 10.91, mill off 3 inches of asphalt and replace with 5 inches of asphalt.

If the road is below 10.91 feet, reconstruct the road to so that the black base is 1 foot above the design high water elevation of 8 feet. This gives a crown of 11.04 feet.

TENTATIVELY SELECTED PLAN:

The Tentatively Selected Plan (TSP) is Alternative 3.2.2a as described below.

GENERAL NOTES:

1. All design information for the road and bridge is contained in the original 2005 Revised General Reevaluation Report (RGRR). The 2005 RGRR is located at http://www.saj.usace.army.mil/dp/mwdenp-c111/index.htm the engineering information is in Appendix D. This information was used to evaluate all the alternatives. All asphalt work was based on the depth of asphalt needed for the Alternative 14 in the 2005 RGRR and crown heights were lowered as necessary.

2. The location for all bridges would be as proposed under the 2005 RGRR, which is south of the existing Tamiami Trail. This alignment allows existing transportation lanes to be open during construction to allow easier maintenance of traffic.

3. Design elevations were based on the following hydraulic requirements and pertinent water levels. As water levels in the canal are held at lower stages than the Natural System Model (NSM), the elevations for design high water (DHW) are lowered proportionally. The control water elevation (CWE) for the bridges remains the same for each alternative.

    a. Roadway DHW elevation: Defined as the 20-year 24-hour stage, assuming a natural systems condition, based on a regional hydrologic model and a 36-year simulated period of record. This water level is only used to establish the vertical clearance requirements for the reconstructed roadway.
    b. Bridge CWE: Defined as the average high water elevation assuming a natural systems condition, based on regional hydrologic model and a 36-year simulated period of record. This elevation does not represent a stage that will be maintained but a stage used to determine the required low chord elevation for the proposed bridge. Between the 2005 RGRR and the 30% design, FDOT required a bridge low cord height of 8 feet from the CWE. This height restriction was relieved to 6 feet low cord height from the CWE and has been adjust in this report.

4. Geotechnical data for the 60% design of Alternative 14 is located at ftp://ftp.saj.usace.army.mil/pub/Public_Dissemination in the folder named, 'Tamiami_Trail'. One file is named 'Roadway Geotechnical Report' and the other is

named 'Bridge Geotechnical Report'. These data were utilized in estimating the cost for the foundations of the Bridge.

5. All alternative bridges had two 12–foot travel lanes with 10-foot shoulders. The approaches to the bridges also had 12-foot travel lanes with a 10-foot shoulder. The approaches had a 2-on-1 side slope. The approach shoulders are paved for 5 feet and grassed for the remaining 5 feet.

6. All alternatives were evaluated by reviewing the 10.7 miles of road.

ALTERNATIVE GROUPS

The 27 alternatives were arranged into five groups or categories. The categories are separated by extent of mitigation thought appropriate to safely allow higher stages in L-29 Canal.

CATEGORY 1: NO ROADWAY MITIGATION:

No increase in L-29 Canal stage. Enhanced flow modification features, without roadway modifications.

Alternative 1.1: No Action (***Figure B-1***). The No Action alternative maintained existing conditions for the Tamiami Trail. This alternative did not allow additional discharges into the Everglades National Park (ENP) as envisioned in the 1992 General Design Memorandum (GDM). It has a stage constraint in L-29 Canal of 7.5 feet, National Geodetic Vertical Datum (NGVD) average water elevation.

Alternative 1.2: Spreader swales south of culverts. This alternative introduced spreader swales at each set of culverts. The swale dimensions (***Figure B-2***) were 30 feet wide and 1,000 feet long (bottom width). The assumption used to determine the quantities was the peat was four feet thick and required a 1-on-3 side slope. The swales would be constructed by removing the trees and shrubs from the culvert openings and then removing the peat to rock to the width and length of the swale thus providing a place for the water to overflow. These swales were included in all designs to allow the culverts to continue to operate. Any additional openings require a cleared area for water to flow. This alternative will be addressed by a pilot test. If the test provides appreciable benefits, then the remaining swales would be considered for construction as part of the remaining conveyance and seepage control features through a separate NEPA process. Swales will require minimal maintenance.

