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# APPENDIX A

Luiz Munoz Marin International Airport Project, Carolina, Puerto Rico – Drainage Study

# LUIZ MUÑOZ MARÍN INTERNATIONAL AIRPORT PROJECT, CAROLINA, PUERTO RICO

## Drainage Study

Prepared for
AEROSTAR AIRPORT HOLDINGS, LLC
Post Office Box 38085
San Juan, Puerto Rico 00937-1085

March 2019

by

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# SUMMARY OF FINDINGS

- Flooding issues at the Luiz Muñoz Marín International Airport are driven by sediment and mangrove accumulation throughout the system, localized obstructions, and high tailwater conditions in the surrounding estuary system, especially during storm surge events.
- **Alternative A** model results simulating cleaning channels and culverts of sediment, vegetation, and obstructions predict reduced water surface elevations and reduced frequency of flooding in the channel system under normal tidal conditions.
- **Alternative B** model results simulating pumping and isolation gates in addition to channel and pipe cleaning predict reduced water surface levels and frequency of flooding events during storm surge conditions.
- Construction costs in Puerto Rico have increased by a factor of 2 following the extreme hurricane season in 2017. Opinions of probable costs for project alternatives are listed below:
    - **Alternative A**: $5,314,000
    - **Alternative B**: $17.3 Million to $20.3 Million

# 1 PROJECT OVERVIEW / INTRO

The Luiz Muñoz Marín International Airport (SJU) is located in northeast Puerto Rico approximately 3 miles southeast of the City of San Juan. The airport is located at a low elevation, close to sea level and is in close proximity to the ocean, and nearby lagoons. The airport site frequently experiences flooding that can shut down runways and damage airport infrastructure. This drainage report is intended to assess drainage problems at the site and review design alternatives for reducing flooding at the airport. Design alternatives that are addressed in this report include:

1. A "do nothing" scenario using existing conditions (Drainage No-Action Alternative),
2. A scenario with vegetation clearing and pipe cleaning, channel dredging, and some culvert replacements (Alternative A), and
3. A scenario including all interventions included in Alternative A with additional isolation gates and pumps (Alternative B).

The modeling completed for this study is intended to assist in the evaluation of the incremental benefit of drainage improvements at the airport. The modeling provides a basis for comparison but does not generate flood inundation boundaries to directly interpret level of service impacts due to the extent of flooding on the runway or taxiways at the site for a particular storm of interest.

## 1.1 Existing Conditions

SJU is located in northeast Puerto Rico, within the Gobierno Municipal Autónomo de Carolina (approximately three miles southeast of San Juan) (Figure 1).

The 1,460-acre airport is located approximately 600 feet from the Atlantic Ocean, within an estuarine setting. SJU abuts tidally-influenced Laguna San Jose to the west and Laguna La Torrecilla to the east. Drainage from the airport discharges through surface water canals to the adjacent tidally influenced lagoons. Highways and urban development are found along the northern and southern borders of the airport. Land to the north includes recreation areas (beaches and a park), resorts, hotels, and other commercial development. Land on the south side of the airport includes commercial development along Highway 190 and several large residential neighborhoods.


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SOURCE: ESA, 2018

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**Figure 1**
Vicinity
San Juan, PR

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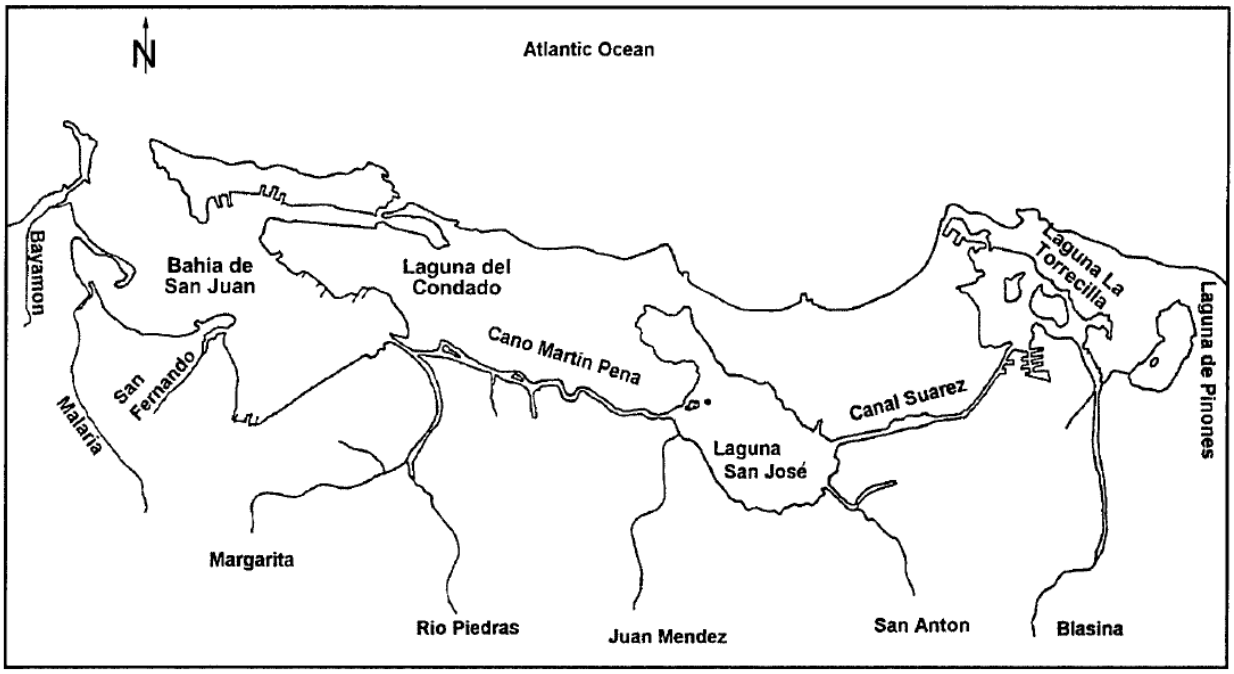
## 1.2 San Juan Bay Estuary System

SJU is located within an interconnected lagoon system, with the Atlantic Ocean to the north, Laguna La Torrecilla to the east, Laguna San Jose to the west and southwest, and Canal Suarez to the south (Figure 2). The three main drainage outlets from the airport drain to Laguna San Jose, Canal Suarez, and Laguna La Torrecilla. Laguna San Jose is the innermost lagoon, connected to the ocean only by Cano Martin Pena to the Bahia de San Juan and to Laguna La Torrecilla by Canal Suarez. These channels are very narrow and reduce the tidal range of WSE in Laguna San Jose significantly. The tidally influenced water surface elevations (WSE) in the estuary system are critically important to the function of drainage at the airport.




SOURCE: Bunch et al. 2000

**Figure 2**
Surrounding Lagoon System.

This is due to the fact that runoff at the airport is conveyed through surface canals that flow based on the difference in WSE at the airport and the WSE in the receiving tidal estuary. When the tide is low the difference in WSE between the airport and the estuary is maximized which increases drainage efficiency at the airport. On the other hand, during high tide drainage efficiency at the airport is impaired. Drainage is further restricted by the condition of the airport drainage system which is clogged with sediment and vegetation encroachment.

## 1.3 Drainage System

Drainage of the airport is accomplished through a system of open water channels, inlets, stormwater pipes, and culverts. Figure 3 shows an overview of the existing drainage system at the airport.

A network of open water channels conveys runoff from the airport to the Laguna La Torrecilla and the Canal Suarez. These open water channels flow through culverts and/or pipes where they cross under roads, runways, or other airport infrastructure. These channels and culverts are located below mean sea level and are continually inundated with water. For ease of discussion, ESA has developed a naming convention for each channel that is outlined on Figure 3.

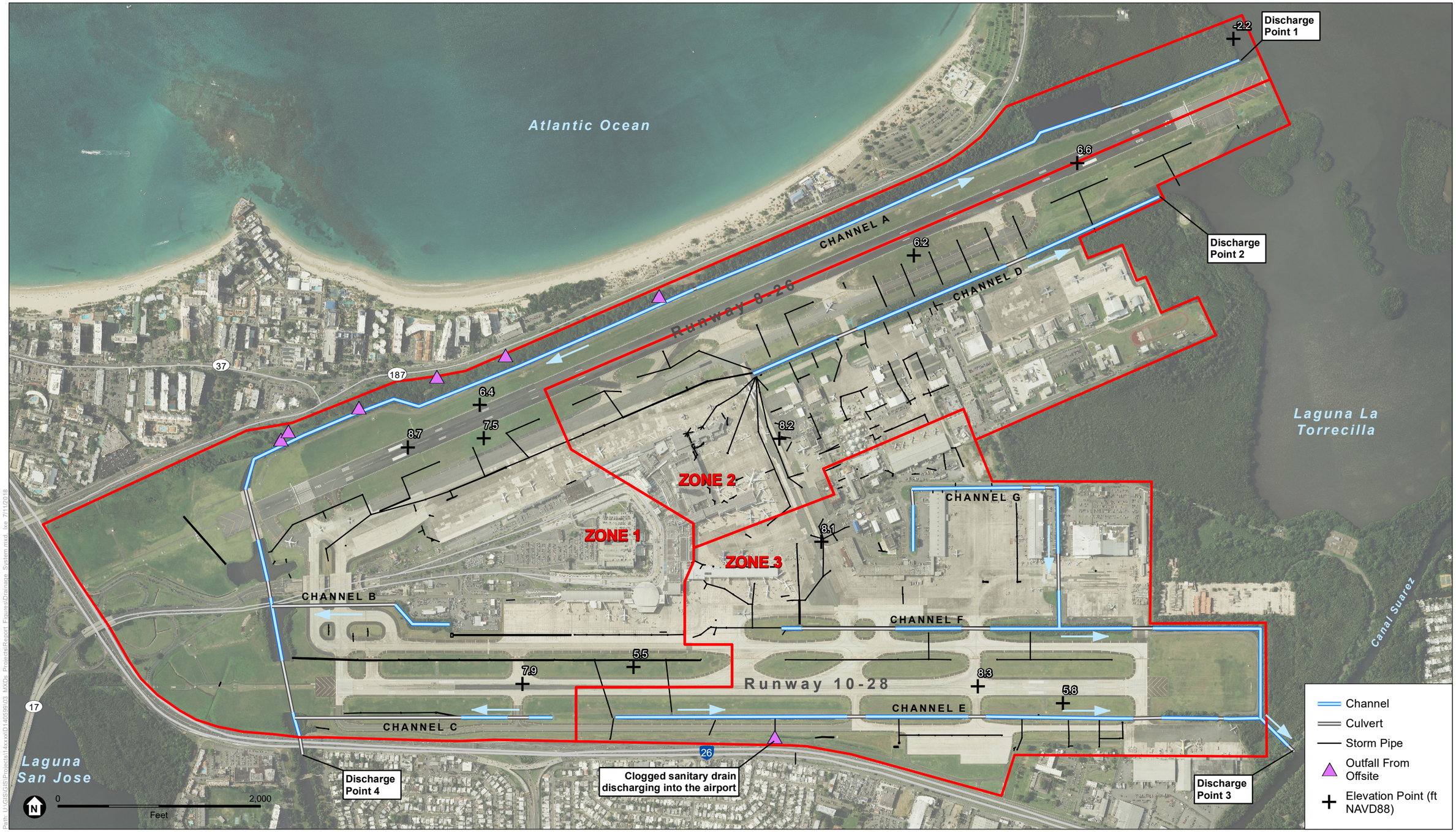
There are several outfalls that discharge to the airport property from off-site drainage basins. Most of these outfalls are along the southern edge of Highway 187 and discharge to Channel A. Runoff from these outfalls originates in the Isla Verde neighborhood north of the airport. In addition, a single outfall discharges to Channel E at the southern boundary of the airport. This outfall discharges runoff from the neighborhood south of the airport and also appears to be contaminated with sanitary waste.

There are five primary outlet locations where the open channel drainage system enters the surrounding estuary system. These outlet locations were first identified in the Stormwater Pollution Prevention Plan (SWPPP) (Eco Stahlia, 2015). Outlet location 5 was not considered in this study because it is serves a relatively small portion of land and is outside of the study area of this report. Outlet location 1 is heavily overgrown with mangrove and discharges via a small channel to the marina to the north of the airport.

To assist in the analysis and discussion of the drainage system, ESA divided the site into 3 hydraulically independent zones (Figure 3). Zone 1 includes the drainage basins and channels draining to discharge point 1 to Laguna La Torrecilla and discharge point 4 leading to Laguna San José. Zone 2 includes the area that drains to Channel D and discharges to Laguna La Torrecilla at discharge point 2. Zone 3 includes all channels draining to discharge point 3 to Canal Suarez.

Many of the open water channels are populated by significant mangroves which encroach upon the channel, and in some cases spread across the entire channel (Photo 1). Field observations and measurements indicate that approximately 2 feet of sediment has accumulated along the channel bottoms. This sediment is likely deposited from airport runoff, inflow from tidal flows, and from decaying organic matter within the channels themselves. Sediment and vegetation has partially filled many of the culverts which connect the open water channels as well as some of the stormwater pipes that discharge to the channel system.

Due to the direct connection of the airport channel system to the surrounding lagoons, tidal fluctuations from Laguna La Torrecilla have a direct impact on water levels within the drainage channels. Flow directions and flow rates within the channel system are influenced by the tidal elevations in the adjacent water bodies.

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SOURCE: ESA, 2018

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**Figure 3**
Drainage System
San Juan, PR

ESA

SOURCE: ESA Field Investigation

**Photo 1**
Mangrove encroachments in Channel A.

## 1.4 Flooding Issues

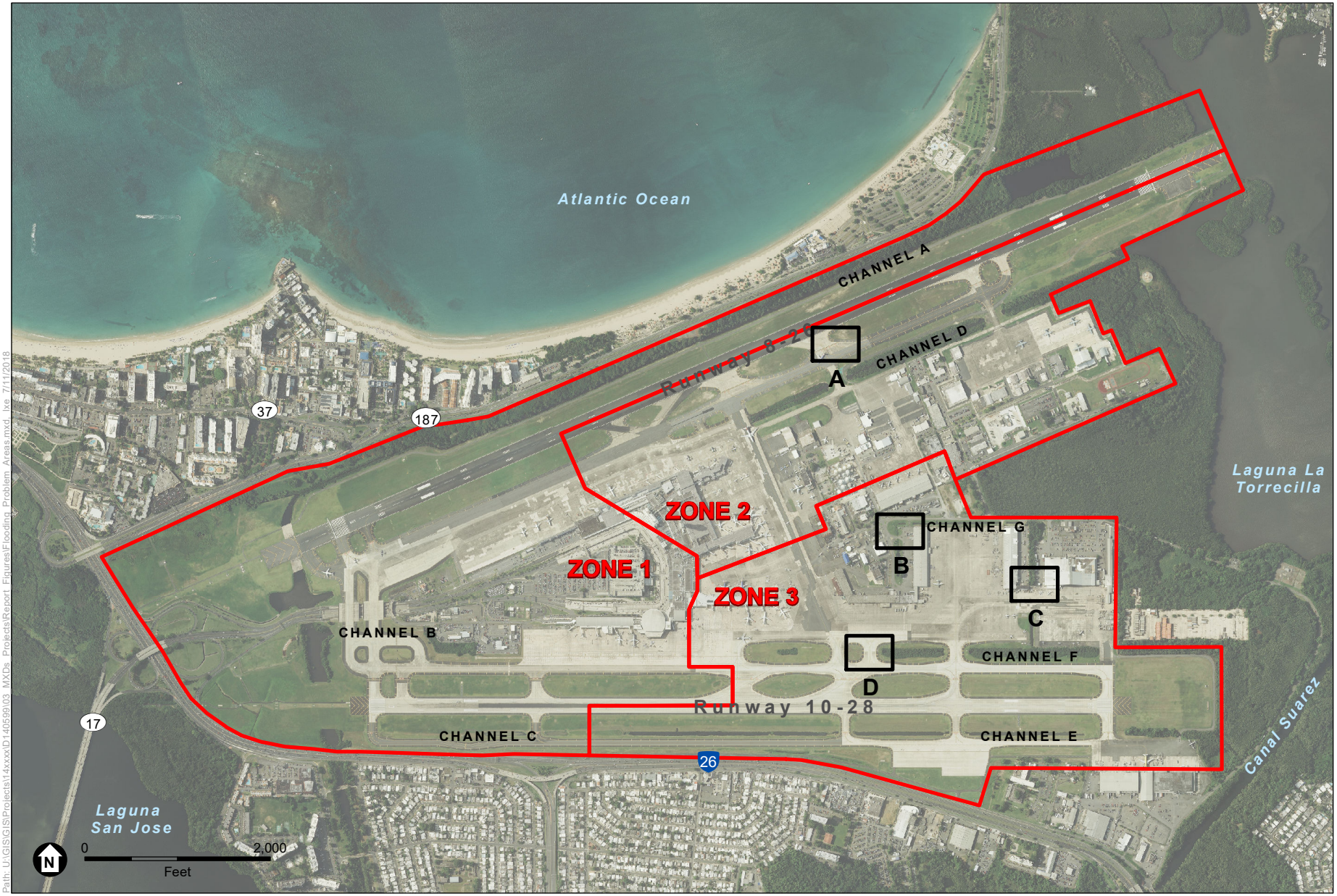
Flooding has been a persistent problem at various locations throughout the airport. Known problem flooding areas at the airport are shown in Figure 4. These areas were identified based on conversations and information provided by airport staff. Photos of historical flooding events were provided to the team by Aerostar (Photo 2 and Photo 3).


SOURCE: Aerostar

**Photo 2**
Flooding overtopping lights and signs.

SOURCE: Aerostar

**Photo 3**
Ponding water above a stormwater inlet.




SOURCE: ESA, 2018

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**Figure 4**
Flooding Problem Areas
San Juan, PR

ESA

- Problem Area A is connected to the system in Zone 2. Flooding in this location results in encroachment of the adjacent runway and taxiway and can damage nearby infrastructure such as signage and lighting.

- Problem Area B is connected to the drainage system in Zone 3. The drainage channel in this area is adjacent to a sanitary sewer pump station. When flooding occurs at this location, it can inundate the pump station and cause damage to the pumping facility.

- Problem Areas C, and D are also located along the drainage system in Zone 3. Flooding at these locations can result in encroachment on adjacent taxiways and damage to nearby infrastructure including signage and lighting.

An additional flooding problem area was identified in the vehicle loop that accesses the airport terminal building. This problem area is not directly connected to the drainage channel system and is outside of the study area for this report.

Flooding at the airport is driven by two overarching issues: (1) reduced capacity of the drainage system due to accumulated sediment and vegetation encroachment and (2) high water levels in the surrounding estuary system which backs water up into the canal system and impedes drainage away from the airport. These overriding issues are compounding and it is expected that the worst flooding is caused when the problems coincide (reduced capacity due to vegetation and sediment and high tide).

## 1.5 Field Investigations

ESA engineers performed a field investigation of the airport drainage system on June 8, 9, and 12, 2017. No flooding was observed during the site visit, however it was clear that water surface elevations in the surrounding estuary system during dry conditions result in high water levels in the open water channels of the airport system. Standing water levels were observed nearly submerging many of the existing culverts and backing up into the connected storm sewer system.

ESA engineers observed that many of the drainage channels are heavily encroached with mangrove trees. The mangrove vegetation increases the roughness of these channels, likely contributes to sediment accumulation, and inhibits maintenance of the channels by airport staff.

Richard Chang Sierra performed a survey of the airport drainage infrastructure in July and August of 2017. The survey included a series of cross-sections along each of the open drainage channels as well as a survey of all the culverts, storm pipes, and inlets on site. The survey documents are included in Appendix A.

Cross sections taken by Chang reveal that the bottom of most of the channels are layered in an average of 2 feet of muck. Elevations were measured at the top of the muck using a platform on the bottom of the survey rod and at the channel bottom by removing the platform and probing for solid ground. The elevations at the top of the muck were in many cases higher than the invert elevations of pipes leading into and out of the channels.

During the ESA site visit, culverts bottoms in all of the channels were submerged with water making direct observation of sediment condition in the culverts impractical but it is likely that many of these

culverts are also filled with sediment reducing conveyance capacity.

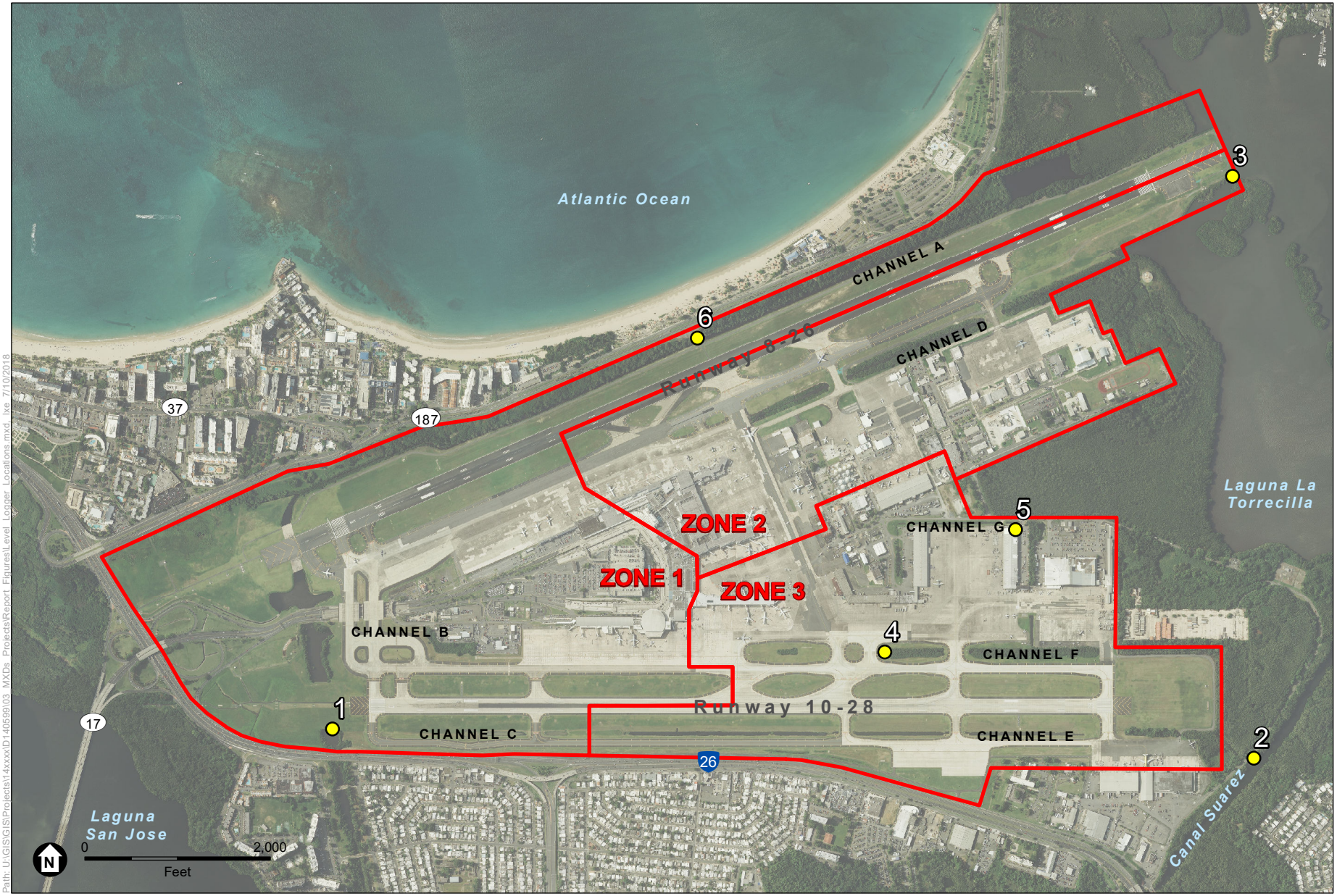
The field investigations identified several clogged stormwater pipe outfalls draining portions of the airport at Problem Area A in Zone 2 (Figure 4). These outfalls are intended to discharge to the nearby adjacent drainage channel D.

## 1.6 Water Level Logger Study

To gain a greater understanding of the drainage network and to assist in the calibration of the model of the site, the ESA team performed a field study of water surface elevations by recording water surface elevations over a six-week period. Engineers from Gregory L Morris Engineering (GLM) installed water level loggers within the drainage system at 6 locations around the airport (Figure 5). Data loggers 1, 2, and 3 were installed at drainage outlets, and loggers 4, 5, and 6 were installed at locations along the internal airport channels. The loggers were installed inside vertical perforated PVC pipes that were secured to culvert headwalls or other structures within the channel (Photo 4). The level loggers collected water surface elevation data every 10 minutes continuously from August 4, 2017 to September 14, 2017 (Appendix B).

SOURCE: GLM Engineering

**Photo 4**
Installed level logger.




SOURCE: ESA, 2018

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**Figure 5**
Level Logger Locations
San Juan, PR

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The data collected during this time allowed engineers to review tidal fluctuations of water surface elevations on site during dry conditions as well as the response to several precipitation events. The level-loggers were also deployed during the September 6, 2017 storm surge and precipitation event associated with Hurricane Irma.

Historic rainfall data for the period that the loggers were installed was obtained from NOAA weather station SAN JUAN L M INTL AP located at the airport (http://w2.weather.gov/climate/xmacis.php?wfo=sju). Data collected from the water level loggers along with rainfall depths measured at the airport are plotted together for every location (Appendix B).

Logger 1 is located at Outfall 4 where the channel system connects to Laguna San Juan. Logger 1 water surface elevations are driven primarily by elevations in Laguna San Juan. A tidal signal can still be seen, though it is very weak in comparison to WSEs measured in Laguna La Torecilla where a stronger tidal connection exists. This is expected due to the constricted conditions of the canals that drain Laguna La Torecilla. An increase of WSE can be seen due to at least 5 precipitation events, and it takes several days after the precipitation event for the WSE to recede to normal levels due to the constrictions in Canal de Martin Pena and Canal Suarez (Figure 2).

Level logger 2 was tampered with while it was deployed and the data was not reliable. The measurements from this logger were disregarded during our analysis. Due to the tampering, a datum for the measurements could not be established. However, review of the data collected shows that the water surface elevations in this location respond in much the same way as the elevations measured at Logger 3.

Logger 3 is located at Outfall 2 located in the Laguna La Torrecilla. This outlet is located relatively close to the Boca de Cangrejos, the primary connection to the ocean for the estuary system, and a strong tidal signal can be seen in the data. Precipitation events did not have a strong effect on water surface elevation in this location.

Logger 4 was installed in Channel F in the SE portion of the airport. The outlet to these channels flows into Canal Suarez near Laguna La Torrecilla. When directly comparing the WSE data from logger 4 to logger 3, it can be seen that the WSE corresponding to high tides correlate almost directly to the data from logger 3 (Appendix B). However, during low tides the WSE at logger 4 almost never drops below 0.2ft, suggesting the water is perched there with sediment or an obstruction preventing draining below this level. Also, during precipitation events water levels at logger 4 rise dramatically above levels at logger 3, indicating a surge in water surface elevation resulting from runoff from the surrounding drainage basin.

Logger 5 was installed along Channel G. The WSE at logger 5 behaves similarly to logger 4, except that water is perched at an even higher level, with WSE never dropping below 0.5 ft above MSE. This suggests that the blockage in this channel is even greater than in the channel with logger 4, which correlates with on the ground observations as both Problem Areas B and C are located along Channel G (Figures 3 and 4).

Logger 6 is located about 7,500 ft upstream of Logger 1, in Channel A. The WSE results exhibit a very similar pattern to Logger 1, except consistently about 0.5ft higher and with a slightly weaker tidal signal

(Appendix B). The peak of the 9/6/2017 event was about 0.7ft above the peak at logger 1, but tapered off quicker, showing the influence of Laguna San Juan decreasing this far up the channel system.

Important takeaways from the level logger study include the following:

- The tidal influence from the Laguna la Torecilla (Logger 3) is reduced in the central and western portions of the airport. The connection to Laguna San José (Logger 1) shows very little tidal variation.

- The pattern of tidal influence at the interior airport drainage channels (Loggers 4 and 5) suggests that sediment or other obstructions are preventing the water surface in the channels from equalizing with the tidal elevations in Laguna La Torecilla during low tide periods.

- Storm surge conditions in Laguna La Torrecilla result in raised WSE in the airport drainage channels.

# 2 HYDROLOGIC AND HYDRAULIC MODELING

In order to assess the potential for design alternatives to ameliorate flooding issues at SJU, Aerostar contracted GLM to perform a hydrologic/hydraulic analysis of the airport drainage network (Appendix C). GLM created two complimentary models describing the overall drainage network at the airport: a channel model describing the main drainage channels and their connections, and another internal piping model describing the pipe systems located below the airport facilities. The channel model is the primary tool used for this study. The pipe system model is discussed in section 2.4.

These models were constructed using the best available data, including the survey of the pipe system performed as part of this study, and publicly available LIDAR topographic data from 2004. Both of these data sources have gaps in the data, and limitations that impact the accuracy of the models. Because of the approximate nature of these models, ESA's approach is to use these models as a general tool to assess the potential for improvement if the proposed alternatives are implemented. The models will not accurately predict performance of the existing drainage system without considerable additional effort to collect more detailed information on the site topography and condition of the piped system.

## 2.1 Model Methodology

Existing conditions and design alternatives were modeled by GLM using the Interconnected Pond Routing Model (ICPR). ICPR is a coupled hydrologic/hydraulic model that uses a 1D network to model hydraulically interconnected systems. The GLM modeling report is provided in Appendix C. The ICPR 1D network uses a node-link scheme to route water between storage areas. For this modeling effort, drainage channels are defined as nodes connected by links that are used to define culverts, weirs, pipes, and other connection types.

Hydrologic conditions are defined in the model by delineating drainage basins and calculating runoff rates from rainfall data and the nature of the drainage basin. Basins were delineated within the study area using LIDAR, aerial imagery, and site survey data. There are 32 drainage basins within the airport site that are delineated for this study by GLM. For each basin, a corresponding area, time of concentration, and curve number are determined to describe catchment surface condition and runoff potential during precipitation events.

Runoff hydrographs were synthesized for each basin using the NRCS Unit hydrograph method with NOAA rainfall depth-duration data for the 24-hour duration 10, 50, and 100-year rain events. The 10-year rain event was selected for simulation as FAA guidelines specify the 10-year event as the engineering design event (FAA, 2013). In addition, the 50 and 100-year rain events were chosen for simulation to assess how the existing drainage system and proposed drainage improvements would function during lower frequency, higher severity storms.

Hydraulic conditions within the study area are assessed using the ICPR node-link 1D network module. Nodes were assigned stage-volume curves derived from representative cross sections from site survey data. Node and link hydraulic parameters (e.g. roughness) are defined from survey data and field observations. Water level boundary conditions are determined for the 1D network where the drainage channels meet Laguna La Torrecilla and Canal Suarez (Boundary 1), and Laguna San José (Boundary 2).

## 2.2 Model Calibration

The model was calibrated for existing conditions using rainfall and water level data from two recorded storm events occurring on August 17 and September 6, 2017 (Appendix C). The September event corresponds to Hurricane Irma, where considerable storm surge was observed in recorded water level data. 15-minute rainfall data was obtained from USGS station 50049620 Quebrada Margarita at Caparra Inter near Guaynabo, which is located 7 miles west of the airport. Boundary condition water level data was obtained from Logger 1 and Logger 3 corresponding to water levels in Laguna San José (Boundary 2) and Laguna La Torrecilla and Canal Suarez (Boundary 1), respectively. Calibration parameters included channel roughness and percent of obstructed pipe opening. Results of the calibration model were compared to the water levels measured during the level logger study. Calibration results indicate that the model is capable of replicating the general pattern of water level response to the storm events that were simulated.

## 2.3 Modeled Scenarios

The model was constructed to run three scenarios: a No-Action scenario using existing conditions (Drainage No-Action Alternative); a scenario with vegetation clearing and pipe cleaning, channel dredging, and some culvert replacements (Alternative A); and a scenario including all interventions included in Alternative A with additional isolation gates and pumps (Alternative B). All alternatives were simulated for the 24-hour duration 10, 50, and 100-year rain events with and without storm surge conditions (Table 1). Storm surge conditions were modeled by varying the water surface elevations at the boundary points in the model to coincide with the predicted storm surge elevations in the lagoons.

These scenarios allow for a comparison of flooding location and frequency between the existing conditions and the design alternatives for large storm events with and without storm surge.

Table 1 summarizes the parameters that define the six model scenarios used to evaluate each of the alternatives.

**TABLE 1**
**SUMMARY OF MODEL SCENARIOS**

| | 10-year Rain Event | | 50-year Rain Event | | 100-year Rain Event | |
|---|---|---|---|---|---|---|
| | **no surge** | **surge** | **no surge** | **surge** | **no surge** | **surge** |
| **24-hr Precipitation (in)** | 6.78 | | 9.44 | | 10.60 | |
| **Boundary 1 WSE - Laguna La Torrecilla** | Constant (1 ft) | Time Varying (max 3.9 ft) | Constant (1 ft) | Time Varying (max 3.9 ft) | Constant (1 ft) | Time Varying (max 3.9 ft) |
| **Boundary 2 WSE - San José** | Constant (1 ft) | Time Varying (max 4.9 ft) | Constant (1 ft) | Time Varying (max 4.9 ft) | Constant (1 ft) | Time Varying (max 4.9 ft) |

NOTES:
All elevations referenced to mean sea level (MSL) NAVD 88

Storm surge conditions are entered into the model at the water level boundaries using the maximum storm surge elevations defined in the FEMA FIRM maps for Laguna La Torrecilla (3.9 ft MSL) and Laguna San José (4.9 ft MSL). The FEMA storm surge elevations represent a severe storm surge event. By comparison, the storm surge associated with Hurricane Irma was measured to be 2.6 ft MSL at Level Logger Location 3 during the study.

The FEMA maximum storm surge elevations were used to adjust water levels recorded during the September calibration event for Laguna La Torrecilla and Laguna San José to create 24-hour time varying boundary conditions for a storm surge event (Appendix C). For the no storm surge condition, a constant water level of 1 ft MSL was used at both water level boundaries consistent with the maximum tidal elevation measured in Laguna la Torrecilla (Boundary 1) and Laguna San José (Boundary 2) during the level logger study.

Flooding areas at the airport were determined by ESA based on model output WSE as compared to the site survey cross sections and LIDAR topography data. When water surface elevations in a particular node of the model exceeded the top of bank elevation of the corresponding channel, this indicated a flooding event of concern that could affect airport level of service. The location and number of these predicted flooding events was used as a point of comparison between existing conditions and design alternatives. The results of the model are intended to identify problematic flooding areas and to assess changes in drainage performance as a result of the design alternatives. The model results should not be interpreted to indicate the physical extent of flooding in a particular channel.

## 2.4 Pipe System Model

A hydrologic-hydraulic analysis of airport's storm sewer system was undertaken to assess the capacity of the existing storm sewer and the potential for design alternatives to ameliorate flooding issues within the storm sewer system (Appendix C). The pipe network modeling was conducted using StormCAD CONNECT. Hydrologic conditions were defined as described in Section 2.1, by delineating basins and defining a runoff inflow hydrograph using the unit hydrograph method. The pipe network, comprised of

catch basins, manholes, and pipes, was defined in the model from survey data to include pipe sizes and storm sewer element invert and top elevations. Tailwater conditions in the pipe network model were defined using the water level output from the ICPR channel model described in Section 2.1.

An existing conditions and two design conditions scenarios were simulated for the 10-year and 25-year rain events with and without storm surge conditions. The following models were prepared:

- Existing Conditions Model – This model simulates the existing storm sewer network using tailwater elevations predicted from the existing conditions ICPR channel model.

- Proposed Condition Model – Canal Alt A – This model simulates the existing storm sewer network using tailwater elevations predicted from the Alt A ICPR channel model, which were generally lower than in the existing conditions channel model.

- Proposed Conditions Model – Canal Alt A + Pipe Improvements – This model simulates the storm sewer network with replacement of pipes where existing conditions pipes had a reduction in flow capacity. This model uses the tailwater elevations predicted from the Alt A ICPR channel model.

The pipe system model has significant limitations that make it difficult to draw any conclusions from the model results. The pipe system model is constructed using the survey data collected with this study. However, during the survey, field crews were unable to locate the destination or source of many pipes on the site and the mapping of this pipe system is incomplete. The survey contains many gaps in the understanding of the pipe network that are critical for the development of a reliable pipe system model.

Given these limitations, the results of the storm sewer models should only be considered as a relative comparison between alternatives and not as an estimate of real world conditions. The model does predict a reduction in water levels for the proposed conditions model in comparison with the existing conditions model.

In order to develop this model into a useful tool, and assess effectiveness of design alternatives to the piped system, additional survey should be performed to identify all pipe locations and interconnections as well as the condition of the network elements (i.e. collapsed or clogged). An additional survey should include more rigorous methods of locating pipe infrastructure that may include, dye testing, smoke testing, or remote video inspection.

# 3 EXISTING CONDITIONS

## 3.1 Drainage No-Action Alternative

The Drainage No-Action Alternative represents the "do nothing" alternative. The calibrated existing conditions model was used to assess the base level flooding for the simulated storm events.

If the current sedimentation and mangrove encroachment issues are not addressed, it is expected that flooding problems at the airport will increase over time as sediment continues to accumulate and mangrove encroachment grows.

### 3.1.1 Model Results

The results of the existing conditions model are illustrated in Figures 6a and 6b for the no surge and surge conditions respectively. Each figure identifies the name and location of each model node and indicates the node where flooding is predicted for a storm event but not the extent of flooding in the area. Model results are discussed by zone in the following sections. More detailed documentation of model input and output parameters are included in the GLM report in Appendix C.

#### 3.1.1.1 Zone 1

For the no storm surge scenarios (Figure 6a) flooding is only predicted in Channel C. Flooding is predicted for Channel C for the 10, 50, and 100-year storm events.

For the storm surge scenarios, flooding for the 10, 50, and 100-year events is predicted in Channels A and C.

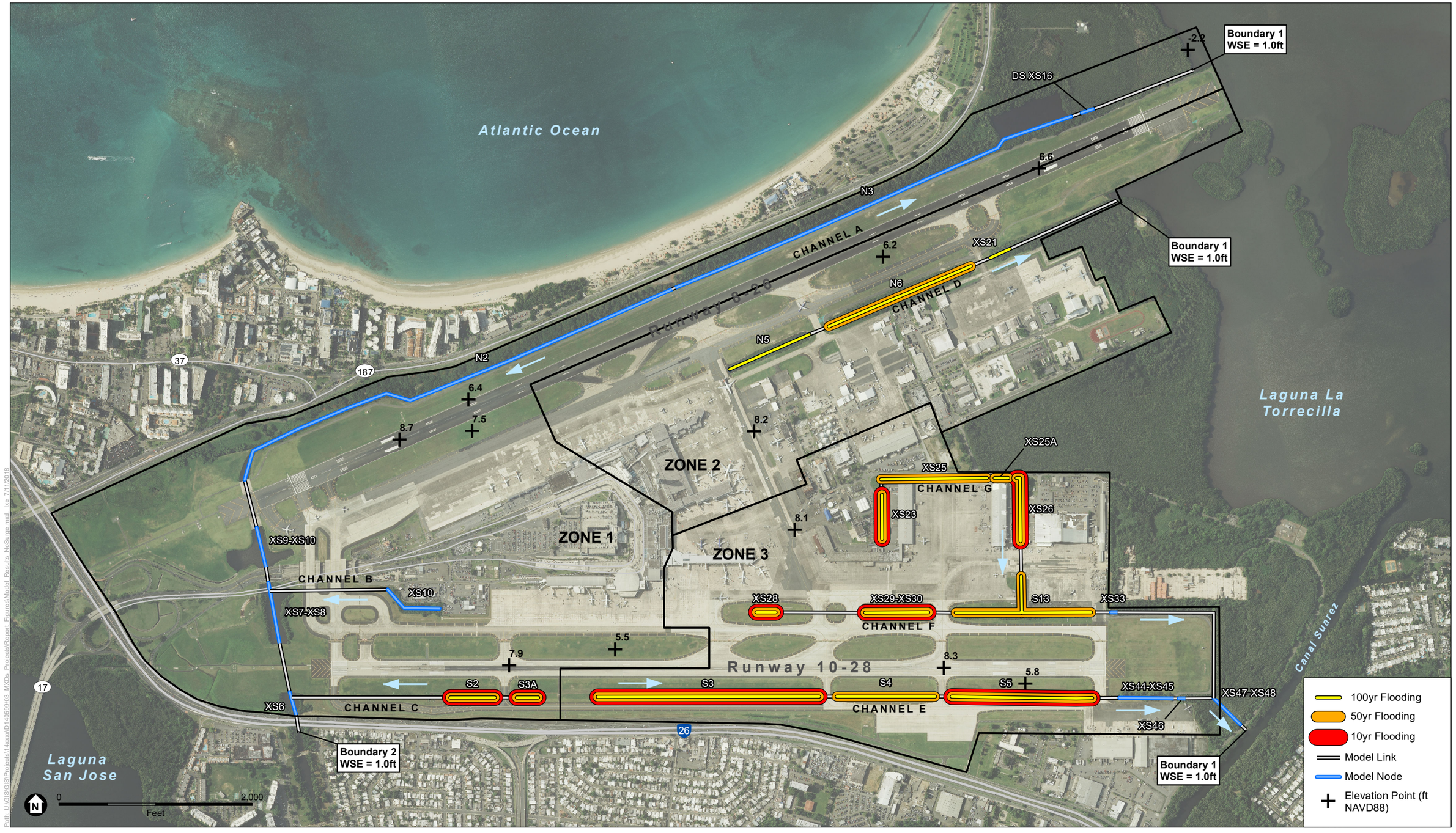
No historic flooding issues were reported by Aerostar in the region of Channel C. This may be that flooding is under-reported in this area or that the model is overestimating water surface elevations in this region.

#### 3.1.1.2 Zone 2

In Channel D, flooding was predicted for the 50-year and 100-year rainfall events under the no storm surge conditions.

Under the storm surge conditions flooding was predicted at each node of Channel D for the 50 and 100-year rainfall events, but no flooding was predicted under the 10-year storm event.

Although Problem Area A (Figure 4) is located just north of Channel D, the model does not predict flooding during the more frequent 10-year event. This flooding is most likely the result of clogged stormwater outfalls that discharge into Channel D and were not simulated in the model.

