APPENDIX K

INTERPOLATION OF MODELED BEACH IMPACTS

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Final Programmatic Environmental Impact Statement

USMCA Mitigation of Contaminated Transboundary Flows Project

Interpolation of Modeled Beach Impacts

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

APTP	Advanced Primary Treatment Plant
BIF	beach impact fraction
CILA	Comisión International de Limites y Aguas
EPA	United States Environmental Protection Agency
FIB	fecal indicator bacteria
ITP	South Bay International Wastewater Treatment Plant
MGD	million gallons per day
N_{ill}	Number of ill swimmers
PB-CILA	Planta de Bombeo CILA
PEIS	Programmatic Environmental Impact Statement
SAB	San Antonio de los Buenos
SABTP	San Antonio de los Buenos Wastewater Treatment Plant
U.S.	United States
USIBWC	United States Section of the International Boundary and Water Commission
USMCA	United States–Mexico–Canada Agreement

1. INTRODUCTION

The United States (U.S.) Environmental Protection Agency (EPA) and the United States Section of the International Boundary and Water Commission (USIBWC), as joint lead agencies pursuant to National Environmental Policy Act, are proposing to fund and implement the United States–Mexico–Canada Agreement (USMCA) Mitigation of Contaminated Transboundary Flows Project (the Proposed Action) to reduce transboundary flows from Tijuana that cause adverse public health and environmental impacts in the Tijuana River watershed and adjacent coastal areas. Beaches in the County of San Diego are regularly required to close due to untreated wastewater discharges to the Pacific Ocean via San Antonio de los Buenos (SAB) Creek at Punta Bandera in Mexico and via the Tijuana River. The beaches at Imperial Beach Pier and Border Field State Park have averaged 66 and 170 closure days per year since 2003, respectively, with even more frequent closures at Border Field State Park in recent years (averaging 262 closure days per year since 2019) (City of Imperial Beach, 2022). The County of San Diego monitors the ocean water for fecal indicator bacteria (FIB) and closes beaches if the FIB concentration exceeds the threshold estimated to result in 32 illnesses per 1,000 primary contact recreators (known as the EPA beach action value).

In a recent modeling study (*Modeling Untreated Wastewater Evolution and Swimmer Illness for Four Wastewater Infrastructure Scenarios in the San Diego-Tijuana (US/MX) Border Region* [2021]), the Scripps Institution of Oceanography examined the frequency and causes of water quality-driven human health impacts at four beaches along the U.S. and Mexican coasts, based on four wastewater input scenarios representing different combinations of untreated wastewater contributions from SAB Creek and the Tijuana River (Feddersen et al., 2021). In this study, the authors estimated the following for each beach and input scenario:

- Shoreline norovirus concentrations.
- Number of ill swimmers (N_{ill}) due to exposure to norovirus pathogens in untreated wastewater discharges.
- Beach impact fraction (BIF), which is the fraction of time that the modeled mean (expected) probability of swimmer illness exceeds 0.036 (i.e., 36 per 1,000) due to exposure to norovirus pathogens in untreated wastewater discharges (Feddersen et al., 2021).

The model results indicate that untreated wastewater from SAB Creek is the dominant cause of swimmer illness at regional beaches during the tourist (dry) season (i.e., approximately Memorial Day to Labor Day) and that human health risk during the dry season may be greater than previously understood, due to transport of norovirus from coastal discharges in Mexico (Feddersen et al., 2021).

Drawing from the modeled relationship between discharges from untreated wastewater via SAB Creek and the resulting beach impacts, EPA and USIBWC interpolated the expected tourist (dry) season impacts at regional beaches—specifically, the expected beach impact fraction and N_{ill} values—that would result from reduced discharges of untreated wastewater via SAB Creek under the Proposed Action. To simplify this interpolation, EPA and USIBWC focused only on beach impacts during the tourist (dry) season—i.e., when the Tijuana River would be expected to contribute no flows of untreated wastewater to the Pacific Ocean. This scope limitation also avoids conflicts arising from differences in Tijuana River flow reductions between Feddersen et al. (2021) modeled scenarios and the Proposed Action. This appendix documents the interpolation methodology used by EPA and USIBWC, as well as the results and limitations of the interpolation.

