Feasibility Analysis for Project 7: Divert or Reuse Treated Wastewater from Existing Wastewater Treatment Plants in Mexico to Reduce Flows into the Tijuana River

Technical Memorandum

USMCA Mitigation of Contaminated Tijuana Transboundary Flows Project

Prepared for:

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5	Final	Updated impacts; removed internal markings	PG	11/22/21

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

AACE International	Association for the Advancement of Cost Engineering
BOD_5	amount of oxygen consumed by microorganisms within five days
CEISA	Consorcio Especializado en Ingeniería
CESPT	Comisión Estatal de Servicios Públicos de Tijuana
CONAGUA	Comisión Nacional del Agua
EID	Environmental Information Document
ERG	Eastern Research Group, Inc.
EPA	United States Environmental Protection Agency
ft/s	feet per second
HDPE	high-density polyethylene
ITP	South Bay International Wastewater Treatment Plant
LPS	liters per second
MGD	million gallons per day
MXN	Mexican peso
NADB	North American Development Bank
O&M	operation and maintenance
PB1-A	Pump Station 1A
PB1-B	Pump Station 1B
PB-CILA	CILA Pump Station
SAB	San Antonio de los Buenos
SBOO	South Bay Ocean Outfall
SEPROA	Secretaría para el Manejo Saneamiento y Protección del Agua
USD	United States dollars
USMCA	United States–Mexico–Canada Agreement
WWTP	wastewater treatment plant

EXECUTIVE SUMMARY

PG Environmental conducted a feasibility analysis for Project 7, "Divert or Reuse Treated Wastewater from Existing Wastewater Treatment Plants in Mexico to Reduce Flows into the Tijuana River," one of 10 proposed projects to mitigate transboundary wastewater flows in the Tijuana River watershed under the United States–Mexico–Canada Agreement (USMCA). This feasibility analysis report includes an analysis of the technical, economic, and environmental feasibility of the project and builds on past studies and consultation with engaged stakeholders using available data.

Approximately half of dry-weather flow in the Tijuana River consists of treated effluent from two wastewater treatment plants (WWTPs), Arturo Herrera and La Morita. The two WWTPs produced a combined average of 10.3 MGD of treated effluent per month from April 2019 to November 2020. This project involves separating the WWTPs' effluent from the river. This would avoid treating these flows for a second time, resulting in lower pumping and treatment costs as well as providing additional capacity in the Tijuana River Diversion system (PB-CILA, PB1-A, PB1-B, and either SAB or ITP). It would reduce the need to divert and treat river water at the border, and ultimately reduce the quantity and frequency of transboundary flows.

Project 7 consists of two sub-projects. Either sub-project would reduce transboundary flows by 79 days per year and 700 million gallons at the current combined average flow of 10.3 MGD, and 84 days per year and 900 million gallons at the combined plant capacity flow of 16.2 MGD.

1. **Discharge to the Rodriguez Dam impoundment for potential indirect potable reuse** as conceived in the 2020 presentation by the Secretaría para el Manejo Saneamiento y Protección del Agua (SEPROA) titled *Como Eliminar 250 LPS del Río Tijuana a Corto Plazo (Short-Term Plan to Eliminate 250 LPS from the Tijuana River)*. This sub-project includes building new infrastructure to pipe the effluent from both WWTPs to the Rodriguez Dam impoundment. PG also evaluated using an existing pipeline that runs near La Morita WWTP to the Rodriguez Dam impoundment in conjunction with the new pipeline from Arturo Herrera to the Rodriguez Dam impoundment. Either approach was determined to be technically feasible and capable of removing the effluent from the Tijuana River to accomplish the project's purpose. The estimated capital cost of all new infrastructure is $36.9 million, and the estimated 40-year life cycle cost is $50.2 million; using the existing pipeline would reduce the project capital cost to $20.7 million with an estimated 40-year life cycle cost of $34.0 million. Additionally, this sub-project would potentially provide a source for indirect potable reuse in Tijuana.

2. **Piping of treated wastewater from La Morita and Arturo Herrera WWTPs directly to the South Bay Ocean Outfall (SBOO)** as proposed in Arcadis' 2019 *Tijuana River Diversion Study: Flow Analysis, Infrastructure Diagnostic and Alternatives Development.* PG determined that Alternative 2a "gravity reclaimed water pipeline system—pipeline from La Morita/Herrera Solis WWTPs to SBOO" in Arcadis' preliminary cost evaluation, which relies on a gravity pipeline to transport the treated effluent from La Morita and Arturo Herrera WWTPs to the SBOO, is more feasible than the design presented in the final report on the Arcadis study. Both the preliminary and final designs achieve the project purpose of reducing transboundary flows; the final report design includes replacing the pump stations and river intake, which PG determined is unnecessary for that purpose. The Arcadis project has an estimated capital cost of $112.7 million (not including life cycle costs, which were not provided in the report). PG developed pricing for a gravity pipeline that most closely

matches the Arcadis preliminary design: the estimated capital cost is $77.9 million and the estimated 40-year life cycle cost is $79.0 million.

PG has also explored Project 7's projected performance in reducing transboundary flows and increasing opportunities for reuse, including some high-level environmental and social impacts. ERG is preparing an Environmental Impact Document with a more thorough evaluation of potential environmental and social impacts in the U.S. associated with Project 7.

Note that more information on background data analyzed and referenced in this document can be found in PG's *Baseline Conditions Summary: Technical Document,* available from EPA.

1. INTRODUCTION

Under EPA Contract No. 68HERH19D0033, Task Order No. 53, PG Environmental conducted a detailed feasibility analysis of 10 project proposals to mitigate transboundary wastewater flows in the Tijuana River watershed. Each feasibility analysis considered an estimate of capital costs; an estimate of design, project, and construction management costs; operation and maintenance (O&M) costs; project implementation schedule; regulatory, engineering, and any possible implementation issues; and social and environmental impacts.

This feasibility analysis specifically addresses Project 7: "Divert or Reuse Treated Wastewater from Existing Wastewater Treatment Plants in Mexico To Reduce Flows into the Tijuana River." During the analysis, PG consulted with stakeholders and reviewed previous work including the following:

- *Tijuana River Diversion Study: Flow Analysis, Infrastructure Diagnostic and Alternatives Development* (Arcadis 2019).
- *Proyecto de Construcción y Rehabilitación de la Planta de Tratamiento de Aguas Residuales de San Antonio de los Buenos* (Construction and Rehabilitation Project of the San Antonio de los Buenos Wastewater Treatment Plant) (MAV and CEISA 2020).