Alternative 1.3: Culverts only. Add 19 sets of three five-foot diameter culverts to the road for a total of 535 feet or 0.1 mile of opening. The new sets of culverts were placed between the existing culverts reducing the culvert set

spacing from ~3,000 feet to ~1,500 feet. The exact location of the culverts will be determined by field investigation. The culverts will be installed by jacking and boring under the road. These culverts will include swales as described above.

Alternative 1.4a: Add 1-mile eastern bridge. This alternative will meet the minimum opening requirement necessary to affect a change in the elevations of marsh. The alternative did not allow water elevations to increase in the L-29 Canal. The cross section and crown elevations are not changed from existing. The bridge CWE for this alternative is 8.75 ft NGVD. The bridge low cord would be six feet above this elevation for inspection purposes. The low cord elevation would be 14.75 ft NGVD.

Alternative 1.4b: Add 1-mile western bridge. This alternative is the same as above, except for the foundation design. Because of poorer soil conditions in the western section, the foundations required battered piles and additional piles that were not required for the eastern bridge. The bridge location was the western 1-mile portion of the 2005 RGRR Alternative 14 western bridge. It would have more private real estate impacts during construction than the eastern bridge.

Alternative 1.5: Is similar to Alternative 5.4, but will not include the levees. This alternative included a one-mile western bridge. The road elevation itself would have to be a minimum of 13 feet NGVD at the crown. The road cross section would be similar to Alternative 4.2.3. Modeling was not performed for this alternative. It was assumed to have the same hydraulics as 1.4b. Modeling would have to occur prior to beginning design. Any additional features would be evaluated as part of the conveyance and seepage features.

CATEGORY 2: LIMITED ROADWAY MITIGATION:

Mitigate the low areas to increase stage above 8.0 ft NGVD. Raising the L-29 Canal elevation to 8.0 feet NGVD did not meet the required elevation variations of the NSM as proposed in the Combined Structural and Operational Plan (CSOP) or Comprehensive Everglades Restoration Plan (CERP). The roadway for this set of alternatives was approximately one foot above the low area of the road. This category involved minimal roadway width improvement. The template did not change from the original template except in the low areas. The figures for this alternative are shown in the low areas. The existing roadway had two 12-foot lanes with one 10-foot shoulder and one 8-foot shoulder which had varying pavement depth. The travel lanes and six feet of the shoulder had an average of 8.75 inches asphalt with the remaining shoulder having 2 inches asphalt. Improvement sections had two 12-foot lanes with two 10-foot shoulders (5 feet paved and 5 feet grassed). The existing side slope is approximately 1.5-to-1. The improved sections were designed with a side slope of 2-to-1.

Alternative 2.1: Mitigate low sections of road (***Figure B-3***). This alternative mitigated the top of the road crown to 11.05 ft NGVD, which met the current criteria established with Florida Department of Transportation (FDOT) on the cross section crown elevation (3.05 feet above the average water elevation) at that time. The roadway design used here was the same as the 2005 RGRR design. This alternative does not address the need for additional openings in the road; however, it does provide some improvement. This alternative will have a stacking effect at the road and into Water Conservation Area (WCA) 3B that will not provide the benefits that an opening would provide with raising the road.

CATEGORY 2.2: LIMITED ROADWAY MITIGATION WITH INCREASED OPENING:

Limited changes were introduced to the roadway along with additional openings.

Alternative 2.2.1: Mitigate road, add culverts. This alternative mitigated the road as described in Alternative 2.1 and added 19 sets of three five-foot diameter culverts to the road for a total of 535 feet or 0.1 mile of opening. The new sets of culverts were placed between the existing culverts reducing the culvert set spacing from ~3,000 feet to ~1,500 feet. The exact location of the culverts will be determined by field investigation. The culverts will be installed by jacking and boring under the road thus the road raising can be concurrent with jacking and boring. Swales were included at each new set of culverts for costing.