See the Final Programmatic Environmental Impact Statement (PEIS) for further discussion and interpretation of the results.

2. INTERPOLATION METHODOLOGY

The following projects implemented under the Proposed Action would be expected to decrease discharges of untreated wastewater to the Pacific Ocean via SAB Creek: Project A (Expanded South Bay International Wastewater Treatment Plant [ITP]), Project B (Tijuana Canyon Flows to ITP), Project C (Tijuana Sewer Repairs), Project D (Advanced Primary Treatment Plant [APTP] Phase 1), and Project G (New San Antonio de los Buenos Wastewater Treatment Plant [SABTP]).

Feddersen et al. (2021) modeled beach impact fraction and N_{ill} under baseline conditions (Baseline Scenario) and three scenarios depicting reduced discharges of untreated wastewater to the Pacific Ocean via SAB Creek and/or the Tijuana River (Scenarios A, B, and C). Of these, only Scenario A included a reduction of wastewater discharges via SAB Creek. Therefore, EPA and USIBWC examined the Baseline Scenario and Scenario A presented in Feddersen et al. (2021)to interpolate beach impacts during the tourist (dry) season that would result from reducing SAB Creek untreated wastewater discharges under the Proposed Action. The Baseline Scenario assumes that discharges from SAB Creek to the shoreline equal 50 million gallons per day (MGD), of which 35 MGD is untreated wastewater. Scenario A assumes that discharges via SAB Creek are reduced to 10 MGD of <u>treated</u> wastewater with no discharges of <u>untreated</u> wastewater (Feddersen et al., 2021).

EPA and USIBWC coordinated with Dr. Falk Feddersen, lead author for Feddersen et al. (2021), to obtain the data for tourist season beach impact fraction at the four beaches under the Baseline Scenario and Scenario A. Dr. Feddersen confirmed that it would be reasonable to use untreated wastewater discharges via SAB Creek to interpolate beach impacts during the tourist season. Dr. Feddersen also provided beach impact fraction (but not N_{ill}) data for an additional wastewater input scenario, hereinafter referred to as Scenario AA, which assumes that wastewater discharged via SAB Creek would be reduced to 10 MGD of <u>untreated</u> wastewater (F. Feddersen, personal communication, April 23, 2022). With this third data point, EPA and USIBWC were able to create a more tailored linear regression of the relationship between SAB Creek untreated wastewater discharges and modeled beach impact fractions. See Table 1 for the beach impact fraction values for the Baseline Scenario, Scenario A, and Scenario AA at the four beaches. See Figure 1 and Table 2 for the linear regression derived from the values in Table 1.

Table 1. Tourist (Dry) Season Beach Impact Fraction Values by Wastewater Input Scenario at Four Beaches

Model Scenario	Untreated Wastewater from SAB Creek (MGD)	Tourist Season BIF			
		Playas Tijuana	Imperial Beach	Silver Strand Beach	Hotel del Coronado
Baseline Scenario	35	0.6158	0.44	0.3356	0.2622
Scenario AA	10	0.4706	0.2737	0.1693	0.073
Scenario A	0	0.0677	0	0	0

Source: Feddersen et al. (2021); F. Feddersen, personal communication, April 23, 2022.