Baseline Conditions Summary: Technical Document, prepared for EPA under the United States–Mexico–Canada Agreement (USMCA) Mitigation of Contaminated Tijuana Transboundary Flows Project, contains more information on background data analyzed, U.S. and Mexico entities, infrastructure and its operating conditions, water bodies, affected areas, other studies and reports, and dry- and wet-weather flow conditions referenced in this document.

This report has been revised and finalized from the draft version based on comments and discussions with EPA, and on new information presented to PG. PG is working with EPA to acquire additional information that would enhance this feasibility analysis:

- Structural assessment of the Rodriguez Dam. This information could affect the project's feasibility.

- Discussion with Arcadis to further understand their design for piping the effluent to the South Bay Ocean Outfall (SBOO). This information is not expected to affect the project's feasibility but may affect the costs presented in this report.

Consistent with the task order scope, PG will work with EPA to develop and analyze several infrastructure alternatives, including a preferred alternative, to mitigate the transboundary wastewater and stormwater flows. The alternatives will include groupings of one or more projects evaluated in the feasibility analyses, scaled if necessary, and will be presented to EPA in the Alternatives Document. Where applicable, the Alternatives Document will also include any changes to the estimated costs or feasibility of this project based on evaluation of the additional information described above.

1.1 Project Purpose

Treated wastewater is discharged into the Tijuana River from two wastewater treatment plants (WWTPs) in eastern Tijuana, Arturo Herrera and La Morita, together historically producing about 12 MGD of treated effluent. Piping the effluent from Arturo Herrera and La Morita WWTPs out of the Tijuana River would make it possible to avoid treating these flows for a second time, resulting

in lower pumping and treatment costs. This will also provide up to 16.2 MGD in additional capacity at the Tijuana River Diversion system, allowing for water from wet weather or other sources in the river before transboundary flows occur. The Tijuana River Diversion System consists of the CILA Pump Station (PB-CILA), Pump Station 1A (PB1-A), Pump Station 1B (PB1-B), and either the San Antonio de los Buenos (SAB) Wastewater Treatment or the South Bay International Wastewater Treatment Plant (ITP).

Diverting these flows should also reduce the duration of transboundary flows, as flows would drop below PB-CILA's operational threshold more quickly. For the sub-project of piping the effluent into the Rodriguez Dam impoundment, a source for indirect potable reuse in Tijuana would be created; however, treatment of the water would be required prior to potable use.

1.2 Current Conditions

According to MAV and CEISA (2020), the Arturo Herrera and La Morita WWTPs serviced an estimated 386,916 people in 2020 and are projected to serve 444,516 people by 2047. Effluent rates from the two WWTPs for the past 20 months, as well as the operational capacity of each plant, are provided in Table 1-1 below (values shown are MGD), averaging a combined 10.3 MGD over those 20 months (data from CESPT 2020b).

Table 1-1. Arturo Herrera and La Morita WWTPs Effluent Rates from April 2019 to November 2020

	April 2019	May 2019	June 2019	July 2019	Aug. 2019	Sept. 2019	Oct. 2019	Nov. 2019	Dec. 2019	Jan. 2020	Feb. 2020	March 2020	April 2020	May 2020	June 2020	July 2020	Aug. 2020	Sept. 2020	Oct. 2020	Nov. 2020	Average	Operational Capacity
Arturo Herrera	6.0	5.7	5.7	5.2	7.0	7.1	5.1	3.8	3.9	5.3	5.3	4.7	3.3	4.9	5.5	5.2	5.4	4.0	3.6	3.3	5.0	10.5
La Morita	5.8	6.0	6.0	5.1	4.1	5.2	5.2	4.4	5.1	7.0	5.4	5.0	4.9	5.1	5.3	5.7	6.2	5.9	5.4	2.8	5.3	5.8
																				TOTAL	10.3	16.2

PG reviewed two water reuse proposals, provided to PG as presentations: *Sistema de Alejamiento de Aguas Saneadas Para Inflitración* (Sanitary Water Removal System for Infiltration), developed by CESPT (2020a), which proposes to divert the effluent of both WWTPs 16.3 miles from a common location between Arturo Herrera and La Morita to the Valle de la Palmas for aquifer recharge, and *Como Eliminar 250 LPS del Río Tijuana a Corto Plazo*, developed by the Secretaría para el Manejo Saneamiento y Protección del Agua, or SEPROA (2020), which proposes to divert the effluent just from La Morita WWTP to the Rodriguez Dam impoundment for indirect potable reuse. During conversations with both EPA and the North American Development Bank (NADB), PG was informed that there is a demand for potable water in Tijuana that will continue to increase as the population grows. During an interview with NADB, PG learned of a potable reuse scenario that is being considered by CESPT and involves drilling wells and extracting water from the riverbed below Rodriguez Dam. This reuse scenario was not evaluated by PG.

1.3 Major Project Elements Considered

The feasibility assessment for Project 7 included the evaluation of two sub-projects:

1. **Discharge to Rodriguez Dam impoundment for potential indirect potable reuse.** Under this sub-project, piping of the effluent from La Morita and/or Arturo Herrera WWTPs to the Rodriguez Dam impoundment were evaluated. The pumping of the effluent from the two WWTPs to Valle de la Palmas was not assessed by PG.

2. **Piping of treated wastewater from La Morita and Arturo Herrera WWTPs directly to the SBOO.** This sub-project involves piping the treated effluent from La Morita and Arturo

Herrera WWTPs through a pipeline that follows the Tijuana River channel to the border and discharges at the SBOO.

2. DESIGN INFORMATION

Sections 2.1 and 2.2 provide overviews of the project locations, design features, engineering considerations, and regulatory issues associated with both sub-projects. Figure 2-1, on the next page, provides an overview of the locations and known elevations of both sub-projects.

2.1 Discharge to the Rodriguez Dam Impoundment for Potential Indirect Potable Reuse

2.1.1 Design Features

This sub-project features new pipelines and pump stations from La Morita and Arturo Herrera WWTPs to the Rodriguez Dam impoundment. The pipelines and pump stations are independent of each other. From La Morita to the Rodriguez Dam impoundment, 17,100 feet of new 18-inch high-density polyethylene (HDPE) force main and a 5.8 MGD pump station are required. From Arturo Herrera to the Rodriguez Dam impoundment, 6,300 feet of new 24-inch HDPE force main and a 10.5 MGD pump station are required. Figure 2-2, on page 2-3, shows approximate routing of the proposed pipeline, project elevations and location relative to the floodplain.