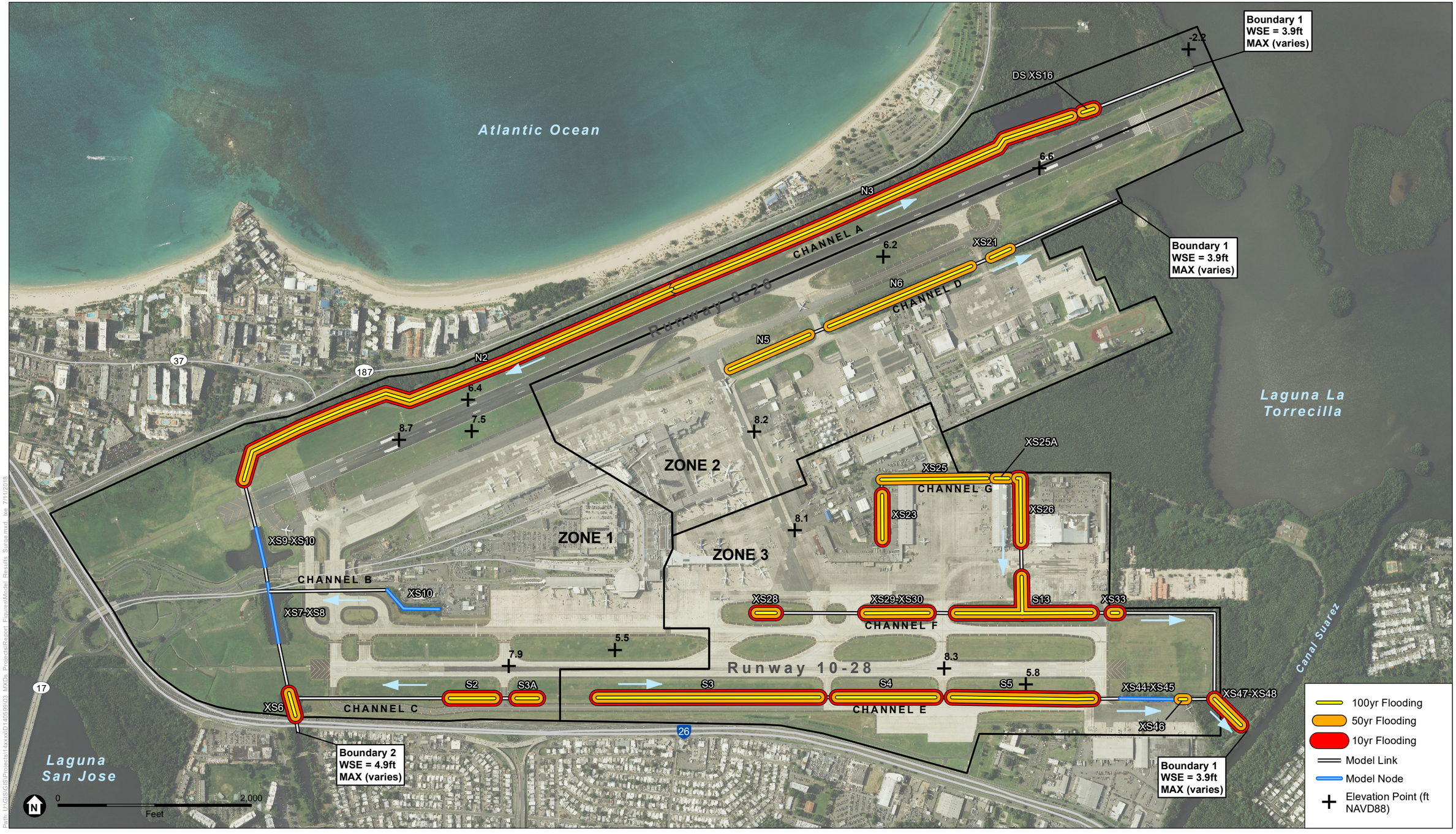



SOURCE: ESA, 2018

D140599. Luis Muñoz Marín International Airport - Drainage Study

**Figure 6a**
Model Results - Existing Conditions, No Surge
San Juan, PR

ESA

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SOURCE: ESA, 2018

D140599. Luis Muñoz Marín International Airport - Drainage Study

**Figure 6b**
Model Results - Existing Conditions, Surge
San Juan, PR

ESA

#### 3.1.1.3 Zone 3

Of all zones, flooding was most extensive in Zone 3, with flooding predicted in all channels for all simulated events.

Under the no storm surge scenarios, flooding was predicted in Channels E, F, and G for the 10, 50, and 100-year events, although not at all nodes.

Under the storm surge scenarios, flooding was predicted in Channels E, F, and G for the 10, 50, and 100-year events with even more nodes flooded for the 10-year event as compared to the no storm surge conditions.

Under the no storm surge scenarios, the nodes that predicted flooding for the 10-year event along Channels F and G correspond to Problem Areas B (XS23), C (XS26), and D (XS29-30). The culvert immediately downstream of Problem Area B is a single 24-inch diameter pipe. The other culverts along Channel G consist of two 42 or 48-inch pipes. The undersized culvert at XS23 is likely a major contributor to flooding at problem area B.

The model predicts flooding during the 10-year event along Channel E for the no surge and storm surge scenarios. No flooding problems have been reported by Aerostar along this channel and it may be that the model is overestimating water surface elevations along Channel E or that this flooding is under reported by airport staff.

# 4 DESIGN ALTERNATIVES

The ESA team developed two design alternatives for evaluation. Alternative A consists of clearing vegetation and sediment from the ditch and culvert system while Alternative B evaluates the effectiveness of installing a pumping system.

## 4.1 Alternative A

Design Alternative A is shown on Figure 7 and includes the following improvements to the drainage system:

- Remove mangrove vegetation encroaching on the drainage channels.
- Dredge sediment 2 feet deep from the bottom of the drainage channels.
- Clear all culverts along the channel system of sediment and obstructions.
- Replace the 24-inch culvert along Channel G with two 42-inch culverts.
- Clear the clogged outfalls that discharge to Channel D.

Vegetation encroachment in the drainage channels as well as sediment deposition in the channels and pipes were observed to be impeding drainage efficiency in the study area. Alternative A consists of removing vegetation in the channels, dredging two feet of accumulated sediment from the bottom of all channels, clearing sediment and obstructions from all interconnecting pipes, and replacing an undersized 24-inch pipe with two 42-inch pipes (link between node "XS23" and node "XS25") (Figure 7). Alternative A also includes the clearing of the clogged outfalls that discharge into Channel D to node "N6" that were observed during field investigations.

We understand that Aerostar is considering constructing an access road through the wetland area along the north side of Channel A to assist with vegetation maintenance associated with the Runway Object Free Area. Channel A is hydraulically connected to this wetland area which likely provides a storage benefit for flood reduction in the channel. If a maintenance access road were constructed, it would be important to maintain this hydraulic connection by installing culverts at regular intervals across the road that connect the channel to the wetland area to the north. This existing hydraulic connection is not however modeled as part of this study.

### 4.1.1 Model Results

Alternative A improvements are simulated in the model by reducing Manning's n roughness in channels from 0.015 to 0.05 to reflect reduced vegetation (cover and density) in the channels, adjusting the stage-volume curves for each node in accordance with channel bottom dredging, reducing the percent of obstructed pipe parameter to zero, and updating the hydraulic parameters of the link between nodes "XS23" and "XS25" to reflect the replacement of the undersized culvert.

## ALTERNATIVE A

- Remove Vegetation
- Dredge Sediment From Channel
- Clear Sediment and/or Obstructions From Pipe
- Storm Pipe
- + Elevation Point (ft NAVD88)

Atlantic Ocean

Laguna La Torrecilla

Laguna San Jose

Canal Suarez

Runway 8-26

Runway 10-28

CHANNEL A

CHANNEL B

CHANNEL C

CHANNEL D

CHANNEL E

CHANNEL F

CHANNEL G

ZONE 1

ZONE 2

ZONE 3

-2.2

6.6

6.2

6.4

7.5

8.7

8.2

8.1

7.9

5.5

8.3

5.8

Discharge Point 1

Discharge Point 2

Discharge Point 3

Discharge Point 4

Remove sediment from pipe outlets (currently clogged)

Replace 24" culvert with two 42" pipes

37

187

17

26

N

0

2,000

Feet

Path: U:\GIS\GIS\Projects\14xxxx\D140599\03_MXDs_Proiects\Report_Figures\Alternative1.mxd, lxe 7/11/2018

SOURCE: ESA, 2018

D140599. Luis Muñoz Marín International Airport - Drainage Study

**Figure 7**
Alternative A
San Juan, PR

ESA

The results of Alternative A model are illustrated in Figures 8a and 8b. Each figure identifies the name and location of each node of the model and indicates the locations of predicted flooding for each storm event. Model results are presented by zone in the following sections. More detailed documentation of model input and output parameters are included in the GLM report in Appendix C.

#### 4.1.1.1 Zone 1

Alternative A behaved the same as the Drainage No-Action Alternative for all simulated events, suggesting no flood benefit for drainage improvements in Zone 1.

#### 4.1.1.2 Zone 2

Under Alternative A, no flooding was predicted in Channel D for any of the simulated events. Alternative A exhibited a decrease in water surface levels and predicted flooding events compared to the Drainage No-Action Alternative for the 10-year, 50-year, and 100-year events. This suggests that clearing channels of vegetation and culvert and pipe obstructions was effective for mitigating flooding across all simulated events for Zone 2 under Alternative A improvements.

#### 4.1.1.3 Zone 3

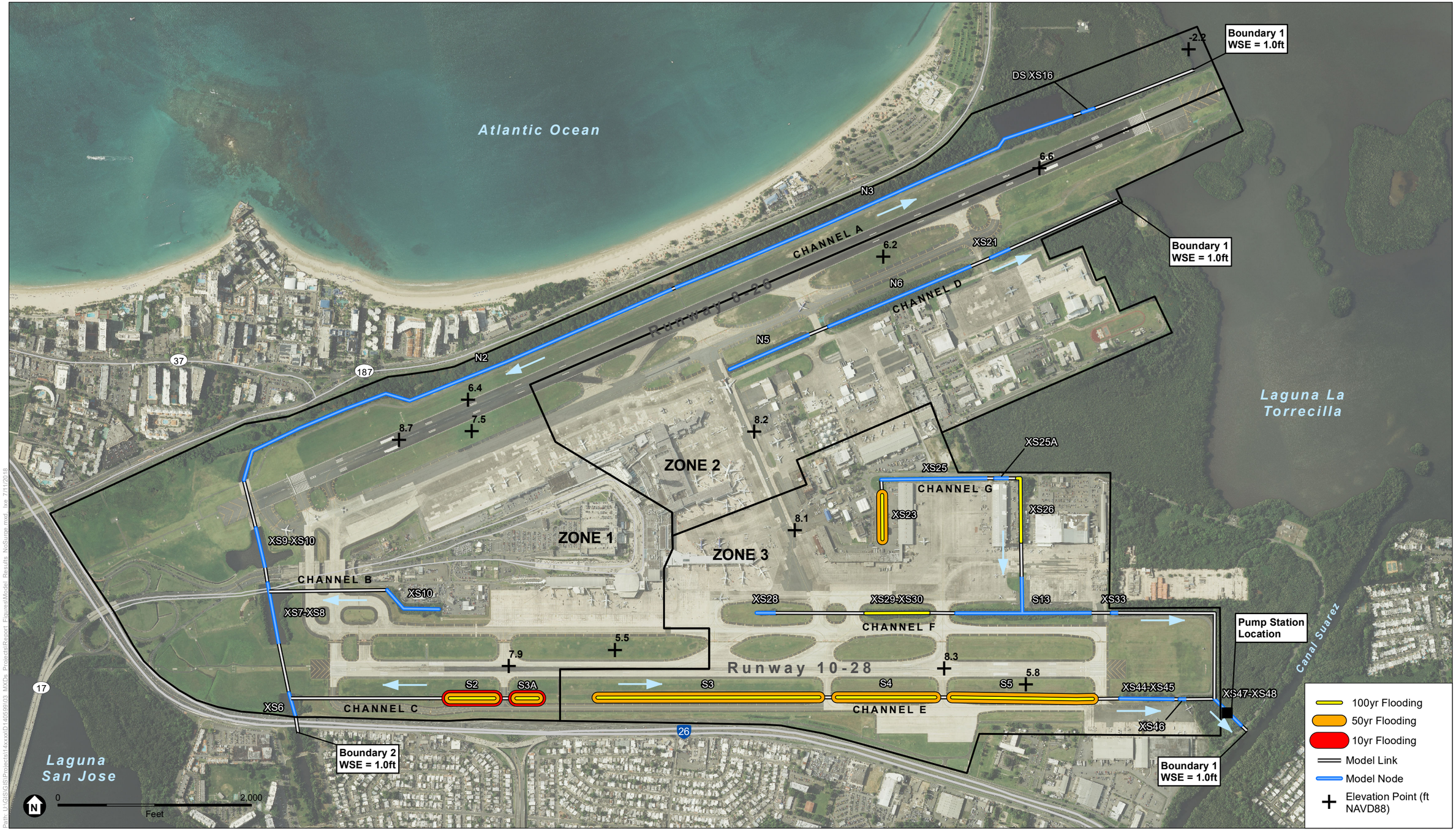
Under the no surge scenarios, no flooding was predicted in Channel E, F, and G for the 10-year storm event. Flooding was predicted for Channels E and G during the 50-year event, and for all channels during the 100-year event.

In Zone 3, the Alternative A model predicts significant improvements over the the Drainage No-Action Alternative (existing conditions) model during the no surge scenarios. Predicted flooding was eliminated at problem areas B, C, and D under the 10-year no surge scenario. Predicted flooding at the problem areas was improved although not eliminated under the 50 and 100-year events.

For the storm surge scenarios flooding was predicted in all three Channels under the 10, 50, and 100-year events. A detailed review of the model output in Appendix C shows that although flooding is predicted in each channel, the water surface elevations predicted by the model in Channels E, F, and G are lower than those predicted in the Drainage No-Action Alternative, suggesting an improvement in drainage and reduced volumes in the case of flooding events over existing conditions.

Under storm surge conditions, drainage improvements modeled in Alternative A appear to provide limited benefit at the identified problem areas.

Overall, drainage improvements modeled in Alternative A were sufficient to achieve flood mitigation at least to the 10-year event level at Problem Areas B, C, and D under no storm surge conditions. Under storm surge conditions, flooding persisted at all problem areas for all return interval events simulated. These results suggest that in Zone 3, drainage improvements decrease rainfall driven flooding, but storm surge conditions overwhelm the capacity of the system to effectively drain runoff from rainfall events under storm surge conditions.



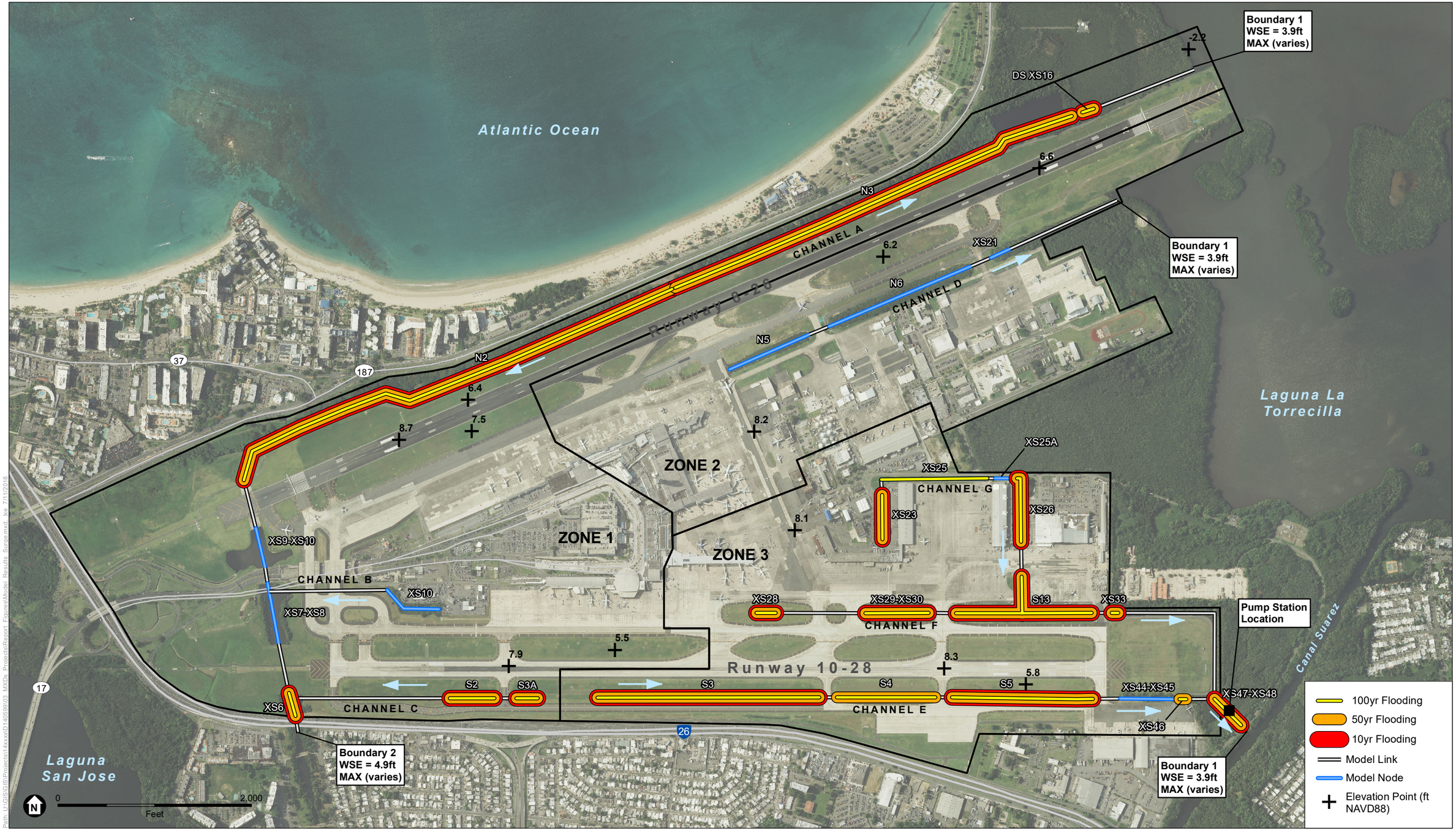

Path: U:\GIS\GIS\Projects\14xxxx\D140599\03 MXDs Projects\Report Figures\Model Results NoSurge.mxd lxe 7/11/2018

SOURCE: ESA, 2018

D140599. Luis Muñoz Marín International Airport - Drainage Study

**Figure 8a**
Model Results - Alternative A, No Surge
San Juan, PR

ESA

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SOURCE: ESA, 2018

D140599. Luis Muñoz Marín International Airport - Drainage Study

**Figure 8b**
Model Results - Alternative A, Surge
San Juan, PR

ESA

## 4.2 Alternative B

Design Alternative B is shown on Figure 9 and includes the following improvements to the drainage system:

- Install a pumping station with isolation gates and two 60,000 GPM pumps at Discharge Point 3.
- Remove mangrove vegetation encroaching on the drainage channels.
- Dredge sediment 2 feet deep from the bottom of the drainage channels.
- Clear all culverts along the channel system of sediment and obstructions.
- Replace the 24-inch culvert along Channel G with two 42-inch culverts.
- Clear the clogged outfalls that discharge to Channel D.

In addition to inadequate drainage observed in the existing system, high water levels within the estuary system have been observed to be another key driver of flooding within the study area. Alternative B consists of all improvements described in Alternative A with an additional system of isolation gates, to prevent storm surge flow into the airport drainage system, and two 60,000 gpm pumps, to extract water from the channels at the discharge point to Canal Suarez while the gates are closed. The gates and pumps were modeled at the link between the node "XS47-XS48" and Boundary 1, just upstream of discharge point 3.

The ESA team evaluated several sizes of commonly installed pumping systems in the region. Based on the predicted flow rates in the channels and the results of interim modeling runs, the engineers determined that two 60,000 GPM pumps would be the most appropriate for the pumping station at the airport.

While developing Alternative B, the ESA team evaluated the effectiveness of pumps installed in Channel D downstream of node "XS21" and in channel A downstream of node "XS6". ESA determined that pump stations installed in channels D and A would not provide sufficient benefit to justify the costs of installation.

### 4.2.1 Model Results

The results of the Alternative B model are illustrated in Figures 10a and 10b. Each figure identifies the name and location of each node of the model and indicates the locations of predicted flooding for each storm event. Model results are discussed by zone in the following sections. More detailed documentation of model input and output parameters are included in the GLM report in Appendix C.

#### 4.2.1.1 Zone 1

Alternative B behaved the same as the Drainage No-Action Alternative and Alternative A for all simulated events. This was expected as the pumping improvements included in Alternative B are not hydraulically connected to Zone 1.

## ALTERNATIVE B

- Remove Vegetation
- Dredge Sediment From Channel
- Clear Sediment and/or Obstructions From Pipe
- Storm Pipe
- \+ Elevation Point (ft NAVD88)

Install pump station with isolation gate and two 60,000 gpm pumps

Atlantic Ocean

Laguna La Torrecilla

Laguna San Jose

Canal Suarez

Runway 8-26

Runway 10-28

CHANNEL A

CHANNEL B

CHANNEL C

CHANNEL D

CHANNEL E

CHANNEL F

CHANNEL G

ZONE 1

ZONE 2

ZONE 3

-2.2

6.6

6.2

6.4

7.5

8.7

8.2

8.1

7.9

5.5

8.3

5.8

Discharge Point 1

Discharge Point 2

Discharge Point 3

Discharge Point 4

Remove sediment from pipe outlets (currently clogged)

Replace 24" culvert with two 42" pipes

Install two 60,000 GPM pumps with isolation gates

37

187

17

26

0 2,000 Feet

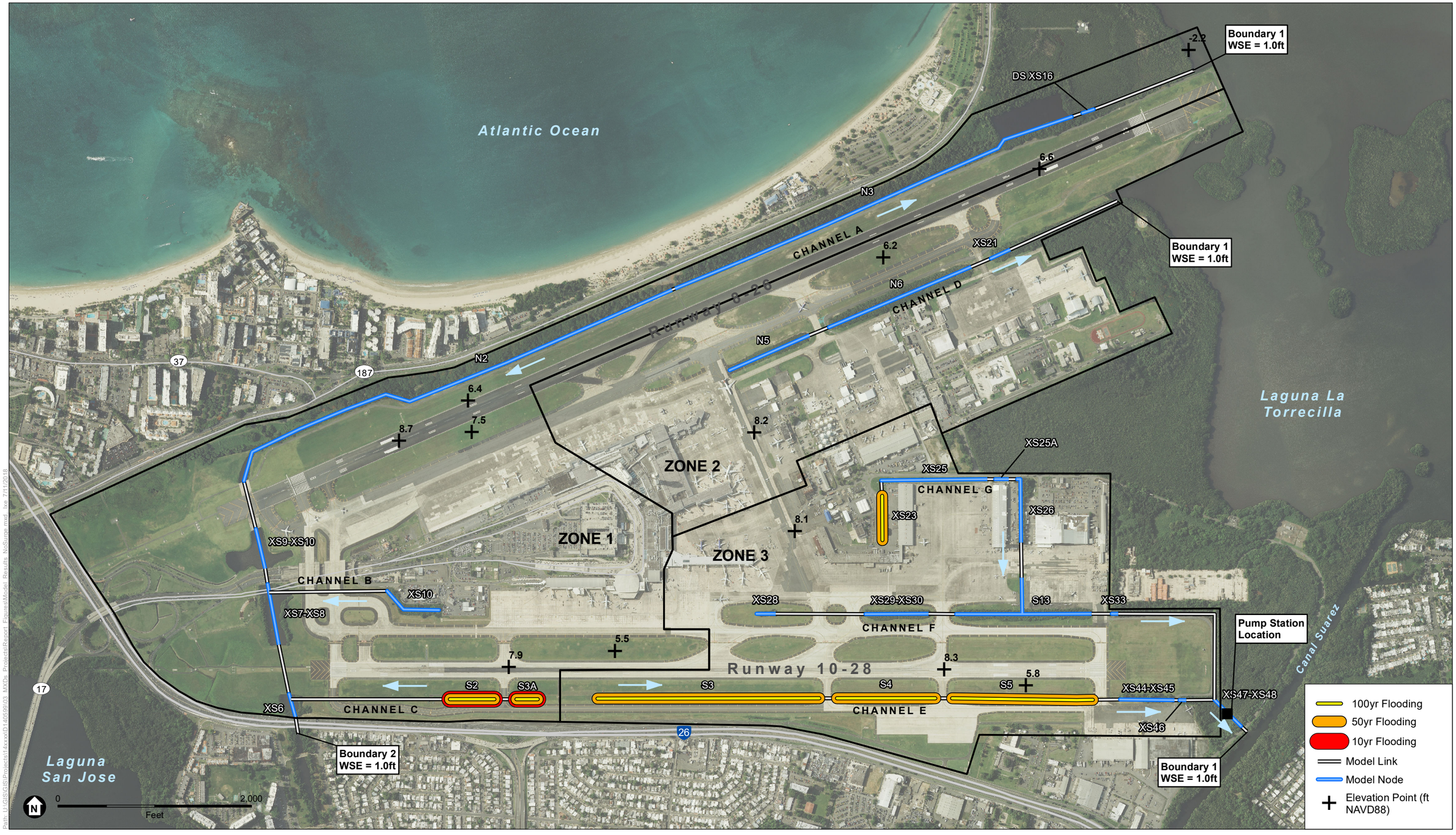
Path: U:\GIS\GIS\Projects\14xxxx\D140599\03 MXDs Proiects\Report Figures\Alternative2.mxd, lxe 7/11/2018

SOURCE: ESA, 2018

D140599. Luis Muñoz Marín International Airport - Drainage Study

**Figure 9**
Alternative B
San Juan, PR

ESA

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SOURCE: ESA, 2018

D140599. Luis Muñoz Marín International Airport - Drainage Study

**Figure 10a**
Model Results - Alternative B, No Surge
San Juan, PR

ESA


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SOURCE: ESA, 2018

D140599. Luis Muñoz Marín International Airport - Drainage Study

**Figure 10b**
Model Results - Alternative B, Surge
San Juan, PR

ESA

#### 4.2.1.2 Zone 2

No flooding was predicted in Channel D for any of the simulated events. Alternative B did not show an improvement over Alternative A for any of the simulated events because Zone 2 is also hydraulically disconnected from the pumping station.

#### 4.2.1.3 Zone 3

Under the no storm surge condition, no flooding was predicted at the 10-year storm event. Alternative B behaved the same as Alternative A for all but the 100-year storm event. For the 100-year no storm surge event, Alternative B showed decreased flooding at one node in Channel F ("XS29-XS30") and one node in Channel G ("XS 26").

Under the storm surge condition, all events showed decreased flooding for Alternative B relative to Alternative A and the Drainage No-Action Alternative, with flood improvements in all channels. The 10-year storm surge event showed no flooding in Zone 3 for Alternative B. For both the 50-year and 100-year storm surge events, Alternative B exhibited flooding in Channel E and Channel F.

The addition of pumps and gates upstream of discharge point 3 appears to reduce flooding at Problem Areas B, C, and D for all simulated events. At Problem Area B, predicted flooding was eliminated for only the 10-year storm surge event, however maximum predicted flood levels were reduced for all simulated events at the 50 and 100-year return intervals.

The results of the Alternative B simulations suggest that in Zone 3 the primary benefit of the isolation gates and pumps is to reduce flooding under storm surge conditions. With the no storm surge condition, the added gates and pumps had only a limited benefit over Alternative A. However, under the storm surge scenarios, Alternative B performed significantly better than Alternative A and the existing conditions, eliminating predicted flooding for the 10-year event.

## 4.3 Maintenance

Ongoing maintenance of the drainage system will be required for continued functioning of the drainage improvements for Alternatives 1 and 2. Regular monitoring of sediment accumulation and mangrove vegetation encroachment should be performed to inform the frequency of maintenance activities. Table 2 summarizes the required maintenance activities and the estimated frequency of these activities.

**TABLE 2.**
**REQUIRED MAINTENANCE ACTIVITIES AND ESTIMATED FREQUENCY.**

| Maintenance Activity | Frequency |
|---|---|
| Dredging Channels | Every 5 years |
| De-silting Culverts | Every 5 years |
| Mangrove removal | Every 6 months |
| Inspection and removal of obstructions | Every 6 months |

Continued function of the drainage system relies on a clear and unobstructed path for conveyance of water through the system. Dredging the channels and removal of sediment from the culverts will prevent excessive sediment build-up from impeding flow through the system. Because it is difficult to predict the rate at which sediment will accrue, yearly inspection of sediment build-up should be performed to inform when sediment removal is necessary.

Mangrove vegetation removal will be required at a higher frequency than sediment removal. The mangrove vegetation grows quickly and should be removed at frequent intervals in order to maintain the function of the drainage system and to avoid more costly removal of larger and more established vegetation.

Regular inspection of the system should be performed in order to identify and remedy localized obstructions in the system. Any large debris or clogging should be removed as soon as identified.

**Maintenance of pumps**

Maintenance of a pumping station will be an ongoing effort and cost. A detailed operations and maintenance plan should be prepared by the design engineer if a pumping system is installed.

## 4.4 Cost Estimates

Aerostar contracted Kimley-Horn to generate an Opinion of Probable Costs (OPC) for proposed design alternatives. Table 3 shows the estimated total costs for both design alternatives. The OPC memorandum, including a detailed breakdown of expense categories and costs, can be found in Appendix D. The OPC was estimated using information from local contractors from bids on similar projects as well as unit prices from Florida Department of Transportation (FDOT). Due to post-hurricane conditions in Puerto Rico, a factor of 2 was applied to all material and labor costs for both alternatives to reflect the increased costs of materials and importation of material and labor.

**TABLE 3.**
**ESTIMATED COSTS FOR DESIGN ALTERNATIVES. PROVIDED BY KIMLEY-HORN.**

| Alternative A | Alternative B |
|---|---|
| $5.3 Million* | $17.3-20.3 Million* |

*includes factor of 2 increase on materials and labor as well as 10% of total cost for both mobilization and contingency

# 5 SEA LEVEL RISE

Water levels in the Atlantic Ocean near Puerto Rico have a direct influence on water levels in Laguna La Torrecilla and Laguna San Jose, which set the tailwater for the drainage system at Luiz Muñoz Marín International Airport, directly influencing and aggravating flooding and drainage issues at the airport. As see levels rise due to climate change, water levels in the lagoons and open channels in the airport will rise as well.

Aurelia Mercado-Irizarry was tasked by the Puerto Rico Climate Change Council to estimate sea level rise around Puerto Rico, and in his report titled "Sea Level Rise Around Puerto Rico: A Projection" provided sea level rise estimates for the year 2100. Based on several different scenarios, climate models, and calculators, the range of sea level rise projected varied from 0.33 meters (1.1 ft) to 3.75 meters (12.3 ft) (Mercado-Irizarry, 2017). This wide range in values reflects the inherent uncertainty associated with making projections for 2100 due to difficulty in predicting the many parameters including future behavior of ice shelves and global emissions. Regardless of the exact amount of sea level rise, water levels are only increasing and it is expected that flooding issues at the airport due to backwater effects of high water in the lagoons are only going to increase.

The analysis of the drainage alternatives show that the installation of pumps has the greatest benefit during high storm surge conditions. As sea level rises, pumping systems will be the most effective at mitigating the impacts of higher boundary conditions and more frequent storm surge events.

# 6 WATER QUALITY

Water quality was not the focus of this study, however, ESA identified several opportunities for improving runoff water quality within the airport drainage system.

During the field investigations of the site, the project team identified an outfall that originates from off-site and discharges to the channel at the south of the airport. The location of this outfall is identified on Figure 3. ESA observed a smell and buildup of trash at the outfall that indicates that this outfall is discharging sanitary sewer waste to the airport site (Photo 5). The discharge from the outfall is coming from the neighborhood to the south. It is unclear if the sanitary sewer contamination is the result of a direct connection or a consequence of failing pipes within the sewer system and inflow and infiltration into the off-site drainage system.

SOURCE: ESA

**Photo 5**
Clogged sanitary drain discharging into airport.

The discharge of untreated sanitary waste is a clear water quality, aquatic species, and human health concern. The drainage channels of the airport provide a direct conveyance path for untreated sanitary waste to enter the Laguna la Torrecilla. ESA recommends that the airport coordinate with the Municipality of Carolina and take steps to eliminate this discharge.

During construction of both Alternative A and 2, measures should be taken to reduce the migration of sediment disturbed by construction activities. During dredging of the channels, best management practices (BMPs) should be installed downstream of the work area to prevent sediment from migrating into the lagoon system. Work area isolation and pumping systems may also need to be utilized to protect sensitive receiving waters.

The Storm Water Pollution Prevention Plan (Eco Stahlia, 2015) prepared for the airport outlines a number of suggestions for best management practices (BMPs) to protect water quality in the stormwater system.

# 7 ENGINEERING CONCLUSIONS / RECOMMENDATIONS / NEXT STEPS

Flooding issues are driven by sediment and mangrove accumulation throughout the system, localized obstructions, and high tailwater conditions in the surrounding estuary system, especially during storm surge events.

Modeling of Alternative A shows reduced water surface elevations and reduced frequency of flooding in the channel system during 10, 50, and 100-year precipitation events during normal tidal conditions. Modeling of storm surge conditions in Alternative A show less improvement when precipitation events coincide with FEMA storm surge levels in the surrounding lagoon system.

Modeling of Alternative B demonstrates that a pumping system installed at discharge location 3 at Canal Suarez will reduce water surface levels and the frequency of flooding events during storm surge conditions in Zone 3.

To address the current nuisance flooding issues ESA recommends implementing the improvements associated with Alternative A immediately. Once the improvements are complete it is essential that vegetative and sediment management occurs at a rate that prevents degradation of the drainage system.

ESA also recommends monitoring and documentation of any continued flooding events at the airport including dates, rainfall amounts, and photos depicting high water areas. High water marks could be documented in the field with PK Nails so they can be surveyed in the future.

To address issues within the piping system, ESA recommends that airport maintenance staff perform an inspection of all pipe and inlet infrastructure as part of a regular maintenance program, and remove or repair obvious obstructions, sedimentation blockages, and pipe failures as they are discovered.

If flooding at the airport remains an issue after the implementation of Alternative A improvements then further study of the piping system and the installation of a pumping system should be considered.

# 8 REFERENCES

Bunch, Barry W., Cerco, Carl F, and Dortch, Mark S. (2000). Hydrodynamic and Water Quality Model Study of San Juan Bay Estuary (ERDC TR-00-1). Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Eco Stahlia. (2015). Stormwater Pollution Prevention Plan for the Luis Muñoz Marín International Airport Carolina, Puerto Rico.

Federal Aviation Administration. (2013). Airport Drainage Design (AC 150/5320-5D).

Federal Aviation Administration. (2014). Airport Design (AC 150/5300-13A).

Mercado-Irizarry, Aurelio. (2017). Sea Level Rise Around Puerto Rico: A Projection

Drainage Report Appendices Available Upon Request

# APPENDIX B

Opinion of Probable Costs Memorandum

Kimley»Horn

# MEMORANDUM

To: Environmental Science Associates

From: Kimley-Horn Puerto Rico, LLC

Date: 7/3/18

Subject: San Juan Airport Alternative 1 & 2 Opinion of Probable Cost

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The Opinion of Probable Costs (OPC) was estimated using information obtained from local contractor bids of similar projects and Florida Department of Transportation (FDOT) Statewide Average Unit prices for 2017-2018. A factor of 2 was considered for the items used in both alternatives which considered post-hurricane conditions, importing material and labor, and the increased cost of materials (metals). Please see attached for breakdown of costs and references.

## Alternative 1 (Clear Ditches and Pipe Obstructions)

The cost for Alternative 1 listed below considers the construction of a new drainage connection, removing or trimming vegetation, dredging sediment from channels, and clearing sediment and/or obstructions from pipes, and 10% contingencies for mobilization and total costs.

- **$5,313,485.22**

## Alternative 2 (Clear Ditches and Pipe Obstructions and a Storm Water Pumping Station with a Gate)

The cost for Alternative 2 listed below considers Alternative 1 with the addition of installing of an isolation gate and (2) pumping systems (60,000 GPM) at one location.

- **($17.3 Million - $20.3 Million)**

Kimley-Horn Puerto Rico, LLC. has no control over the cost of labor, materials, equipment, or services furnished by others, or over methods of determining price, or over competitive bidding or market conditions. Any and all professional opinions as to costs reflected herein, including but not limited to professional opinions as to the costs of construction materials, are made on the basis of professional experience and available data. Kimley-Horn and Associates, Inc. cannot and does not guarantee or warrant that proposals, bids, or actual costs will not vary from the professional opinions of costs shown herein.

Kimley»Horn

**OPINION OF PROBABLE COST**
**SAN JUAN AIRPORT ALTERNATIVE I**

DATE: 7/3/2018

| ITEM NUMBER | DESCRIPTION | UNIT | QTY. | FDOT UNIT PRICE | 30% COST FACTOR PRE-HURRICANE | POST HURRICANE FACTOR | TOTAL COST |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | **DRAINAGE PAY ITEMS** | | | | | | |
| 1 | SEDIMENT BARRIER | LF | 8750 | $ 1.24 | $ 1.61 | $ 2.48 | $ 21,700.00 |
| 2 | FLOATING TURBIDITY BARRIER | LF | 1500 | $ 9.90 | $ 12.87 | $ 19.80 | $ 29,700.00 |
| 3 | CHANNEL EXCAVATION | CY | 113200 | $ 7.84 | $ 10.19 | $ 15.68 | $ 1,774,976.00 |
| 4 | DESILTING PIPE, 25-36" | LF | 200 | $ 10.16 | $ 13.21 | $ 20.32 | $ 4,064.00 |
| 5 | DESILTING PIPE, 37-48" | LF | 1482 | $ 25.97 | $ 33.76 | $ 51.94 | $ 76,975.08 |
| 6 | DESILTING PIPE, 49-60" | LF | 7134 | $ 12.76 | $ 16.59 | $ 25.52 | $ 182,059.68 |
| 5 | SELECTIVE CLEARING AND GRUBBING | AC | 35.08 | $ 15,500.82 | $ 20,151.07 | $ 31,001.64 | $ 1,087,537.53 |
| 7 | CONCRETE CLASS I, ENDWALLS | CY | 16.22 | $ 1,123.00 | $ 1,459.90 | $ 2,246.00 | $ 36,430.12 |
| 8 | STEEL | LB | 16.86 | $ 0.93 | $ 1.21 | $ 1.86 | $ 31.36 |
| 9 | PIPE CULV, 42" | LF | 180.00 | $ 152.59 | $ 198.37 | $ 305.18 | $ 54,932.40 |
| | | **SUB-TOTAL** | | | | | **$ 3,268,406.17** |
| | OTHER | | | | | | |
| | SURETY INSURANCE, PERFORMANCE AND BONDS | LS | 1 | - | | | $ 159,047.58 |
| | CONTRACTOR QUALITY CONTROL | LS | 1 | | | | $ 72,473.51 |
| | MAINTENANCE OF AIR OPERATIONS | LS | 1 | | | | $ 826,429.08 |
| | SAFETY PLAN COMPLIANCE DOCUMENT | LS | 1 | | | | $ 12,423.36 |
| | PROJECT SURVEY AND STAKEOUT | LS | 1 | | | | $ 52,530.40 |
| | | **SUB-TOTAL** | | | | | **$ 1,122,903.93** |
| | MOBILIZATION | LS | 10% | - | | | $ 439,131.0 |
| | CONTINGENCY | LS | 10% | - | | | $ 483,044.1 |
| | | **GRAND TOTAL** | | | | | **$ 5,313,485.22** |

Unit prices are per FDOT Item Average Unit for year 2017-2018 using Statewide.

Kimley-Horn Puerto Rico, LLC. has no control over the cost of labor, materials, equipment, or services furnished by others, or over methods of determining price, or over competitive bidding or market conditions. Any and all professional opinions as to costs reflected herein, including but not limited to professional opinions as to the costs of construction materials, are made on the basis of professional experience and available data. Kimley-Horn and Associates, Inc. cannot and does not guarantee or warrant that proposals, bids, or actual costs will not vary from the professional opinions of costs shown herein.

C:\Users\Kyle.Cabrera\Desktop\Puerto Rico\OPC\[20180613 SJU OPC.xlsx]OPC_ALT1

OPC (Opinion of Probable Cost)

**Alternative 1 (Clear Ditches and Pipe Obstructions)**

Alternative 1 consists of a new drainage connection, removing or trimming vegetation, dredging sediment from channels, and clearing sediment and/or obstructions from pipes. The items listed below were considered for the estimate of Alternative 1.

The following items were based on local contractor bids

- Surety Insurance, Performance, and Bonds
- Contractor Quality Control
- Maintenance of Air Operations
- Safety Plan Compliance Document
- Project Survey and Stakeout
  **Sub-Total Cost: $1,122,903.93**

The following items were based on FDOT Item Average Unit prices for the year 2017-2018 (Statewide)

- Soil Erosion and Siltation Control (Sediment Barrier & Floating Turbidity Barrier)
- Desilting Pipes (36",42",48" and 60" Dia.)
- Excavation (Channel)
- Selective Clearing and Grubbing
- Construction of End Walls (Concrete, Steel, and Pipe)
  **Sub-Total Cost: $3,268,406.17**

Based on FDOT unit prices, and the quantities provided by ESA, a factor of 2 was considered to estimate the cost of materials considering post hurricane conditions. In addition, 10% of total cost was considered for Mobilization and a 10% of total cost was considered for contingencies.

- Alternative 1 (Clear Ditches and Pipe Obstructions)
  **Grand Total: $5,313,485.22**

**Alternative 2 (Clear Ditches and Pipe Obstructions and a Storm Water Pumping Station with a Gate)**

Alternative 2 consists of the same items as Alternative 1 (new drainage connection, removing or trimming vegetation, dredging sediment from channels, and clearing sediment and/or obstructions from pipes) in addition to, installing isolation gate and (2) pumping systems (60,000 GPM Pump Capacity) at (1) locations. The items listed below were considered for the estimate of Alternative 2.

- Alternative 1 (Clear Ditches and Pipe Obstructions)
  **Grand Total: $5,313,485.22**

The following items were based on local contractor bids with the consideration of an increase of costs in Puerto Rico due to post hurricane conditions, increased cost of steel, and imported materials and labor.

- (2) Pumping System (Dewatering, Gates, Sheet Piles, Materials, Labor)
  **Sub-Total Costs: Ranges ($12 Million - $15 Million)**

- Alternative 2
  (Clear Ditches and Pipe Obstructions and 1 Storm water Pumping Stations and Gates
  **Grand Total: ($ 17.3 Million - $20.3 Million)**

Similar project bids ranged from ($1 Million - $ 6 Million). The City of Miami Beach project is currently in construction.

**City of Miami Beach** - (2 Pump Stations (60,000 GPM Pump Capacity), Gates, Dewatering, Sheet Piles)

- $6 Million per Pump Station. Includes materials and labor.

**Ave Los Angeles** - (3 Pump Stations (40,000 GPM Pump Capacity), Gates, Dewatering, Sheet Piles)

- $ 5 Million

**Vista Mar, Carolina Site** - (1 Pump Station (24,000 GPM Pump Capacity))

- $1 Million

**Isla Verde** - (2 Pump Station (24,000-40,000 GPM Pump Capacity))

- $5 Million

Kimley-Horn Puerto Rico, LLC. has no control over the cost of labor, materials, equipment, or services furnished by others, or over methods of determining price, or over competitive bidding or market conditions. Any and all professional opinions as to costs reflected herein, including but not limited to professional opinions as to the costs of construction materials, are made on the basis of professional experience and available data. Kimley-Horn and Associates, Inc. cannot and does not guarantee or warrant that proposals, bids, or actual costs will not vary from the professional opinions of costs shown herein.