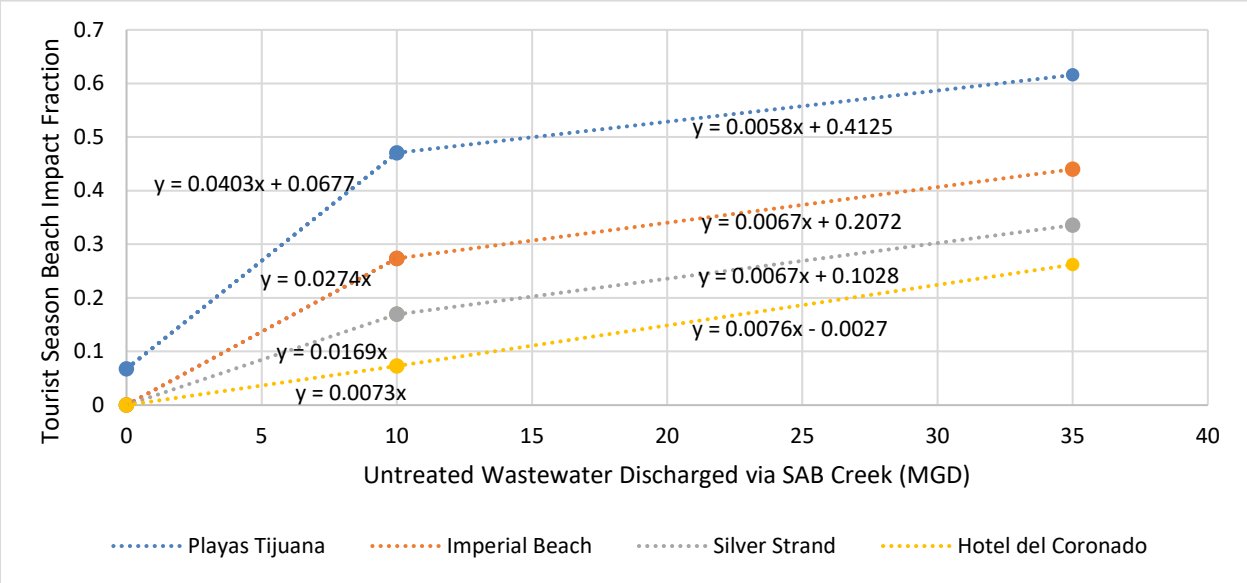

Figure 1. Linear Regressions of Relationships Between SAB Creek Untreated Wastewater Discharges and Tourist (Dry) Season Beach Impact Fraction at Four Beaches

Table 2. Variables for Linear Regressions of Relationships Between SAB Creek Untreated Wastewater Discharges and Tourist (Dry) Season Beach Impact Fraction at Four Beaches (Derived from Figure 1)

Variable	Playas Tijuana	Imperial Beach	Silver Strand Beach	Hotel del Coronado
SAB Creek Untreated Wastewater Discharge of Less than 10 MGD				
Slope	0.0403	0.0274	0.0169	0.0073
y-intercept	0.0677	0	0	0
SAB Creek Untreated Wastewater Discharge of Equal to or Greater than 10 MGD				
Slope	0.0058	0.0067	0.0067	0.0076
y-intercept	0.4125	0.2072	0.1028	-0.0027

EPA and USIBWC used these linear regressions to interpolate how implementation of the Proposed Action would reduce expected tourist (dry) season beach impact fractions at four regional beaches. The results are presented below in Table 3 and Table 4.

Table 3. Impacts on Tourist (Dry) Season Beach Impact Fraction (Initial Operations) – Alternative 1

Project	Untreated Wastewater from SAB Creek (MGD)	Playas Tijuana		Imperial Beach		Silver Strand Beach		Hotel del Coronado	
		BIF [e]	% Change	BIF [e]	% Change	BIF [e]	% Change	BIF [e]	% Change
Current conditions [a]	28.2	0.576	N/A	0.396	N/A	0.292	N/A	0.212	N/A
Project A, Option A1 (Expand to 40 MGD) only [c]	13.4	0.490	-15%	0.297	-25%	0.193	-34%	0.099	-53%
Project A, Option A2 (Expand to 50 MGD) only [b, c, d]	6.5	0.330	-43%	0.178	-55%	0.110	-62%	0.047	-78%
Project A, Option A3 (Expand to 60 MGD) only [b, c, d]	6.5	0.330	-43%	0.178	-55%	0.110	-62%	0.047	-78%
Project D (35 MGD) only [c]	22.7	0.544	-6%	0.359	-9%	0.255	-13%	0.170	-20%
Alternative 1 maximum (Projects A [Option A3] + D)	**2.2**	**0.156**	**-73%**	**0.060**	**-85%**	**0.037**	**-87%**	**0.016**	**-92%**