The proposal by SEPROA to pipe effluent from La Morita WWTP to the Rodriguez Dam impoundment uses 1,600 feet of new pipeline to connect the La Morita effluent to 15,500 feet of an existing, unutilized, 48-inch pipeline that runs from the Rodriguez Dam impoundment past La Morita WWTP. PG's analysis includes an option for reducing project costs by utilizing the 15,500 feet of existing pipeline; 1,600 feet of new 18-inch pipeline are required to connect La Morita to the existing 48-inch pipeline, along with a new 5.8 MGD pump station to complete the connection to the Rodriguez Dam impoundment.

2.1.2 Engineering Issues

The Rodriguez Dam impoundment is currently estimated to be at 20% capacity.[1] With the effluent of both WWTPs entering the reservoir at the current average flow rate over the past 20 months, PG determined it would take 7.7 years to fill the reservoir, and 4.9 years if the WWTPs produced effluent at their capacity rates.[2] These times to fill the reservoir assume perpetual drought and equilibrium between inflow from runoff and other sources, and evaporation and exfiltration in the impoundment area. If rainfall returns to long-term historic averages or historic peaks, the time to fill the impoundment will be significantly reduced. PG is unaware of any structural assessment of the dam's integrity. Failure of the dam would be devastating to Tijuana, and an assessment must be done prior to advancing the project.

Only small sections of pipeline, and neither pump station, are expected to lie in the existing river channel. As a result, impacts to construction during wet weather are expected to be negligible.

[1] Conversation with Suez on 11/6/2020.

[2] Rodriguez Dam impoundment capacity: MAV and CEISA (2020).