Alternative 2.2.2a: Mitigate low sections of road and add 1-mile eastern bridge (***Figure B-4***). This alternative met the minimum opening requirement necessary to affect a change in the elevations of marsh. The cross section and crown elevations were the same as in Alternative 2.1. The bridge CWE for this alternative is 8.75 feet NGVD. The bridge low cord was designed to six feet above the CWE elevation for inspection purposes. The low cord elevation was 14.75 feet NGVD.

Alternative 2.2.2b: Mitigate low sections of road and add 1-mile western bridge (***Figure B-5***). This alternative was the same as above except for the foundation design. Because of poorer soil conditions in the western section, the foundations required battered piles and additional piles that were not required for the eastern bridge. The bridge location was the western 1-mile portion of the 2005 RGRR Alternative 14 western bridge. It would have more private real estate impacts during construction than the eastern bridge.

Alternative 2.2.3: Mitigate low sections of road and add two-mile and one-mile bridges (***Figure B-6***). This alternative met the opening

requirements necessary to affect a change in the elevations of the marsh. The design parameters do not change from above.

CATEGORY 3: MAJOR ROAD MITIGATION:

Roadway modifications were designed for category 3 alternatives to allow an increase of water levels in L-29 Canal to 8.5 feet NGVD. Raising the L-29 Canal elevation to 8.5 feet NGVD did not meet the required elevation variations of the NSM as proposed in the CSOP or CERP. The roadway for these alternatives has a travel lane width of 12 feet and shoulders of 10 feet. At the elevation for the crown, more of the road would have to be widened. This design required two 12-foot travel lanes and two 10-foot shoulders (5 feet paved and 5 feet grassed). The side slope design of the improved sections was 2-to-1.

Alternative 3.1: Mitigate road (***Figure B-7***). This alternative mitigated the top of the road crown to 11.55 feet NGVD, which meets the current criteria established with FDOT on the cross section crown elevation of 3.05 feet above the average water elevation. This roadway design was the current 2005 RGRR design. This alternative did not address the need for additional openings in the road; however, it provides some improvement. This alternative had a stacking effect at the road and did not provide the benefits that an opening and raising the road would provide.

CATEGORY 3.2: MAJOR ROAD MITIGATION WITH INCREASED OPENINGS:

Major changes were introduced to the roadway along with additional openings.

Alternative 3.2.1: Mitigate road, add culverts. This alternative mitigated the road as described in Alternative 3.1 and added 19 sets of three five-foot diameter culverts to the road for a total of 535 feet or 0.1 mile of opening. The new sets of culverts were placed between the existing culverts reducing the culvert set spacing from ~3,000 feet to ~1,500 feet. The exact location of the culverts will be determined by field investigation. The culverts will be installed by jacking and boring under the road thus the road raising could be concurrent with jacking and boring.

Alternative 3.2.2a: Mitigate road, add one-mile eastern bridge (***FigureB-8***). This alternative meets the minimum opening requirement necessary to affect a change in the elevations of marsh. The cross section and crown elevations were the same as in Alternative 3.1. The bridge CWE for this alternative was 8.75 feet NGVD. The bridge low cord was designed six feet above the CWE elevation for inspection purposes. The low cord elevation was 14.75 feet NGVD.

Alternative 3.2.2b: Mitigate road, add one-mile western bridge (***Figure B-9***). This alternative was the same as above except for the foundation design. Because of poorer soil conditions in the western area, the foundations required battered piles and additional piles that were not required for the eastern bridge. The bridge location was the western 1-mile portion of the 2005 RGRR Alternative 14 western bridge. It would have more private real estate impacts during construction than the eastern bridge.

Alternative 3.2.3: Mitigate road, add two-mile and one-mile bridges (***Figure B-10***). This alternative meets the opening requirements necessary to affect a change in the elevations of the marsh. The design parameters did not change from above.