a – Current conditions were calculated using Tijuana River flow data from January 2016 through January 2022, during a period when Planta de Bombeo—Comisión International de Limites y Aguas (PB-CILA) capacity was 23 MGD.

b – Reflects ITP treatment of inflows resulting from Project B.

c – Reflects ITP treatment of inflows resulting from Project C.

d – Reflects changes in discharges and loadings that would be achieved upon startup of new treatment facilities (i.e., before the full treatment capacity comes into service in response to population growth in Tijuana).

e – BIF is defined as the fraction of time that the modeled mean (expected) probability of swimmer illness exceeds 0.036 (i.e., 36 per 1,000) due to exposure to norovirus pathogens in untreated wastewater discharges.

Table 4. Impacts on Tourist (Dry) Season Beach Impact Fraction (Initial Operations) – Alternative 2

Project	Untreated Wastewater from SAB Creek (MGD)	Playas Tijuana		Imperial Beach		Silver Strand Beach		Hotel del Coronado	
		BIF [e]	% Change	BIF [e]	% Change	BIF	% Change	BIF [e]	% Change
Current conditions [a]	28.2	0.576	N/A	0.396	N/A	0.292	N/A	0.212	N/A
Alternative 1 maximum (Projects A [Option A3] + D) [b, c, d]	2.2	0.156	-73%	0.060	-85%	0.037	-87%	0.016	-92%
Alternative 2 maximum (Projects A [Option A3] + D + G) [b, c, d]	**0.1**	**0.072**	**-88%**	**0.003**	**-99.3%**	**0.002**	**-99.4%**	**0.001**	**-100%**

a – Current conditions were calculated using Tijuana River flow data from January 2016 through January 2022, during a period when PB-CILA capacity was 23 MGD.
b – Reflects ITP treatment of inflows resulting from Project B.
c – Reflects ITP treatment of inflows resulting from Project C.
d – Reflects changes in discharges and loadings that would be achieved upon startup of new treatment facilities (i.e., before the full treatment capacity comes into service in response to population growth in Tijuana).
e – BIF is defined as the fraction of time that the modeled mean (expected) probability of swimmer illness exceeds 0.036 (i.e., 36 per 1,000) due to exposure to norovirus pathogens in untreated wastewater discharges.

Drawing from the modeled N_{ill} results from Feddersen et al. (2021) under the Baseline Scenario and Scenario A, EPA and USIBWC also interpolated the expected reductions in N_{ill} that would result from implementation of the Proposed Action. However, N_{ill} values for an additional Scenario AA were not available. See Table 5 for the N_{ill} values for the Baseline Scenario and Scenario A at Imperial Beach. EPA and USIBWC plotted the two data points for the N_{ill} values and developed a linear regression to represent how N_{ill} varies depending on volumes of untreated wastewater discharged via SAB Creek (see Figure 2 and Table 6).

Table 5. Ill Swimmers at Imperial Beach During Tourist (Dry) Season

Model Scenario	Untreated Wastewater from SAB Creek (MGD)	N_{ill}	Ill Swimmer Percentage [a]
Baseline Scenario	35	25,750	4.5%
Scenario A	0	3,111	0.5%

Source: (Feddersen et al., 2021).
a – The percent of ill swimmers is based on a total count of 568,152 hourly swimmers at Imperial Beach.