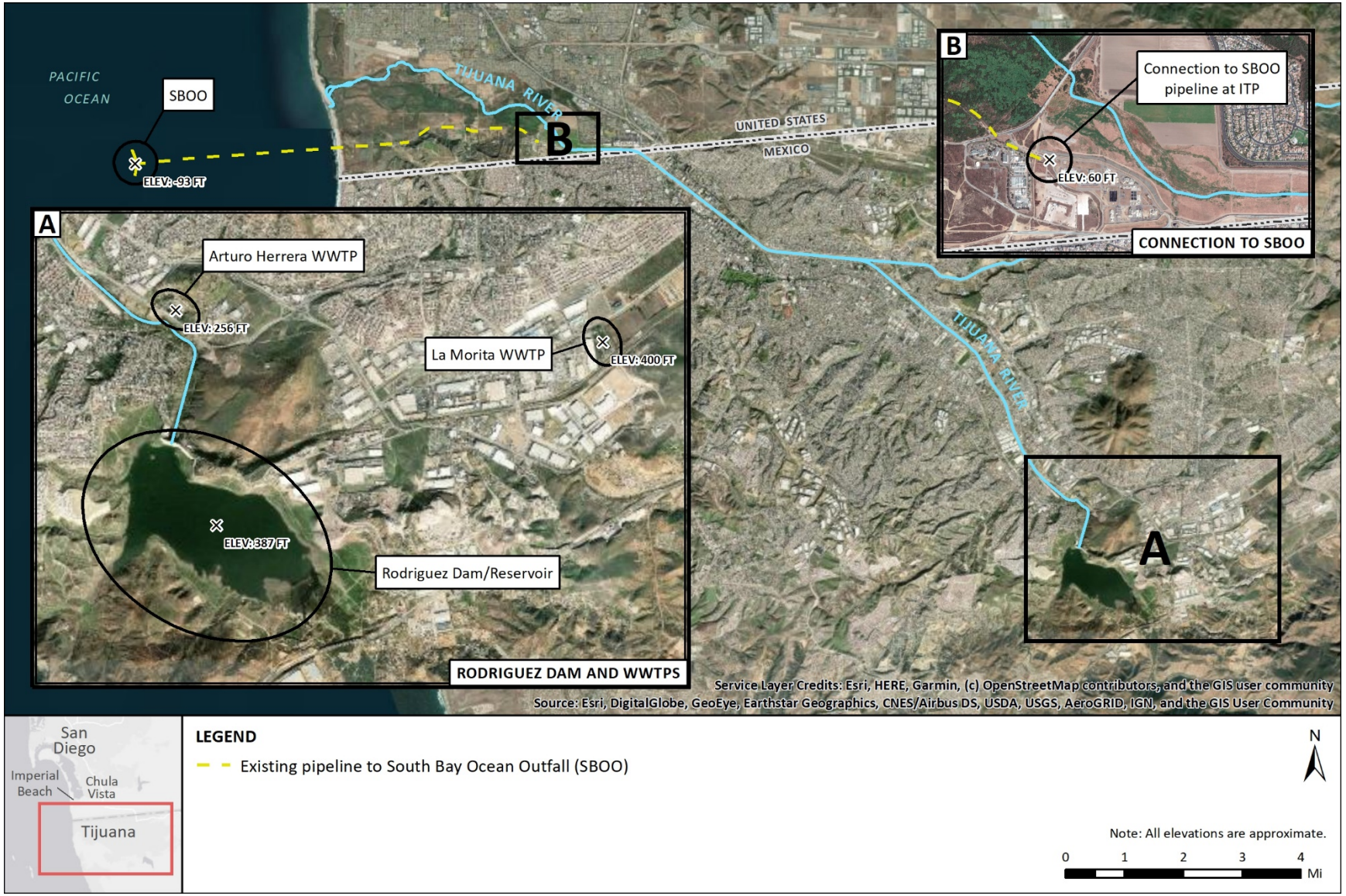

Figure 2-1. Locations and Known Elevations of Both Sub-Projects

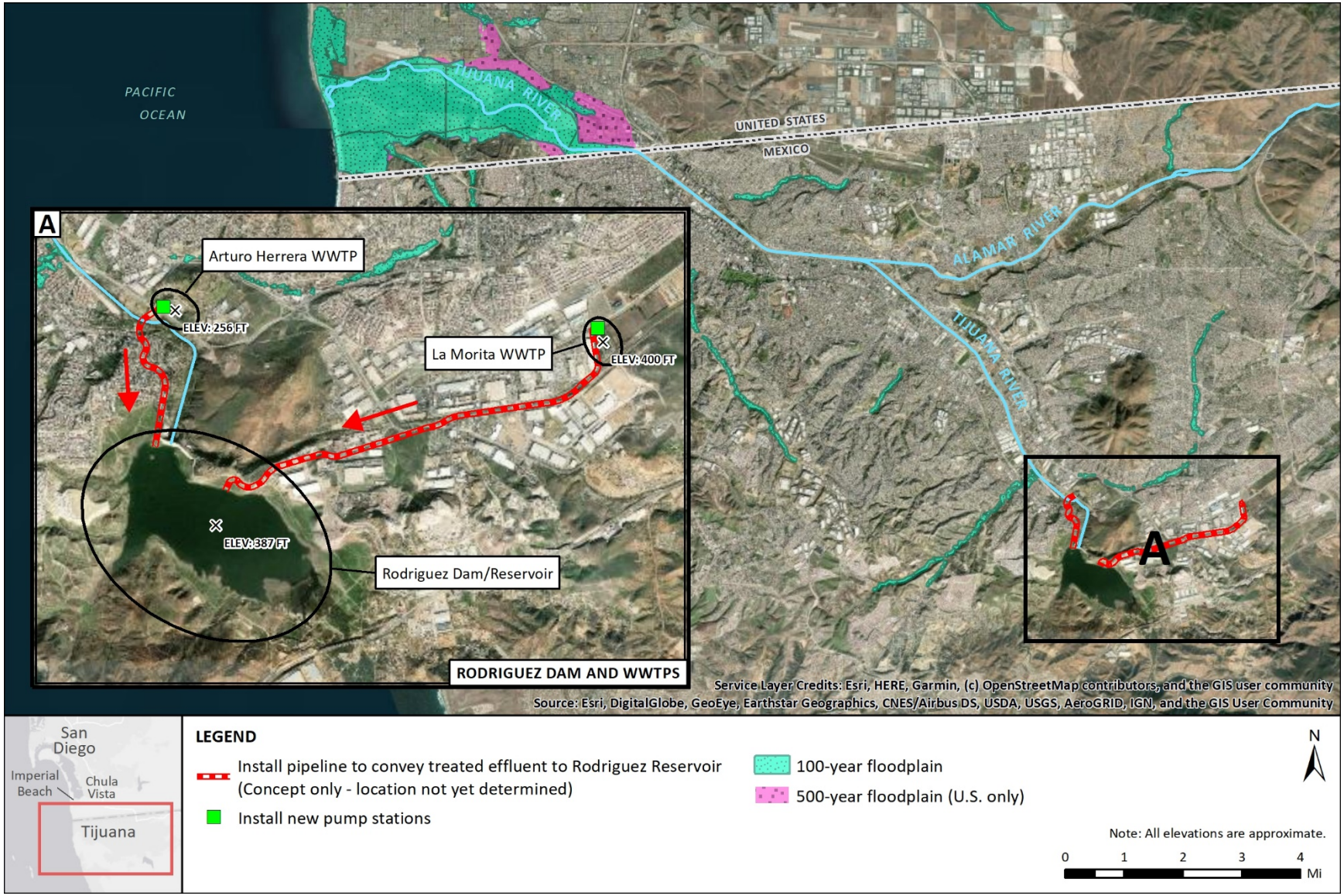

Figure 2-2. Map of Proposed Piping from WWTPs to the Rodriguez Dam Impoundment

2.1.3 Implementation and Regulatory Issues

PG does not have information about the permitting requirements in Mexico, and in particular whether pumping wastewater effluent into a reservoir for potential indirect potable reuse will have any potential permitting issues. It will be necessary to evaluate the permitting requirements before advancing to the next stage of design. It is anticipated that the Comisión Nacional del Agua (CONAGUA) will be responsible for O&M of all infrastructure downstream of the WWTPs' discharge, as the effluent is considered treated water at that point and falls under CONAGUA's jurisdiction. During discussions with Suez, PG learned that the Rodriguez Dam impoundment is subjected to illicit wastewater inflow, impairing the water quality in the reservoir. As a result, treatment of the water will be required prior to potable use, as well as a distribution system, neither of which PG has analyzed. However, because the project will take place entirely in Mexico, it is not expected to require any burdensome environmental regulatory approvals by U.S. federal, state, or local agencies. The overall timeline for implementing the Rodriguez Dam impoundment sub-project is likely three to four years.

2.2 Piping of Treated Wastewater from La Morita and Arturo Herrera WWTPs Directly to the SBOO

2.2.1 Design Features

Alternative 5a in the Arcadis study—piping the effluent from La Morita and Arturo Herrera WWTPs to the SBOO—features a gravity pipeline originating at the La Morita WWTP and connecting to the outfall of Arturo Herrera, and ultimately to the SBOO for discharge into the Pacific Ocean (Arcadis 2019). This final Arcadis design included several elements that PG did not incorporate into its final design. These are described below, along with PG's assessment and rationale:

- Arcadis Alternative 5a included replacement and rehabilitation costs for PB-CILA, PB1-A, and PB1-B. Figures in the report indicate connection to two or more of these facilities; however, it is unclear to PG why the connections to PB-CILA, PB1-A, and PB1-B are required for this design, and the report did not provide any information on this design feature. Therefore, PG did not incorporate these connections into its design.
- The Arcadis design features 16 miles of pipeline, beginning with 36-inch PVC pipes at La Morita WWTP, increasing in size along the way, and terminating with 78-inch HDPE pipes at the connection to the SBOO. At the current average combined flow rate of both WWTPs (10.3 MGD), the velocity in a 78-inch pipe would be too low (below 2 ft/s). PG determined that a pipe 36 inches in diameter would be sufficient even at double the current capacity of both WWTPs combined, as this would only be a peaking flow rate and the pipe is not designed for sustained flow. Current engineering practice is to design a wastewater gravity pipeline's pipe diameter around flow velocities between 2 ft/s and 5 ft/s at the average daily flow rate, which is accomplished with a 36-inch pipe as seen in Table 2-1.