**Florida Department of Transportation**
**Item Average Unit Cost**
**From 2017/05/01 to 2018/04/30**

**Contract Type: CC STATEWIDE**
**Displaying: VALID ITEMS WITH HITS**
**From: 0102 1 To: 9999999**

| Item | No. of Conts | Weighted Average | Total Amount | Total Quantity | Unit Meas | Obs? | Description |
|---|---|---|---|---|---|---|---|
| 0102911 3 | 7 | $2.32 | $21,449.50 | 9,265.000 | SF | N | PAVT MARKING REMOVABLE TAPE,WH BLK,OTHER |
| 0102912 1 | 3 | $2.30 | $3,118.50 | 1,355.000 | LF | N | PAVT MARKING REMOVABLE TAPE,YELLOW,SKIP |
| 0102912 2 | 26 | $1.77 | $252,022.07 | 142,545.000 | LF | N | PAVT MARKING REMOVABLE TAPE,YELLOW,SOLID |
| 0104 1 | 35 | $2.27 | $264,113.83 | 116,298.000 | SY | N | ARTIFICIAL COVERINGS / ROLL EROSION CNTL |
| 0104 6 | 2 | $4.76 | $12,619.30 | 2,653.000 | LF | N | TEMPORARY SLOPE DRAIN / RUNOFF CONT STR |
| 0104 7 | 2 | $3,101.76 | $27,915.88 | 9.000 | EA | N | SEDIMENT BASIN / CONTAINMENT SYSTEM |
| 0104 9 | 2 | $1,074.06 | $9,666.56 | 9.000 | EA | N | SEDIMENT BASIN / CONTAINMENT SY CLEANOUT |
| 0104 10 3 | 150 | $1.24 | $2,551,399.41 | 2,064,960.000 | LF | N | SEDIMENT BARRIER |
| 0104 11 | 65 | $9.90 | $726,431.93 | 73,344.000 | LF | N | FLOATING TURBIDITY BARRIER |
| 0104 12 | 32 | $6.54 | $216,102.18 | 33,018.000 | LF | N | STAKED TURBIDITY BARRIER- NYL REINF PVC |
| 0104 15 | 56 | $2,280.57 | $640,839.06 | 281.000 | EA | N | SOIL TRACKING PREVENTION DEVICE |
| 0104 18 | 157 | $105.29 | $821,816.38 | 7,805.000 | EA | N | INLET PROTECTION SYSTEM |
| 0104 19 | 5 | $2.24 | $43,283.66 | 19,335.000 | SY | N | CHEMICAL TREATMENT FOR EROSION CONTROL |
| 0107 1 | 168 | $16.93 | $2,255,459.38 | 133,221.050 | AC | N | LITTER REMOVAL |
| 0107 2 | 163 | $24.90 | $2,622,810.62 | 105,332.410 | AC | N | MOWING |
| 0108 1 | 78 | $9,469.35 | $823,833.33 | 87.000 | LS | N | MONITOR EXISTING STRUCTURES- SETTL |
| 0108 2 | 50 | $11,785.37 | $636,410.20 | 54.000 | LS | N | MONITOR EXISTING STRUCTURES- VIBRA |
| 0108 3 | 9 | $20,726.82 | $186,541.34 | 9.000 | LS | N | MONITOR EXISTING STRUCTURES- GROUN |
| 0110 1 1 | 177 | $10,273.29 | $28,294,183.05 | 2,754.150 | AC | N | CLEARING & GRUBBING |
| 0110 2 2 | 26 | $15,500.82 | $684,826.35 | 44.180 | AC | N | SELECTIVE CLEARING AND GRUBBING, TREES R |
| 0110 2 3 | 1 | $10,800.00 | $15,444.00 | 1.430 | AC | N | SELECTIVE CLEARING AND GRUB, PLANT PRES |
| 0110 3 | 27 | $52.38 | $5,604,223.31 | 106,992.000 | SF | N | REMOVAL OF EXISTING STRUCTURES/BRIDGES |
| 0110 4 10 | 108 | $18.23 | $2,626,024.04 | 144,047.000 | SY | N | REMOVAL OF EXIST CONC |
| 0110 6 | 1 | $1,000.00 | $3,000.00 | 3.000 | EA | N | PLUGGING WATER WELLS, NON-ARTESIAN |
| 0110 7 1 | 53 | $183.45 | $110,256.08 | 601.000 | EA | N | MAILBOX, F&I SINGLE |
| 0110 8 2 | 1 | $297.54 | $28,266.30 | 95.000 | LF | N | UNDERWATER DEBRIS REMOVAL |
| 0110 12 1 | 1 | $205.97 | $364,772.87 | 1,771.000 | SY | N | HYDRODEMOLITION, REM OF DECK SURFACE |
| 0110 71 1 | 1 | $331.12 | $195,360.80 | 590.000 | LF | N | BRIDGE FENDER SYSTEM, REMOVAL & DISPOSAL |
| 0110 73 | 1 | $67.00 | $10,050.00 | 150.000 | LF | N | REMOVE EXISTING BULKHEAD |
| 0110 82 | 2 | $3,368.00 | $42,100.00 | 12.500 | MB | N | REMOVE & DISPOSE OF STRUCTURAL TIMBER |
| 0110 86 | 30 | $1,263.95 | $48,030.18 | 38.000 | LS | N | DELIVERY OF SALVAGEABLE MATERIAL TO FDOT |
| 0120 1 | 115 | $4.50 | $10,010,841.41 | 2,226,233.200 | CY | N | REGULAR EXCAVATION |
| 0120 2 2 | 60 | $8.74 | $1,378,583.67 | 157,817.400 | CY | N | BORROW EXCAVATION, TRUCK MEASURE |
| 0120 3 | 1 | $8.70 | $15,320.70 | 1,761.000 | CY | N | LATERAL DITCH EXCAVATION |
| 0120 4 | 29 | $9.96 | $2,902,878.44 | 291,548.700 | CY | N | SUBSOIL EXCAVATION |
| 0120 5 | 3 | $7.84 | $4,466,962.10 | 570,046.400 | CY | N | CHANNEL EXCAVATION |
| 0120 6 | 92 | $7.75 | $33,746,307.97 | 4,352,178.500 | CY | N | EMBANKMENT |
| 0120 71 | 35 | $27,606.70 | $1,049,054.51 | 38.000 | LS | N | REGULAR EXCAVATION (3-R PROJECTS ONLY) |
| 0120 74 | 4 | $3.21 | $382,229.68 | 119,194.000 | CY | N | SURCHARGE EMBANKMENT |
| 0125 1 | 4 | $23.09 | $39,599.20 | 1,714.700 | CY | N | EXCAVATION FOR STRUCTURES |

**Florida Department of Transportation**
**Item Average Unit Cost**
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| Item | No. of Conts | Weighted Average | Total Amount | Total Quantity | Unit Meas | Obs? | Description |
|---|---|---|---|---|---|---|---|
| 0337 7 26 | 4 | $134.80 | $3,159,318.85 | 23,437.800 | TN | N | ASPH CONC FC,FC-5,FC-5, HIGH POLYMER |
| 0337 7 80 | 12 | $97.27 | $7,622,789.77 | 78,371.100 | TN | N | ASPH CONC FC,TRAFFIC B,FC-9.5,PG 76-22 |
| 0337 7 81 | 19 | $103.11 | $4,794,515.77 | 46,500.200 | TN | N | ASPH CONC FC,TRAFFIC B,FC-12.5,PG 76-22 |
| 0337 7 82 | 34 | $129.08 | $6,522,265.05 | 50,529.600 | TN | N | ASPH CONC FC,TRAFFIC C,FC-9.5,PG 76-22 |
| 0337 7 83 | 60 | $102.74 | $29,953,883.51 | 291,545.200 | TN | N | ASPH CONC FC,TRAFFIC C,FC-12.5,PG 76-22 |
| 0337 7 85 | 9 | $104.61 | $3,606,848.38 | 34,477.500 | TN | N | ASPH CONC FC,TRAFFIC D,FC-12.5,PG 76-22 |
| 0337 7 90 | 1 | $106.62 | $1,166,955.90 | 10,945.000 | TN | N | ASPH CONC FC,TRAFFIC B,FC-9.5,HIGH POLYM |
| 0337 7 93 | 4 | $135.04 | $3,489,739.15 | 25,842.200 | TN | N | ASPH CONC FC,TRAF C,FC-12.5,HIGH POLYMER |
| 0337 7 94 | 2 | $125.27 | $427,272.67 | 3,410.800 | TN | N | ASPH CONC FC,TRAF D,FC-12.5,HIGH POLYMER |
| 0339 1 | 88 | $165.45 | $4,146,102.46 | 25,059.200 | TN | N | MISCELLANEOUS ASPHALT PAVEMENT |
| 0350 3 1 | 2 | $110.34 | $5,406.58 | 49.000 | SY | N | PLAIN CEMENT CONC PAVT, 6" |
| 0350 3 5 | 2 | $105.24 | $125,336.88 | 1,191.000 | SY | N | PLAIN CEMENT CONC PAVT, 8" |
| 0350 3 7 | 1 | $89.00 | $37,113.00 | 417.000 | SY | N | PLAIN CEMENT CONC PAVT, 9" |
| 0350 3 9 | 1 | $118.00 | $3,304.00 | 28.000 | SY | N | PLAIN CEMENT CONC PAVT, 10" |
| 0350 3 10 | 2 | $88.11 | $635,691.38 | 7,215.000 | SY | N | PLAIN CEMENT CONC PAVT, 10.5" |
| 0350 3 12 | 1 | $93.57 | $1,396,906.53 | 14,929.000 | SY | N | PLAIN CEMENT CONC PAVT, 11.5" |
| 0350 3 14 | 1 | $90.00 | $1,363,950.00 | 15,155.000 | SY | N | PLAIN CEMENT CONC PAVT, 12.5" |
| 0350 4 1 | 1 | $83.00 | $22,410.00 | 270.000 | SY | N | REINFORCED CEMENT CONC PVMT,6" |
| 0350 4 5 | 1 | $125.33 | $21,556.76 | 172.000 | SY | N | REINFORCED CEMENT CONC PVMT,8" |
| 0350 4 13 | 1 | $120.00 | $26,760.00 | 223.000 | SY | N | REINFORCED CEMENT CONC PVMT,12" |
| 0350 5 | 4 | $3.42 | $238,881.15 | 69,797.000 | LF | N | CLEANING & SEALING JOINTS - CONC PVMT |
| 0350 6 | 2 | $7.44 | $4,902.88 | 659.000 | LF | N | CLEANING & SEALING CRACKS - CONC PVMT |
| 0350 30 13 | 3 | $68.41 | $180,940.00 | 2,645.000 | SY | N | CONC PAVEMENT FOR ROUNDABOUT APRON, 12" |
| 0352 70 | 7 | $7.45 | $334,711.22 | 44,903.000 | SY | N | GRINDING CONCRETE PAVT |
| 0353 70 | 1 | $1,319.41 | $300,957.42 | 228.100 | CY | N | CONC PAVT SLAB REPLACEMENT |
| 0370 1 | 1 | $212.50 | $67,150.00 | 316.000 | LF | N | BRIDGE APPR EXP JOINT FOR CONC PVMT |
| 0400 0 11 | 34 | $512.13 | $4,490,705.25 | 8,768.600 | CY | N | CONC CLASS NS, GRAVITY WALL |
| 0400 0 13 | 3 | $1,995.56 | $44,900.00 | 22.500 | CY | N | CONC CLASS NS, STEPS |
| 0400 1 2 | 30 | $1,123.08 | $667,221.82 | 594.100 | CY | N | CONC CLASS I, ENDWALLS |
| 0400 1 11 | 1 | $963.31 | $15,412.96 | 16.000 | CY | N | CONC CLASS I, RETAINING WALLS |
| 0400 2 1 | 5 | $692.81 | $1,314,257.00 | 1,897.000 | CY | N | CONC CLASS II, CULVERTS |
| 0400 2 2 | 3 | $1,401.38 | $91,790.57 | 65.500 | CY | N | CONC CLASS II, ENDWALLS |
| 0400 2 4 | 14 | $539.37 | $8,727,376.89 | 16,180.800 | CY | N | CONC CLASS II, BRIDGE SUPERSTRUCTURE |
| 0400 2 5 | 4 | $871.42 | $389,962.50 | 447.500 | CY | N | CONC CLASS II, BRIDGE SUBSTRUCTURE |
| 0400 2 10 | 20 | $399.63 | $1,951,253.20 | 4,882.600 | CY | N | CONC CLASS II, APPROACH SLABS |
| 0400 2 11 | 1 | $100.00 | $3,770.00 | 37.700 | CY | N | CONC CLASS II, RETAINING WALLS |
| 0400 2 25 | 1 | $600.00 | $225,300.00 | 375.500 | CY | N | CONC CLASS II, MASS, BRIDGE SUBSTRUCTURE |
| 0400 2 41 | 2 | $787.93 | $334,792.50 | 424.900 | CY | N | CONC CLASS II, PRECAST DECK OVERLAY |
| 0400 2 47 | 2 | $836.77 | $211,368.00 | 252.600 | CY | N | CONC CLASS II, CIP TOP W/ SR ADMIX |
| 0400 3 20 | 2 | $429.09 | $134,477.08 | 313.400 | CY | N | CONC CLASS III, SEAL |

**Florida Department of Transportation**
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| Item | No. of Conts | Weighted Average | Total Amount | Total Quantity | Unit Meas | Obs? | Description |
|---|---|---|---|---|---|---|---|
| 0400 4 1 | 10 | $1,336.07 | $2,863,196.74 | 2,143.000 | CY | N | CONC CLASS IV, CULVERTS |
| 0400 4 4 | 4 | $1,469.31 | $555,987.72 | 378.400 | CY | N | CONC CLASS IV, SUPERSTRUCTURE |
| 0400 4 5 | 21 | $942.51 | $4,378,614.61 | 4,645.700 | CY | N | CONC CLASS IV, SUBSTRUCTURE |
| 0400 4 8 | 8 | $893.83 | $2,287,224.30 | 2,558.900 | CY | N | CONC CLASS IV, BULKHEAD |
| 0400 4 11 | 4 | $695.51 | $603,705.00 | 868.000 | CY | N | CONC CLASS IV, RETAINING WALLS |
| 0400 4 25 | 5 | $676.81 | $5,096,702.66 | 7,530.500 | CY | N | CONC CLASS IV, MASS, SUBSTRUCTURE |
| 0400 4 47 | 2 | $781.75 | $378,680.94 | 484.400 | CY | N | CONC CLASS IV, CIP TOP W/SR ADMIX |
| 0400 7 | 12 | $14.56 | $162,710.90 | 11,174.000 | SY | N | BRIDGE DECK GROOVING, LESS THAN 8.5" |
| 0400 9 | 11 | $9.32 | $459,932.62 | 49,331.000 | SY | N | BRIDGE DECK GROOV &PLANING, DECK 8.5" GR |
| 0400 20 | 1 | $49.07 | $10,795.40 | 220.000 | SY | N | GRINDING BRIDGE DECK- REHABILITATION |
| 0400 32 | 1 | $8,500.00 | $210,800.00 | 24.800 | CY | N | CONCRETE FOR JOINT REPAIR |
| 0400128 | 2 | $29.75 | $77,740.00 | 2,613.000 | LF | N | GRTNING PRCST DECK PNL, NON-SHRINK GRTN |
| 0400140 1 | 1 | $2,700.00 | $54,000.00 | 20.000 | EA | N | NEOPRENE PAD REPLACEMENT, BENT/PIER |
| 0400142 3 | 1 | $35.00 | $91,980.00 | 2,628.000 | SF | N | CATHODIC PROTECTION SYSTEM, ZINC ALUM SP |
| 0400143 | 3 | $1.57 | $56,430.50 | 35,906.000 | SF | N | CLEAN & COAT CONCRETE SURF , CLASS 5 |
| 0400145 | 2 | $.69 | $95,003.75 | 138,505.000 | SF | N | CLEANING CONC SURFACE |
| 0400147 | 12 | $728.77 | $337,346.64 | 462.900 | CF | N | COMPOSITE NEOPRENE PADS |
| 0400148 | 3 | $907.23 | $31,118.04 | 34.300 | CF | N | PLAIN NEOPRENE BEARING PADS |
| 0400153 | 2 | $464.15 | $118,265.00 | 254.800 | CF | N | NON SHRINK GROUT, F&I, MISCELLANEOUS- RE |
| 0401 70 | 4 | $228.93 | $2,035,442.00 | 8,891.000 | CF | N | RESTORE SPALLED AREAS, GUNITE |
| 0401 70 1 | 3 | $132.17 | $38,330.00 | 290.000 | CF | N | RESTORE SPALLED AREAS, EPOXY |
| 0401 70 2 | 2 | $353.22 | $221,506.00 | 627.100 | CF | N | RESTORE SPALL AREA,LATX MOD MTR,STY-BUT |
| 0401 70 3 | 8 | $468.14 | $717,147.34 | 1,531.900 | CF | N | RESTORE SPALL AREA,LATX MOD MTR, ACRYLC |
| 0401 70 4 | 5 | $859.91 | $107,489.00 | 125.000 | CF | N | RESTORE SPALLED AREAS,PORTLND CEM GROUT |
| 0401 70 5 | 1 | $262.00 | $61,570.00 | 235.000 | CF | N | RESTORE SPALL AREAS,CONTRACTORS OPTION |
| 0403 1 7 | 1 | $70.00 | $46,200.00 | 660.000 | SY | N | EPOXY CONC OVERLAY- CONC BR 43927315201 |
| 0403 2 7 | 1 | $300.00 | $3,000.00 | 10.000 | CF | N | RESTORE SPALLED AR CONC BRI 43927315201 |
| 0404 5 11 | 1 | $750.00 | $77,250.00 | 103.000 | SY | N | PRECAST DECK PANEL, NONPRES, 8" |
| 0404 7 | 1 | $50.00 | $11,500.00 | 230.000 | LF | N | CLOSURE JOINT FOR PRECAST DECK PANEL |
| 0405 70 1 | 1 | $1,000.00 | $42,000.00 | 42.000 | CF | N | LATEX MOD PORTLAND CEMENT CONC, TYPE I |
| 0411 1 | 11 | $82.23 | $14,391.09 | 175.000 | GA | N | EPOXY MATERIAL- STRUCTURES REHAB |
| 0411 2 | 12 | $41.01 | $177,764.47 | 4,335.000 | LF | N | CRACKS INJECT & SEAL- STRUCTURES REHAB |
| 0413149 | 1 | $500.00 | $1,000.00 | 2.000 | GA | N | PENETRANT SEALER |
| 0413151 | 2 | $30.33 | $180,086.00 | 5,937.000 | GA | N | METHACRYLATE MONOMER |
| 0413154 | 3 | $.61 | $361,429.00 | 594,877.000 | SF | N | CLEAN & SEAL CONC- PENETR OR METHACR |
| 0415 1 1 | 17 | $.93 | $723,513.14 | 781,628.000 | LB | N | REINF STEEL- ROADWAY |
| 0415 1 3 | 8 | $1.00 | $105,502.45 | 106,023.000 | LB | N | REINF STEEL- RETAINING WALL |
| 0415 1 4 | 23 | $.82 | $3,424,961.97 | 4,184,787.000 | LB | N | REINF STEEL- SUPERSTRUCTURE |
| 0415 1 5 | 23 | $.83 | $2,038,880.69 | 2,448,797.000 | LB | N | REINF STEEL- SUBSTRUCTURE |
| 0415 1 6 | 9 | $1.90 | $7,650.50 | 4,032.000 | LB | N | REINF STEEL- MISCELLANEOUS |

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|---|---|---|---|---|---|---|---|
| 0425 5 1 | 37 | $1,184.56 | $615,968.81 | 520.000 | EA | N | MANHOLE, ADJUST, UTILITIES |
| 0425 6 | 49 | $551.40 | $518,318.65 | 940.000 | EA | N | VALVE BOXES, ADJUST |
| 0425 7 | 3 | $445.74 | $12,034.90 | 27.000 | EA | N | MANHOLE COVER- REPLACE |
| 0425 11 | 17 | $2,452.54 | $161,867.38 | 66.000 | EA | N | MODIFY EXISTING DRAINAGE STRUCTURE |
| 0425 14 1 | 2 | $100.00 | $7,000.00 | 70.000 | SF | N | GRATE FOR EXISTING DRAINAGE STR, FUR INS |
| 0425 74 1 | 2 | $467.50 | $18,700.00 | 40.000 | EA | N | MANHOLES & INLETS CLEANING & SEAL, <10' |
| 0425 78 | 1 | $1,176.79 | $2,353.58 | 2.000 | EA | N | INLET CAP, PRECAST |
| 0425 82 | 5 | $1,681.56 | $139,569.36 | 83.000 | EA | N | REPLACE GRATE |
| 0430 94 1 | 14 | $8.45 | $98,831.52 | 11,701.000 | LF | N | DESILTING PIPE, 0 - 24" |
| 0430 94 2 | 6 | $10.16 | $85,584.48 | 8,424.000 | LF | N | DESILTING PIPE, 25 - 36" |
| 0430 94 3 | 4 | $25.97 | $38,664.72 | 1,489.000 | LF | N | DESILTING PIPE, 37 - 48" |
| 0430 94 4 | 2 | $12.76 | $6,177.12 | 484.000 | LF | N | DESILTING PIPE, 49 - 60" |
| 0430 95 2 | 1 | $30.60 | $12,270.60 | 401.000 | LF | N | OUTFALL BARNACLE REMOVAL, 25 - 36" |
| 0430173118 | 1 | $95.00 | $278,635.00 | 2,933.000 | LF | N | PIPE CULV OPT MATL, ROUND, 18", GD |
| 0430173124 | 1 | $90.00 | $49,860.00 | 554.000 | LF | N | PIPE CULV OPT MATL, ROUND, 24", GD |
| 0430173136 | 1 | $135.00 | $10,665.00 | 79.000 | LF | N | PIPE CULV OPT MATL, ROUND, 36", GD |
| 0430173218 | 1 | $210.63 | $30,120.09 | 143.000 | LF | N | PIPE CULV OPT MATL, OTHER/ELLIP, 18", GD |
| 0430174112 | 1 | $110.00 | $2,750.00 | 25.000 | LF | N | PIPE CULV, OPT MATL, ROUND,12"SD |
| 0430174115 | 5 | $54.24 | $54,515.21 | 1,005.000 | LF | N | PIPE CULV, OPT MATL, ROUND,15"SD |
| 0430174118 | 31 | $62.64 | $532,589.24 | 8,502.000 | LF | N | PIPE CULV, OPT MATL, ROUND,18"SD |
| 0430174124 | 15 | $80.27 | $362,421.60 | 4,515.000 | LF | N | PIPE CULV, OPT MATL, ROUND,24"SD |
| 0430174130 | 6 | $85.96 | $56,732.80 | 660.000 | LF | N | PIPE CULV, OPT MATL, ROUND,30"SD |
| 0430174136 | 3 | $125.97 | $16,250.00 | 129.000 | LF | N | PIPE CULV, OPT MATL, ROUND,36"SD |
| 0430174215 | 3 | $93.91 | $9,579.00 | 102.000 | LF | N | PIPE CULV, OPT MATL, OTHER, 15"SD |
| 0430174218 | 20 | $75.33 | $370,864.40 | 4,923.000 | LF | N | PIPE CULV, OPT MATL, OTHER, 18"SD |
| 0430174224 | 8 | $102.26 | $94,283.94 | 922.000 | LF | N | PIPE CULV, OPT MATL, OTHER, 24"SD |
| 0430174230 | 2 | $123.16 | $76,727.00 | 623.000 | LF | N | PIPE CULV, OPT MATL, OTHER, 30"SD |
| 0430174236 | 1 | $150.00 | $14,700.00 | 98.000 | LF | N | PIPE CULV, OPT MATL, OTHER, 36"SD |
| 0430174248 | 1 | $439.78 | $32,103.94 | 73.000 | LF | N | PIPE CULV, OPT MATL, OTHER, 48"SD |
| 0430175112 | 9 | $78.73 | $31,019.60 | 394.000 | LF | N | PIPE CULV, OPT MATL, ROUND, 12"S/CD |
| 0430175115 | 31 | $161.71 | $213,130.34 | 1,318.000 | LF | N | PIPE CULV, OPT MATL, ROUND, 15"S/CD |
| 0430175118 | 78 | $66.68 | $8,055,937.67 | 120,809.000 | LF | N | PIPE CULV, OPT MATL, ROUND, 18"S/CD |
| 0430175124 | 49 | $76.05 | $5,612,864.62 | 73,803.000 | LF | N | PIPE CULV, OPT MATL, ROUND, 24"S/CD |
| 0430175130 | 29 | $96.53 | $4,209,008.57 | 43,601.000 | LF | N | PIPE CULV, OPT MATL, ROUND, 30"S/CD |
| 0430175136 | 24 | $121.85 | $4,351,856.99 | 35,714.000 | LF | N | PIPE CULV, OPT MATL, ROUND, 36"S/CD |
| 0430175142 | 13 | $152.59 | $2,674,318.04 | 17,526.000 | LF | N | PIPE CULV, OPT MATL, ROUND, 42"S/CD |
| 0430175148 | 14 | $158.83 | $2,418,079.91 | 15,224.000 | LF | N | PIPE CULV, OPT MATL, ROUND, 48"S/CD |
| 0430175154 | 5 | $193.70 | $1,127,889.42 | 5,823.000 | LF | N | PIPE CULV, OPT MATL, ROUND, 54"S/CD |
| 0430175160 | 3 | $248.81 | $247,568.82 | 995.000 | LF | N | PIPE CULV, OPT MATL, ROUND, 60"S/CD |
| 0430175166 | 2 | $289.93 | $473,463.40 | 1,633.000 | LF | N | PIPE CULV, OPT MATL, ROUND, 66"S/CD |

# DATA AND ESTIMATED QUANTITIES FOR ONE ENDWALL

## ROUND CONCRETE AND CORRUGATED METAL PIPE

| D | Opening Area (SF) | | | | Dimensions | | | | | | | | | | | | Class I Concrete (CY) | | | | | | | | | | | | | | | | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | Number And Type Of Pipe And Skew Angle Of Pipe | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | Single | | Double | | | | | | Triple | | | | | | Quadruple | | | | |
| | Number Of Pipes | | | | | | | | | | | | X | | | | Conc | Metal | Concrete | | | | Metal | | | | Concrete | | | | Metal | | | | |
| | 1 | 2 | 3 | 4 | A | B | C | E | F | G | S | 0° | 15° | 30° | 45° | 0° | 0° | 0° | 15° | 30° | 45° | 0° | 15° | 30° | 45° | 0° | 15° | 30° | 45° | 0° | 15° | 30° | 45° | 0° | 15° | 30° | 45° | 0° | 15° | 30° | 45° | |
| 15" | 1.23 | 2.46 | 3.69 | 4.92 | 1'-11" | 1'-2" | 4'-0" | 1'-10" | 1'-2" | 0'-6" | 2'-7" | 2'-7" | 2'-8" | 3'-0" | 3'-8" | 1.23 | 1.24 | 1.59 | 1.60 | 1.65 | 1.74 | 1.62 | 1.63 | 1.68 | 1.78 | 1.94 | 1.96 | 2.05 | 2.23 | 1.99 | 2.02 | 2.11 | 2.30 | 2.30 | 2.34 | 2.47 | 2.74 | 2.37 | 2.41 | 2.75 | 2.84 | 15" |
| 18" | 1.77 | 3.54 | 5.31 | 7.08 | 2'-2" | 1'-3" | 4'-6" | 1'-11" | 1'-3" | 1'-0" | 2'-10" | 2'-10" | 2'-11" | 3'-3" | 4'-0" | 1.56 | 1.59 | 1.99 | 2.01 | 2.06 | 2.17 | 2.04 | 2.06 | 2.11 | 2.23 | 2.43 | 2.46 | 2.56 | 2.79 | 2.51 | 2.54 | 2.65 | 2.89 | 2.86 | 2.91 | 3.06 | 3.40 | 2.96 | 3.01 | 3.17 | 3.53 | 18" |
| 21" | 2.41 | 4.82 | 7.23 | 9.64 | 2'-5" | 1'-4" | 5'-0" | 2'-0" | 1'-4" | 1'-6" | 3'-2" | 3'-2" | 3'-3" | 3'-8" | 4'-6" | 1.97 | | | | | | | | | | | | | | | | | | | | | | | | | | 21" |
| 24" | 3.14 | 6.28 | 9.42 | 12.56 | 2'-8" | 1'-4" | 5'-6" | 2'-0" | 1'-4" | 2'-0" | 3'-5" | 3'-5" | 3'-6" | 3'-11" | 4'-10" | 2.24 | 2.29 | 2.82 | 2.84 | 2.91 | 3.06 | 2.91 | 2.93 | 3.01 | 3.17 | 3.39 | 3.43 | 3.57 | 3.87 | 3.52 | 3.56 | 3.71 | 4.03 | 3.97 | 4.03 | 4.24 | 4.69 | 4.14 | 4.20 | 4.43 | 4.91 | 24" |
| 27" | 3.98 | 7.96 | 11.94 | 15.92 | 2'-11" | 1'-5" | 6'-0" | 2'-1" | 1'-5" | 2'-6" | 3'-10" | 3'-10" | 4'-0" | 4'-5" | 5'-5" | 2.73 | | | | | | | | | | | | | | | | | | | | | | | | | | 27" |
| 30" | 4.91 | 9.82 | 14.73 | 19.64 | 3'-2" | 1'-6" | 6'-6" | 2'-2" | 1'-6" | 3'-0" | 4'-3" | 4'-3" | 4'-5" | 4'-11" | 6'-0" | 3.26 | 3.34 | 4.13 | 4.16 | 4.26 | 4.49 | 4.28 | 4.31 | 4.43 | 4.67 | 4.98 | 5.04 | 5.25 | 5.69 | 5.20 | 5.27 | 5.49 | 5.97 | 5.84 | 5.93 | 6.24 | 6.91 | 6.13 | 6.23 | 6.56 | 7.29 | 30" |
| 36" | 7.07 | 14.14 | 21.21 | 28.28 | 3'-8" | 1'-8" | 7'-6" | 2'-4" | 1'-8" | 4'-0" | 5'-1" | 5'-1" | 5'-3" | 5'-10" | 7'-2" | 4.53 | 4.64 | 5.73 | 5.77 | 5.92 | 6.23 | 5.95 | 6.00 | 6.15 | 6.49 | 6.92 | 7.00 | 7.29 | 7.91 | 7.25 | 7.34 | 7.65 | 8.33 | 8.13 | 8.26 | 8.69 | 9.62 | 8.57 | 8.71 | 9.18 | 10.20 | 36" |
| 42" | 9.62 | 19.24 | 28.86 | 38.48 | 4'-2" | 1'-10" | 8'-6" | 2'-6" | 2'-0" | 5'-0" | 6'-0" | 6'-0" | 6'-3" | 6'-11" | 8'-6" | 6.33 | 6.49 | 8.11 | 8.17 | 8.39 | 8.85 | 8.43 | 8.50 | 8.73 | 9.23 | 9.90 | 10.02 | 10.45 | 11.38 | 10.38 | 10.52 | 10.98 | 11.99 | 11.68 | 11.87 | 12.51 | 13.89 | 12.32 | 12.52 | 13.22 | 14.73 | 42" |
| 48" | 12.57 | 25.14 | 37.71 | 50.28 | 4'-8" | 2'-1" | 9'-6" | 2'-9" | 2'-0" | 6'-0" | 6'-9" | 6'-9" | 7'-0" | 7'-10" | 9'-7" | 8.15 | 8.38 | 10.40 | 10.48 | 10.75 | 11.33 | 10.85 | 10.94 | 11.23 | 11.87 | 12.64 | 12.80 | 13.34 | 14.50 | 13.34 | 13.51 | 14.11 | 15.39 | 14.89 | 15.13 | 15.93 | 17.68 | 15.82 | 16.08 | 16.97 | 18.90 | 48" |
| 54" | 15.90 | 31.80 | 47.70 | 63.60 | 5'-2" | 2'-6" | 10'-6" | 3'-2" | 2'-3" | 7'-0" | 7'-8" | 7'-8" | 7'-11" | 8'-10" | 10'-10" | 11.71 | 11.77 | 15.23 | 15.35 | 15.78 | 16.69 | 15.35 | 15.48 | 15.90 | 16.83 | 18.77 | 19.02 | 19.86 | 21.69 | 18.93 | 19.18 | 20.04 | 21.89 | 22.29 | 22.66 | 23.93 | 26.67 | 22.51 | 22.89 | 24.17 | 26.96 | 54" |

## CORRUGATED METAL PIPE ARCH

| Span | Rise | Opening Area (SF) | | | | Dimensions | | | | | | | | | | | Class I Concrete (CY) | | | | | | | | | | | | Span | Rise | Approx. Equiv. Round Pipe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | Number Of Pipe And Skew Angle Of Pipe | | | | | | | | | | | | | | |
| | | Number Of Pipes | | | | | | | | | | | X | | | | Single | Double | | | | Triple | | | | Quadruple | | | | | | |
| | | 1 | 2 | 3 | 4 | A | B | C | E | F | G | S | 0° | 15° | 30° | 45° | 0° | 0° | 15° | 30° | 45° | 0° | 15° | 30° | 45° | 0° | 15° | 30° | 45° | | | |
| 17" | 13" | 1.1 | 2.2 | 3.3 | 4.4 | 1'-9" | 1'-2" | 3'-10" | 1'-10" | 1'-2" | 0'-4" | 2'-6" | 2'-6" | 2'-7" | 2'-11" | 3'-6" | 1.16 | 1.47 | 1.48 | 1.52 | 1.60 | 1.78 | 1.80 | 1.88 | 2.04 | 2.09 | 2.12 | 2.23 | 2.48 | 17" | 13" | 15" |
| 21" | 15" | 1.6 | 3.2 | 4.8 | 6.4 | 1'-11" | 1'-2" | 4'-3" | 1'-10" | 1'-2" | 0'-9" | 2'-10" | 2'-10" | 2'-11" | 3'-3" | 4'-0" | 1.33 | 1.69 | 1.70 | 1.75 | 1.84 | 2.04 | 2.06 | 2.15 | 2.33 | 2.40 | 2.44 | 2.57 | 2.84 | 21" | 15" | 18" |
| 28" | 20" | 2.8 | 5.6 | 8.4 | 11.2 | 2'-4" | 1'-3" | 5'-2" | 1'-11" | 1'-3" | 1'-8" | 3'-5" | 3'-5" | 3'-6" | 3'-11" | 4'-10" | 1.78 | 2.31 | 2.33 | 2.39 | 2.53 | 2.83 | 2.87 | 2.99 | 3.26 | 3.36 | 3.42 | 3.60 | 4.01 | 28" | 20" | 24" |
| 35" | 24" | 4.3 | 8.6 | 12.9 | 17.2 | 2'-8" | 1'-4" | 5'-11½" | 2'-0" | 1'-4" | 2'-5½" | 4'-0" | 4'-0" | 4'-2" | 4'-7" | 5'-8" | 2.34 | 3.03 | 3.05 | 3.14 | 3.32 | 3.72 | 3.77 | 3.93 | 4.29 | 4.40 | 4.47 | 4.72 | 5.25 | 35" | 24" | 30" |
| 42" | 29" | 5.9 | 11.8 | 17.7 | 23.6 | 3'-1" | 1'-5" | 6'-10½" | 2'-1" | 1'-5" | 3'-4½" | 4'-9" | 4'-9" | 4'-11" | 5'-6" | 6'-9" | 3.13 | 4.06 | 4.09 | 4.20 | 4.45 | 4.99 | 5.06 | 5.28 | 5.76 | 5.93 | 6.03 | 6.36 | 7.09 | 42" | 29" | 36" |
| 49" | 33" | 8.4 | 16.8 | 25.2 | 33.6 | 3'-5" | 1'-6" | 7'-8" | 2'-2" | 1'-6" | 4'-2" | 5'-6" | 5'-6" | 5'-8" | 6'-4" | 7'-9" | 3.83 | 5.00 | 5.04 | 5.18 | 5.48 | 6.16 | 6.24 | 6.52 | 7.12 | 7.32 | 7.44 | 7.86 | 8.76 | 49" | 33" | 42" |
| 57" | 38" | 10.6 | 21.2 | 31.8 | 42.4 | 3'-10" | 1'-7" | 8'-7½" | 2'-3" | 1'-7" | 5'-1½" | 6'-4" | 6'-4" | 6'-7" | 7'-4" | 8'-11" | 4.87 | 6.31 | 6.36 | 6.53 | 6.91 | 7.74 | 7.84 | 8.18 | 8.93 | 9.18 | 9.33 | 9.85 | 10.96 | 57" | 38" | 48" |
| 64" | 43" | 13.2 | 26.4 | 39.6 | 52.8 | 4'-3" | 1'-8" | 9'-6½" | 2'-4" | 1'-8" | 6'-0½" | 7'-1" | 7'-1" | 7'-4" | 8'-2" | 10'-0" | 5.88 | 7.64 | 7.70 | 7.91 | 8.37 | 9.40 | 9.52 | 9.94 | 10.86 | 11.15 | 11.33 | 11.97 | 13.33 | 64" | 43" | 54" |
| 71" | 47" | 16.9 | 33.8 | 50.7 | 67.6 | 4'-7" | 1'-10" | 10'-4" | 2'-6" | 2'-0" | 6'-10" | 7'-10" | 7'-10" | 8'-1" | 9'-1" | 11'-1" | 7.80 | 10.15 | 10.23 | 10.51 | 11.12 | 12.49 | 12.65 | 13.22 | 14.43 | 14.85 | 15.10 | 15.94 | 17.77 | 71" | 47" | 60" |

## CONCRETE ELLIPTICAL PIPE

| Rise | Span | Opening Area (SF) | | | | Dimensions | | | | | | | | | | | Class I Concrete (CY) | | | | | | | | | | | | Rise | Span | Approx. Equiv. Round Pipe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | Number Of Pipe And Skew Angle Of Pipe | | | | | | | | | | | | | | |
| | | Number Of Pipes | | | | | | | | | | | X | | | | Single | Double | | | | Triple | | | | Quadruple | | | | | | |
| | | 1 | 2 | 3 | 4 | A | B | C | E | F | G | S | 0° | 15° | 30° | 45° | 0° | 0° | 15° | 30° | 45° | 0° | 15° | 30° | 45° | 0° | 15° | 30° | 45° | | | |
| 12" | 18" | 1.3 | 2.6 | 3.9 | 5.2 | 1'-8" | 1'-2" | 3'-9" | 1'-10" | 1'-2" | 0'-3" | 2'-10" | 2'-10" | 2'-11" | 3'-3" | 4'-0" | 1.09 | 1.45 | 1.46 | 1.51 | 1.60 | 1.80 | 1.82 | 1.91 | 2.09 | 2.16 | 2.20 | 2.33 | 2.60 | 12" | 18" | 15" |
| 14" | 23" | 1.8 | 3.6 | 5.4 | 7.2 | 1'-10" | 1'-3" | 4'-2½" | 1'-11" | 1'-3" | 8½" | 3'-5" | 3'-5" | 3'-6" | 3'-11" | 4'-10" | 1.36 | 1.82 | 1.84 | 1.89 | 2.01 | 2.29 | 2.32 | 2.43 | 2.68 | 2.75 | 2.80 | 2.97 | 3.33 | 14" | 23" | 18" |
| 19" | 30" | 3.3 | 6.6 | 9.9 | 13.2 | 2'-3" | 1'-4" | 5'-1½" | 2'-0" | 1'-4" | 1'-7½" | 4'-2" | 4'-2" | 4'-4" | 4'-10" | 5'-11" | 1.89 | 2.55 | 2.57 | 2.65 | 2.82 | 3.22 | 3.27 | 3.43 | 3.77 | 3.88 | 3.95 | 4.19 | 4.70 | 19" | 30" | 24" |
| 24" | 38" | 5.1 | 10.2 | 15.3 | 20.4 | 2'-8" | 1'-5" | 6'-3" | 2'-1" | 1'-5" | 2'-9" | 5'-2" | 5'-2" | 5'-4" | 6'-0" | 7'-4" | 2.64 | 3.55 | 3.58 | 3.69 | 3.93 | 4.48 | 4.54 | 4.77 | 5.24 | 5.39 | 5.49 | 5.82 | 6.53 | 24" | 38" | 30" |
| 29" | 45" | 7.4 | 14.8 | 22.2 | 29.6 | 3'-1" | 1'-6" | 7'-0" | 2'-2" | 1'-6" | 3'-6" | 6'-0" | 6'-0" | 6'-3" | 6'-11" | 8'-6" | 3.32 | 4.48 | 4.52 | 4.66 | 4.96 | 5.64 | 5.72 | 6.00 | 6.60 | 6.80 | 6.92 | 7.34 | 8.24 | 29" | 45" | 36" |
| 34" | 53" | 10.2 | 20.4 | 30.6 | 40.8 | 3'-6" | 1'-7" | 7'-11½" | 2'-3" | 1'-7" | 4'-5½" | 7'-1" | 7'-1" | 7'-4" | 8'-2" | 10'-0" | 4.24 | 5.76 | 5.81 | 6.00 | 6.39 | 7.29 | 7.40 | 7.76 | 8.55 | 8.81 | 8.97 | 9.52 | 10.70 | 34" | 53" | 42" |
| 38" | 60" | 12.9 | 25.8 | 38.7 | 51.6 | 3'-10" | 1'-8" | 8'-9" | 2'-4" | 1'-8" | 5'-3" | 7'-11" | 7'-11" | 8'-2" | 9'-2" | 11'-2" | 5.22 | 7.16 | 7.23 | 7.46 | 7.96 | 9.10 | 9.24 | 9.70 | 10.71 | 11.05 | 11.25 | 11.95 | 13.46 | 38" | 60" | 48" |
| 43" | 68" | 16.6 | 33.2 | 49.8 | 66.4 | 4'-3" | 1'-10" | 9'-8½" | 2'-6" | 1'-10" | 6'-2½" | 8'-10" | 8'-10" | 9'-2" | 10'-2" | 12'-6" | 6.63 | 9.01 | 9.09 | 9.38 | 10.00 | 11.39 | 11.56 | 12.13 | 13.36 | 13.77 | 14.02 | 14.88 | 16.73 | 43" | 68" | 54" |
| 48" | 76" | 20.5 | 41.0 | 61.5 | 82.0 | 4'-8" | 2'-1" | 10'-8" | 2'-9" | 2'-0" | 7'-2" | 9'-9" | 9'-9" | 10'-1" | 11'-3" | 13'-9" | 8.66 | 11.74 | 11.85 | 12.22 | 13.02 | 14.82 | 15.04 | 15.77 | 17.37 | 17.91 | 18.23 | 19.34 | 21.74 | 48" | 76" | 60" |
| 53" | 83" | 24.8 | 49.6 | 74.4 | 99.2 | 5'-1" | 2'-6" | 11'-7" | 3'-2" | 2'-6" | 8'-1" | 10'-7" | 10'-7" | 10'-11" | 12'-3" | 15'-0" | 12.50 | 16.98 | 16.98 | 17.67 | 18.83 | 21.47 | 21.78 | 22.86 | 25.18 | 25.97 | 26.44 | 28.06 | 31.55 | 53" | 83" | 66" |
| 58" | 91" | 29.5 | 59.0 | 88.5 | 118.0 | 5'-6" | 2'-10" | 12'-6½" | 3'-6" | 2'-10" | 9'-0½" | 11'-4" | 11'-4" | 11'-9" | 13'-1" | 16'-0" | 16.46 | 22.26 | 22.46 | 23.16 | 24.66 | 28.05 | 28.46 | 29.85 | 32.85 | 33.85 | 34.46 | 36.55 | 41.05 | 58" | 91" | 72" |

*Note: Use the guidelines of General Note No. 8 for selecting tabular quantities.*

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| LAST REVISION | REVISION | DESCRIPTION: | | | | |
|---|---|---|---|---|---|---|
| 07/01/01 | | | FDOT FY 2017-18 DESIGN STANDARDS | STRAIGHT CONCRETE ENDWALLS SINGLE AND MULTIPLE PIPE | INDEX NO. 250 | SHEET NO. 2 of 2 |

# APPENDIX C

Technical Memorandum - Habitat Assessment and Biological Characterization Report

TECHNICAL MEMORANDUM:

# HABITAT ASSESSMENT AND BIOLOGICAL CHARACTERIZATION

## OBJECT FREE AREA CLEARING AND AIRFIELD DRAINAGE IMPROVEMENT PROJECT LUIS MUÑOZ MARIN INTERNATIONAL AIRPORT-SJU MUNICIPALITY OF CAROLINA, PUERTO RICO

PREPARED FOR:

AEROSTAR
AIRPORT HOLDINGS LLC

PREPARED BY:

AMBIENTA INC.
*Environmental Consultants*

MARCH 2019

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TECHNICAL MEMORANDUM:

# HABITAT ASSESSMENT AND BIOLOGICAL CHARACTERIZATION

## OBJECT FREE AREA CLEARING AND AIRFIELD DRAINAGE IMPROVEMENT PROJECT LUIS MUÑOZ MARIN INTERNATIONAL AIRPORT-SJU MUNICIPALITY OF CAROLINA, PUERTO RICO

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MARCH 2019

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***Two sided printing document format.***

# TABLE OF CONTENTS

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## 1.0 EXECUTIVE SUMMARY

Aerostar Airport Holdings LCC (Aerostar) contracted the services of Ambienta Inc. to conduct a habitat assessment and biological characterization for the *Object Free Area Clearing and Airfield Drainage Improvement Project* (the Project) at the Luis Muñoz Marín International Airport (SJU) in the Municipality of Carolina, Puerto Rico. The need of the proposed Project actions are based first, on the Federal Aviation Administration (FAA) requirements regarding areas that need to be clear of any object obstruction for the safety of aircraft operations and second, to address the problem of periodic flooding of various operational areas during heavy rainfall events.