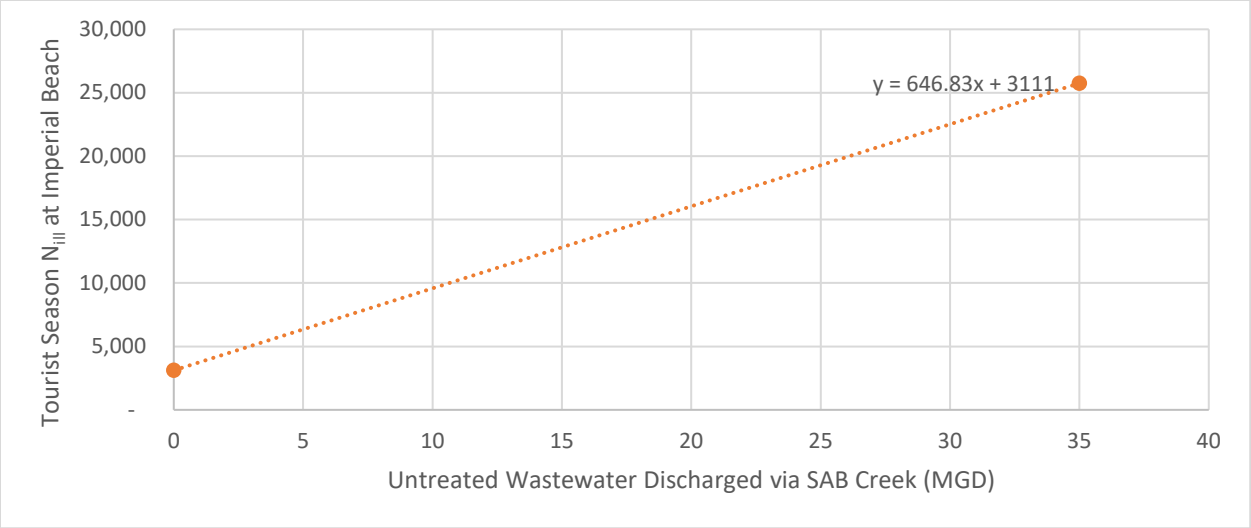

Figure 2. Linear Regression of Relationship Between SAB Creek Untreated Wastewater Discharges and Tourist (Dry) Season N_{ill} at Imperial Beach

Table 6. Variables for Linear Regression of Relationship Between SAB Creek Untreated Wastewater Discharges and Tourist (Dry) Season N_{ill} at Imperial Beach (Derived from Figure 2)

Variable	Imperial Beach
Slope	646.83
y-intercept	3,111

EPA and USIBWC used this linear regression to interpolate how implementation of the Proposed Action would reduce the expected tourist (dry) season number of ill swimmers at Imperial Beach. The results are presented below in Table 7 and Table 8.

Table 7. Impacts on Tourist (Dry) Season N_{ill} at Imperial Beach (Initial Operations) – Alternative 1

Project	Untreated Wastewater from SAB Creek (MGD)	Imperial Beach	
		N_{ill} [e]	Percent Change
Current conditions [a]	28.2	21,352	N/A
Project A, Option A1 (Expand to 40 MGD) only [c]	13.4	11,779	-45%
Project A, Option A2 (Expand to 50 MGD) only [b, c, d]	6.5	7,315	-66%
Project A, Option A3 (Expand to 60 MGD) only [b, c, d]	6.5	7,315	-66%
Project D (35 MGD) only [c]	22.7	17,794	-17%
Alternative 1 maximum (Projects A [Option A3] + D)	**2.2**	**4,534**	**-79%**

a – Current conditions were calculated using Tijuana River flow data from January 2016 through January 2022, during a period when PB-CILA capacity was 23 MGD.
b – Reflects ITP treatment of inflows resulting from Project B.
c – Reflects ITP treatment of inflows resulting from Project C.
d – Reflects changes in discharges and loadings that would be achieved upon startup of new treatment facilities (i.e., before the full treatment capacity comes into service in response to population growth in Tijuana).
e – N_{ill} is defined as the number of ill swimmers due to exposure to norovirus pathogens in untreated wastewater discharges.