Table 2-1. Flow Velocity as a Function of Pipe Size and Flow

		Pipe Size (in.)			
		36	**48**	**60**	**78**
Flow (MGD)	**10**	**2.23**	1.26	0.80	0.48
	32.4	**7.09**	3.99	2.55	1.51
	40	8.76	4.92	3.15	1.87
		Flow Velocity (ft/s)			

- The water being transported is assumed to be highly treated effluent with minimal grease and solids. Figure 2-3, below, shows the effluent limits. Therefore, the customary 2 ft/s minimum is likely not needed for self-cleaning purposes. While the 78-inch line proposed by Arcadis would accomplish the transportation goals, it would do so at a much higher cost than a smaller pipeline. There are also greater social, community, and environmental impacts with a larger pipeline compared to a smaller one. Section 3.5 discusses these preferences further.

NOM 001 SEMARNAT 1996

LÍMITES MÁXIMOS PERMISIBLES PARA CONTAMINANTES BÁSICOS											
PARÁMETROS	RÍOS						EMBALSES NATURALES Y ARTIFICIALES				PLANTA DE TRATAMIENTO "LA MORITA"
(miligramos por litro, excepto cuando se especifique)	Uso en riego agrícola (A)		Uso público urbano (B)		Protección de vida acuática (C)		Uso en riego agrícola (B)		Uso público urbano (C)		Planta de Tratamiento de Aguas Residuales, construida en los años 2008-2010 y puesta en marcha en el mes de Junio del 2010, su capacidad de diseño de tratamiento fue de 254 LPS, con remoción de nutrientes, fue diseñada para producir un efluente que cumpliera con la **NOM-001-SEMARNAT-1996** y la NOM-003-SEMARNAT-1997.
	P.M.	P.D.	P.M.	P.D.	P.M.	P.D	P.M.	P.D.	P.M.	P.D.	
Temperatura °C (1)	N.A	N.A	40	40	40	40	40	40	40	40	<28°C
Grasas y Aceites (2)	15	25	15	25	15	25	15	25	15	25	<5
Materia Flotante (3)	ausente		ausente		ausente		ausente		ausente		ausente
Sólidos Sedimentables (ml/l)	1	2	1	2	1	2	1	2	1	2	<0.1
Sólidos Suspendidos Totales	150	200	75	125	40	60	75	125	40	60	<11
Demanda Bioquímica de Oxígeno$_5$	150	200	75	150	30	60	75	150	30	60	<1.98
Nitrógeno Total	40	60	40	60	15	25	40	60	15	25	10.65
Fósforo Total	20	30	20	30	5	10	20	30	5	10	3.93

Fuente: Departamento de Control de Calidad de **CESPT** (septiembre del 2020)

Figure 2-3. La Morita WWTP Effluent Limits

Arcadis also conducted a preliminary cost evaluation, titled *Tijuana Diversion Tech Memo: U.S. Based Solutions Preliminary Cost Evaluation*, dated July 23, 2018 (Appendix L in the 2019 study), which included Alternative 2a, "gravity reclaimed water pipeline system from La Morita/Herrera Solis WWTPs to SBOO." This preliminary design is more consistent with PG's evaluation of project needs. This design utilized a 36-inch pipeline and did not include connection to the aforementioned pump stations, instead tying directly to the SBOO. This design also included a note that pipe size was selected to accommodate future peak flows of 40 MGD. Arcadis's Final Report provided no explanation on why this preliminary design was changed to include connections to the pump stations or why a larger pipe was used in the final design. Both of the Arcadis designs follow the river channel from La Morita WWTP to Arturo Herrera WWTP, but then veer to the east of the river channel and cut through the city following Highway 2 before joining the Alamar River channel and crossing the border. Neither report provided an explanation for this routing.

The PG design is similar to the Arcadis preliminary design, with some notable differences. The recommended design features a buried gravity pipeline for the entire run, which begins at the La Morita outfall and follows the current effluent flow path through a concrete-lined channel until it reaches an unpaved section near the base of Rodriguez Dam, then follows this unpaved section until it reaches the outfall of Arturo Herrera WWTP, and shortly thereafter reaches the main concrete

lined channel that extends to the border before connecting to the SBOO. This routing follows the natural grade of the river: 0.656% average grade for the run from La Morita WWTP to Arturo Herrera WWTP and 0.308% average grade from Arturo Herrera WWTP to the SBOO. The design proposes 20,000 feet of 24-inch PVC pipe from La Morita WWTP to Arturo Herrera WWTP and 65,000 feet of 36-inch HDPE pipe from Arturo Herrera WWTP to the SBOO, consistent with the calculations in Table 2-1. Figure 2-4, on the next page, shows the proposed pipeline routing from La Morita to the SBOO, project elevations and location relative to the floodplain.

2.2.2 Engineering Issues

PG believes that following the river channel creates a better flow path compared to the Arcadis design and likely avoids potential utility issues. The PG design was chosen over a force main for greater energy efficiency, as a gravity pipeline avoids pumping costs. During the development of this design, PG evaluated a range of future flows from the two WWTPs, including future growth in the area, and sized the pipeline appropriately. Section 2.2.1 discusses this analysis. PG followed standard design practices and design guidance in accordance with EN 1610 and ISO 1452-2. The section of pipeline from La Morita WWTP to Arturo Herrera WWTP, as well as the section from Arturo Herrera to the SBOO, lie within the existing river channel. This location makes them prone to impacts from water flowing in the river channel during wet weather. As such, construction during wet weather should be avoided to minimize potential impacts.

2.2.3 Implementation and Regulatory Issues

The quality of the effluent will not be in control of the U.S. Permitting for transboundary flows discharged at the SBOO will need to be considered, and coordination with the San Diego Regional Water Quality Control Board will be required. Otherwise, the project involves only limited construction in the U.S. and is not expected to require any burdensome environmental regulatory approvals by U.S. federal, state, or local agencies, though a Presidential Permit would be required for any transboundary pipeline. As with the piping to the Rodriguez Dam impoundment sub-project, it is anticipated that CONAGUA will be responsible for O&M of all infrastructure downstream of the WWTPs. Ownership of the pipeline will also need to be evaluated. The overall timeline for the SBOO sub-project is likely four to five years.

Adding the effluent from both WWTPs to the SBOO will reduce the available capacity of the SBOO from 163 MGD to approximately 153 MGD based on the 20-month combined effluent average flow rate of 10.3 MGD. This impact to current and future operations at the ITP and other projects will be evaluated in the Alternatives Document, as applicable.