FAA Advisory Circular 150/5300-13A, Airport Design, defines an Object Free Area (OFA) as "an area centered on the ground on a runway, taxiway, or taxilane centerline provided to enhance the safety of aircraft operations by remaining clear of objects, except for objects that need to be located in the OFA for air navigation or aircraft ground maneuvering purposes." The FAA's safety-based OFA design standards require keeping the OFA of above-ground objects primarily to avoid wing or wingtip collisions. Also, portions of the SJU airfield, including taxiways, aprons, and utilities (sanitary sewer pump station) experience periodic flooding during rainfall events. Airfield flooding disrupts aviation activities and can damage airfield equipment (e.g., pavement edge lights and directional signs). Reducing airfield flooding will enhance safety at SJU. As part of the environmental documentation for the proposed Project, a habitat assessment and biological characterization of the OFA and drainage areas has been performed to evaluate potential impacts over habitats and wildlife, and recommend mitigation measures to offset those impacts.

This Habitat Assessment and Biological Characterization Report (the Study) has been prepared to document the findings of existing data revision and site reconnaissance conducted within the Project area in the SJU. This Study is required, among other environmental documentation, for the Project's National Environmental Policy Act (NEPA) Environmental Assessment (EA) and was performed to identify potentially sensitive habitats and threatened and/or endangered species and resources such as wetlands that may require local, state, and/or federal permits and mitigation components. Based on the results of this Study, the proposed measures related to the Project may have the potential to impact some biological resources, in this case wetlands, at SJU.



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## 2.0 INTRODUCTION

Aerostar Airport Holdings LCC (Aerostar) proposes the *Object Free Area Clearing and Airfield Drainage Improvement Project* (the Project) at the Luis Muñoz Marín International Airport (SJU) in the Municipality of Carolina, Puerto Rico. This Project is intended to achieve and maintain various safety standards for airport operations. The Project proposed actions and improvements are needed as compliance with the Federal Aviation Administration (FAA) requirements and to solve existing problems of stormwater management within the airfield. The proposed Project consists of clearing vegetation and obstructions within the Object Free Area (OFA) and improvements to the on-site stormwater drainage system in order to safely manage runoff within the airfield.

FAA Advisory Circular 150/5300-13A, Airport Design, defines an Object Free Area (OFA) as "an area centered on the ground on a runway, taxiway, or taxilane centerline provided to enhance the safety of aircraft operations by remaining clear of objects, except for objects that need to be located in the OFA for air navigation or aircraft ground maneuvering purposes." The FAA's safety-based OFA design standards require keeping the OFA of above-ground objects primarily to avoid wing or wingtip collisions. There are no fill or grade requirements for an OFA.

The proposed OFA Clearing components of the proposed Project could include, but are not limited to the following actions:

1. Runway 8-26 ROFA Clearing – The Runway 8-26 Object Free Area (ROFA) is 800 feet wide, centered on the runway centerline, and extends 1,000 feet beyond each end of the runway. This project element requires trimming and potential removal of woody vegetation (primarily mangroves) to runway elevation and/or clearing and removal of all vegetation within a strip of land ranging from approximately 75 feet to 145 feet wide located along the north side of Runway 8-26. This strip of land encompasses a major airfield drainage ditch. Over time, the ditch has become overgrown with vegetation and the channel bottom reduced through deposition of sediments. Other small areas on the south side of the runway will also require trimming or clearing of mangroves and other vegetation. No fill or excavation is required in the areas to be trimmed or cleared.
2. Runway 10-28 ROFA Clearing – The Runway 10-28 ROFA is 800 feet wide and extends 1,000 feet beyond each end of the runway. This project element requires trimming and potential removal of woody vegetation within and along the edges of man-made airfield drainage ditches.



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3. Taxiway OFA Clearing – Taxiway Object Free Areas (TOFAs) at SJU vary in width based on the size of aircraft the taxiway was designed to accommodate. This project element requires trimming and potential removal of woody vegetation within and along the edges of several man-made airfield drainage ditches.
4. Measures to minimize erosion and sedimentation during vegetation trimming and clearing.
5. Mitigation options for potential impacts to wetland resources.

The OFA clearing project could also include the removal of invasive and nuisance plant species on the north side of Runway 8-26, between the ROFA and the airport property line.

Portions of the SJU airfield, including taxiways, aprons, and utilities (sanitary sewer pump station) experience periodic flooding during rainfall events. Airfield flooding disrupts aviation activities, can damage airfield equipment (e.g., pavement edge lights and directional signs), and can create a safety concern for aircraft, pilots and passengers. The proposed project includes the preparation of a drainage study that will evaluate and recommend improvements to alleviate airfield flooding in aircraft operational areas. The recommended improvements will be incorporated into and evaluated in the EA. At this time, it is assumed that airfield drainage improvements may include, but may not necessarily be limited to, one or more of the following actions:

A. Remove vegetation and clean out sediments accumulated in certain airfield storm water drainage ditches, swales, and ponds to restore ditch capacities and flow rates. Modify existing airport storm water management ponds to enhance storage capacity.
B. Repair and/or install new airfield storm water drainage inlets, pipes, and outfall structures.
C. Remove accumulated sediment from existing inlets and pipes.
D. Rehabilitate, replace, and/or re-pave sections of airfield pavement to improve surface water flow and drainage.
E. Implement a long-term program to maintain drainage infrastructure at SJU, including periodic cleaning and removal of vegetation in ditches and at outfalls.
F. Measures to minimize erosion and sedimentation during vegetation trimming and clearing.
G. Potential mitigation for unavoidable impacts to environmental resources.



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**AMBIENTA INC.** was contracted by Aerostar to conduct a **Habitat Assessment and Biological Characterization** (the Study) for the **Project Area**, which encompasses the OFA Clearing Study Area, the Drainage Study Area (see **Figure 4** of this report) and some adjacent natural corridors. This document represents the report for the Study and will be used for the preparation of the Environmental Assessment of the Project. The purpose of the Study is to: identify the occurrence of federal and commonwealth endangered, vulnerable or listed species; the presence of sensitive habitats; and to produce a descriptive inventory of the flora and fauna within the Project area.

The methodology employed for the Study followed the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Caribbean Islands Region* (Caribbean supplement, 2011) to identify wetlands and wetland types. Although, a formal jurisdictional delineation was not performed, the wetland boundary was field-mapped using USACE guidelines. Federal listed species information maintained by the US Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA), existing literature, and reference materials were used to identify the federal and commonwealth listed species that may occur on or in the vicinity of the project site and to describe natural systems. Later, field reconnaissance and assessment, by establishing and using transects, plots and point counts, were performed in order to gather field data. As part of data collection, this Study was developed corresponding to the proposed area for the Project. This information provides details of the habitat and biotic community that dwells in the Study Area. Finally, an evaluation of the potential impacts to the natural attributes of the area including listed and documented species and ecosystems was performed.

This report is organized into four (4) sections: 1) site description, 2) methodology and technical approach, 3) results and discussion, and 4) conclusions and recommendations. **Appendix A** contains the Wetland Boundary. **Appendix B** contains the Flora Inventory; **Appendix C** contains the Fauna Inventory; while **Appendix D** contains the Environmental Sensitivity Index (ESI) and the Puerto Rico's Threatened and Endangered Species List NOAA for the Study Area. General data is presented describing some environmental components of the Study Area in order to complement the available information and for a more comprehensive and integral image of the natural resources present. The initial assessment, evaluation and field reconnaissance for the Study started on April 26, 2017 and ended on June 28, 2017. **Appendix E** contains photographic documentation of the Study Area. Also, other appendices are included to support the performed tasks, analysis and results.



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## 3.0 STUDY AREA GENERAL DESCRIPTION

The Luis Muñoz Marín International Airport (SJU) is a joint civil-military international airport named for Puerto Rico's first democratically elected governor. SJU is located in suburban Carolina, Puerto Rico, five kilometers (5 km or 3 miles) southeast of San Juan. It is the busiest airport in the Caribbean region by passenger traffic. Over 4 million passengers board a plane at the airport per year according to the Federal Aviation Administration. The airport is owned by the Puerto Rico Ports Authority and managed by Aerostar Airport Holdings, a public–private partnership which was awarded a lease by the government of Puerto Rico to operate and manage the airport for 40 years beginning in 2013. SJU is the second international airport to be privatized in the United States and its territories, and, as of 2013, is the only currently privatized airport in the nation. SJU has two runways: 9,723ft x 200ft (8/26) and 8,016 x 150' (10/28). Aircraft operations average 448 per day: 49% commercial aviation, 35% air taxi, 15% transient general aviation, and 2% military. The following information is complemented with the corresponding figures, and contains the description of the principal and relevant components of the Study Area to be occupied by the Project.

### 3.1 LOCATION

The SJU is located in the Cangrejo Arriba Ward in the Municipality of Carolina, Puerto Rico. **Figure 1** contains the U.S. Geological Survey Quadrangle portion for the Study Area.

### 3.2 TOPOGRAPHY

The Study Area is nearly level, with ground elevations fluctuating between two to three meters (2-3m) above mean sea level at the existing airport facilities. A series of drainage channels run along the runways to manage local and adjacent storm water.

### 3.3 CLIMATE

The Study Area is located in the subtropical humid zone, according to the Holdridge Life Zone System, with an annual average temperature of 86.2 $^{o}$F and a minimum of 70.5 $^{o}$F. Maximum annual precipitation is 79.24 inches. The months from May to November are the most humid of the year.



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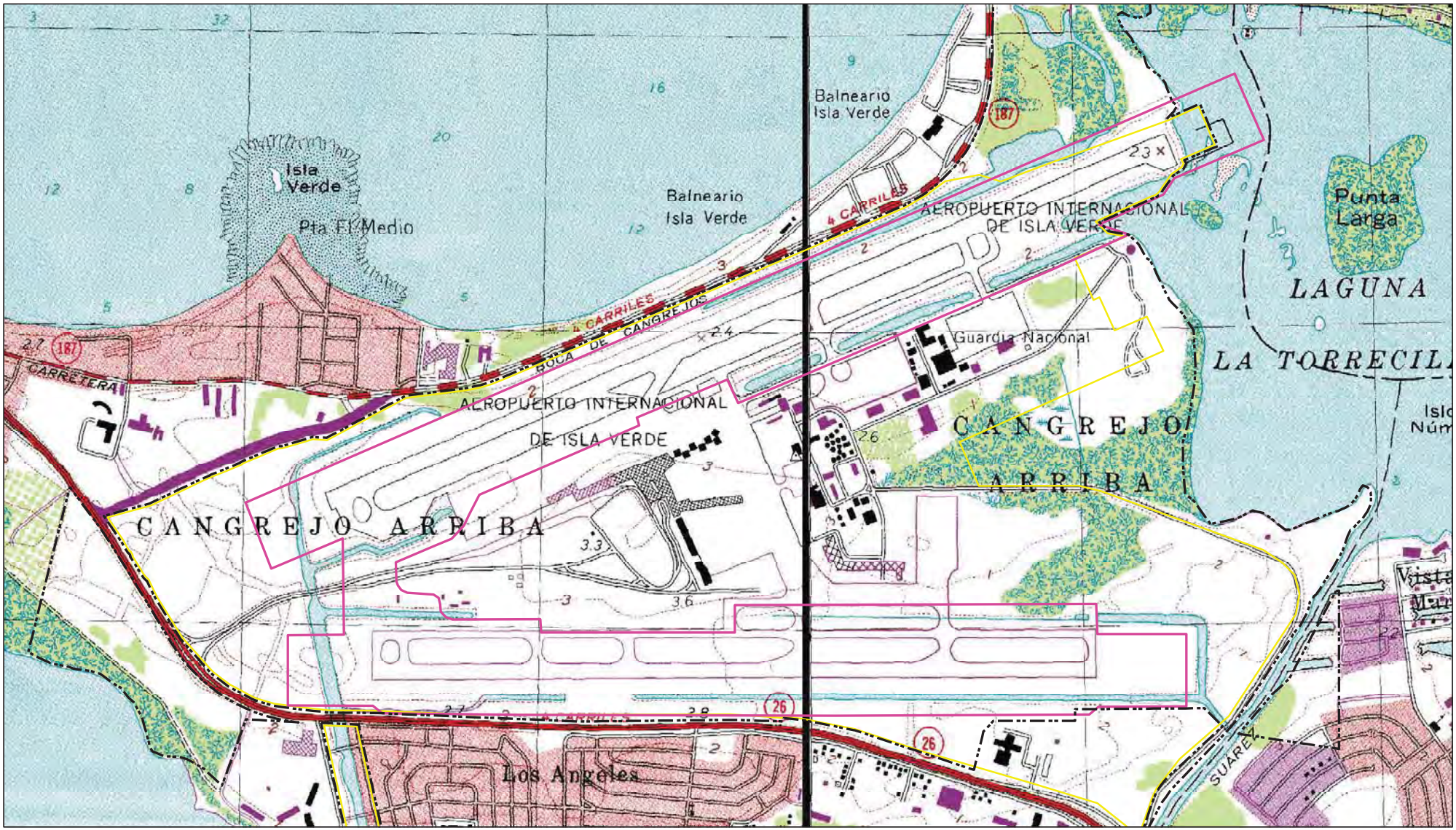


Legend

- OFA Clearing Study Area
- Drainage Study Area
- Property Limits

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Figure 1: Location Map

OFA Clearing and Airfield Drainage Improvement Project
Luis Muñoz Marín International Airport (SJU)

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## 3.4 SOILS

Based on the Soil Survey of the Humacao Area of Eastern Puerto Rico from the U.S. Department of Agriculture Soil Conservation Service, the Study Area contains one (1) soil series (Cf: Cataño loamy sand) among four (4) soil series mapping units. Also, Soils not surveyed, Made Land (MD) and Tidal Swamp (TS) are land types, as defined. **Table 1** contains the descriptions of the soil series mapping units present within the Study Area. **Figure 2** shows the Soil Survey Map of the area.

**Table 1: USDA-Soil Conservation Service Soil Series Descriptions*.**

| Soil Series | Description* |
|---|---|
| Candelero loamy sand** (Cf) | Nearly level soil along coast, not suited for crops because of its low available water capacity, rapid permeability and low fertility. Could be classified as hydric soils when found with inclusion from other soils within depressional areas. It is used for coconut tree, cassava, nut tree, pasture, wildlife cover and recreational activities. |
| Tidal swamp** (TS) | Land type defined as covered with a thick growth of mangroves trees and under salty water most of the year. The sandy or clayey soils are light colored and saline and contain organic material from decaying mangrove trees. It is not extensive and has no value for farming, but it serves as a feeding and breeding place for birds, oysters, and crabs. |
| Made land (Md). | Land type where the soil profile has been converted or destroyed by earthmoving operations. Generally, they have been graded for engineering purposes. Not suitable for farming because soil conditions are variable and require special management. |
| Soil Not Surveyed (SNS) | Soils not surveyed by the Soil Conservation Service from the United States Department of Agriculture. |

**Soil descriptions from Soil Survey of Humacao Area of Eastern of Puerto Rico.*
***Classified as hydric soils in the Hydric Soils of the Caribbean Area List from the USDA Soil Conservation Service.*

## 3.5 HABITATS, AQUATIC RESOURCES AND WETLANDS

The habitats, aquatic resources and wetlands present within the Study Area can be summarized as: a) fringe secondary forest; b) developed land (airport); c) seasonal and/or temporarily flooded palustrine emergent wetlands; d) marshland; e) mangroves; and f) other surface waters (OSW's: drainage channels, ditches swales, etc.).

The National Wetland Inventory (NWI) Map from the U.S. Fish and Wildlife Service (USFWS) designates most of the Study Area as upland (U), with wetlands around the perimeter of existing structures and airfield operation areas. Based on the Cowardin classification (1979) of the NWI Map, the wetland areas within the Study Area are classified as Palustrine and Estuarine. **Figure 3** shows the National Wetland Inventory Map of the area.



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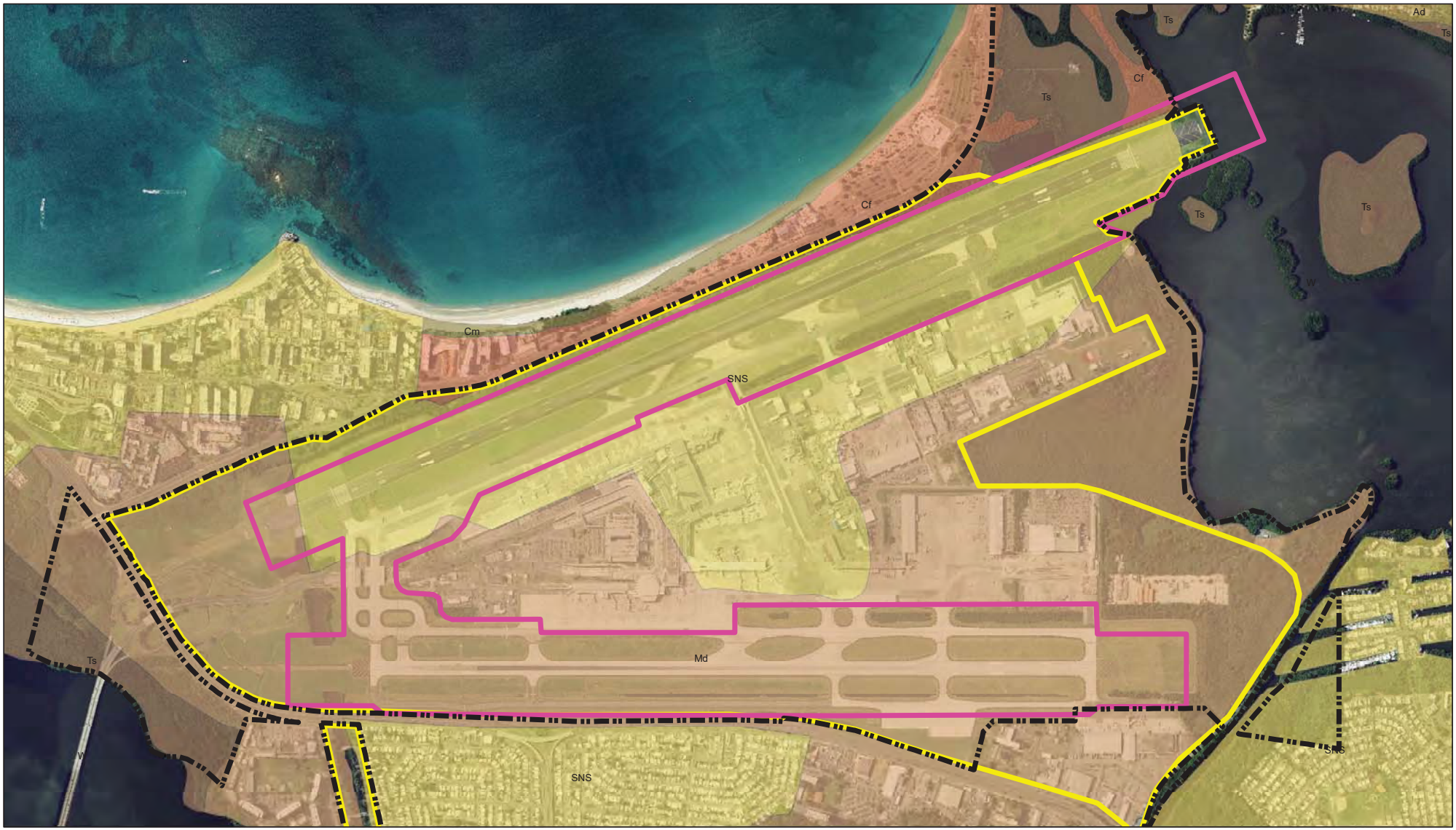


Legend

- OFA Clearing Study Area
- Drainage Study Area
- Property Limits

**Soils**

- Ad, Aguadilla loamy sand
- Cf, Catano loamy sand
- Cm, Coastal beach
- Md, Made land
- SNS, Soil not surveyed
- Ts, Tidal swamp

Figure 2: Soil Map

OFA Clearing and Airfield Drainage Improvement Project
Luis Muñoz Marín International Airport (SJU)

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Legend

OFA Clearing Study Area
Drainage Study Area
Property Limits

| NWI_CODE | | | | | |
|---|---|---|---|---|---|
| E1AB5L | E2EM1P | M1AB5/RF1L | PEM1A |
| E1UBL | E2FO3/US3M | M1AB5L | PEM1C |
| E1UBLx | E2FO3M | M2RS1P | PEM1F |
| E2EM1M | E2FO3P | M2US2P | PFO3A |
| | E2SS3/EM1P | PEM1/FO3C | PFO3C |

Figure 3: NWI Map

OFA Clearing and Airfield Drainage Improvement Project
Luis Muñoz Marín International Airport (SJU)

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## 3.6 LIFE ZONE

The Study Area is located in a life zone classified as subtropical moist forest (Ewel & Whitmore, 1973). The climate, soil, run-off and other factors give way to the form and structure of the floristic associations found in this life zone. However, the vegetation on the Study area was extensively altered during the construction of the airfield in most areas of the property. Field observations suggest that the mangrove forest to the East of the Study area may have existed prior to airfield construction, and most likely dominated other areas that currently are occupied by the airfield. Thus, most of the existing flora within the Study Area appears to be in an early stage of secondary succession, generally associated to previously disturbed areas. **Figure 4** shows the 2016 aerial photograph of the Study area.



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Figure 4: Aerial Photograph
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Luis Muñoz Marín International Airport (SJU)

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## 4.0 TECHNICAL APPROACH AND METHODOLOGY

The **Project Area** encompasses the OFA Clearing Study Area, the Drainage Study Area and some adjacent natural corridors. The methodology employed for this Study consisted at first in a preliminary screening process of existing literature to identify the federal (USFWS and NOAA) and commonwealth reported locations of endangered species and natural systems; followed by field reconnaissance and assessment, and then, an evaluation of the potential impacts to the natural attributes of the area including listed and documented species and ecosystems.

### 4.1 REVIEW OF EXISTING LITERATURE

Multiple sources of literature where consulted for the preparation of this Study. However, greater analysis was given to information from: the *Puerto Rico Critical Wildlife Areas*, the Department of Natural and Environmental Resources (DNER) of Puerto Rico and the Bureau of Fish and Wildlife; the Natural Heritage Office of DNER; the *Environmental Sensitivity Index (ESI) Atlas* from NOAA; the *Endangered and Threatened Species List* of the USFWS and NOAA Fisheries; and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Caribbean Islands Region* (USACE). All gathered information was supplemented using as reference the existing environmental documents prepared for past projects within the SJU. Other consulted sources of literature are listed in the Reference section of this Study report.

### 4.2 SITE RECONNAISSANCE AND ASSESSMENT

The field reconnaissance and assessment efforts for this Study started on May 30, 2017 and ended on June 28, 2017. Performed tasks included: flora and fauna inventories, including bird census and aquatic life sampling; habitat characterization; mangrove forest density and condition assessment; and wetland boundary reconnaissance and assessment. These tasks were performed by one (1) senior biologist, one (1) wildlife biologist, one (1) senior scientist and one (1) environmental technician (including certified arborists, an agronomist and wetland specialists).



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## 4.3 FIELD WORK

This Study describes the species composition of the Study area. It emphasizes in the presence or absence of sensitive species or those listed in the federal and commonwealth scope. Species identification was primarily carried out through field recognition around the Study area.

The combined establishment of sampling points, sampling transects and sampling plots was intended to cover the complete area or parcel containing the airport facilities and the proposed Project so as to include as much of the species present as possible.

Qualitative flora and fauna sampling transects were established through developed and undeveloped areas and along runways, taxiways, road sides, wetlands and forested areas so as to cover as much vegetation area as possible. These transects were primarily established for inventorying flora species, as well as vegetative communities, but were used for fauna species as well. In addition, a total of six (6) modified Gentry transects (50m x 2m) and a Sampling Plot (20m x 20m) were established to estimate mangrove structure, density and composition. Also, flora and fauna sighted within the mangrove transects, plot and in its vicinity were recorded.

Field work for the fauna species inventory included the combination of several techniques. The most widely used technique for this Study was the Visual Encounter Survey (VES) as described by Heyer (1994). For a VES, field personnel walk through an area or habitat for a prescribed time period systematically searching for animals. For the Study, three (3) VES sampling designs were used: the randomized-walk design, the quadrant design and the transect design. A VES is useful to determine the species richness of an area, to compile a species list, and to estimate relative abundances of species within an area, but not for determining population densities for specific species. Also, secretive, fossorial (burrowing), canopy-dwelling, and deep-water species, are more difficult to inventory and require specialized searching methods, which were not used during this assessment.

Search methods were standardized among fieldworkers to reduce bias in the results. During the performed VES, all possible microhabitats were searched at an intermediate- intensity, so as not to provoke habitat disturbance. Searches covered: ground, water surface, tree trunks, stems, upper and lower surfaces of leaves, over and under leaf litter and under rocks and logs. The VES were validated by repeated sampling of the same areas.



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To identify birds, morning and evening census were carried out using both lineal transect and point-count methodologies, whereby the name of each species observed and heard during a fixed time period for each transect is written down, as described by Wunderle (1994). For amphibian and reptile searches, focus was taken in combing through potential or appropriate habitats, such as under tree trunks, and dry and fallen leaves; in and around rocks, on the soil and in humid or wetland areas, as described by Rivero (1998) and Heyer (1994).

For aquatic fauna characterization, a total of eighteen (18) sampling points were established along drainage channels and open water areas. Minnow traps were used for this purpose during a twenty-four hour period in each sampling point. **Figure 5** includes the aquatic fauna sampling points, and mangrove transects and plot locations over the aerial photograph.

Also, the work included mapping wetland boundaries and wetland types, but not conducting a formal jurisdictional delineation. Although a formal delineation was beyond the scope of the study, the wetland boundaries were field mapped consistent with the approach and methods outlined in the USACE's *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Caribbean Islands Region.*

For mangrove areas a tree density assessment and mangrove general condition assessment were performed in two point of interest. Mangrove density assessment was performed by the implementation of modified Gentry transects, while general condition assessment was performed by the implementation of the Draft Antilles Rapid Assessment Method (ARAM) within two (2) mangrove areas.

The ARAM rules for establishing an AA and its buffer zone are the same as those contained in the USA-RAM and National Wetland Condition Assessment Field Operations Manual (USEPA 2010).

Once the sampling point has been identified and verified, the AA is established. The guidelines for establishing an AA are summarized as follows:

- The “Standard Circular AA” is a 40m-radius circle centered on the POINT.
- The “Standard Circular AA–Shifted” is used when the center of the AA has to be shifted away from the POINT to fit within the wetland area that can be assessed.



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- The "Polygon AA" is used for sites that are large enough for a full-sized (0.5 ha) AA, if the AA is not a circle. In this situation, a 0.5 ha polygon is established with the center of the AA situated as close to the POINT as possible.
- The "Wetland Boundary AA" is used when the total area of the site is less than 0.5 ha but at least 0.1 ha. In this case, the AA boundary coincides with the wetland boundary.

The buffer zone for an AA is established as follows (see Chapter 4 of the National Wetland Condition Assessment Field Operations Manual for full details).

- For a Circular AA, the buffer zone is the area that lies within a 100m distance of the AA perimeter or 140m from the AA center. To mark the edge of the buffer zone, four (4) 140m transects are established in the four cardinal directions from the AA center, whether or not the center is the POINT. The buffer zone is defined by the distance greater than 40m from the AA center.
- For a Polygon AA, the buffer zone is the area that lies within a 100m distance from the polygon boundary.
- For a Wetland Boundary AA, the buffer extends 100m from the wetland boundary.

## 4.4 DATA MANAGEMENT

All sighted flora and fauna species were documented in field notebooks and later transferred to digital format. Photographs were taken every day as part of the documentation process. Plants that could not be identified in the field were collected and identified using botanical keys of relevant taxonomical literature, and corroborated by comparing with herbarium specimens at the Herbarium of the Botanical Garden of the University of Puerto Rico. Most of the collected specimens were incorporated in the collection of the UPR Herbarium. Fauna species that could not be identified on the field were photographed for later identification or, when applicable, their calls recorded. The recorded fauna species documentation was later analyzed and identified using relevant taxonomical literature, and corroborated by consensus of several consulted specialists. Field Data Forms were filled and completed for the two mangrove areas assessed using the ARAM.



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**Legend**

- Way Points
- Mangrove Sampling Transect
- Mangrove Sampling Plot Area
- OFA Clearing Study Area
- Drainage Study Area
- Property Limits

N

Figure5: Aquatic Fauna Sampling Points
and Mangrove Transects and Plots Locations

OFA Clearing and Airfield Drainage Improvement Project
Luis Muñoz Marín International Airport (SJU)

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## 5.0 RESULTS AND DISCUSSION

Predominant natural systems within the Study Area consist mostly of Developed Land (Airport), secondary forests corridors, herbaceous wetlands, OSW's and mangroves. Vast areas within the Study Area are occupied by the existing airport facilities. **Appendix A** of this report includes the preliminary wetland boundary over the aerial image.

The overall Study's results were as follows: one hundred and forty (140) species of flora were identified among fifty-six (56) families. **Appendix B** includes the Flora inventory for the Study Area. Also, a total of one hundred and five (105) fauna species were identified, of which, eighty- seven (87) are considered vertebrates, and eighteen (18) invertebrates. **Appendix C** includes the Fauna inventory for the Study Area.

Based on the review of existing literature (USFWS and NOAA Fisheries), habitat within the Study Area, and field observations, no endangered or threaten species have been documented to inhabit the airfield property. **Appendix D** contains the Environmental Sensitivity Index (ESI) and the PR Threatened and Endangered Species List from NOAA Fisheries for the Study Area.

The following sections will describe the findings in detail with descriptions of the habitats, flora and the fauna documented during field reconnaissance, previously reported to the airfield or that could be found within the Study Area during particular seasons. **Appendix E** of this report includes photographic documentation of the study area. Also, other appendices are included to support the performed tasks, analysis and results.

### 5.1 HABITAT ASSESSMENT

After the assessment of the natural habitats and field work task implementation, the habitats, aquatic resources and wetlands present within the Study are: a) fringe secondary forest; b) Developed Land (airport); c) seasonal and/or temporarily flooded palustrine emergent wetlands; d) marshland; e) mangroves; and f) drainage ditches (OSW's). **Appendix F** includes the map of the land uses and habitats types within the study area. The descriptions of these habitats are:



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a) Fringe Secondary Forest: These fringe upland forested areas are located North of Runway 8-26 and extend along the north bank of the Northern drainage channel. They could be classified as two different sections (East and West), divided by a bridge crossing over the drainage channel, which gave access to airfield Gate 4 and to the Northern perimeter road and security fence. The Western Fringe Secondary Forest was observed in an early development stage, with an open canopy dominated mostly by exotic species like *Delonix regia*, ("Flamboyán"), *Casuarina equisetifolia* ("Pino australiano"), *Albizia procera* ("Albizia") and *Terminalia catappa* ("Almendro"), with scarce recruitment of native species, and an understory dominated mostly by herbaceous and vine species like *Megatirsus maximum* ("Yerba de guinea"), *Sansevieria hyacinthoides* ("Lengua de vaca"), *Pennisetum purpureum* ("Yerba de elefante"), *Paulinia pinnata* ("Bejuco de guajanilla"), *Cassytha filiformis* ("Fideillo"), and *Passiflora suberosa* ("Parcha yedra"). The Eastern Fringe Secondary Forest was observed in an intermediate development stage, with a fully close canopy dominated mostly by the native species *Calophyllum antillanum* ("María) and the occurrence of mature individuals of the exotic species *Delonix regia*, ("Flamboyán"), *Casuarina equisetifolia* ("Pino Australiano"), *Albizia procera* ("Albizia"), *Terminalia catappa* ("Almendro") and *Cocos nucifera* ("Palma de coco"). Strong recruitment of native species was observed within this area. Portions of this forested area are located within wetlands and wetland transitional zones that based on the Cowardin et al 1979 classification can be identified as PFO3C (palustrine, forested, broad-leave evergreen, seasonally flooded). Both forested areas have been subject to management activities during the past years consisting in pruning the trees to a height of no more than forty feet, this has caused the fragmentation of several areas because of the creation of various paths in order to create access for machinery (cranes and skid steers) for work performance.

b) Developed Land (airport): These upland areas cover most of the Study area and consist of pavement, buildings, and non-native grassed areas subject to regular mowing as part of the operation, management, and maintenance of the airfield. The grassed areas are located contiguous and as perimeters around the runways, taxiways, aprons and some utility structures. The dominant species found within these areas were *Zoysia matrella* ("Yerba de Manila"), *Cynodon dactylon* ("Bermuda común"), *Chloris spp*. ("Paragüta"), *Megatirsus maximum* ("Yerba de guinea"), *Cuphea micrantha* ("Sanalotodo"), *Cenchrus echinatus* ("Abrojo"), *Bidens alba* ("Margarita silvestre"), *Bidens alba* ("Paragüita"), *Eleusine indica* ("Pata de gallina") and *Paspalum fasciculatum* ("Yerba venezolana").



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c) Seasonal and/or Temporarily Flooded Palustrine Emergent Wetlands: These wetlands consist mostly of depressional areas of managed (mowed) pasturelands that get flooded seasonally, mostly during the rainy season and heavy rain events. These areas are located West of Runway 8-26, which collect runoff water from the northwestern side of the airport, and South of Runway 10-28, which collect runoff water from the southern sides of runway and taxiways in this area and from Ramón Baldorioty De Castro Avenue. The dominant species found within these areas were *Cyperus ligularis* ("Junco"), *C. iria* ("Junco"), *C. polystachyos* ("Junco"), *C. odoratus* ("Junco"), *Paspalum fasciculatum* ("Yerba venezolana"), *Paspalum vaginatum* ("Cortadero"), *Pennisetum purpureum* ("Yerba de elefante"), *Urochloa mutica* ("Malojillo"), and *Paspalum milegrana* ("Cortadora"). Based on Cowardin, these areas can be classifies as PEM1C (palustrine, emergent, persistent, seasonally flooded).

d) Marshland: This wetland area includes two depressional areas, interconnected by a concrete pipe, both located West of Runway 8-26. These areas collect waters from adjacent emergent wetlands (South) and from a drainage channel located North and Northeast of the marsh. Dominant plant species include *Cyperus ligularis* ("Junco"), *C. iria* ("Junco"), *C. polystachyos* ("Junco"), *C. odoratus* ("Junco"), *Paspalum fasciculatum* ("Yerba venezolana"), *Pennisetum purpureum* ("Yerba de elefante"), *Urochloa mutica* ("Malojillo"), *Colocasia esculenta* ("Malanga"), *Phragmites australis* ("Caña de indio"), and *Typha domingensis* ("Yerba enea"). Based on Cowardin, these areas can be classified as PEM1H (palustrine, emergent, persistent, permanently flooded).

e) Mangroves: These wetlands are located to the Northeast and East side of the Study Area and are mostly dominated by *Laguncularia racemosa* ("Mangle blanco"), *Avicennia germinans* ("Mangle negro"), and *Rhizophora mangle* ("Mangle rojo"). These wetland resources are influenced by tidal fluctuations and are associated to mangrove forests East of Canal Suarez, a channel interconnecting Laguna San José with Laguna La Torrecilla, (a coastal lagoon). Based on Cowardin, these areas can be classifies as EFO3 (estuarine, forested-broad leaved evergreen). Preliminary mangrove density estimates suggest that average mangrove density within object free areas (OFA) is 2,351 mangrove trees per acre [mangrove trees with a height equal or bigger than six feet (6')]. It is important to mention that the mangrove density estimates were calculated before two hurricane events, Irma and Maria, which affected Puerto Rico during September 2017.



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f) Mangrove Condition Assessment: General mangrove condition assessment was performed using a rapid assessment procedure (the method). This assessment is based on a method being developed in a collaborative efforts with an Interagency Team (IT) consisting of the Puerto Rico Department of Natural and Environmental Resources (DNER), the U.S. Army Corps of Engineers (USACE), the U.S. Fish and Wildlife Service (USFWS), the Natural Resources Conservation Service (NRCS), the U.S. Forest Service (USFS) and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS). Our team of professionals, comprised of scientists and wetland specialists, has been supporting the development of the method, using EPA's USA Rapid Assessment Method (USA-RAM) as model. The primary objective of the rapid assessment method is to evaluate (assess) the overall condition and stress for wetlands in the U.S. Antilles Territories (Puerto Rico and the U.S. Virgin Islands) while implementing the regulatory use of a function and condition assessment methodology. The method is being designed to assess overall condition and stress for a 0.5-ha Assessment Area (AA) (defined as a polygon of 40m radius) and its buffer (defined as the area within 100m distance from the perimeter of the AA). Each AA is assessed in terms of Attributes of Condition and Stress, based on Metrics of the Attributes and Field Indicators of the Metrics. The method recognizes four Attributes of Condition and Stress: Buffer, Hydrology, Physical Structure, and Biological Structure.

The score results for the two sites evaluated and assessed using the method are **144 and 156,** which classify these sites within the preliminary established mid fair condition range. The preliminary condition gradient for estuarine forested wetlands in Puerto Rico is 225-167 good, 166-129 fair, and 108-0 poor. **Figure 5** includes the locations of the ARAM sampling points, while. These scores are based on the wetland condition before the mentioned hurricane events. Based on recent assessment of wetland condition, it is highly expected that those scores and wetland condition decreased as an effects of the hurricane events.

g) Drainage Ditches (OSW's): The OSW areas consist of a series of storm water channels that collect airfield runoff and storm waters from adjacent land uses (highways, hotel areas and residential areas) around the airport. Based on their locations, storm water input and tidal influence, the embankments of these OSW's are populated by mangrove species (*A.germinans*, *L.racemosa* and *R.mangle*), swamp tree species (*Anonna glabra*), exotic and invasive species (*Casuarina equisetifolia* and *Dalbergia ecastaphyllum*) and herbaceous



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vegetation (*Cyperus spp*., *T.domingensis*, *P.fasciculatum*, *Hymenachne amplexicaulis*, *Bacopa monnieri*, and *Ludwigia octovalvis*). Easternmost sections of the airfield OSW's were historically influenced by tidal fluctuations, with some sections today experiencing tidal connectivity, however in other sections tidal influence was not observed. In general, the Cowardin classification of these OSW's is very similar to the information shown in NWI Map (see **Figure 3**), with the exceptions already noted. **Appendix A** includes a figure with the Study Area preliminary wetland boundary.

## 5.2 FLORA

Species identification was carried out through field recognition around the Study Area. All flora sighted was documented in field notebooks and later transferred to digital format. Plants that could not be identified in the field were collected and identified using botanical keys of relevant taxonomical literature (See the References Section) and corroborated by comparing them with herbarium specimens deposited at the University of Puerto Rico (UPR) Herbarium of the Botanical Garden. Most of the collected specimens were incorporated in the collection of the UPR Herbarium. For each species, we included its scientific and common name, and its botanical family. This inventory lists a total of one hundred forty (140) species of vascular plants (see **Appendix B**). No federal or Commonwealth threaten or endangered species were documented during this study.

## 5.3 FAUNA

The most widely used technique for the fauna species inventory was the Visual Encounter Survey (VES), as described by Heyer (1994). Fauna species that could not be identified on the field were photographed for later identification or, when applicable, their calls recorded. The recorded fauna species documentation was later analyzed and identified using relevant taxonomical literature (See References Section), and corroborated by consensus of several consulted specialists. A total of one hundred and five (105) fauna species were identified: eighty-seven (87) are considered vertebrates, and eighteen (18) invertebrates (See **Appendix C**).



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### 5.3.1 FEDERALLY LISTED SPECIES

There are no federally listed species reported for the SJU. Revisions Puerto Rico's threatened and endangered species lists from the USFWS and NOAA Fisheries were conducted to determine the presence, absence or potential to occur of listed species within the Study Area. Most of the listed species have no potential to occur within the Study Area because the following reasons: 1) the Study Area is not within the species current range; 2) there is no suitable habitat for this species on-site or in the surrounding area; 3) although suitable habitat exists adjacent to the Study Area for aquatic species (coral, fishes, reptiles, mammals), the airfield ditches are shallow features that are clogged / heavily vegetated surface waters that receive freshwater input from the western side of the airfield and which provide limited access to the Study Area. **Appendix G** includes a table of USFWS and NOAA Fisheries Puerto Rico's listed species, their current status (USFWS and NOAA), general habitat and a brief discussion of their potential to occur in the Study Area. Based on the Environmental Sensitivity Index from NOAA (see **Appendix D**), there are nine (9) commonwealth or federally listed bird species reported for the vicinity of the SJU, specifically for the coastal lagoons Laguna La Torrecilla y Laguna San José. Since these species are birds, and the coastal lagoons are located east/northeast and west/southwest respectively from the airfield, their occurrence in or very near the airfield is likely probable.