CATEGORY 4: MAJOR ROAD MITIGATION IN PREVIOUS REPORTS ESCALATED TO TODAY'S DOLLARS:

Roadway modifications were designed to allow an increase of water levels in L-29 Canal to 9.7 feet NGVD. Raising the L-29 Canal elevation to 9.7 feet NGVD meets the required elevation variations of the NSM as proposed in the CSOP or CERP. This alternative required that the entire road be mitigated. This modification required two 12-foot travel lanes and two 10-foot shoulders (5 feet paved and 5 ft grassed). The roadway shifted to the south by approximately a lane width to make it easier to maintain traffic. The side slope design was 2-to-1.

Alternative 4.1: Mitigate road (***Figure B-11***). This alternative mitigated the top of the road crown to 12.75 ft NGVD, which meets the current criteria established with FDOT on the cross section crown elevation of 3.05 feet above the average water elevation. This roadway design was the same as the current 2005 RGRR design. This alternative did not address the need for additional openings in the road. It provided some improvement but will have a stacking effect at the road and will not provide the benefits that an opening and raising the road would.

CATEGORY 4.2: MAJOR ROAD MITIGATION WITH INCREASED OPENINGS IN PREVIOUS REPORTS ESCALATED TO TODAY'S DOLLARS:

Major changes were introduced to the roadway along with additional openings.

Alternative 4.2.1: Mitigate road, add culverts. This alternative mitigated the road as described in Alternative 4.1 and added 19 sets of three five-foot diameter culverts to the road for a total of 535 feet or 0.1 mile of opening. The new sets of culverts were placed between the existing culverts reducing the culvert set spacing from ~3,000 feet to ~1,500 feet. The exact location of the culverts will be determined by field investigation. The culverts will be

installed by jacking and boring under the road thus the road raising could occur concurrently with jacking and boring.

Alternative 4.2.2a: Mitigate road, add one-mile eastern bridge (***Figure B-12***). This alternative meets the minimum opening requirement necessary to affect a change in the elevations of marsh. The cross section and crown elevations are the same as in Alternative 4.1. The bridge CWE for this alternative was 8.75 feet NGVD. The bridge low cord was designed six feet above the CWE elevation for inspection purposes. The low cord elevation was 14.75 ft NGVD.

Alternative 4.2.2b: Mitigate road, add one-mile western bridge (***Figure B-13***). This alternative was the same as above except for the foundation design. Because of poorer soil conditions in the western area, the foundations required battered piles and additional piles that were not required for the eastern bridge. The bridge location was the western 1-mile portion of the 2005 RGRR Alternative 14 western bridge. It would have more private real estate impacts during construction than the eastern bridge.

Alternative 4.2.3: Alternative 14 from RGRR, mitigate road, add two-mile and one-mile bridges (***Figure B-14***). This alternative meets the opening requirements necessary to affect a change in the elevations of the marsh. The design parameters did not change from above.

Alternative 4.2.4: 10.7-mile bridge. This alternative meets the minimum opening requirement necessary to affect a change in the elevations of marsh. The cross section and crown elevations were the same as in Alternative 4.1. The bridge CWE for this alternative was 8.75 feet NGVD. The bridge low cord design was six feet above the CWE elevation for inspection purposes. The low cord elevation was 14.75 feet NGVD. Short segments of the roadway will be reconstructed at each end of the bridge with only a modest alignment transition from bridge to roadway. Full water quality treatment for the road is required because this is considered new construction.

CATEGORY 5: ALTERNATIVE ALIGNMENTS:

Limited evaluation of the alternative alignments was conducted and rough order of magnitude estimates were calculated. All alternatives in this section assumed new roadway, except for Alternative 5.4 and 5.5. The travel lanes for the roadway and bridges were 12 feet with 10-foot shoulders. For the roadway, the shoulders had a 5-foot paved section and a 5-foot grassed section. The side slopes were designed at 2-to-1. The northern alignments assumed full stormwater treatment with ditches that flowed into dry retention areas. This treatment was required because the Florida Department of Environmental

Protection viewed the northern alignment as new construction. As such all the stormwater treatment requirements for new construction apply.