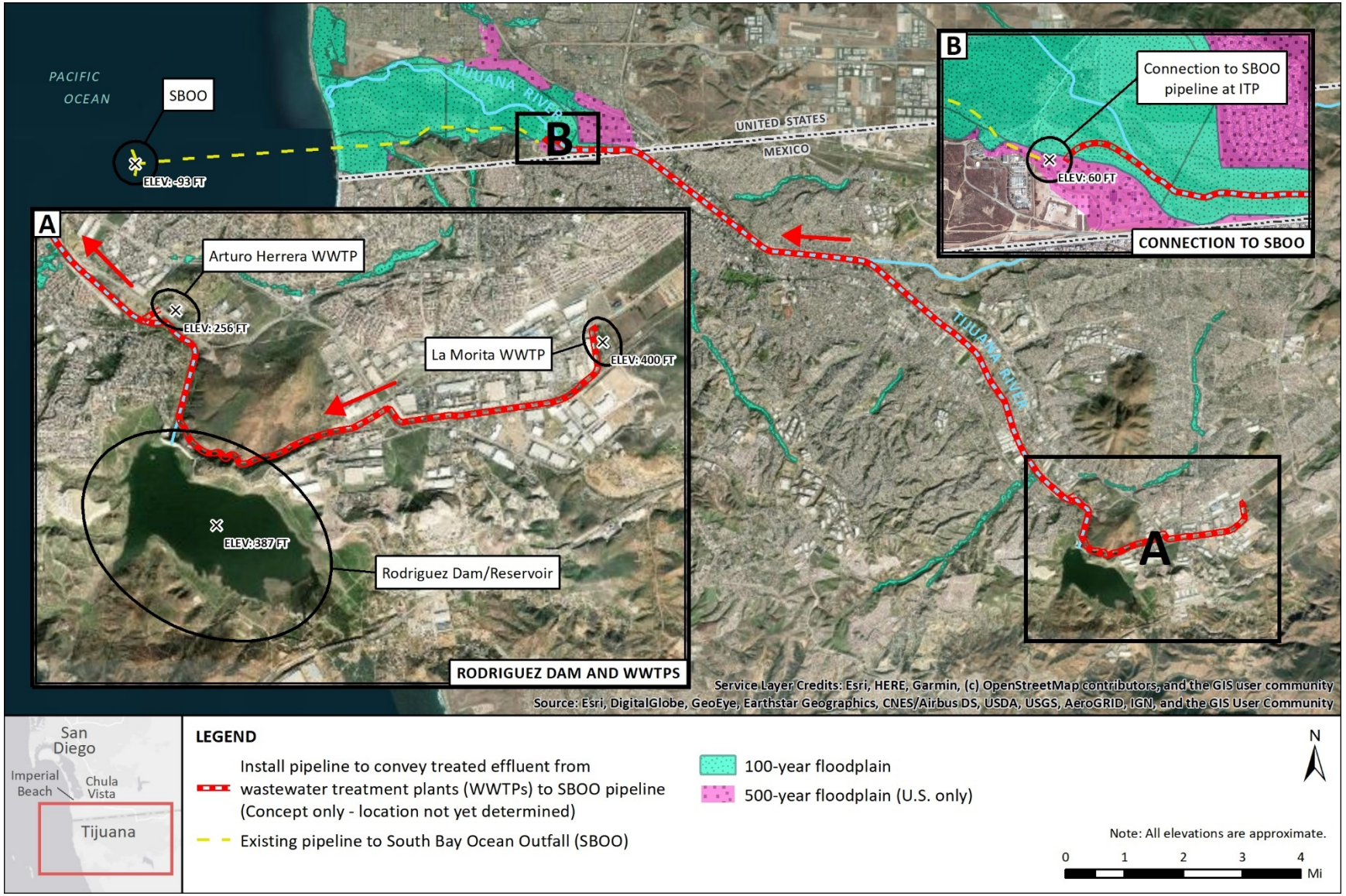

Figure 2-4. Map of Proposed Piping from WWTPs to the SBOO

3. PROJECT IMPACT

3.1 Water Quality Impacts

Both sub-projects have the same primary impacts on the current conditions:

- Reducing flows in the Tijuana River upstream of the Tijuana River Diversion system and thereby reducing the need to divert and treat already-treated water at the Diversion (resulting in lower pumping and treatment costs, including electricity consumption and O&M).
- Providing up to an additional 16.2 MGD capacity to treat flows from wet weather or other sources at the Diversion and reducing the frequency of transboundary flows.

Both sub-projects reduce transboundary flow volume and days, but the resulting flows may contain a higher concentration of pollutants by making the river water more concentrated. However, both sub-projects will decrease the likelihood of untreated river water reaching the estuary by reducing transboundary flow days. By reducing the number of days that PB-CILA will be shut down due to flows exceeding its operational threshold, there would be an increase in overall capture of river water at the Diversion and a reduction in transboundary flows through the river. However, this may also increase transboundary marine flows via discharges at the SAB Creek and potentially increase impacts to southern San Diego County beaches including the Navy SEALs training facility in Coronado, California.

For sub-project 1 (piping the effluent into the Rodriguez Dam impoundment), the water quality gained by the treatment processes at both La Morita and Arturo Herrera WWTPs would be preserved by avoiding discharge into the Tijuana River where mixing with flows from other sources occurs (Arcadis 2019). Piping this water to the Rodriguez Dam impoundment would create a potential source for indirect potable reuse in Tijuana. However, treatment of the water would be required prior to potable use, and a distribution system would also be required, neither of which is included in PG's analysis. Currently, the majority of drinking water used in Tijuana comes from Presa El Carrizo, located approximately 12.5 miles east of Rodriguez Dam (MAV and CEISA 2020). The potential to generate a drinking water supply closer to central Tijuana should be considered when comparing the two sub-projects.

Recent upgrades to PB-CILA increased the Diversion pumping capacity from 23 MGD to 35 MGD. For the purpose of this report and analysis, 23 MGD capacity is assumed. With the effluent of the two WWTPs removed from the river, transboundary flows would last fewer days after storms, as the Tijuana River flow would drop to PB-CILA's operational protocol threshold quicker.