Table 8. Impacts on Tourist (Dry) Season N_{ill} at Imperial Beach (Initial Operations) – Alternative 2

Project	Untreated Wastewater from SAB Creek (MGD)	Imperial Beach	
		N_{ill} [e]	Percent Change
Current conditions [a]	28.2	21,352	N/A
Alternative 1 maximum (Projects A [Option A3] + D) [b, c, d]	2.2	4,534	-79%
Alt. 1 + Project G only	0.1	3,176	-85%
Alternative 2 maximum (Projects A [Option A3] + D + G)	**0.1**	**3,176**	**-85%**

a – Current conditions were calculated using Tijuana River flow data from January 2016 through January 2022, during a period when PB-CILA capacity was 23 MGD.
b – Reflects ITP treatment of inflows resulting from Project B.
c – Reflects ITP treatment of inflows resulting from Project C.
d – Reflects changes in discharges and loadings that would be achieved upon startup of new treatment facilities (i.e., before the full treatment capacity comes into service in response to population growth in Tijuana).
e – N_{ill} is defined as the number of ill swimmers due to exposure to norovirus pathogens in untreated wastewater discharges.

3. LIMITATIONS

To interpolate beach impact fraction, EPA and USIBWC used data points from the Baseline Scenario and Scenario A derived from Feddersen et al. (2021) as well as data points for an additional Scenario AA provided by Dr. Feddersen. The linear regressions for beach impact fraction suggest that incremental reductions in SAB Creek untreated wastewater discharges below 10 MGD result in more substantial reductions in beach impact fraction as compared to similar incremental reductions in discharges between 10 MGD and 35 MGD—i.e., reducing SAB Creek untreated wastewater discharges from 10 MGD to 5 MGD (a 5-MGD reduction) may lead to a more substantial reduction in beach impact fraction as compared to what would be achieved by reducing these discharges from 35 MGD to 30 MGD (also a 5-MGD reduction). This is particularly true for beaches closer to SAB Creek (i.e., those farther south). Therefore, the most substantial reductions in beach impacts would be achieved after untreated wastewater discharges via SAB Creek are reduced below 10 MGD.

While three data points were available for the beach impact fraction interpolation, N_{ill} values for Scenario AA were not readily available. EPA and USIBWC therefore interpolated the Proposed Action N_{ill} values using only the two data points from the Baseline Scenario and Scenario A, producing a simpler linear regression that shows an identical reduction in N_{ill} for every 1 MGD reduction in untreated wastewater discharged via SAB Creek. EPA and USIBWC expect that if a N_{ill} value for Scenario AA were available, the resulting linear regression would show a similar pattern to that of beach impact fractions—i.e., more substantial reductions in N_{ill} would be achieved when untreated wastewater discharges via SAB Creek are reduced below 10 MGD. The estimated reductions in N_{ill} for certain components of the Proposed Action shown in Table 7 and Table 8 may therefore be overestimated, particularly for individual projects such as Project A (Option A1 [Expand ITP to 40 MGD]) and Project D (APTP Phase 1) that would not reduce untreated wastewater discharges via SAB Creek to a level below 10 MGD. However, because full implementation of Alternative 1 or Alternative 2 would almost entirely eliminate untreated wastewater discharges via SAB Creek, this limitation does not substantially affect the overall conclusions regarding reductions in N_{ill} under full implementation of the Proposed Action.

4. REFERENCES CITED

City of Imperial Beach. (2022). IB Beach Closures 12-31-2021 Microsoft Excel Spreadsheet.

Feddersen, F., Boehm, A. B., Giddings, S. N., Wu, X., & Liden, D. (2021). Modeling untreated wastewater evolution and swimmer illness for four wastewater infrastructure scenarios in the San Diego–Tijuana (US/MX) border region. *GeoHealth*, *5*(11), e2021GH000490. https://doi.org/10.1029/2021GH000490