Alternative 5.1: Northern alignment of Alternative 14 (2005 recommended plan) north of L-29 Levee (***Figure B-15***). This alternative moved the RGRR design to the L-29 Levee. The L-29 Levee will have to be removed. The suitable material from the levee removal would be used in the construction of the road on the northern alignment. The S-355A and B structures would have to be removed. Each of two curves transitioned from the existing road to the levee for approximately 1.0 mile to 1.14 miles for a total of 2.24 miles. Two bridges to cross the canal and two bridges for conveyance were designed. The two bridges crossing the canal would be constructed as part of the access curves to the levee and back to the Tamiami Trail. A minimum of three access ramps were needed to the new alignment. The top elevation of the road was 12.75 feet NGVD. The bottom cord elevation of the bridges was 14.75 feet NGVD. The cross section of the road required water treatment as this construction would be considered new. All other road alternatives do not require water treatment as they are considered modifications to an existing structure.

Alternative 5.2: Northern alignment of a one-mile bridge on L-29 Levee (***Figure B-16***). This alternative was similar to Alternative 5.1 except that the two-mile bridge will not be constructed as part of this alternative. There would still have to be an additional bridge for access to the L-29 Levee. The roadway elevations would be the same as well as the bridge elevations. The access ramps would be the same.

Alternative 5.3: Northern alignment with one-mile bridge and realignment of L-29 (***Figure B-17***). This alternative included moving the L-67 Extension to the Blue Shanty Canal edge. It was moved about 500 feet further to the east in order for the curves to fit into the area. The conveyance bridge was on the curves and additional bridging was needed. The L-29 Levee would have to be degraded and compacted to make it a suitable subgrade for the roadway. The structure in L-29 would be similar to the S-334 structure in the 1994 General Reevaluation Report (GRR) which was capable of passing 1,230 cubic feet per second (cfs) of water. The levee to the south and the levee to the north would be constructed to elevation 13 feet NGVD. The levee would have 4-on-1 side slopes for maintenance until it is removed at a later date. The road would have to be mitigated to cross the levee which would position the crown at 15 feet NGVD over the levee. The road elevation itself would have to be a minimum of 13 feet NGVD at the crown. The road cross section would be similar to the cross section for Alternative 5.1. This alternative did not have any modeling and would have

to be modeled prior to beginning design. The remaining features would be evaluated as part of the conveyance and seepage features.

Alternative 5.4: One-mile bridge and realignment of L-29 Levee (***Figure B-17***). This alternative included moving the L-67 extension to the Blue Shanty Canal edge. This alternative also included a one-mile bridge. The structure in L-29 would be similar to the S-334 structure in the 1994 GRR and that structure was capable of passing 1,230 cfs. The levee to the south and the levee to the north would be constructed to elevation 13 feet NGVD. The road would have to be mitigated to cross the levee which would position the crown at 15 feet NGVD over the levee. The road elevation itself would have to be a minimum of 13 feet NGVD at the crown. The road cross section was similar to Alternative 4.2.3. There was no modeling for this alternative and it would have to be modeled prior to beginning design. The roadway was located on lane width south of the existing Tamiami Trail. The travel lanes for the roadway were 12-foot lanes with 10-foot shoulders (5 feet paved and 5 feet grassed). The side slopes were designed 2-to-1. The remaining features would be evaluated as part of the conveyance and seepage features.

Alternative 5.5: Pump stations along L-29 Levee. The size of these pump stations were not modeled. There was no determination of the size of the station or the amount of water it would have to continually pump. Constructing the pump station to convey water across Tamiami Trail would still require raising the road and providing an outlet through the road. Levee protection for the road could be constructed to solve the problem of inundation to the roadway base and keep from raising the entire road. The pump stations provided point source discharges into a protected marsh land that would be detrimental to marsh growth.