PG used transboundary flow data, monthly pump data, and flow and mass balances to estimate the effects of Project 7 on both transboundary flows (Table 3-1) and discharges from San Antonio de los Buenos (SAB) Creek (Table 3-2). For impacts on transboundary flows, PG estimated the reduction in the days of flow and total amount of flow based on International Boundary and Water Commission gauge data from January 1, 2016, through December 31, 2019. More details on the methodology, including assumptions about transboundary flows, PB-CILA's operation, and BOD_5 and sediment levels, can be found in the *Baseline Conditions Summary: Technical Document.* PG estimated the reduction in transboundary flows and BOD_5 and sediment loads from implementing either sub-project at both the combined current average flow and the combined plant capacity (removing 10.3 MGD and 16.2 MGD of treated effluent from the river, respectively) and compared these scenarios to current conditions.

Table 3-1. Project 7 Impacts on Transboundary Flows in the Tijuana River

Parameter of Transboundary Flows in the Tijuana River	Current Conditions[3]	10.3 MGD Removed from River (Average Combined Current Flow)	16.2 MGD Removed from River (Combined Plant Capacity)
Flow days (days/year)	153	74	69
Percent change	*N/A*	-52%	-55%
Flow volume (million gallons/year)	17,500	16,800	16,600
Percent change	*N/A*	-4%	-5%
BOD_5 load (tons/year)	1,670	1,230	1,150
Percent change	*N/A*	-26%	-31%
TSS (sediment) load (tons/year)	187,000	186,000	186,000
Percent change	*N/A*	-1%	-1%

The Arcadis study states that removing 12 MGD from the Tijuana River and the Diversion would result in an average reduction of 96 transboundary flow days per year based on the data Arcadis analyzed from November 2009 to March 2016. PG has not had the opportunity to discuss the results with Arcadis and believes that a discussion may lead to a better understanding of their analysis techniques, their assumptions, and the impacts on transboundary flows.

Removing the effluent of the two WWTPs from the Tijuana River will also affect the discharges at SAB. Even though PB-CILA would be operating for more days due to the river flows falling within the PB-CILA operational protocol ranges, the removal of the flows upstream results in a net decrease in water volume transported to SAB. However, diverted flows will be higher in pollutant concentration as they are no longer diluted by the two WWTPs' treated effluent. The net result is that loads that otherwise would have become transboundary flows into the U.S. via the Tijuana River will be diverted to SAB.

PG estimated the discharges from SAB Creek using flow data from the major pump stations from January 1, 2016, through December 31, 2019, and flow balances. The reduction in total flows sent to SAB is shown in Table 3-2.

PG estimated the total BOD_5 and sediment loads that are discharged from the SAB Creek under current conditions and with both 10.3 MGD and 16.2 MGD removed from the river. The discharges for both scenarios were estimated using mass balances and the flow rates calculated for the total discharge estimates. The increase in BOD_5 and sediment loads discharged to SAB Creek is presented in Table 3-2.

[3] "Current conditions" are based on data from January 1, 2016, through December 31, 2019, and therefore do not reflect the upgrades to PB-CILA that commenced in 2020.

Table 3-2. Project 7 Impacts on Discharges to the Pacific Ocean via SAB Creek

Parameter	Current Conditions	10.3 MGD Removed from River (Average Combined Current Flow)	16.2 MGD Removed from River (Combined Plant Capacity)
Total annual flow (million gallons/year)	13,100	11,600	10,500
Percent change	N/a	-11%	-20%
BOD_5 load (tons/year)	17,200	17,600	17,700
Percent change	N/a	2%	3%
TSS (sediment) load (tons/year)	17,900	18,900	18,900
Percent change	N/a	6%	6%

The increase in both BOD_5 and sediment loads transported to SAB for both the 10.3 and 16.2 MGD scenarios, even though flows are decreased, is a result of the water being sent to SAB increasing in concentration due to the removal of treated water from the river.

3.2 Sediment Impacts

While neither of these sub-projects is intended to directly reduce the transport of sediment, the reduced flows in the Tijuana River will also reduce transboundary sediment transport. However, PG lacks the data to quantify potential sediment transport reduction as well as potential impacts the proposed sub-projects will have on the environment in the estuary and the beaches.

3.3 Trash Impacts

Similar to the reduction of sediment, PG expects that both sub-projects would reduce transboundary flows during dry weather. However, PG lacks the data to quantify potential trash transport reduction as well as potential impacts the proposed sub-projects will have on the environment in the estuary and the beaches.

3.4 Non-Water-Quality Environmental Impacts

In conjunction with the feasibility assessments, ERG is currently preparing an Environmental Information Document (EID) that will describe the potential environmental impacts of the 10 proposed projects (including Project 7), focusing on impacts in the U.S. or caused by activities in the U.S. Based on a review of existing available information, Project 7 is not expected to trigger any non-water-quality environmental impacts of concern in the U.S.[4] The EID will include a more thorough evaluation of potential non-water-quality impacts in the U.S.

[4] ERG considered the following "impacts of concern" to be indicators of potentially significant environmental impacts that warrant detailed review during preparation of the EID, the subsequent National Environmental Policy Act process, and related consultations and resource-specific studies: disproportionate, adverse effects on minority and/or low-income communities; potential for adverse effects on federally listed threatened or endangered species or their critical habitat; adverse effects on tribal/cultural resources; adverse effects on important natural resource areas such as wetlands, floodplains, coastal zones, and significant fish or wildlife habitat; modification, diversion, and/or alteration of the main course of the Tijuana River; criteria pollutant emissions that exceed Clean Air Act General Conformity Rule *de minimis* thresholds; and significant public controversy about a potential environmental impact.

3.5 Social Impacts

While Project 7 will reduce transboundary sewage flows in the Tijuana River, this analysis estimates that the project will slightly increase the pollutant loadings in discharges of untreated or partially treated sewage from SAB Creek. Therefore, it is undetermined whether Project 7 would achieve a net improvement in coastal water quality and the corresponding long-term positive socioeconomic impacts to affected populations (e.g., reduced public health risk and increased economic activity in coastal areas). Project 7 would also result in negative, localized impacts during construction primarily in Mexico (e.g., temporary increase in noise and traffic). The EID will include a more thorough evaluation of potential socioeconomic impacts in the U.S.

Project 7 would reduce contaminated transboundary flows near border infrastructure where the Tijuana River crosses into the U.S. However, it would not resolve existing impacts to U.S. Customs and Border Protection operations and workforce resulting from exposure to contaminated transboundary flows near border infrastructure in Goat Canyon or Smuggler's Gulch.