### 5.3.2 COMMONWEALTH LISTED SPECIES

Based on the DNER puerto Rico's Listed Species Lists and Regulations, Commonwealth-listed species include: the Brown pelican (*Pelecanus occidentalis*), the Peregrine falcon (*Falco peregrinus*), the Least tern (*Sterna antillarum*), the Roseate tern (*Sterna dougalli*), the West Indian whistling duck (*Dendrocygna arborea*), the Ruddy duck (*Oxyura jamaicensis*), the Masked duck (*Nomonix dominicana*), the Caribbean coot (*Fulica caribaea*), and the Yellow-shouldered blackbird (*Agelaius xanthomus*).



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Federally-listed species, which are also included in the commonwealth list, include: the Roseate tern (*Sterna dougallii*) and the Yellow- shouldered blackbird (*Agelaius xanthomus*).

All of the listed bird species are related to some type of aquatic habitat, like shoreline and coastal areas; open water areas, including coastal and fresh water lagoons; open sea and mangroves. The occurrence of most of these species within the Study Area is expected to be limited to transient individuals, since most of them depend on specific resources (e.g., coastal areas, open water areas, and coastal lagoons) which are not located within the Study Area, but is found adjacent to parts of the Study Area. However, the Study Area contains mangroves and OSW's areas that may be attractive and used by some species. Of the listed species, only the Brown Pelican (*Pelecanus occidentalis*) was observed flying high over the area during the field reconnaissance and assessment.

### 5.3.3 COMMONWEALTH FAUNA SPECIES WITH OTHER CLASSIFICATION

Some Commonwealth listed species are included in Regulation 6766 of the DNER as species of conservation priority with classifications other than Vulnerable, Threatened Endangered. The classifications are Least Risk (LR) and Data Deficient (DD). The DNER (2004) defines these classifications as follows:

The Least Risk (LR) classification is given to species that, after being evaluated, do not meet any of the classification definitions for Critical Danger, In Danger, or Vulnerable; and are not Data Deficient. The species included in the LR category, can be divided in three (3) subcategories:

1- Dependant of Conservation (dc) - Species that are the center of a continuous conservation program of taxonomic specificity or habitat specificity, whose cessation would, within a period of five years, make the species qualify for a Threat category.
2- Almost Threatened (ca) - Species that cannot be described as Dependant of Conservation, but come close to being described as Vulnerable.



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3- Least concern (lc) - Species that do not meet the definition for Dependant of Conservation or Almost Threatened.

There are two (2) species classified as LR (dc): the bird species *Vireo latimeri* or Puerto Rican vireo, and the crustacean species *Cardisoma guanhumi* or blue land crab. The Puerto Rican vireo is a fairly common resident in Puerto Rico, where it is endemic (Raffaele, 1989). Its habitat consists mostly of heavily forested valleys, where is more common, but it can also be found in forested haystack hills and in mangrove forests. According to DNER Regulation 6766, the populations of this species have been affected by the introduction of exotic species, and by nest parasitism from the shiny cowbird, *Molothrus bonariensis*. The Blue land crab, which occurs in mangroves, pasturelands and coastal forests with water tables that reach a maximum depth of eight feet (8"), has been classified as LR (dc) because of its habitat destruction and over fishing.



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## 6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on historic aerial photographs and site reconnaissance and assessment, most of the Study Area consists on previously disturbed lands. Past anthropogenic activities, such as airfield construction, required vast clearance of natural areas. There is a mosaic of secondary forest fringe, grasslands and wetlands all across the surroundings of the Study Area, and a healthy mangrove region at the East part.

The proposed Project may potentially cause impacts to environmental resources during the construction and operation phases to achieve the proposed project requirements. But nevertheless, no impacts to endangered or threatened species are expected or likely to occur.

Based on the Project's requirements, mangroves and other wetland areas are expected to be affected. Impacts can be reduced by placing temporary barriers to delineate the areas that will be cleared or improved, and by minimizing contact between construction work and adjacent biological resources. Based on previously and current assessment of the drainage channels condition, further assessment of these aquatic resources is recommended in order to determine the nature of these areas, and whether which sections are palustrine or estuarine channels. This will help in future permit processes.

Nevertheless, flora and fauna impacts could be avoided, minimized and mitigated with the preparation of the best practical Project's design and the application of appropriate architectural and engineering practices. Also, the implementation of mitigation, conservation and management plans, programs and practices is an essential key for conservation and impact minimization.

The main impact on the flora will result from the habitat modification by converting some areas from sub-canopy/canopy to shrub/herbaceous and by needed periodic maintenance activities. In some areas, potential mitigation measures will need to be establish to reduce resource impacts.

The preparation and implementation of mitigation, conservation and management plan is recommended for the proposed project in order to minimize potential impacts. This plan should include strategies such as the identification of potential mitigation sites, and the salvaging and transplant of native flora species to areas selected for mitigation and conservation.



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Commonwealth and federally listed fauna species were not recorded within the airfield facility, but were observed and/or previously documented within the Study Area vicinity, and therefore protected under the Federal Endangered Species Act (ESA) or under the DNER Regulation for the Management of Vulnerable and Endangered Species. All of the listed species reported to the airfield vicinity are related to aquatic habitats. As mentioned before, the occurrence of most of these species within the Study Area is expected to be limited to transient individuals. Of the listed species for the Study Area, only the brown pelican was observed flying high over the area during field reconnaissance and assessment.

Also, a recent determination from the USFWS, after the project was presented in an interagency meeting, stated that "*there are no listed species under the purview of the Service within the airport limits*". **Appendix H** includes the USFWS letter from August 22, 2017.

In conclusion, the Project implementation itself is not expected to have significant long-term impacts on the flora and fauna, as long as it includes the implementation of the management, protection and mitigation actions, and other measures that might be suggested by the pertinent agencies in order to minimize possible impacts. These measures would increase the conservation of natural resources within the Project and, thus minimize its impact. Immediate measures to minimize direct and indirect impact to natural ecosystems should involve the implementation of soil stabilization techniques during Project implementation, as well as other practical improvements to control erosion. This would help minimize sediment and air pollutant flow to the environment in and near the Study Area. Soil stabilization techniques should be implemented before and after construction, particularly in areas susceptible to erosion and near wetland areas. Comprehensive measures to reduce erosion and sedimentation associated with the Project's construction should be established and delineated in a Storm Water Pollution Prevention Plan (SWPPP), and in an Erosion and Sedimentation Control Plan (ESCP) in compliance with Federal and Commonwealth regulations.



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# 8.0 APPENDICES



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# APPENDIX A: PRELIMINARY WETLAND BOUNDARY



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Legend

Wetland Areas | Drainage Study Area | OFA Clearing Study Area | Property Limits

Preliminary Wetland Boundary

OFA Clearing and Airfield Drainage Improvement Project
Luis Muñoz Marín International Airport (SJU)

N

0 50 100 200 300 Meters

1:5,000

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# APPENDIX B: FLORA INVENTORY

| *Scientific Name* | Spanish Common Name | Family | Documented during 2017 Assessment | Presence Based on SJU Background Info. |
|---|---|---|---|---|
| *Abrus precatorius* | Peronía | Fabaceae | X | |
| *Acrocomia media* | Corozo | Arecaceae | X | |
| *Acrostichum aureum* | Palmita de río | Pteridaceae | X | |
| *Acrostichum danaeifolium* | Helecho de pantano | Pteridaceae | | X |
| *Albizia lebbeck* | Acacia amarilla | Mimosoideae | X | X |
| *Albizia procera* | Albizia | Mimosoideae | X | X |
| *Ammannia coccinea* | Romerito | Lythraceae | X | |
| *Andira inermis* | Moca | Papilionoideae | X | |
| *Ardisia eliptica* | Mameyuelo | Myrsinaceae | X | |
| *Ardisia obovata* | Mameyuelo | Myrsinaceae | X | |
| *Areca catechu* | Palma catechu | Araceae | X | |
| *Avicennia germinans* | Mangle negro | Avicenniaceae | X | X |
| *Azadirachta indica* | Neem | Meliaceae | X | |
| *Bacopa innomint* | Yerba de culebra | Plantaginaceae | | X |
| *Bacopa monnieri* | Yerba de culebra | Plantaginaceae | X | X |
| *Bacopa renpens* | Yerba de culebra | Plantaginaceae | | X |
| *Batis maritima* | Planta de sal | Bataceae | | X |
| *Bidens alba* var. *radiata* | Margarita silvestre | Asteraceae | X | |
| *Bidens pilosa* | Aceitillo | Asteraceae | | X |
| *Boerhavia scandens* | Pegapollo | Nyctaginaceae | X | |
| *Bourreria succulenta* | Palo de vaca | Boraginaceae | X | |
| *Brassaia actinophylla* | Schefflera | Araliaceae | X | |
| *Bucida buceras* | Ucar | Combretaceae | X | |
| *Bursera simaruba* | Almácigo | Burseraceae | X | |
| *Caesalpinea bonduc* | Haba de San Antonio | Fabaceae | X | |
| *Calophyllum antillanum* | María | Clusiaceae | X | |
| *Calophyllum inophyllum* | Santa María | Clusiaceae | X | |
| *Calotropis procera* | Algodón de seda | Asclepiadaceae | X | |
| *Cassytha filiformis* | Fideillo | Lauraceae | X | |
| *Casuarina equisetifolia* | Pino Australiano | Casuarinaceae | X | |
| *Cecropia schreberiana* | Yagrumo hembra | Moraceae | X | |
| *Cenchrus echinatus* | Abrojo | Poaceae | X | |
| *Ceratopteris thalictroides* | Pan tropical | Pteridaceae | X | |
| *Cestrum diurnum* | Galán de día | Solanaceae | X | |
| *Chamaecrista nictitans* | Moriviví bobo | Caesalpinioideae | X | |



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| ***Scientific Name*** | **Spanish Common Name** | **Family** | **Documented during 2017 Assessment** | **Presence Based on SJU Background Info.** |
|---|---|---|---|---|
| *Chloris barbata* | Paragüita morada | Poaceae | X | |
| *Chloris inflata* Link | Paragüita | Poaceae | | X |
| *Chloris radiata* | Grama de costa | Poaceae | X | |
| *Chrysobalanus icaco* | Icaco | Chrysobalanaceae | X | |
| *Citharexylum fruticosum* | Péndula | Verbenaceae | X | |
| *Cladium jamaicense* | Serrucho | Cyperaceae | | X |
| *Coccoloba uvifera* | Uva de playa | Polygonaceae | X | |
| *Cocos nucifera* | Palma de Coco | Polygonaceae | X | |
| *Colocasia esculenta* | Malanga | Araceae | X | |
| *Colubrina arborescens* | Abeyuelo | Rhamnaceae | X | |
| *Commelina diffusa* | Cohitre | Commelinaceae | X | |
| *Commelina erecta* | Cohitre azul | Commelinaceae | X | |
| *Conocarpus erectus* | Mangle de botón | Combretaceae | X | |
| *Cuphea micrantha* | Sanalotodo | Lythraceae | X | |
| *Cynodon dactylon* | Bermuda común | Poaceae | X | |
| *Cyperus articulatus* | Junco cimarrón | Cyperaceae | X | |
| *Cyperus distans* | Pantropical | Cyperaceae | | X |
| *Cyperus iria* | Junco | Cyperaceae | X | |
| *Cyperus ligularis* | Junco | Cyperaceae | X | |
| *Cyperus odoratus* | Junco | Cyperaceae | | X |
| *Cyperus polystachyos* | Junco | Cyperaceae | X | |
| *Cyperus rotundus* | Coquí | Cyperaceae | | X |
| *Dalbergia ecastaphyllum* | Maray-Maray | Papilionoideae | X | |
| *Delonix regia* | Flamboyán | Caesalpinioideae | X | |
| *Desmanthus virgatus* | Desmanto | Mimosoideae | X | |
| *Desmodium incanum* Var. *incanum* | Zarzabacoa común | Fabaceae-Faboideae | X | |
| *Dryopteris filix-mas* | Helecho macho | Dryopterideceae | X | |
| *Eleocharis cellulosa* | Junco fino | Cyperaceae | X | |
| *Eleocharis elegans* | Junquillo | Cyperaceae | | X |
| *Eleocharis geniculata* | Junco | Cyperaceae | X | |
| *Eleocharis interstincta* | Junco | Cyperaceae | X | |
| *Eleocharis mutata* | Junco | Cyperaceae | | X |
| *Eleusine indica* | Pata de gallina | Poaceae | | X |
| *Emilia Sonchifolia* | Yerba sosialista | Asteraceae | | X |
| *Eugenia pseudopsidium* | Guayaba silvestre | Myrtaceae | X | |



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| ***Scientific Name*** | **Spanish Common Name** | **Family** | **Documented during 2017 Assessment** | **Presence Based on SJU Background Info.** |
|---|---|---|---|---|
| *Fimbristylis cymosa* | Junco | Cyperaceae | X | |
| *Heliotropium curassavicum* | Cotorrera de playa | Boraginaceae | | X |
| *Hymenachne amplexicaulis* | Trompetilla | Poaceae | X | |
| *Ipomoea pes-caprae* Ssp. *Brasiliensis* | Bejuco de playa | Convolvulaceae | | X |
| *Ipomoea tiliacea* | Bejuco de puerco | Convolvulaceae | X | |
| *Isachne angustifolia* | Yerba de alambre | Poaceae | | X |
| *Jasminum fluminense* | Jazmín oloroso | Oleaceae | X | |
| *Laguncularia racemosa* | Mangle blanco | Combretaceae | X | X |
| *Leucaena leucocephala* | Tamarindillo | Lamiaceae | X | X |
| *Lippia nodiflora* | Yerba de sapo | Verbenaceae | X | |
| *Ludwigia octovalvis* | Yerba cangá | Onagraceae | X | |
| *Megatirsus maximum* | Yerba de guinea | Poaceae | X | X |
| *Melicoccus bijugatus* | Quenepa | Sapindaceae | X | |
| *Miconia laevigata* | Camasey de paloma | Melastomataceae | X | |
| *Mimosa casta* | Zarza | Mimosoidae | X | |
| *Mimosa pudica* | Moriviví | Mimosoideae | X | X |
| *Momordica charantia* | Cundeamor | Cucurbitaceae | | X |
| *Nephrolepis exaltata* | Helecho espada | Lomariopsidaceae | | X |
| *Neptunia plena* | Desmanto amarillo | Fabaceae | X | |
| *Paspalum conjugatum* | Horquetilla blanca | Poaceae | X | |
| *Paspalum distichum* | Saladillo | Poaceae | | X |
| *Paspalum fasciculatum* | Yerba venezolana | Poaceae | X | |
| *Paspalum millegrana* | Cortadora | Poaceae | X | X |
| *Paspalum vaginatum* | Cortadero | Poaceae | X | |
| *Passiflora suberosa* | Parcha yedra | Passifloraceae | X | |
| *Paulinia pinnata* | Bejuco de Guajanilla | Sapindaceae | X | |
| *Peltophorum pterocarpum* | Flamboyán amarillo | Fabaceae | X | |
| *Pennisetum purpureum* | Yerba de elefante | Poaceae | X | |
| *Phragmites australis* | Caña de indio | Poaceae | X | |
| *Piper aduncum* | Higuillo | Piperaceae | X | X |
| *Pithecellobium dulce* | Guamá americano | Mimosoideae | X | X |
| *Ptychosperma macarthurii* | Palma Macarthur | Papilionoideae | X | |
| *Pueraria phaseoloides* | Kudzú tropical | Papilionoideae | X | |
| *Randia aculeata* | Tintillo | Rubiaceae | X | |
| *Rhizophora mangle* | Mangle rojo | Rhizophoraceae | X | X |
| *Rhynchospora colorata* | Euphorbiaceae | Cyperaceae | X | |



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|---|---|---|---|---|
| *Ricinus communis* | Higuereta | Euphorbiaceae | | X |
| *Roystonea borinquena* | Palma Real | Arecaceae | X | |
| *Saccharum spontaneum* | Caña de azúcar silvestre | Poaceae | | X |
| *Sagittaria lancifolia* | Flecha de agua | Alismataceae | X | |
| *Sansevieria hyacinthoides* | Lengua de vaca | Asparagaceae | X | |
| *Sansevieria trifasciata* | Lengua de suegra | Asparagaceae | X | |
| *Schoenoplectus americanus* | Junco | Cyperaceae | X | |
| *Senna nitida* | Hedionda | Caesalpinioideae | X | |
| *Senna siamea* | Casia amarilla | Caesalpinioideae | X | |
| *Sesbania sericea* | Papagayo | Papilionoideae | X | |
| *Sesuvium portulacastrum* | Verdolaga rosada | Aizoaceae | | X |
| *Setaria geniculata* | Arrocillo | Poaceae | X | |
| *Sida rhombifolia* | Escoba colorada | Malvaceae | | X |
| *Spathodea campanulata* | Tulipan africano | Bignoniaceae | X | |
| *Sphagneticola trilobata* | Manzanilla de playa | Asteraceae | X | X |
| *Spondias monbin* | Jobo | Anacardiaceae | X | |
| *Sporolobus indicus* | Cerrillo | Poaceae | X | |
| *Sporolobus virginicus* | Matojo de burro | Poaceae | X | X |
| *Stachytarpheta jamaicensis* | Bretónica | Verbenaceae | | X |
| *Swietenia macrophylla* | Caoba hondureña | Meliaceae | X | |
| *Synedrella nodiflora* | Serbatana | Asteraceae | X | |
| *Syngonium podophyllum* | Malanga trepadora | Araceae | X | |
| *Tabebuia heterophylla* | Roble nativo | Bignoniaceae | X | |
| *Tabebuia rosea* | Roble venezolano | Bignoniaceae | X | |
| *Terminalia catappa* | Almendro | Combretaceae | X | X |
| *Thalia geniculata* | Pámpano | Marantaceae | X | |
| *Thespesia populnea* | Emajagüilla | Malvaceae | X | |
| *Thumbergia alata* | Flor de poeta | Acanthaceae | X | |
| *Tridax procumbens* | Pancha | Asteraceae | X | |
| *Typha domingensis* | Yerba de eneas | Typhaceae | X | X |
| *Urochloa adspersa* | Cohitrillo | Poaceae | X | |
| *Urochloa mutica* | Malojillo | Poaceae | X | X |
| *Veitchia merrillii* | Palma de Adonidia | Arecaceae | X | |
| *Zoysia matrella* var. *matrella* | Yerba de manila | Poaceae | X | |



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# APPENDIX C: FAUNA INVENTORY

| *Scientific Name* | Spanish Common Name | English Common Name | Documented during 2017 Assessment | Presence Based on SJU Background Info. |
|---|---|---|---|---|
| **BIRDS** | | | | |
| *Podicipedidae* | | | | |
| *Podilymbus podiceps* | Zaramago | Pied-billed Grebe | X | |
| Pelecanidae | | | | |
| *Pelecanus occidentalis* | Pelícano Pardo | Brown Pelican | X | X |
| Fregatidae | | | | |
| *Fregata magnificens* | Fragata Magnífica | Magnificent Frigatebird | X | X |
| Ardeidae | | | | |
| *Ardea herodias* | Garzón Cenizo | Great Blue Heron | X | |
| *Ardea alba* | Garza Real | Great Egret | X | X |
| *Egretta garzetta* | Garza Común | Little Egret | X | |
| *Egretta thula* | Garza Blanca | Snowy Egret | X | |
| *Egretta caerulea* | Garza Azul | Little Blue Heron | | X |
| *Egretta tricolor* | Garza Tricolor | Tricolored Heron | X | |
| *Bubulcus ibis* | Garza Ganadera | Cattle Egret | X | X |
| *Butorides virescens* | Martinete Verde | Green Heron | X | X |
| *Nycticorax nycticorax* | Yaboa Real | Black-crowned Night-Heron | X | |
| *Nyctanassa violacea* | Yaboa Común | Yellow-crowned Night-Heron | X | |
| Accipitridae | | | | |
| *Pandion haliaetus* | Águila Pescadora | Osprey | X | X |
| *Buteo jamaicensis* | Guaraguao Colirrojo | Red-tailed Hawk | X | |
| Falconidae | | | | |
| *Falco sparverius* | Falcón Común | American Kestrel | | X |
| Rallidae | | | | |
| *Rallus longirostris* | Pollo de Mangle | Clapper Rail | X | |
| *Gallinula chloropus* | Gallareta Común | Common Moorhen | X | |
| *Fulica americana* | Gallinazo Americano | American Coot | X | |
| Charadriidae | | | | |
| *Charadrius semipalmatus* | Chorlo Acollarado | Semipalmated Plover | | X |
| *Charadrius vociferus* | Chorlo Sabanero | Killdeer | | X |
| Recurvirostridae | | | | |
| *Himantopus mexicanus* | Viuda Mexicana | Black-necked Stilt | | X |
| Scolopacidae | | | | |
| *Actitis macularius* | Playero Coleador | Spotted Sandpiper | X | |
| *Tringa solitaria* | Playero Solitario | Solitary Sandpiper | X | |
| *Tringa melanoleuca* | Playero Guineilla Grande | Greater Yellowlegs | | X |
| Laridae | | | | |
| *Leucophaeus atricilla* | Gaviota Cabecinegra | Laughing Gull | X | |
| *Sternula antillarum* | Charrán Pequeño | Least Tern | X | |
| *Gelochelidon nilotica* | Charrán de Pico Corto | Gull-billed Tern | | X |
| *Thalasseus maximus* | Charrán Real | Royal Tern | | X |



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| **BIRDS** | | | | |
| Columbidae | | | | |
| *Columba livia* | Paloma Doméstica | Rock Pigeon | | X |
| *Patagioenas leucocephala* | Paloma Cabeciblanca | White-crowned Pigeon | X | |
| *Zenaida asiatica* | Tórtola Aliblanca | White-winged Dove | X | X |
| *Zenaida aurita* | Tórtola Cardosantera | Zenaida Dove | X | X |
| *Columbina passerina* | Rolita | Common Ground-Dove | X | X |
| Psittacidae | | | | |
| *Myiopsitta monachus* | Perico Monje | Monk Parakeet | | X |
| Cuculidae | | | | |
| *Coccyzus vieilloti* | Pájaro Bobo Mayor | Puerto Rican Lizard-Cuckoo | X | |
| *Crotophaga ani* | Garrapatero | Smooth-billed Ani | X | |
| Trochilidae | | | | |
| *Anthracothorax viridis* | Zumbador Verde | Green Mango | X | |
| Alcedinidae | | | | |
| *Megaceryle alcyon* | Martín Pescador Norteño | Belted Kingfisher | | X |
| Picidae | | | | |
| *Melanerpes portoricensis* | Carpintero de Puerto Rico | Puerto Rican Woodpecker | X | |
| Tyrannidae | | | | |
| *Tyrannus dominicensis* | Pitirre Gris | Gray Kingbird | X | X |
| *Tyrannus caudifasciatus* | Clérigo | Loggerhead Kingbird | X | |
| Vireonidae | | | | |
| *Vireo latimeri* | Bienteveo de Puerto Rico | Puerto Rican Vireo | X | |
| *Vireo altiloquus* | Vireo Julián Chiví | Black-whiskered Vireo | X | |
| Hirundinidae | | | | |
| *Progne dominicensis* | Golondrina de Iglesias | Caribbean Martin | X | |
| *Petrochelidon fulva* | Golondrina de Cuevas | Cave Swallow | X | |
| Muscicapidae | | | | |
| *Turdus plumbeus* | Zorzal Patirrojo | Red-legged Thrush | X | X |
| Mimidae | | | | |
| *Mimus polyglottos* | Ruiseñor | Northern Mockingbird | X | X |
| *Margarops fuscatus* | Zorzal Pardo | Pearly-eyed Thrasher | X | |
| Parulidae | | | | |
| *Seiurus noveboracensis* | Pizpita de Mangle | Northern Waterthrush | X | |
| Coerebidae | | | | |
| *Coereba flaveola* | Reinita Común | Bananaquit | X | X |
| Emberizidae | | | | |
| *Loxigilla portoricensis* | Comeñame de Puerto Rico | Puerto Rican Bullfinch | X | |
| *Tiaris bicolor* | Gorrión Negro | Black-faced Grassquit | X | |
| *Tiaris olivacea* | Gorrión Barba Amarilla | Yellow-faced Grassquit | X | |



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|---|---|---|---|---|
| Icteridae | | | | |
| *Quiscalus niger* | Mozambique | Greater Antillean Grackle | X | X |
| *Molothrus bonariensis* | Tordo Lustroso | Shiny Cowbird | X | |
| Passeridae | | | | |
| *Passer domesticus* | Gorrión Doméstico | House Sparrow | X | |
| Ploceidae | | | | |
| *Euplectes franciscanus* | Obispo Colorado | Orange Bishop | X | |
| | | | | |
| **ANPHIBIA** | | | | |
| Bufonidae | | | | |
| *Bufo marinus* | Sapo Común | Cane Toad | X | X |
| Leptodactylidae | | | | |
| *Eleutherodactylus brittoni* | Coquí de las Yerbas | Grass coqui | X | X |
| *Eleutherodactylus coqui* | Coquí Común | Common coqui | X | |
| *Leptodactylus albilabris* | Ranita de Labio Blanco | White-lipped Frog | X | X |
| Rannidae | | | | |
| *Rana catesbeana* | Rana Toro | Bullfrog | X | X |
| | | | | |
| **REPTILIA** | | | | |
| Emydidae | | | | |
| *Trachemys stejnegeri* | Jicotea de Puerto Rico | Puerto Rican Slider | X | |
| *Trachemys scripta elegans* | Tortuga Orejiroja | Red-eared Slider | X | |
| *Trachemys scripta scripta* | Tortuga Barreguiamarilla | Yellow-bellied Slider | X | |
| Iguanidae | | | | |
| *Iguana iguana* | Iguana Verde | Green Iguana | X | X |
| Polychrotidae | | | | |
| *Anolis cristatellus cristatellus* | Lagartijo Común | Common Anole | X | X |
| *Anolis pulchellus* | Lagartijo de Jardín | Grass Anole | X | X |
| *Anolis stratulus* | Lagartijo Manchado | Painted Anole | X | X |
| Teiidae | | | | |
| *Ameiva exsul* | Siguana Común | Puerto Rican Common Ameiva | X | X |
| Geckonidae | | | | |
| *Sphaerodactylus macrolepis ateles* | Salamanquita Común | Common Puerto Rican Gecko | X | |
| Crocodylidae | | | | |
| *Caiman cocodrilus* | Caiman de Anteojos | Specktacled Caiman | X | |



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|---|---|---|---|---|
| **MAMMALIA** | | | | |
| Molossidae | | | | |
| *Molossus molossus debilis* | Murciélago de Techos | Velvety Free-tailed Bat | X | |
| Muridae | | | | |
| *Rattus norvegicus* | Rata | Brown Rat | X | |
| *Mus musculus* | Jarriero | House Mouse | | |
| Mustelidae | | | | |
| *Herpestes auropunctatus* | Mangosta | Indian Mongoose | X | |
| Carnivora | | | | |
| Felidae | | | | |
| *Felis domesticus* | Gato asilvestrado | Feral Cat | | X |
| Canidae | | | | |
| Canis lupus | Perro asilvestrado | Feral dog | | X |
| | | | | |
| **PISCES** | | | | |
| Megalopidae | | | | |
| *Megalopus atlantica* | Sábalo | Tarpon | | X |
| Eopidae | | | | |
| *Elops saurus* | Macabí | Lady fish | | X |
| Engraulidae | | | | |
| *Centenralis edentulus* | Anchoveta | Whale bone | | X |
| Poeciliidae | | | | |
| *Poecilia vivipara* | Gupi | Top minnow | | X |
| Centropomidae | | | | |
| *Centropomus ensiferus* | Róbalo machuelo | Swordspine snook | | X |
| *Centropomus undecimalis* | Róbalo | Snook | X | X |
| Gerreidae | | | | |
| *Eucinostomus sp.* | Mojarra | Crappie | | X |
| Sphyraenidae | | | | |
| *Sphyraena barracuda* | Picua | Barracuda | | X |
| Eleotridae | | | | |
| *Gobiomorus dormitor* | Guavina | Bigmouth sleeper | X | |
| Cichlidae | | | | |
| *Tilapia mossambica* | Tilapia | Tilapia | X | |



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| **ARTHROPODA** | | | | |
| **Decapoda** | | | | |
| Palaemonidae | | | | |
| *Macrobrachium acanthurus* | Silgao | Freswater shrimp | X | |
| *Xyphocaris sp.* | Camarón | Freswater shrimp | X | X |
| *Callinectes sapidus* | Cocolia | Blue crap | | X |
| Searmidae | | | | |
| *Aratus pisonii* | Cangrejo arboreo | | X | X |
| Crapsidae | | | | |
| *Sesarma ricordi* | Cangrejo de Pantano | Humic marsh crap | X | |
| Palaemonidae | | | | |
| Macrobrachium acanthurus | Silgao | Cinnamon river shrimp | X | |
| Ocypodidae | | | | |
| Uca pugnax rapax | Cangrejo violinista | Fiddler crap | X | |
| Gecarcinidae | | | | |
| Cardisoma guanhumi | Juey común | Blue land crap | X | |
| Grapsidae | | | | |
| Ganiopsis cruentata | Cangrejo rojo | Mangrove crap | | X |
| Scolopendromorpha | | | | |
| *Scolopendridae* | | | | |
| *Scolopendra alternana* | Cienpies | Caribbean Giant Centipede | | X |
| **Odonata** | | | | |
| Libellulidae | | | | |
| *Orthemis ferruginea* | Libélula | Dragonfly | | X |
| **Isoptera** | | | | |
| Termitidae | | | | |
| *Nasutitermes costalis* | Comején | Termite | X | |
| **Araneae** | | | | |
| Araneidae | | | | |
| *Argiope argentata* | Araña | Silver argiope | | X |
| **Lepidoptera** | | | | |
| Pieriidae | | | | |
| *Phoebis sp.* | Mariposa | Butterfly | X | X |
| **Polydesmida** | | | | |
| Paradoxomatidae | | | | |
| *Orthmorpha coarctata* | Gongolí | Millipede | X | X |
| **Spirobolidia** | | | | |
| Rhinocricidae | | | | |
| *Orthocricus arboreus* | Gongolí arboreo | Tree millipede | X | X |
| | | | | |
| **MOLLUSCA** | | | | |
| **Gastropoda** | | | | |
| **Pulmonata** | | | | |
| Camaenidae | | | | |
| *Caracolus caracolla* | Caracol | Snail | X | |
| | | | | |
| **Stylommatophora** | | | | |
| Bulimulidae | | | | |
| *Bulimulus guadalupensis* | Caracol | Snail | X | X |



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# APPENDIX D: ENVIRONMENTAL SENSITIVITY INDEX (NOAA)



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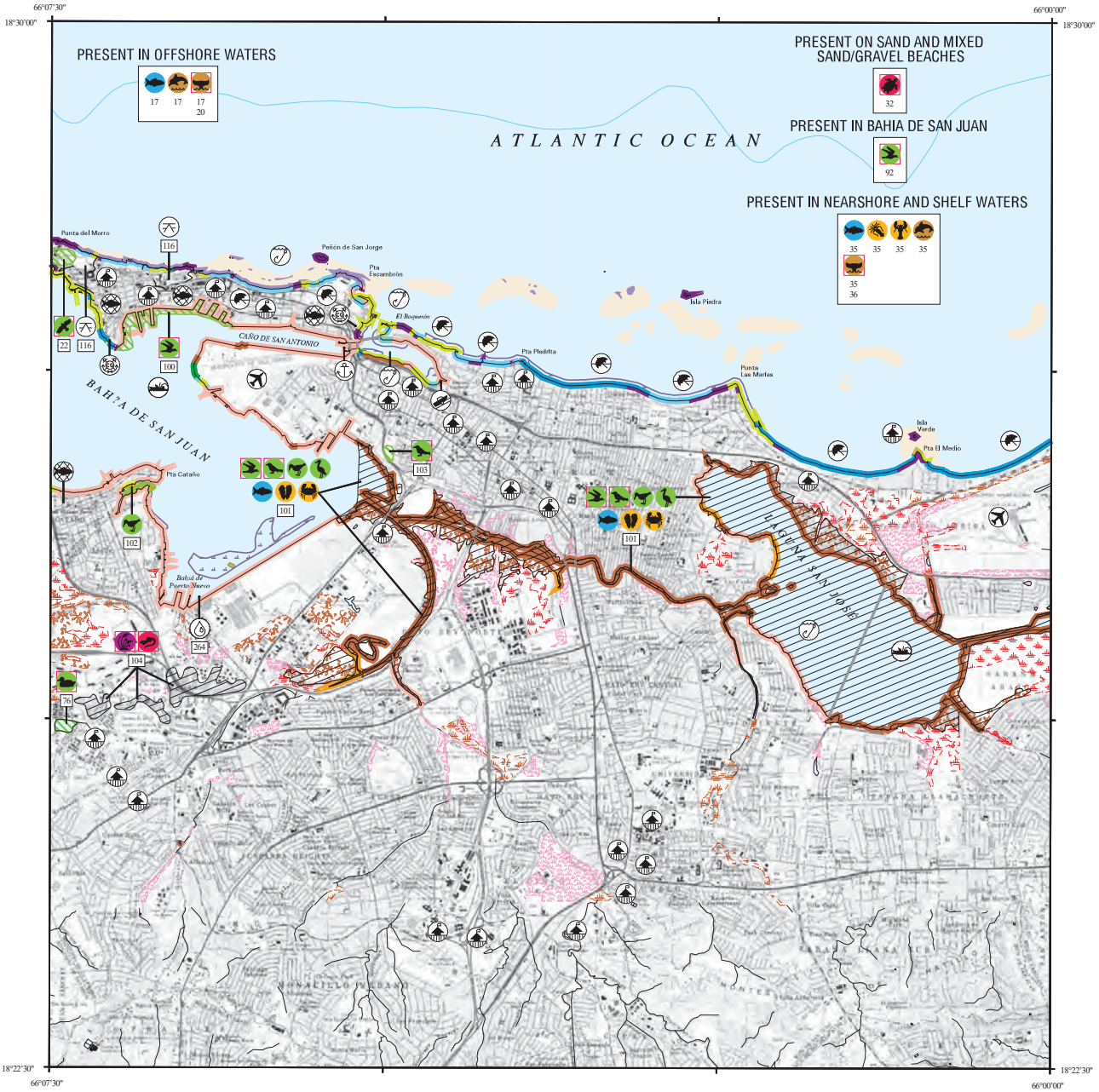
# ENVIRONMENTAL SENSITIVITY INDEX MAP




SHORELINE HABITATS (ESI)

- 1A EXPOSED ROCKY CLIFFS
- 1B EXPOSED, SOLID MAN-MADE STRUCTURES
- 2A EXPOSED WAVE-CUT PLATFORMS IN BEDROCK
- 2B SCARPS AND STEEP SLOPES IN MUDDY SEDIMENTS
- 3A FINE- TO MEDIUM-GRAINED SAND BEACHES
- 4 COARSE-GRAINED SAND BEACHES
- 5 MIXED SAND AND GRAVEL BEACHES
- 6A GRAVEL BEACHES
- 6B RIPRAP
- 7 EXPOSED TIDAL FLATS
- 8A SHELTERED ROCKY SHORES
- 8B SHELTERED, SOLID MAN-MADE STRUCTURES
- 9A SHELTERED TIDAL FLATS
- 9B SHELTERED VEGETATED LOW BANKS
- 10D MANGROVES
- SALT- AND BRACKISH-WATER MARSHES
- FRESHWATER MARSHES
- FRESHWATER SWAMPS
- FRESHWATER SCRUB/SHRUB

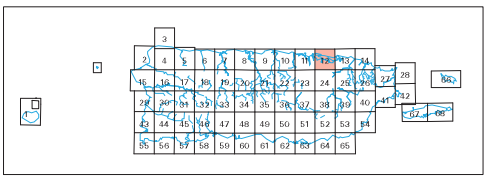
STREAM REACHES (RSI)

- 1 QUIET POOL; LOW-SENSITIVE BANKS
- 2 STRAIGHT CHANNEL WITH CURRENTS; LOW-SENSITIVE BANKS (MUD DOMINANT)
- 3 MEANDERING CHANNEL; SAND POINT BARS
- 4 MEANDERING CHANNEL; VEGETATED POINT BARS
- 5 RAPIDS OVER BEDROCK
- 6 MEANDERING CHANNEL; SAND AND GRAVEL POINT BARS
- 7 SPLIT CHANNEL WITH COARSE GRAVEL; SOME RAPIDS
- 8 SMALL FALLS; BOULDERS IN CHANNEL
- 9 LARGE FALLS; BOULDERS IN CHANNEL
- 10 CHANNELS WITH ASSOCIATED VULNERABLE WETLANDS
- KARST

SCALE 1:55000

1 .5 0 1 KILOMETER

1 .5 0 1 MILE



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# PUERTO RICO - ESIMAP 12

## BIOLOGICAL RESOURCES:

### BIRD:

| RAR# | Species | S/F | T/E | Conc. | J | F | M | A | M | J | J | A | S | O | N | D | Nesting |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22 | Peregrine falcon | S | E | | X | X | X | X | | | | | | X | X | X | - |
| 76 | Ruddy duck | S | T | | X | X | X | X | X | X | X | X | X | X | X | X | - |
| 92 | Brown pelican | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Gulls | | | | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Terns | | | | | | X | X | X | X | X | X | X | | | | - |
| 100 | Brown pelican | S/F | E/E | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Seabirds | | | | X | X | X | X | X | X | X | X | X | X | X | X | - |
| 101 | Brown pelican | S/F | E/E | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Least tern | S | T | | | | X | X | X | X | X | | | | | | - |
| | Roseate tern | S/F | E/T | | | | X | X | X | X | X | X | | | | | - |
| | Royal tern | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Sandwich tern | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Shorebirds | | | HIGH | X | X | X | X | X | | | X | X | X | X | X | - |
| | Wading birds | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Yellow-shouldered blackbird | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X | MAR-SEP |
| 102 | Shorebirds | | | HIGH | X | X | X | X | X | | | X | X | X | X | X | - |
| 103 | Yellow-shouldered blackbird | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X | MAR-SEP |

### FISH:

| RAR# | Species | S/F | T/E | Conc. | J | F | M | A | M | J | J | A | S | O | N | D | Spawning | Eggs | Larvae | Juveniles | Adults |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | Pelagic fish | | | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC |
| 35 | Pelagic fish | | | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC |
| | Reef fish | | | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC |
| 101 | Nursery fish | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | - |
| | Snook | | | | X | X | X | X | X | X | X | X | X | X | X | X | APR-FEB | APR-FEB | JAN-DEC | JAN-DEC | JAN-DEC |
| | Tarpon | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | MAY-DEC | JAN-DEC | JAN-DEC |

### PLANT:

| RAR# | Species | S/F | T/E | Conc. | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104 | Ottoschulzia rhodoxylon | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X |

### INVERTEBRATE:

| RAR# | Species | S/F | T/E | Conc. | J | F | M | A | M | J | J | A | S | O | N | D | Spawning | Eggs | Larvae | Juveniles | Adults |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | Caribbean spiny lobster | | | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC |
| | Octopus | | | | X | X | X | X | X | X | X | X | X | X | X | X | DEC-MAR | DEC-APR | - | JAN-DEC | JAN-DEC |
| 101 | Blue crabs | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | JAN-DEC |
| | Blue land crab | | | | X | X | X | X | X | X | X | X | X | X | X | X | JUL-AUG | JUL-AUG | JUL-SEP | JAN-DEC | JAN-DEC |
| | Quahog (hard clam) | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | - | JAN-DEC |

### MARINE MAMMAL:

| RAR# | Species | S/F | T/E | Conc. | J | F | M | A | M | J | J | A | S | O | N | D | Mating | Calving |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | Dolphins | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - |
| | Whales | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - |
| 20 | Sperm whale | S/F | E/E | HIGH | X | X | X | X | X | X | X | | X | X | X | X | - | - |
| 35 | Dolphins | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - |
| | Whales | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - |
| 36 | Humpback whale | S/F | E/E | VERY HIGH | X | X | X | X | X | | | | | X | X | | - | - |

### REPTILE:

| RAR# | Species | S/F | T/E | Conc. | J | F | M | A | M | J | J | A | S | O | N | D | Nesting | Hatching | Internesting | Juveniles | Adults |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32 | Green sea turtle | S/F | E/T | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC | - | JAN-DEC | JAN-DEC |
| | Hawksbill sea turtle | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC | - | JAN-DEC | JAN-DEC |
| | Leatherback sea turtle | S/F | E/E | | | X | X | X | X | X | X | X | | | | | FEB-JUN | APR-SEP | - | APR-SEP | FEB-JUN |
| 104 | Puerto Rican boa | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | JAN-DEC |

## HUMAN USE RESOURCES:

### NATIONAL PARK:

| HUN# | Name | Owner/Manager | Contact | Phone |
|---|---|---|---|---|
| 116 | SAN JUAN NATIONAL HISTORIC SITE | NPS | PARK MANAGER | 787/729-6777 |

### WATER INTAKE:

| HUN# | Name | Owner/Manager | Location | Phone |
|---|---|---|---|---|
| 264 | POWER PLANT | PREPA | | |

Biological information shown on the maps represents known concentration areas or occurrences, but does not necessarily represent the full distribution or range of each species. This is particularly important to recognize when considering potential impacts to protected species.

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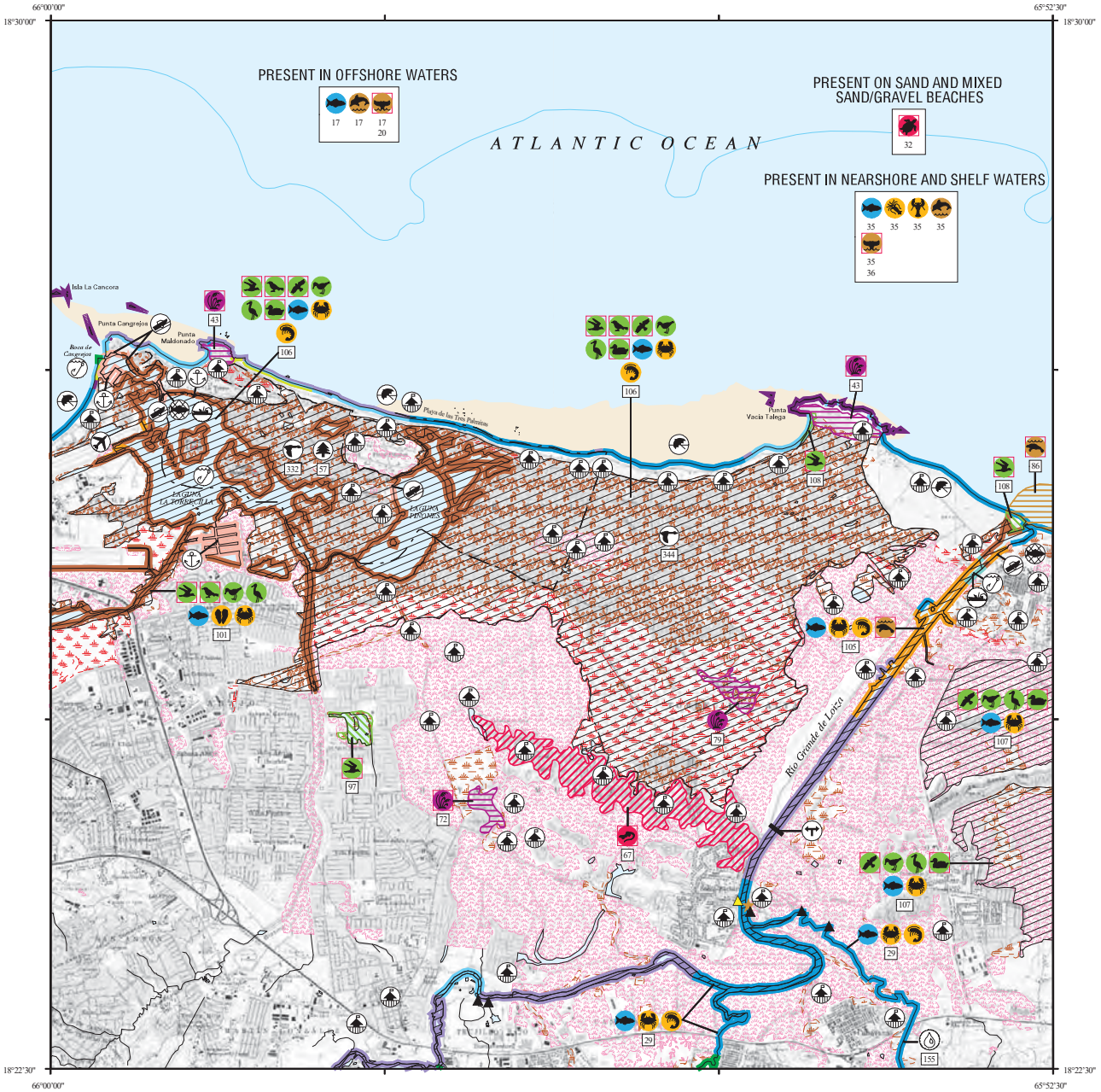
# ENVIRONMENTAL SENSITIVITY INDEX MAP




## SHORELINE HABITATS (ESI)

- 1A EXPOSED ROCKY CLIFFS
- 1B EXPOSED, SOLID MAN-MADE STRUCTURES
- 2A EXPOSED WAVE-CUT PLATFORMS IN BEDROCK
- 2B SCARPS AND STEEP SLOPES IN MUDDY SEDIMENTS
- 3A FINE- TO MEDIUM-GRAINED SAND BEACHES
- 4 COARSE-GRAINED SAND BEACHES
- 5 MIXED SAND AND GRAVEL BEACHES
- 6A GRAVEL BEACHES
- 6B RIPRAP
- 7 EXPOSED TIDAL FLATS
- 8A SHELTERED ROCKY SHORES
- 8B SHELTERED, SOLID MAN-MADE STRUCTURES
- 9A SHELTERED TIDAL FLATS
- 9B SHELTERED VEGETATED LOW BANKS
- 10D MANGROVES
- SALT- AND BRACKISH-WATER MARSHES
- FRESHWATER MARSHES
- FRESHWATER SWAMPS
- FRESHWATER SCRUB/SHRUB

## STREAM REACHES (RSI)

- 1 QUIET POOL; LOW-SENSITIVE BANKS
- 2 STRAIGHT CHANNEL WITH CURRENTS; LOW-SENSITIVE BANKS (MUD DOMINANT)
- 3 MEANDERING CHANNEL; SAND POINT BARS
- 4 MEANDERING CHANNEL; VEGETATED POINT BARS
- 5 RAPIDS OVER BEDROCK
- 6 MEANDERING CHANNEL; SAND AND GRAVEL POINT BARS
- 7 SPLIT CHANNEL WITH COARSE GRAVEL; SOME RAPIDS
- 8 SMALL FALLS; BOULDERS IN CHANNEL
- 9 LARGE FALLS; BOULDERS IN CHANNEL
- 10 CHANNELS WITH ASSOCIATED VULNERABLE WETLANDS
- KARST

N W E S

SCALE 1:55000

1 .5 0 1 KILOMETER

1 .5 0 1 MILE

Not For Navigation
Published: May 2000


Published at Seattle, Washington
National Oceanic and Atmospheric Administration
National Ocean Service
Office of Response and Restoration
Hazardous Materials Response Division


CAROLINA, P.R. (1982) **PR-13**

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# PUERTO RICO - ESIMAP 13

## BIOLOGICAL RESOURCES:

### BIRD:

| RAR# | Species | S/F | T/E | Conc. | J | F | M | A | M | J | J | A | S | O | N | D | Nesting |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 97 | Brown pelican | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X | - |
| 101 | Brown pelican | S/F | E/E | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Least tern | S | T | | | | | X | X | X | X | X | | | | | - |
| | Roseate tern | S/F | E/T | | | | | X | X | X | X | X | X | | | | - |
| | Royal tern | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Sandwich tern | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Shorebirds | | | HIGH | X | X | X | X | X | | | X | X | X | X | X | - |
| | Wading birds | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Yellow-shouldered blackbird | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X | MAR-SEP |
| 106 | American coot | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Blue-winged teal | | | HIGH | X | X | X | X | | | | | | X | X | X | - |
| | Brown pelican | S/F | E/E | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Caribbean coot | S | T | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Common moorhen | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Common snipe | | | HIGH | X | X | X | X | | | | | | X | X | X | - |
| | Green-winged teal | | | HIGH | X | X | X | | | | | | | X | X | X | - |
| | Gulls | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Lesser scaup | | | HIGH | X | X | X | | | | | | | | X | X | - |
| | Masked duck | S | T | LOW | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Merlin | | | LOW | X | X | X | | | | | | | X | X | X | - |
| | Northern pintail | | | HIGH | X | X | X | X | | | | | X | X | X | X | - |
| | Osprey | | | LOW | X | X | X | X | | | | | X | X | X | X | - |
| | Peregrine falcon | S | E | LOW | X | X | X | X | | | | | | X | X | X | - |
| | Pied-billed grebe | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Purple gallinule | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Ring-necked duck | | | HIGH | X | X | X | | | | | | | X | X | X | - |
| | Royal tern | | | | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Ruddy duck | S | T | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Sandwich tern | | | | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Shorebirds | | | HIGH | X | X | X | X | X | | | X | X | X | X | X | - |
| | Wading birds | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | West Indian whistling-duck | S | T | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | White-cheeked pintail | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | White-crowned pigeon | | | | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Yellow-shouldered blackbird | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X | MAR-SEP |
| 107 | American coot | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Blue-winged teal | | | HIGH | X | X | X | X | | | | | | X | X | X | - |
| | Caribbean coot | S | T | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Common moorhen | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Common snipe | | | HIGH | X | X | X | X | | | | | | X | X | X | - |
| | Green-winged teal | | | HIGH | X | X | X | | | | | | | X | X | X | - |
| | Lesser scaup | | | HIGH | X | X | X | | | | | | | | X | X | - |
| | Masked duck | S | T | LOW | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Merlin | | | LOW | X | X | X | | | | | | | X | X | X | - |
| | Northern pintail | | | HIGH | X | X | X | X | | | | | X | X | X | X | - |
| | Peregrine falcon | S | E | LOW | X | X | X | X | | | | | | X | X | X | - |
| | Pied-billed grebe | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Purple gallinule | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Ring-necked duck | | | HIGH | X | X | X | | | | | | | X | X | X | - |
| | Ruddy duck | S | T | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | Wading birds | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | West Indian whistling-duck | S | T | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| | White-cheeked pintail | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - |
| 108 | Least tern | S | T | | | | | X | X | X | X | X | | | | | APR-JUL |

### FISH:

| RAR# | Species | S/F | T/E | Conc. | J | F | M | A | M | J | J | A | S | O | N | D | Spawning | Eggs | Larvae | Juveniles | Adults |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | Pelagic fish | | | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC |
| 29 | Native stream fish | | | | X | X | X | X | X | X | X | X | X | X | X | X | APR-MAY | APR-MAY | APR-MAY | JAN-DEC | JAN-DEC |
| | | | | | | | | | | | | | | | | | AUG-NOV | AUG-NOV | AUG-NOV | | |
| 35 | Pelagic fish | | | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC |
| | Reef fish | | | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC |
| 101 | Nursery fish | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | - |
| | Snook | | | | X | X | X | X | X | X | X | X | X | X | X | X | APR-FEB | APR-FEB | JAN-DEC | JAN-DEC | JAN-DEC |
| | Tarpon | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | MAY-DEC | JAN-DEC | JAN-DEC |
| 105 | Native stream fish | | | | | | | X | X | | | X | X | X | | | - | - | APR-MAY | - | - |
| | | | | | | | | | | | | | | | | | | | AUG-NOV | | |
| | Nursery fish | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | - |
| | Snook | | | | X | X | X | X | X | X | X | X | X | X | X | X | APR-FEB | APR-FEB | JAN-DEC | JAN-DEC | JAN-DEC |
| | Tarpon | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | MAY-DEC | JAN-DEC | JAN-DEC |
| 106 | Nursery fish | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | - |
| | Snook | | | | X | X | X | X | X | X | X | X | X | X | X | X | APR-FEB | APR-FEB | JAN-DEC | JAN-DEC | JAN-DEC |
| | Tarpon | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | MAY-DEC | JAN-DEC | JAN-DEC |
| 107 | Nursery fish | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | - |
| | Snook | | | | X | X | X | X | X | X | X | X | X | X | X | X | APR-FEB | APR-FEB | JAN-DEC | JAN-DEC | JAN-DEC |
| | Tarpon | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | MAY-DEC | JAN-DEC | JAN-DEC |

### PLANT:

| RAR# | Species | S/F | T/E | Conc. | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 43 | Schoepfia arenaria | S/F | T/T | | X | X | X | X | X | X | X | X | X | X | X | X |
| 72 | Ottoschulzia rhodoxylon | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X |
| 79 | Pterocarpus swamp | | | | X | X | X | X | X | X | X | X | X | X | X | X |

### INVERTEBRATE:

| RAR# | Species | S/F | T/E | Conc. | J | F | M | A | M | J | J | A | S | O | N | D | Spawning | Eggs | Larvae | Juveniles | Adults |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | Freshwater crab | | | | X | X | X | X | X | X | X | X | X | X | X | X | APR-MAY | APR-MAY | - | JAN-DEC | JAN-DEC |
| | | | | | | | | | | | | | | | | | AUG-NOV | AUG-NOV | | | |
| | Native stream shrimp | | | | X | X | X | X | X | X | X | X | X | X | X | X | APR-MAY | APR-MAY | APR-MAY | JAN-DEC | JAN-DEC |
| | | | | | | | | | | | | | | | | | AUG-NOV | AUG-NOV | AUG-NOV | | |
| 35 | Caribbean spiny lobster | | | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC | JAN-DEC |
| | Octopus | | | | X | X | X | X | X | X | X | X | X | X | X | X | DEC-MAR | DEC-APR | - | JAN-DEC | JAN-DEC |
| 101 | Blue crabs | | | HIGH | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | JAN-DEC |
| | Blue land crab | | | | X | X | X | X | X | X | X | X | X | X | X | X | JUL-AUG | JUL-AUG | JUL-SEP | JAN-DEC | JAN-DEC |
| | Quahog (hard clam) | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | - | JAN-DEC |
| 105 | Blackback land crab | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | JAN-DEC |
| | Blue land crab | | | | X | X | X | X | X | X | X | X | X | X | X | X | JUL-AUG | JUL-AUG | JUL-SEP | JAN-DEC | JAN-DEC |
| | Native stream shrimp | | | | | | | X | X | | | X | X | X | | | - | - | APR-MAY | - | - |
| | | | | | | | | | | | | | | | | | | | AUG-NOV | | |
| | Purple land crab | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | JAN-DEC |
| 106 | Blackback land crab | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | JAN-DEC |
| | Blue crabs | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | JAN-DEC |
| | Blue land crab | | | | X | X | X | X | X | X | X | X | X | X | X | X | JUL-AUG | JUL-AUG | JUL-SEP | JAN-DEC | JAN-DEC |
| | Penaeid shrimp | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | - |
| | Purple land crab | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | JAN-DEC |
| 107 | Blackback land crab | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | JAN-DEC |
| | Blue land crab | | | | X | X | X | X | X | X | X | X | X | X | X | X | JUL-AUG | JUL-AUG | JUL-SEP | JAN-DEC | JAN-DEC |
| | Purple land crab | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | JAN-DEC |

# PUERTO RICO - ESIMAP 13 cont.

## BIOLOGICAL RESOURCES: cont.

### MARINE MAMMAL:

| RAR# | Species | S/F | T/E | Conc. | J | F | M | A | M | J | J | A | S | O | N | D | Mating | Calving |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | Dolphins | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - |
| | Whales | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - |
| 20 | Sperm whale | S/F | E/E | HIGH | X | X | X | X | X | X | | X | X | X | X | | - | - |
| 35 | Dolphins | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - |
| | Whales | | | | X | X | X | X | X | X | X | X | X | X | X | X | - | - |
| 36 | Humpback whale | S/F | E/E | VERY HIGH | X | X | X | X | X | | | | | X | X | | - | - |
| 86 | West Indian manatee | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC |
| 105 | West Indian manatee | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC |

### REPTILE:

| RAR# | Species | S/F | T/E | Conc. | J | F | M | A | M | J | J | A | S | O | N | D | Nesting | Hatching | Internesting | Juveniles | Adults |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32 | Green sea turtle | S/F | E/T | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC | - | JAN-DEC | JAN-DEC |
| | Hawksbill sea turtle | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X | JAN-DEC | JAN-DEC | - | JAN-DEC | JAN-DEC |
| | Leatherback sea turtle | S/F | E/E | | | X | X | X | X | X | X | X | X | | | | FEB-JUN | APR-SEP | - | APR-SEP | FEB-JUN |
| 67 | Puerto Rican boa | S/F | E/E | | X | X | X | X | X | X | X | X | X | X | X | X | - | - | - | JAN-DEC | JAN-DEC |

## HUMAN USE RESOURCES:

| HUN# | Name | Owner/Manager | Contact | Phone |
|---|---|---|---|---|
| **FOREST:** | | | | |
| 57 | BOSQUE PINONES | DRNA | DIVISION DE MANEJO BOSQUES ESTATALES | 787/721-5495 |
| **WILDLIFE REFUGE:** | | | | |
| 332 | RESERVA NATURAL DE PINONES | DRNA | DIVISION DE RESERVAS NATURALES Y REFUGIOS DE VIDA SILVESTRE | 787/724-2816 |
| 344 | RESERVA TORRECILLA ALTA (PROPOSED) | DRNA | DIVISION DE RESERVAS NATURALES Y REFUGIOS DE VIDA SILVESTRE | 787/724-2816 |

### WATER INTAKE:

| HUN# | Name | Owner/Manager | Location | Phone |
|---|---|---|---|---|
| 155 | CANOVANAS FILTER PLANT | PRASA | | 787/876-0140 |

Biological information shown on the maps represents known concentration areas or occurrences, but does not necessarily represent the full distribution or range of each species. This is particularly important to recognize when considering potential impacts to protected species.

# APPENDIX E: PHOTOGRAPHIC DOCUMENTATION

**PHOTO 1 & 2: ASSESSMENT OF WETLAND AREAS (WEST RUNWAY 8-26).**



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**PHOTO 3 & 4: EMERGENT WETLAND AREAS, WEST RUNWAY 8-26.**



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**PHOTO 5 & 6: TYPICAL VIEW OF DRAINAGE CHANNELS, SOUTHEAST OF RUNWAY 8-26.**



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**PHOTO 7 & 8: STORM WATER INLET AND DRAINAGE WETLAND AREA, SOUTH RUNWAY 10-28.**



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**PHOTO 9 & 10: TYPICAL VIEW OF FRINGE SECONDARY FOREST, NORTHWEST RUNWAY 8-26.**



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**PHOTO 11 & 12: TYPICAL VIEW OF FRINGE SECONDARY FOREST, NORTHEAST RUNWAY 8-26.**



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**PHOTO 13 & 14: TYPICAL VIEW OF MANGROVE AREAS, EAST OF ROFA RUNWAY 8-26.**



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**PHOTO 15 & 16: TYPICAL VIEW OF DRAINAGE CHANNEL AND DRAINAGE WETLAND AREA, SOUTH RUNWAY 10-28.**



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# APPENDIX F: LAND USE AND HABITATS



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SOURCE: Aerostar (Aerial Imagery); Cowardin ET AL, 1979; Adapted by Ambienta Inc. 2017; ESA, 2018.

ESA

0 1,400
Feet

**Legend**

- Developed Land/Airports
- Fringe Secondary Forest
- Mangroves
- Drainage Ditches/OSW
- Seasonal/Temporal Wetlands
- Marshlands

Luiz Muñoz Marín International Airport Environmental Assessment

**Figure 1**

Land Use and Habitats Map

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# APPENDIX G: USFWS & NOAA FISHERIES PR LISTED SPECIES



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## FEDERALLY- LISTED SPECIES HAVING POTENTIAL TO OCCUR IN THE STUDY AREA

| Scientific Name<br>Common Name | USFWS Federal Listing Status | NOAA Listing Status | General Habitat | Potential to Occur in the Detailed Study Area |
|---|---|---|---|---|
| **Amphibians** | | | | |
| *Anolis roosevelti*<br>Culebra Island Giant Anole | FE | | The Culebra Island Giant Anole inhabits the forested slopes of Mt. Resaca. | **None** – No suitable habitat for this species on-site or in the surrounding area. The Study Area is not within the species current range. |
| *Eleutherodactylus cooki*<br>Guajon | FT | | The guajon typically inhabits humid forests near rivers and is found among large bolder clusters. | **None** – No suitable habitat for this species on-site or in the surrounding area. The Study Area is not within the species current range. |
| *Eleutherodactylus jasperi*<br>Golden Coqui | FT | | Species is restricted to a few fresh waterbodies containing bromeliads that are found in certain tropical/subtropical forests and rocky areas. | **None** – No suitable habitat for this species on-site or in the surrounding area The Study Area is not within the species current range. |
| .*Eleutherodactylus juanariveroi*<br>Llanero Coqui | FE | | The Llanero coqui is only found in a single wetland habitat area less than 100 square kilometers in size. All individuals are found in the one location. | **None** – No suitable habitat for this species on-site or in the surrounding area. The Study Area is not within the species current range. |
| *Peitophryne lemur*<br>Puerto Rican Crested Toad | FT | | This species has a restricted range and is known to only occur along the north and south coasts of Puerto Rico. The northern coast population has not been recorded since 1992 and may be extirpated along the northern coast. Species is known to occur in semi-arid, rocky areas of seasonal evergreen forest. | **None** – No suitable habitat for this species on-site or in the surrounding area. The Study Area is not within the species current range. |
| *Sphaerodactylus micropithecus*<br>Monito Gecko | FE | | Only found on Monito Island, which is a part of the Mona and Monito Island Nature Reserve of Puerto Rico. | **None** – No suitable habitat for this species on-site or in the surrounding area. The Study Area is not within the species current range. |
| **Birds** | | | | |
| *Accipiter striatus venator*<br>Puerto Rican Sharp-Shinned Hawk | FE | | Extant breeding populations are known from montane habitat of the Maricao Commonwealth Forest, Toro Negro Commonwealth Forest, Guilarte Commonwealth Forest, Carite Commonwealth Forest, and the Caribbean National Forest. | **None** – No suitable habitat for this species on-site or in the surrounding area. The Study Area is not within the species current range. |

| FEDERALLY- LISTED SPECIES HAVING POTENTIAL TO OCCUR IN THE STUDY AREA | | | | |
|---|---|---|---|---|
| **Scientific Name Common Name** | **USFWS Federal Listing Status** | **NOAA Listing Status** | **General Habitat** | **Potential to Occur in the Detailed Study Area** |
| *Agelaius xanthomus* Yellow-Shouldered Blackbird | FE | | This species was once commonly found in Puerto Rico's coastal dry forests; however, habitat loss and predation has limited the range of this species to three areas (islands of Mona and Monito, Roosevelt Roads Naval Station, and the dry forests along Puerto Rico's southern coastline. | **None** –The Study Area is not within the species current range. |
| *Amazona vittata* Puerto Rican Parrot | FE | | This species is found in forest habitats at elevations of 200 to 600 meters above mean sea level. | **None** – No suitable habitat for this species on-site or in the surrounding area. The Study Area is not within the species current range. |
| *Buteo platypterus brunnescens* Puerto Rican Broad-Winged Hawk | FE | | Extant populations are restricted to montane habitats of three forests: Rio Abajo Commonwealth Forest, Carite Commonwealth Forest and Caribbean National Forest. | **None** – No suitable habitat for this species on-site or in the surrounding area. The Study Area is not within the species current range. |
| *Caprimulgus noctitherus* Puerto Rican Nightjar | FE | | This species is found along the coastal and lower mountain forests of southern and southwestern Puerto Rico. | **None** – No suitable habitat for this species on-site or in the surrounding area. The Study Area is not within the species current range. |
| *Columba inornata wetmorei* Puerto Rican Plain Pigeon | FE | | Populations of this species are known to occur in the municipality of Cidra and parts of the surrounding municipalities of Cayey, Caguas, Comerio, Aguas Buenas, and Aibonito in east-central Puerto Rico. This species Is adaptive to a range of habitats. | **None** – Study Area is not within the species current range |
| *Setophaga angelae* Elfin-Woods Warbler | FT | | This species is endemic to upland forests of Puerto Rico and its range is limited to the middle to higher elevation of tropical habitats along the Cordillera Central, Sierra de Cayey and Sierra de Luquillo. | **None** – No suitable habitat for this species on-site or in the surrounding area. The Study Area is not within the species current range. |
| *Sterna dougallii dougallii* Roseate Western Hemisphere Tern | FT | | Roseate terns nest on small barrier islands, often at ends or breaks. They nest in hollows or under dense vegetation, debris or rocks. | **None** – No suitable habitat for this species on-site or in the surrounding area. |
| **Corals and Allies** | | | | |

**FEDERALLY- LISTED SPECIES HAVING POTENTIAL TO OCCUR IN THE STUDY AREA**

| Scientific Name<br>Common Name | USFWS Federal Listing Status | NOAA Listing Status | General Habitat | Potential to Occur in the Detailed Study Area |
|---|---|---|---|---|
| *Acropora cervicornis*<br>Staghorn Coral | T | T | Staghorn coral are most often observed in back reef and fore reef environments from 0-100 feet (0 to 30 meters) deep. Its growth pattern is defined by wave forces at its upper limits, and the amount of suspended sediments and light availability at its lower limits. | **None** – Actual reef environments are not located within the immediate area of the proposed project, however portions of Laguna La Torrecilla and Laguna Los Corozos may be deep enough to support habitat within the Study Area. |
| *Acropora palmate*<br>Elkhorn Coral | T | T | Elkhorn coral is typically found in shallow water (1-5 meters deep) throughout the Caribbean and on the Florida Reef Tract, in areas of heavy surf. Coral colonies prefer exposed reef crest and fore reef environments in depths of less than 6 meters, | **None** – Actual reef environments are not located within the immediate area of the proposed project, however portions of Laguna La Torrecilla and Laguna Los Corozos may be deep enough to support habitat within the Study Area. |
| *Dendrogyra cylindrus*<br>Pillar Coral | T | T | Colonies of pillar coral are found on flat or gently sloping back reef and fore reef environments from 1-25 meters in depth. | **None** – Actual reef environments are not located within the immediate area of the proposed project, however portions of Laguna La Torrecilla and Laguna Los Corozos may be deep enough to support habitat within the Study Area. |
| *Mycetophyllia ferox*<br>Rough Cactus Coral | T | T | This species is most common in fore reef environments from 5-30 meters in depth, but can also occur in certain deeper back reef habitats and deep lagoons. | **Low** – Actual reef environments are not located within the immediate area of the proposed project, however portions of Laguna La Torrecilla and Laguna Los Corozos may be deep enough to support habitat within the Study Area. |
| *Orbicella annularis*<br>Lobed Star Coral | T | T | It has recently been discovered that this species of coral contains a species complex that can be divided into three distinct species: *O. annularis*, *O. faveolata* and *M. franksi*. This species is found in the ocean between shallow and intermediate depths (between 1 to 20 meters in depth) | **None -** Actual reef environments are not located within the immediate area of the proposed project, however portions of Laguna La Torrecilla and Laguna Los Corozos may be deep enough to support habitat within the Study Area. |

**FEDERALLY- LISTED SPECIES HAVING POTENTIAL TO OCCUR IN THE STUDY AREA**

| Scientific Name<br>Common Name | USFWS Federal Listing Status | NOAA Listing Status | General Habitat | Potential to Occur in the Detailed Study Area |
|---|---|---|---|---|
| *Orbicella faveolata*<br>Mountainous Star Coral | T | T | Mountain star coral is typically found from 1-30 meters in depth, in back reef and fore-reef habitats. This species is considered the most abundant coral between 10-20 meters in depth within four-reef environments. | **None** - Actual reef environments are not located within the immediate area of the proposed project, however portions of Laguna La Torrecilla and Laguna Los Corozos may be deep enough to support habitat within the Study Area. |
| *Orbicella franksi*<br>Boulder Star Coral | T | T | This species is found from 1-30 meters in depth, in back reef and fore-reef marine habitats. | **None** - Actual reef environments are not located within the immediate area of the proposed project, however portions of Laguna La Torrecilla and Laguna Los Corozos may be deep enough to support habitat within the Study Area. |
| **Fish** | | | | |
| *Epinephelus striatus*<br>*Nassau Grouper* | CS | T | Nassau groupers typically occur in water depths of at least 130 meters and are most abundant in clear water with rocky substrate. The eggs and larvae are left to open water surfaces of the ocean; however, as Juveniles they inhibit mangroves, sea grass beds, and coarse rubble areas where they feed on small crustaceans and fishes. | **Low** – Although suitable habitat exists adjacent to the Study Area, the airfield ditches are shallow features that are clogged / heavily vegetated surface waters that receive freshwater input from the western side of the airfield. |
| *Sphyrna lewini*<br>*Scalloped Hammerhead Shark* | T | T | The scalloped hammerhead shark is a coastal and semi-oceanic pelagic shark, It is found over insular shelves and in deep water, ranging from the intertidal and surface to at least 275 meters in depth. The pups of this species tend to stay in coastal zones, near the bottom, occurring at high concentrations during summer in estuaries and bays. Neonates and juveniles are known to shoal in confined coastal pupping areas for up to two years before moving out to adult habitat. | **None** - No suitable habitat for this species on-site or in the surrounding area. |
| **Mammals** | | | | |
| *Balaenoptera borealis*<br>Sei Whale | E | E | Sei whales are observed in deeper waters of the ocean, far from the coastline. | **None** - No suitable habitat for this species on-site or in the surrounding area. |
| *Balaenoptera musculus*<br>Blue Whale | E | E | This species is can be found worldwide and typically occur offshore more so than any other whale species. | **None** - No suitable habitat for this species on-site or in the surrounding area. |
| *Balaenoptera physalus*<br>Fin Whale | E | E | Fin whales are typically found in deep waters of all major oceans, however are less commonly observed in the tropics. | **None** - No suitable habitat for this species on-site or in the surrounding area. |

**FEDERALLY- LISTED SPECIES HAVING POTENTIAL TO OCCUR IN THE STUDY AREA**

| Scientific Name<br>Common Name | USFWS Federal Listing Status | NOAA Listing Status | General Habitat | Potential to Occur in the Detailed Study Area |
|---|---|---|---|---|
| *Physeter microcephalus*<br>*Sperm Whale* | E | E | Sperm Whales are found in almost all marine waters deeper than 1,000 m that are not covered in ice, except in the Black and Red Sea. | **None** - No suitable habitat for this species on-site or in the surrounding area**.** |
| *Trichechus manatus*<br>West Indian Manatee | FT | | Manatees are found in marine, estuarine, and freshwater environments. This species favors habitat that is protected from severe wave action and supports an abundance of submerged aquatic vegetation such as sea grass, eelgrass, and/or other aquatic plants that grow in shallow coastal waters and rivers. Manatees also require a source of fresh water for consumption. As reported by USFWS, the Antillean manatee occurs more frequently along the southern coast of Puerto Rico, than the northern coast. They are least abundant along the north coast, between Rincón and Dorado and on the west along Añasco. | **Low** – Although suitable habitat exists in the vicinity of the Study Area, no suitable habitat exists on-site. A majority of the on-site ditches and canals are narrow, shallow, and vegetated with dense stands of vegetation that would make navigation impractical for manatees. The large drainage canal on the west side of the airfield has limited access and minimal habitat value for this species. |
| **Reptiles** | | | | |
| *Caretta Caretta*<br>Loggerhead Sea Turtle | E | T | Loggerhead sea turtles can occur in three different ecosystems: 1) Beaches, 2) Open Ocean, and 3) Nearshore Coastal Areas. Loggerheads nest on beaches that exhibit high energy waves, with narrow, steeply sloped coarse-grained beaches. Juvenile turtles migrate to nearshore coastal bays, lagoons and estuaries where they may tend to forage year-round. | **Low** - There is a potential for loggerhead turtles to utilize the adjacent lagoon, however the shallow, vegetation filled ditch features within the Study Area do not provide suitable habitat. |
| *Chelonia mydas*<br>Green Turtle | E | T | Green sea turtles typically utilize three types of habitats: 1) beaches for nesting, 2) Open Ocean and 3) Coastal Areas. Hatchlings emerge from beach nests and swim to offshore areas, where they stay for several years. Juveniles typically move to nearshore benthic habitats, where they feed almost exclusively on sea grasses and algae. | **Low** - There is a potential for green sea turtles to utilize the adjacent lagoon, however the shallow, vegetation filled ditch features within the Study Area do not provide suitable habitat. |
| *Cyclura stejnegeri*<br>Mona Ground Iguana | FT | | Endemic to Mona Island located west of Puerto Rico. | **None** – No suitable habitat for this species on-site. Study Area is not within the species current Range. |
| *Dermochelys coriacea*<br>Leatherback Sea Turtle | FE | | Leatherbacks are commonly known as pelagic animals that USFWS notes, requires sandy open nesting beaches that are significantly slopped, with close proximity to deep water and generally rough seas. | **None** – No suitable foraging or nesting habitat for this species on-site or in the surrounding area**.** |

**FEDERALLY- LISTED SPECIES HAVING POTENTIAL TO OCCUR IN THE STUDY AREA**

| Scientific Name<br>Common Name | USFWS Federal Listing Status | NOAA Listing Status | General Habitat | Potential to Occur in the Detailed Study Area |
|---|---|---|---|---|
| *Epricates inornatus*<br>Puerto Rican Boa | FE | | The Puerto Rican Boa is endemic to the island of Puerto Rico and is more common in the karst region on the northwestern part of the island. Greatest abundance of Puerto Rican Boas is found areas dominated by caves and sinkholes. | **None to Low** – Greatest abundance of Puerto Rican Boas are found along the karst region of Puerto Rico and inhabiting extensive forested areas.. |
| *Epricates monensis granti*<br>Virgin Islands Tree Boa | FE | | The Virgin Islands Tree Boa is found in both US and British Virgin Islands and islands off of Puerto Rico. In Puerto Rico, this species is known or believed to occur in the Counties of Ceiba, Culebra, Humacao, Luquillo, and Rio Grande. | **None to Low** – Greatest abundance of Virgin Island Tree Boas are found along the eastern portion of Puerto Rico and inhabiting the Puerto Rican Islands. Study Area is not within the species current Range. |
| *Epicrates monensis monensis*<br>Mona Boa | FT | | Mona boas are found around Mona Island and Cayo Diablo, near Puerto Rico. | **None** – Study Area is not within the species current Range. |
| *Eretmochelys imbricate*<br>Hawksbill Sea Turtle | FE | | Most commonly associated with coral reefs, post – hatchlings are known to take shelter in the pelagic environment of the Atlantic Ocean. Known to also inhabit mangrove fringed bays and estuaries along the eastern edge of continents where coral reefs are absent. NOAA reports that nesting occurs typically on pocket beaches with little to no sand. Critical habitat has been designated for this species along the coastal waters off of Mona and Monito Islands. | **Low** – Although suitable habitat occurs adjacent to the Study Area, a majority of the on-site ditches and canals are narrow, shallow, and vegetated with dense stands of vegetation. The large drainage canal on the west side of the airfield has limited access and minimal habitat value for this species. The Study Area does not contain suitable nesting habitat. |
| **Plants** | | | | |
| Adiantum vivesii | FE | | The only known population of this species exists on privately owned land. This species inhabits deeply shaded hollows at the base of north-facing limestone cliffs at a lower to middle elevation of 250 meters above sea level. | **None** – Species range does not occur within or near the Study Area. |
| Aristida chaseae | FE | | This species is known from three locations: Sierra Bermeja hills of Cabo Rojo, Cabo Rojo National Wildlife Refuge (CRNWR) and Peñones de Melones. | **None** – Study Area is not within the species current Range. |
| *Aristida portoricensis*<br>Pelos del Diablo | FE | | Pelos de diablo occurs on a small plot of land in Cerro las Mesas at an elevation of 350 meters above sea level. | **None** - Suitable habitat does not exist within the Study Area. |
| Auerodendron pauciflorum | FE | | Species found in woodlands on limestone cliffs. | **None** – Suitable habitat does not exist within the Study Area. |

**FEDERALLY- LISTED SPECIES HAVING POTENTIAL TO OCCUR IN THE STUDY AREA**

| Scientific Name<br>Common Name | USFWS Federal Listing Status | NOAA Listing Status | General Habitat | Potential to Occur in the Detailed Study Area |
|---|---|---|---|---|
| *Banara banderbiltii*<br>Pala de Ramon | FE | | Found in evergreen forests on limestone hills at 100 to 160 meters above sea level. | **None** – Suitable habitat does not exist within the Study Area. |
| *Buxus vahlii*<br>Vahl's boxwood | FE | | This species is known occur within the subtropical dry forest life zone and to a lesser extent the subtropical moist forest life zone. At this time there are only two locations where this species is known to exist, 1) the nuclear power plant site at Rincon and 2) Hato Tejas, Bayamon. | **None** – Suitable habitat does not exist within the Study Area. |
| *Callicarpa ampla*<br>Capa Rosa | FE | | The capa rosa is found in dwarf forests that occur at elevations above 600 meters above sea level. This species coverage is currently restricted to the El Yunque National Forest in eastern Puerto Rico. | **None** – Suitable habitat does not exist within the Study Area. |
| *Calyptronoma rivalis*<br>Palma de Manaca | FT | | The species occurs naturally in three known locations, Quebrada Collazo, Rio Camuy and Rio Guajataca. A riparian species, it is found in the limestone region of northwest Puerto Rico. | **None** – Suitable habitat does not exist within the Study Area. |
| *Catesbaea melanocarpa*<br>Tropical Lilythorn | FE | | *Catesbaea melanocarpa* occurs in the subtropical dry forest life zone, the driest life zone in Puerto Rico. | **None** – Suitable habitat does not exist within the Study Area. |
| *Chamaecrista glandulosa var. mirabills* | FE | | This species was once distributed throughout the silica sands in northern Puerto Rico, however, by the late 1990s the species was restricted to two areas: 1) in Dorado and 2) the southern shore of the Tortuguero Lagoon. | **None** - Suitable habitat does not exist within the Study Area. |
| *Cordia bellonis* | FE | | *Cordia bellonis* is found in the western part of the Cordillera Central mountain range in Puerto Rico in open areas exposed to the sun. The total population of Cordia bellonis is estimated at only 200 individuals distributed in three state forests: Maricao, Susúa, and Rio Abajo. | **None** – Suitable habitat does not exist within the Study Area. |
| *Cornutia obovate*<br>Palo de nigua | FE | | This species is found in the evergreen and sub evergreen forests of the subtropical moist forest life zone on limestone hills. | **None** – Suitable habitat does not exist within the Study Area. |
| *Cranichis ricartii* | FE | | This plan species grows in humus of moist serpentine scrub forests of montane ridges at elevations above 680 meters above sea level. | **None** - Suitable habitat does not exist within the Study Area. |
| *Crescentia portoricensis*<br>Higuero de Sierra | FE | | Higuero de sierra distribution is limited to remnants of native vegetation overlying serpentine rock outcrops in southwestern Puerto Rico. Endemic to serpentine soils. | **None** – Suitable habitat does not exist within the Study Area. |
| *Cyathea dryopteroides*<br>Elfin tree Fern | FE | | This species is restricted to elfin or dwarf forests of the central mountains of Puerto Rico. | **None** – Suitable habitat does not exist within the Study Area. |
| *Daphnopsis hellerana* | FE | | This plant species is known to be located in the evergreen and semi-evergreen seasonal forests of the subtropical moist forest life zone on<br>the limestone hills of the northwest coast at elevations between 150 to 350 meters above sea level. | **None** - Suitable habitat does not exist within the Study Area. |
| *Elaphoglossum serpens* | FE | | *Elaphoglossum serpens* specimens are known to occur in the limestone or karst region of northwestern Puerto Rico. | **None** - Suitable habitat does not exist within the Study Area. |

**FEDERALLY- LISTED SPECIES HAVING POTENTIAL TO OCCUR IN THE STUDY AREA**

| Scientific Name<br>Common Name | USFWS Federal Listing Status | NOAA Listing Status | General Habitat | Potential to Occur in the Detailed Study Area |
|---|---|---|---|---|
| *Eugenia hematocarpa*<br>Uvillo | FE | | This species occurs only in subtropical lower montane, wet forest zone of Puerto Rico. | **None** – Suitable habitat does not exist within the Study Area. |
| *Eugenia woodburyana* | FE | | This species is known to occur within the subtropical dry forest life zone. | **None** - Suitable habitat does not exist within the Study Area. |
| *Gesneria pauciflora* | FT | | *Gesneria pauciflora* is known to occur only on serpentine soils in the western mountains of Puerto Rico. | **None** - Suitable habitat does not exist within the Study Area |
| *Goetze elegans*<br>Beautiful goetzea | FE | | This species typically requires a semi-evergreen seasonal forest with and almost continuous upper canopy. | **None** – Suitable habitat does not exist within the Study Area. |
| *Gonocalyx concolor* | FE | | *Gonocalyx concolor* critical habitat is 198 acres of Elfin and Ausubo forests at the Carite Commonwealth Forest in east-central Puerto Rico. | **None** – Suitable habitat does not exist within the Study Area. |
| *Harrisia portoricensis*<br>Higo Chumbo | FT | | Since its listing, this species occurrence is restricted to three islands, Mona, Monito and Desecheo. One individual is present in the Cabo Rojo National Wildlife Refuge and five individuals in the Caja de Muertos Natural Reserve. | **None** – Suitable habitat does not exist within the Study Area. |
| *Ilex cookie*<br>Cook's holly | FE | | This species is known to occur on two mountain peaks in central Puerto Rico (Cerro Punta and Monte Jayuya) | **None** – Suitable habitat does not exist within the Study Area. |
| *Ilex sintenisii* | FE | | All the localities of *Ilex sintenisii* occur in the dwarf forest vegetation type in the Luquillo Mountains region. | **None** – Suitable habitat does not exist within the Study Area. |
| *Juglans jamacensis*<br>West Indian Walnut | FE | | This species is known to occur on lands adjacent to Monte Guilarte Commonwealth forest in the Central Mountains of Puerto Rico. | **None** – Suitable habitat does not exist within the Study Area. |
| *Lepanhtes eltoroensis* | FE | | This plant species is known to occur within the forest ecosystems within the Caribbean National Forest (tabonuco, colorado, sierra palm, and dwarf forest ecosystems). | **None** – Suitable habitat does not exist within the Study Area. |
| *Leptocereus grantianus* | FE | | This species occurs on the island of Culebra falls within the subtropical dry forest life zone. | **None** – Suitable habitat does not exist within the Study Area. |
| *Lyonia truncate var. proctorii* | FE | | This species of Lyoia is endemic to Puerto Rico and is known to occur only in the southwestern municipalities of Cabo Rojo and/or Lajas | **None** – Suitable habitat does not exist within the Study Area. |
| *Mitracarpus maxwelliae* | FE | | *Mitracarpus maxwelliae* is found in the vegetation type which has been described as coastal scrub forest over exposed limestone rock or coastal dwarf forest, where the species grows in crevices and soil pockets of coastal rocks. | **None** – Suitable habitat does not exist within the Study Area. |
| *Mitracarpus polycadus* | FE | | This species, as well as *M. maxwelliae,* above, are found in the vegetation type which has been described as coastal scrub forest over exposed limestone rock or coastal dwarf forest, where the species grows in crevices and soil pockets of coastal rocks. | **None** – Suitable habitat does not exist within the Study Area. |

**FEDERALLY- LISTED SPECIES HAVING POTENTIAL TO OCCUR IN THE STUDY AREA**

| Scientific Name<br>Common Name | USFWS Federal Listing Status | NOAA Listing Status | General Habitat | Potential to Occur in the Detailed Study Area |
|---|---|---|---|---|
| *Myrcia paganii* | FE | | This species occurs in seasonal evergreen or semi-evergreen forest types of the subtropical moist forest life zone in the limestone region of north and northwestern Puerto Rico. | **None** – Suitable habitat does not exist within the Study Area. |
| *Ottoschulzia rhodoxylon*<br>Palo de Rosa | FE | | Known to occur in the limestone hills of north coast or upper slopes of summits and hills and within areas of low rainfall. | **None** – Suitable habitat does not exist within the Study Area. |
| *Peperomia wheeleri*<br>Wheeler's Peperomia | FE | | This species is known to occur in the understory of a semi evergreen seasonal forest, where it grows in humus. | **None** – Suitable habitat does not exist within the Study Area. |
| *Pleodendron macranthum*<br>Chupacallos | FE | | The natural distribution of Chupacallos is limited to the Luquillo Mountains in El Yunque National Forest and the Rio Abajo Commonwealth Forest. | **None** – Suitable habitat does not exist within the Study Area. |
| *Polystichum calderonense* | FE | | Species is found in the limestone or karst region of northwest Puerto Rico. | **None** – Suitable habitat does not exist within the Study Area. |
| *Schoepfia arenaria* | FT | | This species inhabits karst regions or northern Puerto Rico. Specific to steep rounded hills, caves, and/or sinkholes. | **None** – Suitable habitat does not exist within the Study Area. |
| *Solanum drymophilum*<br>Erubia | FE | | Erubia is known in several locations at elevations ranging from 70 to 825 meters above sea level. It occurs mainly on limestone and also on volcanic substrates. | **None** – Suitable habitat does not exist within the Study Area. |
| *Stahlia monosperma*<br>Cobana Negra | FT | | Grows within the subtropical dry forest and subtropical moist forest life zones (specifically the south-southwest coast of Puerto Rico, most of Vieques Island, all of Culebra Island and the northeastern most part of Puerto Rico). | **None** – Suitable habitat does not exist within the Study Area. |
| *Styrax protoricensis*<br>Palo de Jazmin | FE | | One known specimen occurs west of El Cacique – the Palo Colorado association (evergreen forest). | **None** – Suitable habitat does not exist within the Study Area. |
| *Tectaria estremerana* | FE | | *Tectaria estremerana* occurs within the karst region of northwest Puerto Rico. | **None** – Suitable habitat does not exist within the Study Area. |
| *Thernstroemia luquillensis*<br>*Palo Colorado* | FE | | This species occurs within the Palo Colorado association (evergreen forest) at elevations over 600 meters above sea level. | **None** – Suitable habitat does not exist within the Study Area. |
| *Ternstroemia subsessilis* | FE | | This species occurs within the Palo Colorado association (evergreen forest) at an elevation greater than 600 meters above sea level. | **None** – Suitable habitat does not exist within the Study Area. |
| *Thelypteris inabonensis* | FE | | This plant species is known to occur in Rio Inabon in the municipality of Ponce on the southern coast of Puerto Rico. | **None** – Suitable habitat does not exist within the Study Area. |
| *Thelypteris verecunda* | FE | | *Thelypteris vercunda* is found to occur within the karst region of northwest Puerto Rico. | **None** – Suitable habitat does not exist within the Study Area. |

**FEDERALLY- LISTED SPECIES HAVING POTENTIAL TO OCCUR IN THE STUDY AREA**

| Scientific Name<br>Common Name | USFWS Federal Listing Status | NOAA Listing Status | General Habitat | Potential to Occur in the Detailed Study Area |
|---|---|---|---|---|
| *Thelypteris yaucoensis* | FE | | This species grows on humus, on steep shaded rocky banks and ledges at high elevations (850-1200 meters above sea level). | **None** – Suitable habitat does not exist within the Study Area. |
| *Trichilia triacantha*<br>Bariaco | FE | | This species is known to occur in Guanica, Yauco, Guayanilla Santo Domingo, Cabo Rojo, Lajas, and Sabana Grande Counties, at elevations from 25 to 175 meters above sea level on specific soil types. | **None** – Suitable habitat does not exist within the Study Area. |
| *Varronia rupicola* | FT | | This species occurs in dry forested habitat along the southern Puerto Rico coast. | **None** – Suitable habitat does not exist within the Study Area. |
| *Vernonia proctorii* | FE | | This plant species is found within the subtropical dry forest life zone in Cabo Rojo National Wildlife Refuge. | **None** – Suitable habitat does not exist within the Study Area. |
| *Zanthoxylum thomasianum*<br>*St Thomas Prickly-ash* | FE | | This species occurs on rocky outcrops, steep hillsides, and on hilly summits in north western Puerto Rico. Its growth is confined to dry forest over rock of volcanic origin. | **None** – Suitable habitat does not exist within the Study Area. |

*Species were evaluated for their potential to occur within the Study Area and, therefore, their potential to be impacted by the Proposed Project. Potential to occur was based on a combination of database compilation and the 2015 Environmental Assessment.

Status Codes :

FE = Endangered (Federal)
FT = Threatened (Federal)
CS = Candidate Species (Federal)

Life Zones – Identified by the U.S. Department of Agriculture, Forest Service. Puerto Rico contains six (6) life zones. Live zones are grouped by 1) Latitudinal Region, 2) Altitude and 3) Humidity Province, Both mean biotemperature and mean annual precipitation are variables used to delineate a given live zone. The 6 life zones include: the Subtropical Dry Forest, Subtropical Moist Forest, Subtropical Wet Forest, Subtropical Rain Forest, Subtropical Lower montane Wet Forest, and the Subtropical Lower Montane Rain Forest.

SOURCE: USFWS.

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***Two sided printing document format.***



AMBIENTA INC.
*Environmental Consultants*
HC2 BOX 14029 AGUAS BUENAS, PR 00703
TEL. (787) 510-7031 / (787) 732-0907
FAX (787) 732-0907 / ambientainc@gmail.com

# APPENDIX H: USFWS LETTER DATED AUGUST 22, 2017.



AMBIENTA INC.
Environmental Consultants
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***Two sided printing document format.***



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# United States Department of the Interior

FISH AND WILDLIFE SERVICE
Caribbean Ecological Services
Field Office
P.O. Box 491
Boqueron, PR 00622

AUG 2 2 2017

In Response Reply To:
FWS/R4/CESFO/72031-014

Mr. Peter M. Green
Program Manager
ESA
4200 West Cypress St.
Suite 450
Tampa, Florida 33607

Re: Preparation of Environmental Assessment for Object Free Area and Airfield Drainage Improvements, Luis Muñoz Marín International Airport, San Juan, Puerto Rico

Dear Mr. Green

Thank you for your July 6, 2017, letter notifying our office that Aerostar Airport Holdings (Aerostar) is preparing an Environmental Assessment (EA) for the proposed clearing of vegetation within the runway and taxiway Object Free Areas and the implementation of drainage improvements at Luis Muñoz Marín International Airport. Our comments are provided as technical assistance in accordance the Endangered Species Act (16 U.S.C. 1531 et seq. as amended) and the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

This project was presented at a recent U.S. Army Corps of Engineers interagency meeting. The information presented and the discussion during that meeting greatly assisted our office in understanding the nature and need of these two projects. The establishment of Object Free Areas along runways and taxiways is an FAA safety requirement. The maintenance of the existing drainages of the airport is needed to avoid flooding of the runway and taxiway areas and ensure proper stormwater runoff.

Both of these projects would require the clearing, removal or trimming of vegetation which includes upland species and mangrove wetlands. The EA will also mitigation for the unavoidable impacts to wetlands. Based on the information provided we have the following comments and recommendations:

1) Based on the information provided and the information in our files, there are no listed species under the purview of the Service within the airport property limits.

2) The only suitable wetland mitigation site within the airport property is a triangle shaped lot adjacent to the Vista Mar and Villa Venecia residential areas. This lot is on the opposite banks of Suarez Channel but is within the airport property line. Any mitigation for wetland impacts should first consider this area prior to moving off site.

3) There are several ongoing Resource Conservation and Recovery Act (RCRA) actions currently being undertaken at the airport. Most if not all of these involve fuel contamination of ground water. Consideration of contaminated groundwater migrating into the improved drainage areas and stormwater ditches should be considered in the drainage study being conducted by the airport. Migration of contaminated groundwater into the ditches may cause chronic sheening in these areas and into Suarez Channel, Torrecilla Lagoon and San Jose Lagoon.

Thank you for the opportunity to comment on this action if you have any questions please contact Felix Lopez of my staff at 787 851 7297 x 210.

Sincerely yours,

Edwin E. Muñiz
Field Supervisor

fhl
cc:
DNER, San Juan
EQB, San Juan
EPA, San Juan
FAA, San Juan
Jaime Pabon, AeroStar, San Juan

# APPENDIX D

Essential Fish Habitat Data

**EFH Data Notice:** Essential Fish Habitat (EFH) is defined by textual descriptions contained in the fishery management plans developed by the regional Fishery Management Councils. In most cases mapping data can not fully represent the complexity of the habitats that make up EFH. This report should be used for general interest queries only and should not be interpreted as a definitive evaluation of EFH at this location. A location-specific evaluation of EFH for any official purposes must be performed by a regional expert. Please refer to the following links for the appropriate regional resources.

Southeast Regional Office
Atlantic Highly Migratory Species Management Division

## Query Results

Map Scale = 1:144,448
Degrees, Minutes, Seconds: Latitude = 18º25'23" N, Longitude = 66º1'28" E
Decimal Degrees: Latitude = 18.42, Longitude = -66.02

The query location intersects with spatial data representing EFH and/or HAPCs for the following species/management units.

### EFH

| Show | Link | Data Caveats | Species/Management Unit | Life stage(s) Found at Location | Management Council | FMP |
|---|---|---|---|---|---|---|
|  |  |  | Reef Fish (43 Species)<br>**Balistidae - Triggerfishes**<br>Gray triggerfish (*Balistes capriscus*)<br>**Carangidae - Jacks**<br>Greater amberjack (*Seriola dumerili*)<br>Lesser amberjack (*Seriola fasciata*)<br>Almaco jack (*Seriola rivoliana*)<br>Banded rudderfish (*Seriola zonata*)<br>**Labridae - Wrasses**<br>Hogfish (*Lachnolaimus maximus*)<br>**Lutjanidae - Snappers**<br>Queen snapper (*Etelis oculatus*)<br>Mutton snapper (*Lutjanus analis*)<br>Schoolmaster (*Lutjanus apodus*)<br>Blackfin snapper (*Lutjanus buccanella*)<br>Red snapper (*Lutjanus campechanus*)<br>Cubera snapper (*Lutjanus cyanopterus*)<br>Gray (mangrove) snapper (*Lutjanus* | Post-Egg/Larval<br>Larval<br>ALL | Caribbean | Reef Fish |

| Show | Link | Data Caveats | Species/Management Unit | Life stage(s) Found at Location | Management Council | FMP |
|---|---|---|---|---|---|---|
| | | | *griseus*)<br>Dog snapper (*Lutjanus jocu*)<br>Mahogany snapper (*Lutjanus mahogoni*)<br>Lane snapper (*Lutjanus synagris*)<br>Silk snapper (*Lutjanus vivanus*)<br>Yellowtail snapper (*Ocyurus chrysurus*)<br>Wenchman (*Pristipomoides aquilonaris*)<br>Vermilion snapper (*Rhomboplites aurorubens*)<br>**Malacanthidae - Tilefishes**<br>Goldface tilefish (*Caulolatilus chrysops*)<br>Blackline tilefish (*Caulolatilus cyanops*)<br>Anchor tilefish (*Caulolatilus intermedius*)<br>Blueline tilefish (*Caulolatilus microps*)<br>(Golden) Tilefish (*Lopholatilus chamaeleonticeps*)<br>**Serranidae - Groupers**<br>Dwarf sand perch (*Diplectrum bivittatum*)<br>Sand perch (*Diplectrum formosum*)<br>Rock hind (*Epinephelus adscensionis*)<br>Speckled hind (*Epinephelus drummondhayi*)<br>Yellowedge grouper (*Epinephelus flavolimbatus*)<br>Red hind (*Epinephelus guttatus*)<br>Goliath grouper (*Epinephelus itajara*)<br>Red grouper (*Epinephelus morio*)<br>Misty grouper (*Epinephelus* | | | |

| Show | Link | Data Caveats | Species/Management Unit | Life stage(s) Found at Location | Management Council | FMP |
|---|---|---|---|---|---|---|
| | | | *mystacinus*)<br>Warsaw grouper (*Epinephelus nigritus*)<br>Snowy grouper (*Epinephelus niveatus*)<br>Nassau grouper (*Epinephelus striatus*)<br>Marbled grouper (*Epinephelus inermis*)<br>Black grouper (*Mycteroperca bonaci*)<br>Yellowmouth grouper (*Mycteroperca interstitialis*)<br>Gag (*Mycteroperca microlepis*)<br>Scamp (*Mycteroperca phenax*)<br>Yellowfin grouper (*Mycteroperca venenosa*) | | | |
| | | | Queen Conch | Larval<br>ALL | Caribbean | Queen Conch |
| | | | Corals | Larval<br>ALL | Caribbean | Corals |
| | | | Spiny Lobster (2 Species)<br>Spiny lobster (*Panulirus argus*)<br>Slipper lobster (*Scyllarides nodifer*) | Larval<br>ALL | Caribbean | Spiny Lobster |
| | | | Caribbean Reef Shark | ALL | Secretarial | Amendment 10 to the 2006 Consolidated HMS FMP: EFH |

### Pacific Salmon EFH

No Pacific Salmon Essential Fish Habitat (EFH) were identified at the report location.

### HAPCs

No Habitat Areas of Particular Concern (HAPC) were identified at the report location.

### EFH Areas Protected from Fishing

| Show | Link | Name | Management Council |
|---|---|---|---|
| | | Caribbean EEZ gear restrictions | Caribbean |

**Spatial data does not currently exist for all the managed species in this area. The following is a list of species or management units for which there is no spatial data. **For links to all EFH text descriptions see the complete data inventory: open data inventory -->**

**Caribbean HAPCs**,
Los Corchos Reef - Culebra,
Luis Pena Channel - Culebra

**EFH Data Notice:** Essential Fish Habitat (EFH) is defined by textual descriptions contained in the fishery management plans developed by the regional Fishery Management Councils. In most cases mapping data can not fully represent the complexity of the habitats that make up EFH. This report should be used for general interest queries only and should not be interpreted as a definitive evaluation of EFH at this location. A location-specific evaluation of EFH for any official purposes must be performed by a regional expert. Please refer to the following links for the appropriate regional resources.

Southeast Regional Office
Atlantic Highly Migratory Species Management Division

## Query Results

Map Scale = 1:144,448
Degrees, Minutes, Seconds: Latitude = 18º26'35" N, Longitude = 65º59'3" E
Decimal Degrees: Latitude = 18.44, Longitude = -65.98

The query location intersects with spatial data representing EFH and/or HAPCs for the following species/management units.

### EFH

| Show | Link | Data Caveats | Species/Management Unit | Life stage(s) Found at Location | Management Council | FMP |
|---|---|---|---|---|---|---|
| | | | Corals | Post-Egg/Larval<br>Larval<br>ALL | Caribbean | Corals |
| | | | Queen Conch | Post-Egg/Larval<br>Larval<br>ALL | Caribbean | Queen Conch |
| | | | Spiny Lobster (2 Species)<br>Spiny lobster (*Panulirus argus*)<br>Slipper lobster (*Scyllarides nodifer*) | Post-Egg/Larval<br>Larval<br>ALL | Caribbean | Spiny Lobster |
| | | | Reef Fish (43 Species)<br>**Balistidae - Triggerfishes**<br>Gray triggerfish (*Balistes capriscus*)<br>**Carangidae - Jacks**<br>Greater amberjack (*Seriola dumerili*)<br>Lesser amberjack (*Seriola fasciata*)<br>Almaco jack (*Seriola rivoliana*)<br>Banded rudderfish (*Seriola zonata*)<br>**Labridae - Wrasses**<br>Hogfish (*Lachnolaimus maximus*)<br>**Lutjanidae - Snappers**<br>Queen snapper (*Etelis oculatus*)<br>Mutton snapper | Post-Egg/Larval<br>Larval<br>ALL | Caribbean | Reef Fish |

| Show | Link | Data Caveats | Species/Management Unit | Life stage(s) Found at Location | Management Council | FMP |
|---|---|---|---|---|---|---|
| | | | (*Lutjanus analis*)<br>Schoolmaster (*Lutjanus apodus*)<br>Blackfin snapper (*Lutjanus buccanella*)<br>Red snapper (*Lutjanus campechanus*)<br>Cubera snapper (*Lutjanus cyanopterus*)<br>Gray (mangrove) snapper (*Lutjanus griseus*)<br>Dog snapper (*Lutjanus jocu*)<br>Mahogany snapper (*Lutjanus mahogoni*)<br>Lane snapper (*Lutjanus synagris*)<br>Silk snapper (*Lutjanus vivanus*)<br>Yellowtail snapper (*Ocyurus chrysurus*)<br>Wenchman (*Pristipomoides aquilonaris*)<br>Vermilion snapper (*Rhomboplites aurorubens*)<br>**Malacanthidae - Tilefishes**<br>Goldface tilefish (*Caulolatilus chrysops*)<br>Blackline tilefish (*Caulolatilus cyanops*)<br>Anchor tilefish (*Caulolatilus intermedius*)<br>Blueline tilefish (*Caulolatilus microps*)<br>(Golden) Tilefish (*Lopholatilus chamaeleonticeps*)<br>**Serranidae - Groupers**<br>Dwarf sand perch (*Diplectrum bivittatum*)<br>Sand perch (*Diplectrum formosum*)<br>Rock hind (*Epinephelus adscensionis*)<br>Speckled hind (*Epinephelus* | | | |

| Show | Link | Data Caveats | Species/Management Unit | Life stage(s) Found at Location | Management Council | FMP |
|---|---|---|---|---|---|---|
| | | | *drummondhayi*)<br>Yellowedge grouper (*Epinephelus flavolimbatus*)<br>Red hind (*Epinephelus guttatus*)<br>Goliath grouper (*Epinephelus itajara*)<br>Red grouper (*Epinephelus morio*)<br>Misty grouper (*Epinephelus mystacinus*)<br>Warsaw grouper (*Epinephelus nigritus*)<br>Snowy grouper (*Epinephelus niveatus*)<br>Nassau grouper (*Epinephelus striatus*)<br>Marbled grouper (*Epinephelus inermis*)<br>Black grouper (*Mycteroperca bonaci*)<br>Yellowmouth grouper (*Mycteroperca interstitialis*)<br>Gag (*Mycteroperca microlepis*)<br>Scamp (*Mycteroperca phenax*)<br>Yellowfin grouper (*Mycteroperca venenosa*) | | | |
| | | | Caribbean Reef Shark | ALL | Secretarial | Amendment 10 to the 2006 Consolidated HMS FMP: EFH |
| | | | Oceanic Whitetip Shark | ALL | Secretarial | Amendment 10 to the 2006 Consolidated HMS FMP: EFH |

### Pacific Salmon EFH

No Pacific Salmon Essential Fish Habitat (EFH) were identified at the report location.

### HAPCs

No Habitat Areas of Particular Concern (HAPC) were identified at the report location.

### EFH Areas Protected from Fishing

| Show | Link | Name | Management Council |
|---|---|---|---|
| | | Caribbean EEZ gear restrictions | Caribbean |

| **Spatial data does not currently exist for all the managed species in this area. The following is a list of species or management units for which there is no spatial data. **For links to all EFH text descriptions see the complete data inventory: open data inventory -->** |
| --- |
| **Caribbean HAPCs**,<br>Los Corchos Reef - Culebra,<br>Luis Pena Channel - Culebra |

# APPENDIX E

United States Fish and Wildlife Service - Response Letter, Dated August 2017

# United States Department of the Interior

FISH AND WILDLIFE SERVICE
Caribbean Ecological Services
Field Office
P.O. Box 491
Boqueron, PR 00622

AUG 2 2 2017

In Response Reply To:
FWS/R4/CESFO/72031-014

Mr. Peter M. Green
Program Manager
ESA
4200 West Cypress St.
Suite 450
Tampa, Florida 33607

Re: Preparation of Environmental Assessment for Object Free Area and Airfield Drainage Improvements, Luis Muñoz Marín International Airport, San Juan, Puerto Rico

Dear Mr. Green

Thank you for your July 6, 2017, letter notifying our office that Aerostar Airport Holdings (Aerostar) is preparing an Environmental Assessment (EA) for the proposed clearing of vegetation within the runway and taxiway Object Free Areas and the implementation of drainage improvements at Luis Muñoz Marín International Airport. Our comments are provided as technical assistance in accordance the Endangered Species Act (16 U.S.C. 1531 et seq. as amended) and the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

This project was presented at a recent U.S. Army Corps of Engineers interagency meeting. The information presented and the discussion during that meeting greatly assisted our office in understanding the nature and need of these two projects. The establishment of Object Free Areas along runways and taxiways is an FAA safety requirement. The maintenance of the existing drainages of the airport is needed to avoid flooding of the runway and taxiway areas and ensure proper stormwater runoff.

Both of these projects would require the clearing, removal or trimming of vegetation which includes upland species and mangrove wetlands. The EA will also mitigation for the unavoidable impacts to wetlands. Based on the information provided we have the following comments and recommendations:

1) Based on the information provided and the information in our files, there are no listed species under the purview of the Service within the airport property limits.

2) The only suitable wetland mitigation site within the airport property is a triangle shaped lot adjacent to the Vista Mar and Villa Venecia residential areas. This lot is on the opposite banks of Suarez Channel but is within the airport property line. Any mitigation for wetland impacts should first consider this area prior to moving off site.

3) There are several ongoing Resource Conservation and Recovery Act (RCRA) actions currently being undertaken at the airport. Most if not all of these involve fuel contamination of ground water. Consideration of contaminated groundwater migrating into the improved drainage areas and stormwater ditches should be considered in the drainage study being conducted by the airport. Migration of contaminated groundwater into the ditches may cause chronic sheening in these areas and into Suarez Channel, Torrecilla Lagoon and San Jose Lagoon.

Thank you for the opportunity to comment on this action if you have any questions please contact Felix Lopez of my staff at 787 851 7297 x 210.

Sincerely yours,

Edwin E. Muñiz
Field Supervisor

fhl
cc:
DNER, San Juan
EQB, San Juan
EPA, San Juan
FAA, San Juan
Jaime Pabon, AeroStar, San Juan

# APPENDIX F

Oficina Estatal de Conservacion Historica, Response Letter, Dated August 2017

GOBIERNO DE PUERTO RICO
Oficina Estatal de Conservación Histórica

August 2, 2017

**Peter M. Green, AICP**
Program Manager
ESA
4200 West Cypress Street
Suite 450
Tampa, FL 33607

SHPO 07-10-17-07 RUNWAY AND TAXIWAY OBJECT FREE AREA CLEARING AND AIRFIELD DRAINAGE IMPROVEMENTS, LUIS MUÑOZ MARÍN INTERNATIONAL AIRPORT, CAROLINA, PUERTO RICO

Dear Mr. Green,

Our Office has received and reviewed the above referenced project in accordance with 54 U.S.C. 306108 (commonly known as Section 106 of the *National Historic Preservation Act*) and 36 CFR Part 800*: Protection of Historic Properties.* The State Historic Preservation Officer (SHPO) is to advise and assist federal agencies and other responsible entities when identifying historic properties, assessing effects upon them, and considering alternatives to avoid or reduce the project's effects.

We believe that an Agency finding of **no historic properties affected** would be appropriate for this undertaking.

Please note that should the Agency discover other historic properties at any point during project implementation, you should notify the SHPO immediately. If you have any questions regarding this matter, please contact Miguel Bonini at (787) 721-3737 or mbonini@prshpo.pr.gov.

***Sincerely,***

**Carlos A. Rubio-Cancela**
State Historic Preservation Officer

CARC/GMO/BRS/MB

# APPENDIX G

NPDES EQLAB, Dated January 2018 and Sampling Location Map

eqlab
ENVIRONMENTAL QUALITY LABORATORIES, INC.

*January 10, 2018*

*MRS. DANNALY CRUZ*

*AEROSTAR AIRPORTS HOLDINGS LLC*
*PO BOX 38085*
*SAN JUAN PR 00937-1085*

***I hereby certify that the results reported for EQ Lab Samples from 2994222 to 2994224, 2994226 to 2994230 have been reviewed by me and are correct as presented herein.***

SONIA PICHARDO RODRIGUEZ
Químico Licenciado
Estado Libre Asociado de Puerto Rico
LICENCIA NUM. 4538
A 1706562

*Lcda Sonia Pichardo Rodriguez*
*Certified by Laboratory Director*

**To:** AEROSTAR AIRPORTS HOLDINGS LLC
PO BOX 38085
SAN JUAN PR 00937-1085

**Attn:** MRS. DANNALY CRUZ
**Source:** **BACKGROUND STATION 01**
**CAROLINA, PR**

**Project Name:** EQB
**Facility:** CAROLINA
**Description:** STORMWATER - Grab
**Client Ref. #:** N/A

eqlab
ENVIRONMENTAL QUALITY LABORATORIES, INC.

# Laboratory Test Report



| | | | | | |
|---|---|---|---|---|---|
| Sample Number: | **2994222** | Collected Date & Time: | **12/26/2018** 11:26 | Date of Report: | 01/10/2019 |
| Work Order: | 2119-01-07 | Received Date & Time: | 12/26/2018 13:22 | Collected By: | JVELEZ |
| Delivery Slip: | 2018-19953 | Temperature at Arrival: | 4.0 °C | Eqlab Rep.: | EGARCIA |
| Folder Number: | 265743 | | | Proposal Number: | 22205 - 1 |

Remarks:

| Parameter | Method | Results | Units | DQ | Limits | | | Analysis | | | Prep Method | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MDL | MRL | MCL | Date | Time | By | Date | By | Method |
| Oil and Grease (hexane) | EPA 1664 A | 3.10 | mg/L | -- | 1.4 | 1.4 | -- | 01/04/2019 | 13:00 | DSA | -- | -- | N/A |
| pH | SM 4500 H B | 7.88 | S. U. | -- | 1.00 | -- | -- | 12/26/2018 | 15:30 | AFNC | -- | -- | N/A |
| Turbidity | SM 2130 B | 1.26 | NTU | -- | 0.05 | 0.05 | -- | 12/27/2018 | 11:23 | AASR | -- | -- | N/A |
| Cyanide - Total | EPA 335.4 | BDL | mg/L | U | 0.0008 | 0.0050 | -- | 01/03/2019 | 14:12 | LHT | 01/02/2019 | LHT | Distillation |
| Cadmium - Total | EPA 200.7 | BDL | mg/L | D,U | 0.0025 | 0.0050 | -- | 01/04/2019 | 13:32 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Copper - Total | EPA 200.7 | BDL | mg/L | D,U | 0.025 | 0.250 | -- | 01/04/2019 | 13:32 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Lead - Total | EPA 200.7 | BDL | mg/L | D,U | 0.025 | 0.500 | -- | 01/04/2019 | 13:32 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Mercury - Total | EPA 245.1 | BDL | mg/L | U | 0.0002 | 0.0005 | -- | 01/04/2019 | 10:27 | GMBR | 01/02/2019 | AFNC | Method Digestion |

SONIA PICHARDO RODRIGUEZ Químico Licenciado Estado Libre Asociado de Puerto Rico LICENCIA NUM. 4538

Certified by Laboratory Director

**ND = Not Detected MCL = Maximum Contaminant Level BDL = Below Detection Limit DNI = Does Not Ignite MDL = Minimum Detection Limit N/A = Not Applicable**
**MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.**
**+ = Parameter is not accredited under EQLab's NELAP Certification**

ACCREDITED IN ACCORDANCE WITH nelac

The results presented herein meet all NELAC requirements.
Refer to eqlab certification number E87783 at www.eqlab.com.

**PRDOH Certified**
**EPA ID PR00014**

ENVIRONMENTAL QUALITY LABORATORIES, INC.
60 E STREET, MINILLAS INDUSTRIAL PARK, BAYAMÓN, PR 00959
PO BOX 11458 SANTURCE, PR 00910-1458 TEL. (787) 288-6420 FAX (787) 288-6465 www.eqlab.com

To: AEROSTAR AIRPORTS HOLDINGS LLC
PO BOX 38085
SAN JUAN PR 00937-1085

Attn: MRS. DANNALY CRUZ
Source: **BACKGROUND STATION 02**
**CAROLINA, PR**

Project Name: EQB
Facility: CAROLINA
Description: STORMWATER - Grab
Client Ref. #: N/A

eqlab
ENVIRONMENTAL QUALITY LABORATORIES, INC.

# Laboratory Test Report



| | | | | | |
|---|---|---|---|---|---|
| Sample Number: | **2994223** | Collected Date & Time: | **12/26/2018** 11:42 | Date of Report: | 01/10/2019 |
| Work Order: | 2119-01-07 | Received Date & Time: | 12/26/2018 13:22 | Collected By: | JVELEZ |
| Delivery Slip: | 2018-19953 | Temperature at Arrival: | 4.0 °C | Eqlab Rep.: | EGARCIA |
| Folder Number: | 265743 | | | Proposal Number: | 22205 - 1 |

Remarks:

| Parameter | Method | Results | Units | DQ | Limits MDL | Limits MRL | Limits MCL | Analysis Date | Analysis Time | Analysis By | Prep Method Date | Prep Method By | Prep Method |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oil and Grease (hexane) | EPA 1664 A | 2.40 | mg/L | -- | 1.4 | 1.4 | -- | 01/04/2019 | 13:00 | DSA | -- | -- | N/A |
| pH | SM 4500 H B | 7.25 | S. U. | -- | 1.00 | -- | -- | 12/26/2018 | 15:30 | AFNC | -- | -- | N/A |
| Turbidity | SM 2130 B | 15.7 | NTU | -- | 0.05 | 0.05 | -- | 12/27/2018 | 11:23 | AASR | -- | -- | N/A |
| Cyanide - Total | EPA 335.4 | 0.0019 | mg/L | J | 0.0008 | 0.0050 | -- | 01/03/2019 | 14:12 | LHT | 01/02/2019 | LHT | Distillation |
| Cadmium - Total | EPA 200.7 | BDL | mg/L | D,U | 0.0050 | 0.0100 | -- | 01/04/2019 | 21:11 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Copper - Total | EPA 200.7 | BDL | mg/L | D,U | 0.050 | 0.500 | -- | 01/04/2019 | 21:11 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Lead - Total | EPA 200.7 | BDL | mg/L | D,U | 0.050 | 1.000 | -- | 01/04/2019 | 21:11 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Mercury - Total | EPA 245.1 | BDL | mg/L | U | 0.0002 | 0.0005 | -- | 01/04/2019 | 10:27 | GMBR | 01/02/2019 | AFNC | Method Digestion |

NYRMA PICHARDO RODRIGUEZ Químico Licenciado Estado Libre Asociado de Puerto Rico LICENCIA NUM. 5538

Certified by Laboratory Director

ND = Not Detected MCL = Maximum Contaminant Level BDL = Below Detection Limit DNI = Does Not Ignite MDL = Minimum Detection Limit N/A = Not Applicable
MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
+ = Parameter is not accredited under EQLab's NELAP Certification

ACCREDITED IN ACCORDANCE WITH nelac

The results presented herein meet all NELAC requirements.
Refer to eqlab certification number E87783 at www.eqlab.com.

RRDOH Certified
EPA ID PR00014

**To:** AEROSTAR AIRPORTS HOLDINGS LLC
PO BOX 38085
SAN JUAN PR 00937-1085

**Attn:** MRS. DANNALY CRUZ
**Source:** **BACKGROUND STATION 03**
**CAROLINA, PR**

**Project Name:** EQB
**Facility:** CAROLINA
**Description:** STORMWATER - Grab
**Client Ref. #:** N/A

eqlab
ENVIRONMENTAL QUALITY LABORATORIES, INC.

# Laboratory Test Report



| | | | | | |
|---|---|---|---|---|---|
| Sample Number: | **2994224** | Collected Date & Time: | **12/26/2018** 12:00 | Date of Report: | 01/10/2019 |
| Work Order: | 2119-01-07 | Received Date & Time: | 12/26/2018 13:22 | Collected By: | JVELEZ |
| Delivery Slip: | 2018-19953 | Temperature at Arrival: | 4.0 °C | Eqlab Rep.: | EGARCIA |
| Folder Number: | 265743 | | | Proposal Number: | 22205 - 1 |

Remarks:

| | | | | | Limits | | | Analysis | | | Prep Method | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameter | Method | Results | Units | DQ | MDL | MRL | MCL | Date | Time | By | Date | By | Method |
| Oil and Grease (hexane) | EPA 1664 A | 2.70 | mg/L | -- | 1.4 | 1.4 | -- | 01/04/2019 | 13:00 | DSA | -- | -- | N/A |
| pH | SM 4500 H B | 7.67 | S. U. | -- | 1.00 | -- | -- | 12/26/2018 | 15:30 | AFNC | -- | -- | N/A |
| Turbidity | SM 2130 B | 5.69 | NTU | -- | 0.05 | 0.05 | -- | 12/27/2018 | 11:23 | AASR | -- | -- | N/A |
| Cyanide - Total | EPA 335.4 | 0.0025 | mg/L | J | 0.0008 | 0.0050 | -- | 01/03/2019 | 14:12 | LHT | 01/02/2019 | LHT | Distillation |
| Cadmium - Total | EPA 200.7 | BDL | mg/L | D,U | 0.0025 | 0.0050 | -- | 01/04/2019 | 13:38 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Copper - Total | EPA 200.7 | BDL | mg/L | D,U | 0.025 | 0.250 | -- | 01/04/2019 | 13:38 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Lead - Total | EPA 200.7 | BDL | mg/L | D,U | 0.025 | 0.500 | -- | 01/04/2019 | 13:38 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Mercury - Total | EPA 245.1 | BDL | mg/L | U | 0.0002 | 0.0005 | -- | 01/04/2019 | 10:27 | GMBR | 01/02/2019 | AFNC | Method Digestion |

SONIA PICHARDO RODRIGUEZ Químico Licenciado Estado Libre Asociado de Puerto Rico LICENCIA NUM. 4538

Certified by Laboratory Director

ND = Not Detected MCL = Maximum Contaminant Level BDL = Below Detection Limit DNI = Does Not Ignite MDL = Minimum Detection Limit N/A = Not Applicable
MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
+ = Parameter is not accredited under EQLab's NELAP Certification

ACCREDITED IN ACCORDANCE WITH nelac

The results presented herein meet all NELAC requirements.
Refer to eqlab certification number E87783 at www.eqlab.com.

PRDOH Certified
EPA ID PR00014

To: AEROSTAR AIRPORTS HOLDINGS LLC
PO BOX 38085
SAN JUAN PR 00937-1085

Attn: MRS. DANNALY CRUZ
Source: **SW 01**
**CAROLINA, PR**

**Project Name:** EQB
**Facility:** CAROLINA
**Description:** STORMWATER - Grab
**Client Ref. #:** N/A

eqlab
ENVIRONMENTAL QUALITY LABORATORIES, INC.

# Laboratory Test Report



| | | | | | |
|---|---|---|---|---|---|
| Sample Number: | **2994226** | Collected Date & Time: | **12/26/2018** 11:35 | Date of Report: | 01/10/2019 |
| Work Order: | 2119-01-07 | Received Date & Time: | 12/26/2018 13:22 | Collected By: | JVELEZ |
| Delivery Slip: | 2018-19953 | Temperature at Arrival: | 4.0 °C | Eqlab Rep.: | EGARCIA |
| Folder Number: | 265743 | | | Proposal Number: | 22205 - 1 |

Remarks:

| Parameter | Method | Results | Units | DQ | Limits | | | Analysis | | | Prep Method | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MDL | MRL | MCL | Date | Time | By | Date | By | Method |
| Oil and Grease (hexane) | EPA 1664 A | 1.70 | mg/L | -- | 1.4 | 1.4 | -- | 01/04/2019 | 13:00 | DSA | -- | -- | N/A |
| pH | SM 4500 H B | 7.22 | S. U. | -- | 1.00 | -- | -- | 12/26/2018 | 15:30 | AFNC | -- | -- | N/A |
| Turbidity | SM 2130 B | 19.0 | NTU | -- | 0.05 | 0.05 | -- | 12/27/2018 | 11:23 | AASR | -- | -- | N/A |
| Cyanide - Total | EPA 335.4 | 0.0041 | mg/L | J | 0.0008 | 0.0050 | -- | 01/03/2019 | 14:12 | LHT | 01/02/2019 | LHT | Distillation |
| Cadmium - Total | EPA 200.7 | BDL | mg/L | D,U | 0.0025 | 0.0050 | -- | 01/04/2019 | 13:45 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Copper - Total | EPA 200.7 | BDL | mg/L | D,U | 0.025 | 0.250 | -- | 01/04/2019 | 13:45 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Lead - Total | EPA 200.7 | BDL | mg/L | D,U | 0.025 | 0.500 | -- | 01/04/2019 | 13:45 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Mercury - Total | EPA 245.1 | BDL | mg/L | U | 0.0002 | 0.0005 | -- | 01/04/2019 | 10:27 | GMBR | 01/02/2019 | AFNC | Method Digestion |

SONIA PICHARDO RODRIGUEZ Químico Licenciado Estado Libre Asociado de Puerto Rico LICENCIA NUM. 8

Certified by Laboratory Director

ND = Not Detected MCL = Maximum Contaminant Level BDL = Below Detection Limit DNI = Does Not Ignite MDL = Minimum Detection Limit N/A = Not Applicable
MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
+ = Parameter is not accredited under EQLab's NELAP Certification

ACCREDITED IN ACCORDANCE WITH nelac

The results presented herein meet all NELAC requirements.
Refer to eqlab certification number E87783 at www.eqlab.com.

**PRDOH Certified**
**EPA ID PR00014**

**To:** AEROSTAR AIRPORTS HOLDINGS LLC
PO BOX 38085
SAN JUAN PR 00937-1085

**Attn:** MRS. DANNALY CRUZ
**Source:** **SW 02**
**CAROLINA, PR**

**Project Name:** EQB
**Facility:** CAROLINA
**Description:** STORMWATER - Grab
**Client Ref. #:** N/A

eqlab
ENVIRONMENTAL QUALITY LABORATORIES, INC.

# Laboratory Test Report



| | | | | | |
|---|---|---|---|---|---|
| Sample Number: | **2994227** | Collected Date & Time: | **12/26/2018** 11:16 | Date of Report: | 01/10/2019 |
| Work Order: | 2119-01-07 | Received Date & Time: | 12/26/2018 13:22 | Collected By: | JVELEZ |
| Delivery Slip: | 2018-19953 | Temperature at Arrival: | 4.0 °C | Eqlab Rep.: | EGARCIA |
| Folder Number: | 265743 | | | Proposal Number: | 22205 - 1 |

Remarks:

| | | | | | Limits | | | Analysis | | | Prep Method | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameter | Method | Results | Units | DQ | MDL | MRL | MCL | Date | Time | By | Date | By | Method |
| Oil and Grease (hexane) | EPA 1664 A | 1.40 | mg/L | -- | 1.4 | 1.4 | -- | 01/04/2019 | 13:00 | DSA | -- | -- | N/A |
| pH | SM 4500 H B | 7.31 | S. U. | -- | 1.00 | -- | -- | 12/26/2018 | 15:30 | AFNC | -- | -- | N/A |
| Turbidity | SM 2130 B | 12.0 | NTU | -- | 0.05 | 0.05 | -- | 12/27/2018 | 11:23 | AASR | -- | -- | N/A |
| Cyanide - Total | EPA 335.4 | 0.0014 | mg/L | J | 0.0008 | 0.0050 | -- | 01/03/2019 | 14:12 | LHT | 01/02/2019 | LHT | Distillation |
| Cadmium - Total | EPA 200.7 | BDL | mg/L | D,U | 0.0025 | 0.0050 | -- | 01/04/2019 | 13:51 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Copper - Total | EPA 200.7 | BDL | mg/L | D,U | 0.025 | 0.250 | -- | 01/04/2019 | 13:51 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Lead - Total | EPA 200.7 | BDL | mg/L | D,U | 0.025 | 0.500 | -- | 01/04/2019 | 13:51 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Mercury - Total | EPA 245.1 | BDL | mg/L | U | 0.0002 | 0.0005 | -- | 01/04/2019 | 10:27 | GMBR | 01/02/2019 | AFNC | Method Digestion |

SONIA PICHARDO RODRIGUEZ
Químico Licenciado
Estado Libre Asociado de Puerto Rico
LICENCIA NUM. 4539

Certified by Laboratory Director

ND = Not Detected MCL = Maximum Contaminant Level BDL = Below Detection Limit DNI = Does Not Ignite MDL = Minimum Detection Limit N/A = Not Applicable
MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
+ = Parameter is not accredited under EQLab's NELAP Certification

ACCREDITED IN ACCORDANCE WITH nelac

The results presented herein meet all NELAC requirements.
Refer to eqlab certification number E87783 at www.eqlab.com.

**PRDOH Certified**
**EPA ID PR00014**

To: AEROSTAR AIRPORTS HOLDINGS LLC
PO BOX 38085
SAN JUAN PR 00937-1085

Attn: MRS. DANNALY CRUZ
Source: **SW 03A**
**CAROLINA, PR**

Project Name: EQB
Facility: CAROLINA
Description: STORMWATER - Grab
Client Ref. #: N/A

eqlab
ENVIRONMENTAL QUALITY LABORATORIES, INC.

# Laboratory Test Report



| | | | | | |
|---|---|---|---|---|---|
| Sample Number: | **2994228** | Collected Date & Time: | **12/26/2018** 10:25 | Date of Report: | 01/10/2019 |
| Work Order: | 2119-01-07 | Received Date & Time: | 12/26/2018 13:22 | Collected By: | JVELEZ |
| Delivery Slip: | 2018-19953 | Temperature at Arrival: | 4.0 °C | Eqlab Rep.: | EGARCIA |
| Folder Number: | 265743 | | | Proposal Number: | 22205 - 1 |

Remarks:

| Parameter | Method | Results | Units | DQ | Limits | | | Analysis | | | Prep Method | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MDL | MRL | MCL | Date | Time | By | Date | By | Method |
| Oil and Grease (hexane) | EPA 1664 A | 2.50 | mg/L | -- | 1.4 | 1.4 | -- | 01/04/2019 | 13:00 | DSA | -- | -- | N/A |
| pH | SM 4500 H B | 7.43 | S. U. | -- | 1.00 | -- | -- | 12/26/2018 | 15:30 | AFNC | -- | -- | N/A |
| Turbidity | SM 2130 B | 5.75 | NTU | -- | 0.05 | 0.05 | -- | 12/27/2018 | 11:23 | AASR | -- | -- | N/A |
| Cyanide - Total | EPA 335.4 | 0.0013 | mg/L | J | 0.0008 | 0.0050 | -- | 01/03/2019 | 14:12 | LHT | 01/02/2019 | LHT | Distillation |
| Cadmium - Total | EPA 200.7 | BDL | mg/L | U | 0.0005 | 0.0010 | -- | 01/03/2019 | 21:52 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Copper - Total | EPA 200.7 | BDL | mg/L | U | 0.005 | 0.050 | -- | 01/03/2019 | 21:52 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Lead - Total | EPA 200.7 | BDL | mg/L | U | 0.005 | 0.100 | -- | 01/03/2019 | 21:52 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Mercury - Total | EPA 245.1 | BDL | mg/L | U | 0.0002 | 0.0005 | -- | 01/04/2019 | 10:27 | GMBR | 01/02/2019 | AFNC | Method Digestion |

SONIA PICHARDO RODRIGUEZ Químico Licenciado Estado Libre Asociado de Puerto Rico LICENCIA NUM. 4388

Certified by Laboratory Director

ND = Not Detected MCL = Maximum Contaminant Level BDL = Below Detection Limit DNI = Does Not Ignite MDL = Minimum Detection Limit N/A = Not Applicable
MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
+ = Parameter is not accredited under EQLab's NELAP Certification

ACCREDITED IN ACCORDANCE WITH nelac

The results presented herein meet all NELAC requirements.
Refer to eqlab certification number E87783 at www.eqlab.com.

PRDOH Certified
EPA ID PR00014

**To:** AEROSTAR AIRPORTS HOLDINGS LLC
PO BOX 38085
SAN JUAN PR 00937-1085

**Attn:** MRS. DANNALY CRUZ
**Source:** **SW 03B**
**CAROLINA, PR**

**Project Name:** EQB
**Facility:** CAROLINA
**Description:** STORMWATER - Grab
**Client Ref. #:** N/A

eqlab
ENVIRONMENTAL QUALITY LABORATORIES, INC.

# Laboratory Test Report



| | | | | | |
|---|---|---|---|---|---|
| Sample Number: | **2994229** | Collected Date & Time: | **12/26/2018** 10:20 | Date of Report: | 01/10/2019 |
| Work Order: | 2119-01-07 | Received Date & Time: | 12/26/2018 13:22 | Collected By: | JVELEZ |
| Delivery Slip: | 2018-19953 | Temperature at Arrival: | 4.0 °C | Eqlab Rep.: | EGARCIA |
| Folder Number: | 265743 | | | Proposal Number: | 22205 - 1 |

Remarks:

| Parameter | Method | Results | Units | DQ | Limits | | | Analysis | | | Prep Method | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MDL | MRL | MCL | Date | Time | By | Date | By | Method |
| Oil and Grease (hexane) | EPA 1664 A | 1.70 | mg/L | -- | 1.4 | 1.4 | -- | 01/04/2019 | 13:00 | DSA | -- | -- | N/A |
| pH | SM 4500 H B | 7.43 | S. U. | -- | 1.00 | -- | -- | 12/26/2018 | 15:30 | AFNC | -- | -- | N/A |
| Turbidity | SM 2130 B | 5.89 | NTU | -- | 0.05 | 0.05 | -- | 12/27/2018 | 11:23 | AASR | -- | -- | N/A |
| Cyanide - Total | EPA 335.4 | BDL | mg/L | U | 0.0008 | 0.0050 | -- | 01/03/2019 | 14:12 | LHT | 01/02/2019 | LHT | Distillation |
| Cadmium - Total | EPA 200.7 | BDL | mg/L | U | 0.0005 | 0.0010 | -- | 01/03/2019 | 21:58 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Copper - Total | EPA 200.7 | 0.014 | mg/L | J | 0.005 | 0.050 | -- | 01/03/2019 | 21:58 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Lead - Total | EPA 200.7 | BDL | mg/L | U | 0.005 | 0.100 | -- | 01/03/2019 | 21:58 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Mercury - Total | EPA 245.1 | BDL | mg/L | U | 0.0002 | 0.0005 | -- | 01/04/2019 | 10:27 | GMBR | 01/02/2019 | AFNC | Method Digestion |

SONIA PICHARDO RODRIGUEZ
Químico Licenciado
Estado Libre Asociado de Puerto Rico
LICENCIA NUM. 4538

Certified by Laboratory Director

**ND = Not Detected MCL = Maximum Contaminant Level BDL = Below Detection Limit DNI = Does Not Ignite MDL = Minimum Detection Limit N/A = Not Applicable**
**MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.**
**+ = Parameter is not accredited under EQLab's NELAP Certification**

ACCREDITED IN ACCORDANCE WITH nelac

The results presented herein meet all NELAC requirements.
Refer to eqlab certification number E87783 at www.eqlab.com.

**PRDOH Certified**
**EPA ID PR00014**

**To:** AEROSTAR AIRPORTS HOLDINGS LLC
PO BOX 38085
SAN JUAN PR 00937-1085

**Attn:** MRS. DANNALY CRUZ
**Source:** **SW 04**
**CAROLINA, PR**

**Project Name:** EQB
**Facility:** CAROLINA
**Description:** STORMWATER - Grab
**Client Ref. #:** N/A

eqlab
ENVIRONMENTAL QUALITY LABORATORIES, INC.

# Laboratory Test Report



| | | | | | |
|---|---|---|---|---|---|
| Sample Number: | **2994230** | Collected Date & Time: | **12/26/2018** 10:56 | Date of Report: | 01/10/2019 |
| Work Order: | 2119-01-07 | Received Date & Time: | 12/26/2018 13:22 | Collected By: | JVELEZ |
| Delivery Slip: | 2018-19953 | Temperature at Arrival: | 4.0 °C | Eqlab Rep.: | EGARCIA |
| Folder Number: | 265743 | | | Proposal Number: | 22205 - 1 |

Remarks:

| Parameter | Method | Results | Units | DQ | Limits MDL | Limits MRL | Limits MCL | Analysis Date | Analysis Time | Analysis By | Prep Method Date | Prep Method By | Prep Method |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oil and Grease (hexane) | EPA 1664 A | BDL | mg/L | U | 1.4 | 1.4 | -- | 01/04/2019 | 13:00 | DSA | -- | -- | N/A |
| pH | SM 4500 H B | 7.41 | S. U. | -- | 1.00 | -- | -- | 12/26/2018 | 15:30 | AFNC | -- | -- | N/A |
| Turbidity | SM 2130 B | 9.78 | NTU | -- | 0.05 | 0.05 | -- | 12/27/2018 | 11:23 | AASR | -- | -- | N/A |
| Cyanide - Total | EPA 335.4 | BDL | mg/L | U | 0.0008 | 0.0050 | -- | 01/03/2019 | 14:12 | LHT | 01/02/2019 | LHT | Distillation |
| Cadmium - Total | EPA 200.7 | BDL | mg/L | U | 0.0005 | 0.0010 | -- | 01/03/2019 | 22:05 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Copper - Total | EPA 200.7 | BDL | mg/L | U | 0.005 | 0.050 | -- | 01/03/2019 | 22:05 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Lead - Total | EPA 200.7 | BDL | mg/L | U | 0.005 | 0.100 | -- | 01/03/2019 | 22:05 | YDCV | 01/02/2019 | AFNC | Method Digestion |
| Mercury - Total | EPA 245.1 | BDL | mg/L | U | 0.0002 | 0.0005 | -- | 01/04/2019 | 10:27 | GMBR | 01/02/2019 | AFNC | Method Digestion |

SONIA PICHARDO RODRIGUEZ Químico Licenciado Estado Libre Asociado de Puerto Rico LICENCIA NUM. 4538

Certified by Laboratory Director

ND = Not Detected MCL = Maximum Contaminant Level BDL = Below Detection Limit DNI = Does Not Ignite MDL = Minimum Detection Limit N/A = Not Applicable
MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
+ = Parameter is not accredited under EQLab's NELAP Certification

ACCREDITED IN ACCORDANCE WITH nelac

The results presented herein meet all NELAC requirements.
Refer to eqlab certification number E87783 at www.eqlab.com.

**PRDOH Certified**
**EPA ID PR00014**

# ENVIRONMENTAL QUALITY LABORATORIES, INC.

## SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

2018-19953

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: AEROSTAR AIRPORTS HOLDINGS LLC CLIENT ID: 2119-01 W.O. #: 07 SITE: CAROLINA, PR CLIENT REP: MRS. DANNALY CRUZ

P.O. #: 16203-0 PWSID #: FOLDER #: 265743 PROJECT: LMM INTERNATIONAL AI EQLAB REP: EGARCIA

| SAMPLE INFORMATION | | CONTAINER INFORMATION | FIELD TESTING | ANALYSIS REQUESTED |
|---|---|---|---|---|
| SAMPLE #: 2994222-1<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 01, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:26 am<br>TYPE: Grab | TYPE: G/TC COLOR: AMBER VOLUME:<br>PRESERVATIVE: HCl pH<2,Cool 4 °C | | Oil and Grease (HEM) |
| SAMPLE #: 2994222-2<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 01, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:26 am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Immediately | | pH |
| SAMPLE #: 2994222-3<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 01, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:26 am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Cool 4 °C | | Turbidity |
| SAMPLE #: 2994222-4<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 01, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:26 am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: HNO3 pH<2 | | ICP Total Metals: Cd, Cu, Pb, , Mercury - Total |

| CUSTODY RECORD | SIGNATURE | DATE | TIME |
|---|---|---|---|
| Collected in field by: | | 12/26/18 | 11:25am |
| Fixed in field by: | | 12/26/18 | 11:25am |
| Authorized by: | | 12/26/18 | 11:26am |
| Received by EQLF: | N/A | N/A | N/A |
| Released to EQLL by: | | 12-26-18 | 1322 |
| Received by EQLL: | | 12-26-18 | 1322 |

SPECIAL INSTRUCTIONS / COMMENTS:
Javier Vélez Arocho
Contacto: Dannaly Cruz
Tel: 787-212-2422 / 289-7240

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

Arrival Temperature: 4°C Signature:

Eqlab's general terms and conditions on reverse side of this document.

# ENVIRONMENTAL QUALITY LABORATORIES, INC.

2018-19953

## SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: AEROSTAR AIRPORTS HOLDINGS LLC | CLIENT ID: 2119-01 | W.O. #: 07 | SITE: CAROLINA, PR | CLIENT REP: MRS. DANNALY CRUZ

P.O. #: 16203-0 | PWSID #: | FOLDER #: 265743 | PROJECT: LMM INTERNATIONAL AI | EQLAB REP: EGARCIA

| SAMPLE INFORMATION | | CONTAINER INFORMATION | FIELD TESTING | ANALYSIS REQUESTED |
|---|---|---|---|---|
| SAMPLE #: 2994222-5<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 01, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:26 am<br>TYPE: Grab | TYPE: G/PC COLOR: AMBER VOLUME:<br>PRESERVATIVE: Asc Acid,NaOH,Cool 4 °C | | Cyanide - Total |
| SAMPLE #: 2994223-1<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 02, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:42 am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Cool 4 °C | | Turbidity |
| SAMPLE #: 2994223-2<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 02, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:42 am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Immediately | | pH |
| SAMPLE #: 2994223-3<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 02, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:42 am<br>TYPE: Grab | TYPE: G/TC COLOR: AMBER VOLUME:<br>PRESERVATIVE: HCl pH<2,Cool 4 °C | | Oil and Grease (HEM) |

| CUSTODY RECORD | SIGNATURE | DATE | TIME |
|---|---|---|---|
| Collected in field by: | | 12/26/18 | 11:45 |
| Fixed in field by: | | 12/26/18 | 11:45 |
| Authorized by: | | 12/26/18 | 11:45 |
| Received by EQLF: | N/A | N/A | N/A |
| Released to EQLL by: | | 12-26-18 | 1322 |
| Received by EQLL: | | 12-26-18 | 1322 |

**SPECIAL INSTRUCTIONS / COMMENTS:**

Contacto: Dannaly Cruz

Tel: 787-212-2422 / 289-7240

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

Arrival Temperature: 4 °C Signature:

Eqlab's general terms and conditions on reverse side of this document.

# ENVIRONMENTAL QUALITY LABORATORIES, INC.

2018-19953

## SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: AEROSTAR AIRPORTS HOLDINGS LLC | CLIENT ID: 2119-01 | W.O. #: 07 | SITE: CAROLINA, PR | CLIENT REP: MRS. DANNALY CRUZ

P.O. #: 16203-0 | PWSID #: | FOLDER #: 265743 | PROJECT: LMM INTERNATIONAL AI | EQLAB REP: EGARCIA

| SAMPLE INFORMATION | | CONTAINER INFORMATION | FIELD TESTING | ANALYSIS REQUESTED |
|---|---|---|---|---|
| SAMPLE #: 2994223-4<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 02, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:42 am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: HNO3 pH<2 | | ICP Total Metals: Cd, Cu, Pb, , Mercury - Total |
| SAMPLE #: 2994223-5<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 02, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:42am<br>TYPE: Grab | TYPE: G/PC COLOR: AMBER VOLUME:<br>PRESERVATIVE: Asc Acid,NaOH,Cool 4 °C | | Cyanide - Total |
| SAMPLE #: 2994224-1<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 03, CAROLINA, PR | DATE: 12/26/18<br>TIME: 12:00 pm<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Cool 4 °C | | Turbidity |
| SAMPLE #: 2994224-2<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 03, CAROLINA, PR | DATE: 12/26/18<br>TIME: 12:00pm<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Immediately | | pH |

| CUSTODY RECORD | SIGNATURE | DATE | TIME |
|---|---|---|---|
| Collected in field by: | | 10/26/18 | 12:00 pm |
| Fixed in field by: | | 10/26/18 | 12:00 pm |
| Authorized by: | Dannaly Cruz Laboy | 12/26/18 | 12:05pm |
| Received by EQLF: | | N/A | N/A |
| Released to EQLL by: | | 12-26-18 | 1322 |
| Received by EQLL: | | 12-26-18 | 1322 |

**SPECIAL INSTRUCTIONS / COMMENTS:**

Contacto: Dannaly Cruz

Tel: 787-212-2422 / 289-7240

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

P/ DDC

Arrival Temperature: 4°C Signature:

Eqlab's general terms and conditions on reverse side of this document.

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2018-19953

# ENVIRONMENTAL QUALITY LABORATORIES, INC.

## SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: AEROSTAR AIRPORTS HOLDINGS LLC | CLIENT ID: 2119-01 | W.O. #: 07 | SITE: CAROLINA, PR | CLIENT REP: MRS. DANNALY CRUZ

P.O. #: 16203-0 | PWSID #: | FOLDER #: 265743 | PROJECT: LMM INTERNATIONAL AI | EQLAB REP: EGARCIA

| SAMPLE INFORMATION | | CONTAINER INFORMATION | FIELD TESTING | ANALYSIS REQUESTED |
|---|---|---|---|---|
| SAMPLE #: 2994224-3<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 03, CAROLINA, PR | DATE: 12/26/18<br>TIME: 12:00pm<br>TYPE: Grab | TYPE P/PC COLOR N/A VOLUME<br>PRESERVATIVE HNO3 pH<2 | | ICP Total Metals: Cd, Cu, Pb, , Mercury - Total |
| SAMPLE #: 2994224-4<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 03, CAROLINA, PR | DATE: 12/26/18<br>TIME: 12:00pm<br>TYPE: Grab | TYPE G/PC COLOR AMBER VOLUME<br>PRESERVATIVE Asc Acid,NaOH,Cool 4 °C | | Cyanide - Total |
| SAMPLE #: 2994224-5<br>MATRIX: STORMWATER<br>SOURCE: BACKGROUND STATION 03, CAROLINA, PR | DATE: 12/26/18<br>TIME: 12:00pm<br>TYPE: Grab | TYPE G/TC COLOR AMBER VOLUME<br>PRESERVATIVE HCl pH<2,Cool 4 °C | | Oil and Grease (HEM) |
| SAMPLE #: 2994225-1<br>MATRIX: STORMWATER<br>SOURCE: OTHER COST, CAROLINA, PR | DATE: 12/26/18<br>TIME: 12:35pm<br>TYPE: Grab N/A | TYPE COLOR VOLUME<br>PRESERVATIVE | | JUST FOR FIELD TESTING |

| CUSTODY RECORD | SIGNATURE | DATE | TIME |
|---|---|---|---|
| Collected in field by: | | 12/26/18 | 12:05pm |
| Fixed in field by: | | 12/26/18 | 12:05pm |
| Authorized by: | Dannaly Cruz Malaga | 12/26/18 | 12:00pm |
| Received by EQLF: | N/A | N/A | N/A |
| Released to EQLL by: | | 12-26-18 | 1322 |
| Received by EQLL: | | 12-26-18 | 1322 |

**SPECIAL INSTRUCTIONS / COMMENTS:**

Contacto: Dannaly Cruz

Tel: 787-212-2422 / 289-7240

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

PIDs

Arrival Temperature: 4°C Signature:

Eqlab's general terms and conditions on reverse side of this document.

2018-19953

# ENVIRONMENTAL QUALITY LABORATORIES, INC.

## SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: AEROSTAR AIRPORTS HOLDINGS LLC | CLIENT ID: 2119-01 | W.O. #: 07 | SITE: CAROLINA, PR | CLIENT REP: MRS. DANNALY CRUZ

P.O. #: 16203-0 | PWSID #: | FOLDER #: 265743 | PROJECT: LMM INTERNATIONAL AI | EQLAB REP: EGARCIA

| SAMPLE INFORMATION | | CONTAINER INFORMATION | FIELD TESTING | ANALYSIS REQUESTED |
|---|---|---|---|---|
| SAMPLE #: 2994226-1<br>MATRIX: STORMWATER<br>SOURCE: SW 01, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:35am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: HNO3 pH<2 | | ICP Total Metals: Cd, Cu, Pb, , Mercury - Total |
| SAMPLE #: 2994226-2<br>MATRIX: STORMWATER<br>SOURCE: SW 01, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:35am<br>TYPE: Grab | TYPE: G/TC COLOR: AMBER VOLUME:<br>PRESERVATIVE: HCl pH<2,Cool 4 °C | | Oil and Grease (HEM) |
| SAMPLE #: 2994226-3<br>MATRIX: STORMWATER<br>SOURCE: SW 01, CAROLINA, PR | DATE: 12/25/18<br>TIME: 11:35am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Cool 4 °C | | Turbidity |
| SAMPLE #: 2994226-4<br>MATRIX: STORMWATER<br>SOURCE: SW 01, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:35am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Immediately | | pH |

| CUSTODY RECORD | SIGNATURE | DATE | TIME |
|---|---|---|---|
| Collected in field by: | [signature] | 12/26/18 | 11:30 am |
| Fixed in field by: | [signature] | 12/26/18 | 11:30am |
| Authorized by: | Dannaly Cruz Ortega | 12/26/18 | 11:35am |
| Received by EQLF: | N/A | N/A | N/A |
| Released to EQLL by: | [signature] | 12-26-18 | 1322 |
| Received by EQLL: | [signature] | 12-26-18 | 1322 |

SPECIAL INSTRUCTIONS / COMMENTS:

Contacto: Dannaly Cruz

Tel: 787-212-2422 / 289-7240

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

PIDJ

Arrival Temperature: 4°C Signature: DMC

Eqlab's general terms and conditions on reverse side of this document.

2018-19953

# ENVIRONMENTAL QUALITY LABORATORIES, INC.

## SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: AEROSTAR AIRPORTS HOLDINGS LLC | CLIENT ID: 2119-01 | W.O. #: 07 | SITE: CAROLINA, PR | CLIENT REP: MRS. DANNALY CRUZ

P.O. #: 16203-0 | PWSID #: | FOLDER #: 265743 | PROJECT: LMM INTERNATIONAL AI | EQLAB REP: EGARCIA

| SAMPLE INFORMATION | | CONTAINER INFORMATION | FIELD TESTING | | ANALYSIS REQUESTED |
|---|---|---|---|---|---|
| SAMPLE #: 2994226-5<br>MATRIX: STORMWATER<br>SOURCE: SW 01, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:35am<br>TYPE: Grab | TYPE: G/PC COLOR: AMBER VOLUME:<br>PRESERVATIVE: Asc Acid,NaOH,Cool 4 °C | | | Cyanide - Total |
| SAMPLE #: 2994227-1<br>MATRIX: STORMWATER<br>SOURCE: SW 02, CAROLINA, PR | DATE: 12/16/18<br>TIME: 11:16am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: HNO3 pH<2 | | | ICP Total Metals: Cd, Cu, Pb, , Mercury - Total |
| SAMPLE #: 2994227-2<br>MATRIX: STORMWATER<br>SOURCE: SW 02, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:16am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Immediately | | | pH |
| SAMPLE #: 2994227-3<br>MATRIX: STORMWATER<br>SOURCE: SW 02, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:16am<br>TYPE: Grab | TYPE: G/PC COLOR: AMBER VOLUME:<br>PRESERVATIVE: Asc Acid,NaOH,Cool 4 °C | | | Cyanide - Total |

| CUSTODY RECORD | SIGNATURE | DATE | TIME |
|---|---|---|---|
| Collected in field by: | | 12/26/18 | 11:17am |
| Fixed in field by: | | 12/26/18 | 11:17am |
| Authorized by: | | 12/26/18 | 11:16am |
| Received by EQLF: | N/A | N/A | N/A |
| Released to EQLL by: | | 12-26-18 | 1322 |
| Received by EQLL: | | 12-26-18 | 1322 |

SPECIAL INSTRUCTIONS / COMMENTS:

Contacto: Dannaly Cruz

Tel: 787-212-2422 / 289-7240

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

P/DD2

Arrival Temperature: 4°C Signature:

Eqlab's general terms and conditions on reverse side of this document.

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# ENVIRONMENTAL QUALITY LABORATORIES, INC.

2018-19953

## SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: AEROSTAR AIRPORTS HOLDINGS LLC | CLIENT ID: 2119-01 | W.O. #: 07 | SITE: CAROLINA, PR | CLIENT REP: MRS. DANNALY CRUZ

P.O. #: 16203-0 | PWSID #: | FOLDER #: 265743 | PROJECT: LMM INTERNATIONAL AI | EQLAB REP: EGARCIA

| SAMPLE INFORMATION | | CONTAINER INFORMATION | FIELD TESTING | ANALYSIS REQUESTED |
|---|---|---|---|---|
| SAMPLE #: 2994227-4<br>MATRIX: STORMWATER<br>SOURCE: SW 02, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:16 am<br>TYPE: Grab | TYPE: G/TC, COLOR: AMBER, VOLUME<br>PRESERVATIVE: HCl pH<2, Cool 4 °C | | Oil and Grease (HEM) |
| SAMPLE #: 2994227-5<br>MATRIX: STORMWATER<br>SOURCE: SW 02, CAROLINA, PR | DATE: 12/26/18<br>TIME: 11:26 am<br>TYPE: Grab | TYPE: P/PC, COLOR: N/A, VOLUME<br>PRESERVATIVE: Cool 4 °C | | Turbidity |
| SAMPLE #: 2994228-1<br>MATRIX: STORMWATER<br>SOURCE: SW 03A, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:25 am<br>TYPE: Grab | TYPE: P/PC, COLOR: N/A, VOLUME<br>PRESERVATIVE: HNO3 pH<2 | | ICP Total Metals: Cd, Cu, Pb, , Mercury - Total |
| SAMPLE #: 2994228-2<br>MATRIX: STORMWATER<br>SOURCE: SW 03A, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:25 am<br>TYPE: Grab | TYPE: P/PC, COLOR: N/A, VOLUME<br>PRESERVATIVE: Cool 4 °C | | Turbidity |

| CUSTODY RECORD | SIGNATURE | DATE | TIME |
|---|---|---|---|
| Collected in field by: | | 12/26/18 | 10:41 am |
| Fixed in field by: | | 12/26/18 | 10:41 am |
| Authorized by: | | 12/26/18 | 10:41am |
| Received by EQLF: | N/A | N/A | N/A |
| Released to EQLL by: | | 12-26-18 | 1322 |
| Received by EQLL: | | 12-26-18 | 1322 |

**SPECIAL INSTRUCTIONS / COMMENTS:**

Contacto: Dannaly Cruz

Tel: 787-212-2422 / 289-7240

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

PIJJ-

Arrival Temperature: 4°C Signature:

Eqlab's general terms and conditions on reverse side of this document.

+++

2018-19953

# ENVIRONMENTAL QUALITY LABORATORIES, INC.

## SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: AEROSTAR AIRPORTS HOLDINGS LLC | CLIENT ID: 2119-01 | W.O. #: 07 | SITE: CAROLINA, PR | CLIENT REP: MRS. DANNALY CRUZ

P.O. #: 16203-0 | PWSID #: | FOLDER #: 265743 | PROJECT: LMM INTERNATIONAL AI | EQLAB REP: EGARCIA

| SAMPLE INFORMATION | | CONTAINER INFORMATION | FIELD TESTING | ANALYSIS REQUESTED |
|---|---|---|---|---|
| SAMPLE #: 2994228-3<br>MATRIX: STORMWATER<br>SOURCE: SW 03A, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:25 am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Immediately | | pH |
| SAMPLE #: 2994228-4<br>MATRIX: STORMWATER<br>SOURCE: SW 03A, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:25 am<br>TYPE: Grab | TYPE: G/TC COLOR: AMBER VOLUME:<br>PRESERVATIVE: HCl pH<2,Cool 4 °C | | Oil and Grease (HEM) |
| SAMPLE #: 2994228-5<br>MATRIX: STORMWATER<br>SOURCE: SW 03A, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:25am<br>TYPE: Grab | TYPE: G/PC COLOR: AMBER VOLUME:<br>PRESERVATIVE: Asc Acid,NaOH,Cool 4 °C | | Cyanide - Total |
| SAMPLE #: 2994229-1<br>MATRIX: STORMWATER<br>SOURCE: SW 03B, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:20<br>TYPE: Grab | TYPE: G/PC COLOR: AMBER VOLUME:<br>PRESERVATIVE: Asc Acid,NaOH,Cool 4 °C | | Cyanide - Total |

| CUSTODY RECORD | SIGNATURE | DATE | TIME |
|---|---|---|---|
| Collected in field by: | [signature] | 12/26/18 | 10:40 am |
| Fixed in field by: | [signature] | 12/26/18 | 10:40 am |
| Authorized by: | Dannaly Cruz Vélez N/A | 12/26/18 | 10:40pm |
| Received by EQLF: | N/A | N/A | N/A |
| Released to EQLL by: | [signature] | 12-26-18 | 1322 |
| Received by EQLL: | [signature] | 12-26-18 | 1322 |

**SPECIAL INSTRUCTIONS / COMMENTS:**

Contacto: Dannaly Cruz

Tel: 787-212-2422 / 289-7240

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

P/JJ2

Arrival Temperature: 4°C Signature: [signature]

Eqlab's general terms and conditions on reverse side of this document.

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# ENVIRONMENTAL QUALITY LABORATORIES, INC.

2018-19953

## SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: AEROSTAR AIRPORTS HOLDINGS LLC | CLIENT ID: 2119-01 | W.O. #: 07 | SITE: CAROLINA, PR | CLIENT REP: MRS. DANNALY CRUZ

P.O. #: 16203-0 | PWSID #: | FOLDER #: 265743 | PROJECT: LMM INTERNATIONAL AI | EQLAB REP: EGARCIA

| SAMPLE INFORMATION | | CONTAINER INFORMATION | FIELD TESTING | ANALYSIS REQUESTED |
|---|---|---|---|---|
| SAMPLE #: 2994229-2<br>MATRIX: STORMWATER<br>SOURCE: SW 03B, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:20 am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: HNO3 pH<2 | | ICP Total Metals: Cd, Cu, Pb, , Mercury - Total |
| SAMPLE #: 2994229-3<br>MATRIX: STORMWATER<br>SOURCE: SW 03B, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:20 am<br>TYPE: Grab | TYPE: G/TC COLOR: AMBER VOLUME:<br>PRESERVATIVE: HCl pH<2,Cool 4 °C | | Oil and Grease (HEM) |
| SAMPLE #: 2994229-4<br>MATRIX: STORMWATER<br>SOURCE: SW 03B, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:20 am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Cool 4 °C | | Turbidity |
| SAMPLE #: 2994229-5<br>MATRIX: STORMWATER<br>SOURCE: SW 03B, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:20 am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Immediately | | pH |

| CUSTODY RECORD | SIGNATURE | DATE | TIME |
|---|---|---|---|
| Collected in field by: | | 12/26/18 | 10:20 am |
| Fixed in field by: | | 12/26/18 | 10:20 am |
| Authorized by: | Dannaly Cruz Zaloya | 12/26/18 | 10:41 |
| Received by EQLF: | N/A | N/A | N/A |
| Released to EQLL by: | | 12-26-18 | 1322 |
| Received by EQLL: | | 12-26-18 | 1322 |

**SPECIAL INSTRUCTIONS / COMMENTS:**

Contacto: Dannaly Cruz

Tel: 787-212-2422 / 289-7240

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

Arrival Temperature: 4°C Signature:

Eqlab's general terms and conditions on reverse side of this document.

2018-19953

# ENVIRONMENTAL QUALITY LABORATORIES, INC.

## SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: AEROSTAR AIRPORTS HOLDINGS LLC | CLIENT ID: 2119-01 | W.O. #: 07 | SITE: CAROLINA, PR. | CLIENT REP: MRS. DANNALY CRUZ

P.O. #: 16203-0 | PWSID #: | FOLDER #: 265743 | PROJECT: LMM INTERNATIONAL AI | EQLAB REP: EGARCIA

| SAMPLE INFORMATION | | CONTAINER INFORMATION | FIELD TESTING | ANALYSIS REQUESTED |
|---|---|---|---|---|
| SAMPLE #: 2994230-1<br>MATRIX: STORMWATER<br>SOURCE: SW 04, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:56 am<br>TYPE: Grab | TYPE: G/TC COLOR: AMBER VOLUME:<br>PRESERVATIVE: HCl pH<2,Cool 4 °C | | Oil and Grease (HEM) |
| SAMPLE #: 2994230-2<br>MATRIX: STORMWATER<br>SOURCE: SW 04, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:56 am<br>TYPE: Grab | TYPE: G/PC COLOR: AMBER VOLUME:<br>PRESERVATIVE: Asc Acid,NaOH,Cool 4 °C | | Cyanide - Total |
| SAMPLE #: 2994230-3<br>MATRIX: STORMWATER<br>SOURCE: SW 04, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:56 am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Immediately | | pH |
| SAMPLE #: 2994230-4<br>MATRIX: STORMWATER<br>SOURCE: SW 04, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:56 am<br>TYPE: Grab | TYPE: P/PC COLOR: N/A VOLUME:<br>PRESERVATIVE: Cool 4 °C | | Turbidity |

| CUSTODY RECORD | SIGNATURE | DATE | TIME |
|---|---|---|---|
| Collected in field by: | | 12/26/18 | 10:55 am |
| Fixed in field by: | | 12/26/18 | 10:55 am |
| Authorized by: | Dannaly Cruz Delgado | 12/26/18 | 10:56am |
| Received by EQLF: | N/A | N/A | N/A |
| Released to EQLL by: | | 12-26-18 | 1322 |
| Received by EQLL: | | 12-26-18 | 1322 |

**SPECIAL INSTRUCTIONS / COMMENTS:**

Contacto: Dannaly Cruz

Tel: 787-212-2422 / 289-7240

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

PNDC

Arrival Temperature: 4°C Signature:

Eqlab's general terms and conditions on reverse side of this document.

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2018-19953

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| SAMPLE INFORMATION | | CONTAINER INFORMATION | FIELD TESTING | | ANALYSIS REQUESTED |
|---|---|---|---|---|---|
| SAMPLE #: 2994230-5<br>MATRIX: STORMWATER<br>SOURCE: SW 04, CAROLINA, PR | DATE: 12/26/18<br>TIME: 10:56 am<br>TYPE: Grab | TYPE P/PC COLOR N/A VOLUME<br>PRESERVATIVE HNO3 pH<2 | | | ICP Total Metals: Cd, Cu, Pb, , Mercury - Total |
| SAMPLE #:<br>MATRIX:<br>SOURCE: | DATE:<br>TIME:<br>TYPE: | TYPE COLOR VOLUME<br>PRESERVATIVE | | | |
| SAMPLE #:<br>MATRIX:<br>SOURCE: | DATE: N/A<br>TIME:<br>TYPE: A | TYPE COLOR VOLUME<br>PRESERVATIVE | | | N/A |
| SAMPLE #:<br>MATRIX:<br>SOURCE: | DATE:<br>TIME:<br>TYPE: | TYPE COLOR VOLUME<br>PRESERVATIVE | | | |

| CUSTODY RECORD | SIGNATURE | DATE | TIME |
|---|---|---|---|
| Collected in field by: | | 12-26-18 | 10:56 |
| Fixed in field by: | | 12-26-18 | 10:56 |
| Authorized by: | Dannaly Cruz R.Garcia | 12/26/18 | 10:56am |
| Received by EQLF: | N/A | N/A | N/A |
| Released to EQLL by: | | 12-26-18 | 1322 |
| Received by EQLL: | | 12-26-18 | 1322 |

**SPECIAL INSTRUCTIONS / COMMENTS:**

Contacto: Dannaly Cruz

Tel: 787-212-2422 / 289-7240

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PDS2

Arrival Temperature: 4°C Signature:

Eqlab's general terms and conditions on reverse side of this document.

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Backgound St. 01
SW 01
Background St. 02
SW 02
Laguna La Torrecilla
Cangrejo Arriba
SW03B
Background St. 03
Lago Managua
SW 04
SW 03A
© 2017 Google
Google Earth
Tour Guide
1994
18°25'39.05" N 66°00'13.21" W elev 11 ft eye alt 15977 ft

# APPENDIX H

Preliminary General Wetlands and Other Surface Waters Mitigation Plan

# PRELIMINARY GENERAL WETLANDS AND OTHER SURFACE WATERS MITIGATION PLAN

## LUIS MUÑOZ MARÍN INTERNATIONAL AIRPORT - SJU OBJECT FREE AREA ALTERNATIVES 2A AND 3A INCLUDING AIRFIELD DRAINAGE ALTERNATIVES

PREPARED FOR:
AEROSTAR AIRPORT HOLDINGS, LLC

PREPARED BY:
EcoStahlia

TECHNICAL SUPPORT BY:
ESA

MARCH 28, 2019

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# (TO BE FILLED IN WHEN COMPLETED)

# ALTERNATIVES

1) **Alternative 2A: Trim Vegetation and Dredge Other Surface Waters (OSW) Airport Features**
   a) Trimming Impacts
      i) 23.1 acres of mangrove habitat (inside OFA) +.4.2 acres of mangrove habitat (outside OFA) = **27.3 acres of mangrove habitat total**.
      ii) 4.0 acres of non-mangrove - mixed freshwater shrub/scrub wetland vegetation (inside OFA) + 0.7 acres of non-mangrove (outside OFA) = **4.7 acres of non-mangrove - mixed freshwater shrub/scrub wetland vegetation**.

   b) Dredging Impacts
      i) **35.1 acres of OSW (channel dredging activities)**.

2) **Alternative 3A: Trim Vegetation, Fill Wetlands and Dredge OSW Airport Features**
   a) Fill Impacts
      i) **7.3 acres of mangrove habitat**.

   b) Trimming Impacts
      i) 15.8 acres of mangrove habitat (inside OFA) + 4.2 acres (outside OFA) = **20.0 acres of mangrove habitat total**.
      ii) 4.0 acres of non-mangrove - mixed freshwater shrub/scrub wetland vegetation (inside OFA) + 0.7 acres of non-mangrove (outside OFA) = **4.7 acres of non-mangrove - mixed freshwater shrub/scrub wetland vegetation**.

   c) Dredging Impacts
      i) **35.1 acres of OSW (channel dredging activities)**.

## PRELIMINARY GENERAL WETLAND AND OSW MITIGATION PLAN

To be implemented within the "Gran Parque Agroturístico El Dorado/Finca La Julia" in the Municipality of Dorado. The Municipality of Dorado owns an 869 acres property south of the state road PR#165 where lands to implement extensive mitigation plans are available. The areas include herbaceous wetlands and mangrove forests that were completely damaged by Hurricane María. They Municipality of Dorado is very interested in having wetland restoration projects within the proposed site.

**Alternative 2A: Trim Vegetation and Dredge Other Surface Waters (OSW) Airport Features**

a. Trimming Impacts**:**
   i. **27.3 acres of mangrove habitat total**

Proposed Compensatory Mitigation

1) Enhancement of 40.9 acres of existing herbaceous wetland by the creation of mangrove habitat. Proposed ratio is 1.5:1; given that once the existing mangrove habitat at SJU is trimmed most of the functional values provided by the forested habitat will be lost.
   a. Lowering (cutting) existing soil topographic levels of herbaceous wetland to reach soil levels of adjacent mangrove areas within the Gran Parque Agroturístico El Dorado/Finca La Julia.
   b. Planting mangrove trees. This could be achieved by bringing red mangrove (*Rhizophora mangle*) or white mangrove (*Laguncularia racemosa*) trees, according to existing dominant mangrove species at adjacent mangrove habitat to be "mimic". Mangrove trees seedlings/propagules could be brought from the SJU impact areas and/or other mangrove habitats near the Gran Parque Agroturístico El Dorado/Finca La Julia.

ii. **4.7 acres of non-mangrove - mixed freshwater shrub/scrub wetland vegetation**.

Proposed Compensatory Mitigation

No compensatory mitigation is proposed for the impact of non-mangrove - mixed freshwater shrub/scrub wetland vegetation if trimming is carried out by light mowing machinery or by hand. No mechanized land clearing is considered, given that it would be subject to regulations under Section 404 of the CWA.

b) Dredging Impacts: **35.1 acres of OSW (channel dredging activities)**

Proposed Compensatory Mitigation

No compensatory mitigation is proposed for dredging OSW or open waters (no fill material will be disposed on U.S. Waters, including wetlands).

2) The establishment of a conservation easement is proposed to protect the mitigation area (**40.9 acres**).

**Alternative 3A: Trim Vegetation, Fill Wetlands and Dredge OSW Airport Features**

a. Trimming Impacts

i. 20.0 **acres of mangrove habitat total**.

Proposed Compensatory Mitigation

1) Enhancement of 30.0 acres of existing herbaceous wetland by the creation of mangrove habitat. Proposed ratio is 1.5:1; given that once the existing mangrove habitat at SJU is trimmed most of the functional values provided by the forested habitat will be lost.

a) Lowering (cutting) existing soil topographic levels of herbaceous wetland to reach soil levels of adjacent mangrove areas within the Gran Parque Agroturístico El Dorado/Finca La Julia.

b) Planting mangrove trees. This could be achieved by bringing red mangrove (*Rhizophora mangle*) or white mangrove (*Laguncularia racemosa*) trees, according to existing dominant mangrove species at adjacent mangrove habitat to be "mimic". Mangrove trees seedlings/propagules could be brought from the SJU impact areas and/or other mangrove habitats near the Gran Parque Agroturístico El Dorado/Finca La Julia.

ii. 4.7 **acres of non-mangrove - mixed freshwater shrub/scrub wetland vegetation**.

Proposed Compensatory Mitigation

No compensatory mitigation is proposed for the impact of non-mangrove - mixed freshwater shrub/scrub wetland vegetation if trimming is carried out by light mowing machinery or by hand. No mechanized land clearing is considered; given that it would be subject to regulations under Section 404 of the CWA.

b. Fill Impacts

i. **7.3 acres of mangrove habitat**.

Proposed Compensatory Mitigation

1) Enhancement of 21.9 acres of existing herbaceous wetland by the creation of mangrove habitat. Proposed ratio is 3:1; given that once the existing mangrove habitat at SJU is filled all functional values provided by the mangrove habitat will be lost, including function and values provided as essential fish habitat.

a) Lowering (cutting) existing soil topographic levels of herbaceous wetland to create a pond with hydrologic connection to existing channels or open waters at the Gran Parque Agroturístico El Dorado/Finca La Julia.

b) Creation of small islands within the pond by using the excavated material.

c) Planting mangrove trees on the perimeter of the small islands and around the pond. This could be achieved by bringing red mangrove (*Rhizophora mangle*) or

white mangrove (*Laguncularia racemosa*) trees, according to existing dominant mangrove species at mangrove habitats nearby. Mangrove trees seedlings/propagules could be brought from the SJU impact areas and/or other mangrove habitats near the Gran Parque Agroturístico El Dorado/Finca La Julia. Also, upland tree species would be planted in the higher areas of the small islands that were created.

c. Dredging Impacts: **35.1 acres of OSW (channel dredging activities)**

Proposed Compensatory Mitigation

No compensatory mitigation is proposed for dredging OSW or open waters (no fill material will be disposed on U.S. Waters, including wetlands).

2) The establishment of a conservation easement is proposed to protect the mitigation area (51.9acres).

# WETLANDS AND OSW MITIGATION PLAN ESTIMATED COSTS

Alternative 2A: Trim Vegetation and Dredge Other Surface Waters (OSW) Airport Features

- Conceptual compensatory mitigation plan: **$5,000.00**
- Final compensatory mitigation plan: **$64,800** - field work, topography, elevations, drawings, reports,

Alternative 3A: Trim Vegetation, Fill Wetlands and Dredge OSW Airport Features

- Conceptual compensatory mitigation plan: **$6,000.00**
- Final compensatory mitigation plan: **$81,200.00** - field work, topography, elevations, drawings, reports

## ASSUMPTIONS

1. This preliminary general mitigation plan is based on the acreage of wetlands and OSW provided by the client.
2. Compensatory mitigation is proposed within "Finca La Julia", which is located in the Municipality of Dorado.
3. Finca La Julia is mostly covered by herbaceous wetland. Therefore, compensatory mitigation methods will mostly include enhancement of existing wetlands to increase their functional values.
4. Proposed mitigation methods and ratios of compensation for impacts are based on experience and professional judgment that have been acquired by working with similar projects. However, federal and local agencies may require different compensatory mitigation methods and compensation ratios. In Puerto Rico, there is no approved methodology to assess wetland and OWS impacts in order to determine compensation methods and ratios.
5. Forested wetlands and mangrove habitats within SJU are considered to have the same functional values for the purpose of this preliminary general mitigation plan.
6. No compensatory mitigation is proposed for dredging activities within OSW (Open Waters) that are non-wetland.
7. Proposed mitigation method for alternative 3A considers impacts to essential fish habitat.
8. Conceptual compensatory mitigation plan costs do not include land/topographic survey or engineering drawings.
9. Final compensatory mitigation plan costs include land/topographic survey and their respective engineering drawings.
10. Costs for the establishment of the conservation easement are not included in this proposal.

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# APPENDIX

## MAPS OF POSSIBLE SCENARIOS FOR MITIGATION ACTIVITIES ASSOCIATED WITH THE ROFA/TOFA PROJECT

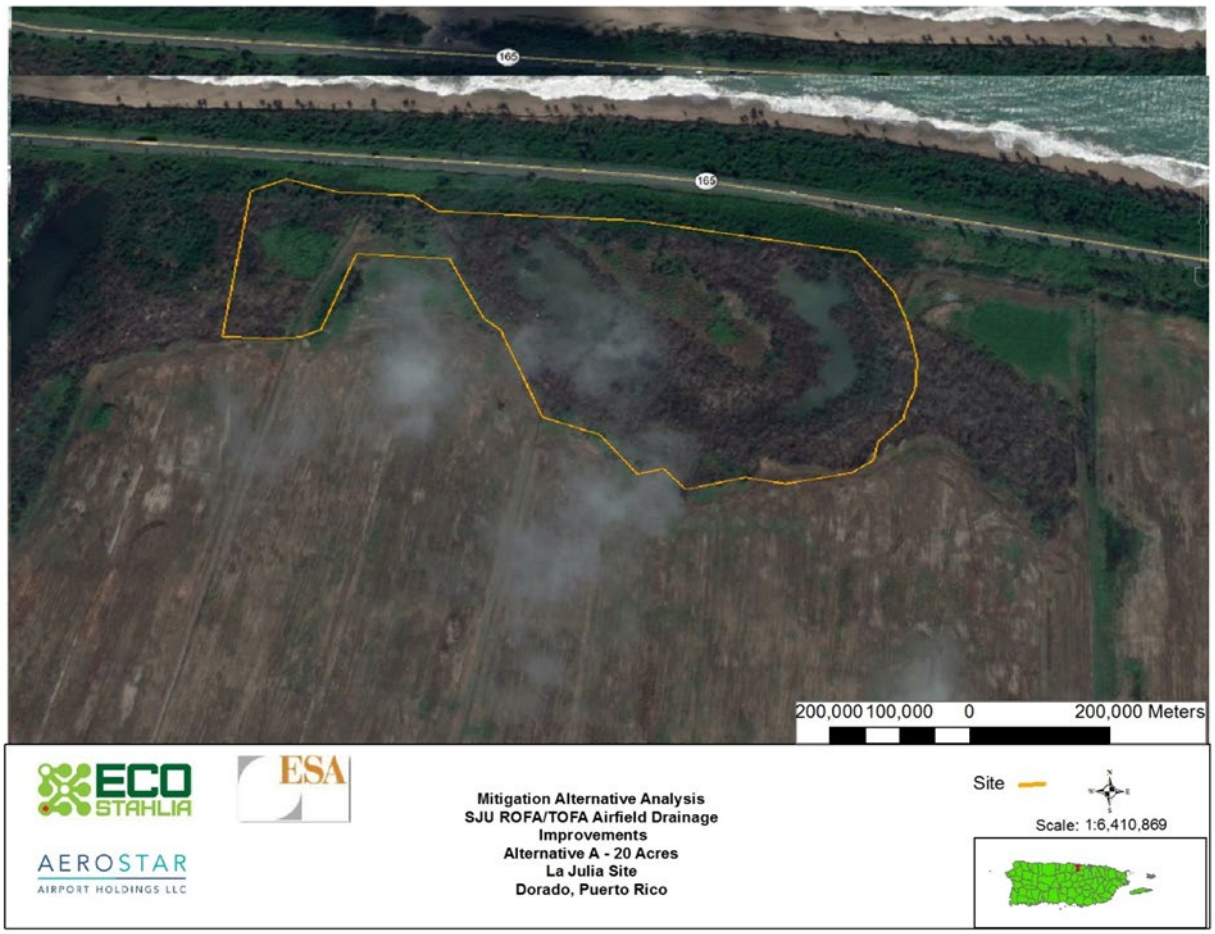


Figure 1: Scenario A Mitigation of 20 acres of wetlands.


Figure 2. Scenario B Mitigation of 40 acres of wetlands


Figure 3. Scenario C mitigation of 60 acres of wetlands.