4. COST IMPACT ANALYSIS

The project construction cost estimates prepared by PG for both sub-projects were developed to a Class V level of accuracy in accordance with the AACE International Recommended Practice No. 17R-97, *Cost Estimate Classification System* (AACE International 2020). Additional details on this methodology can be found in the *Baseline Conditions Summary: Technical Document.*

Factors that affected the PG-developed project capital costs for both sub-projects and project construction costs included the following:

- Capacity and condition information regarding the existing conveyance systems in Mexico and in the U.S.
- Topographical and site development information along practicable conveyance system routes.
- Site demolition and grading for new facilities and site restoration, as well as component costs for pumping facilities and conveyances.
- Non-construction costs for engineering and construction supervision, land acquisition, owner administrative costs, and legal costs.
- Design, project, and construction management costs.

Subsoil conditions at construction locations were not available to PG and were not factored into capital costs. For project construction cost data, PG also used manufacturers' cost information, bid tabulations from similar projects in the U.S. and Mexico in recent years, R.S. Means Heavy Construction Cost Data 2020, and adjustments for a 2020 *Engineering News-Record* (ENR) value of 11,455. Land acquisition is not included in any pricing, as PG did not have land pricing data available. Project capital cost was based on project construction cost multiplied by a factor of 1.4 to account for project engineering and owner administration costs; that total was multiplied by a general contingency factor of 1.5 to account for unanticipated construction, unknown subsoils, and other factors. Therefore, project capital cost equals project construction cost × 1.4 × 1.5, which is equivalent to project construction cost × 2.1.

O&M cost information sources included CAPDET Works preliminary design and cost estimation software, manufacturers' information, O&M cost data from Arcadis, O&M cost data from other publicly owned treatment works, and other similar sources. An annual inflation factor of 2% and an interest rate of 3% was applied to the annual O&M costs, as well as applicable midcycle replacement or major repairs costs, to calculate the life cycle cost in present dollars for each sub-project over a 40-year lifespan.

PG reviewed the cost estimate prepared by Arcadis for Alternative 5a, which uses a gravity reclaimed water pipeline from La Morita and Arturo Herrera WWTPs to the SBOO (Arcadis 2019). Arcadis reported this estimate was prepared to a Class IV level of accuracy in accordance with AACE International Recommended Practice No. 17R-97, *Cost Estimate Classification System*. The level of accuracy for the 2a Preliminary Cost Evaluation was not provided. PG reviewed both estimates and found they were both higher than PG's estimated costs. Alternative 5a contained upgrades to several pumping stations that PG did not include. Even with those upgrades removed, Arcadis's price exceeded PG's by over $56 million. Arcadis' s 2a Preliminary Cost Evaluation design did not include any pumping costs and exceeded the PG-developed cost by $33.4 million. One factor that likely influenced the Arcadis costs being higher than the PG-calculated costs is that the former

are based on wider and longer pipes. The Alternative 5a design includes 116,000 feet of pipeline and the Preliminary 2a design includes 100,000 feet of pipeline, while the PG design includes 85,000 feet of pipeline, though this still does not account for the entire difference in cost. PG's estimate also does not include the cost for the SBOO tie-in, which Arcadis estimated at $1.2 million. A service life of 50 years is expected for pipeline infrastructure and 40 years for pump stations.

The 2020 SEPROA presentation provided an estimated annual cost of $1.3 million Mexican pesos, or MXN (about $62,500 U.S. dollars, or USD) for pumping the La Morita WWTP effluent to the Rodriguez Dam impoundment. PG has estimated this cost to be $87,400 (inclusive of pump station O&M labor, materials and supplies, and energy costs). PG estimates the Arturo Herrera WWTP pump station costs to be $260,000 and the combined WWTP pumping costs, including pipeline O&M, to be $365,000. Appendix A provides detailed costs, along with an itemized cost impact analysis for each sub-project.

The SEPROA presentation estimates the current pumping costs for 5.7 MGD of La Morita WWTP effluent to SAB via PB-CILA and PB1-A to be $30 million MXN annually, about $1.5 million USD. Scaling this cost to the Arturo Herrera WWTP effluent operational capacity of 10.5 MGD yields an annual pumping cost of $2.8 million USD. Removing both WWTPs' effluent from the Tijuana River, PG estimates, could reduce the O&M costs associated with the pumping of their effluent from $4.3 million to $365,500.

As the SBOO sub-project relies on gravity, O&M costs are at a minimum: PG has estimated them to be $39,000 annually. This would result in a savings of almost the entire $4.3 million currently spent on pumping the effluent of the two WWTPs. Tables 4-1 and 4-2 summarize the capital and life cycle costs that PG estimated for each sub-project.

4.1 Discharge to Rodriguez Dam Impoundment for Potential Indirect Potable Reuse

Table 4-1. Sub-Project Life Cycle Costs

Category	Item	Estimated Cost
Capital costs	La Morita WWTP to the Rodriguez Dam Impoundment—17,100 feet of 18-inch force main	$6,300,000
	La Morita WWTP Pump Station (5.8 MGD)	$1,800,000
	Herrera WWTP to the Rodriguez Dam Impoundment —6,300 feet of 24-inch force main	$2,500,000
	Herrera WWTP Pump Station (10.5 MGD)	$2,900,000
	General Contractor, Mob/Demob, Ins, Bonds, Gen Admin, Profit (30%)	$4,050,000
	Indirect costs (engineering, project administration, general contingency)	$19,300,000
	Total capital cost	**$36,900,000**
O&M	Personnel labor	$136,900
	Materials and Supplies	$21,500
	Energy	$189,900
	Vehicle Usage and Maintenance	$11,000
	Piping and Valve Maintenance	$3,000
	Miscellaneous	$3,200
	Annual O&M costs	**$365,500**
Life cycle factors	Interest rate	3%
	Inflation rate	2%
	Total life cycle used	40 years
Total cost		**$50,200,000**

4.2 Piping of Treated Wastewater from La Morita and Arturo Herrera WWTPs Directly to the SBOO

Table 4-2. Sub-Project Life Cycle Costs

Category	Item	Estimated Cost
Capital costs	La Morita WWTP to Herrera WWTP—20,000 feet of 24-inch gravity sewer	$9,000,000
	Herrera WWTP to SBOO—65,000 feet of 36-inch gravity sewer	$19,500,000
	General Contractor, Mob/Demob, Ins, Bonds, Gen Admin, Profit (30%)	$8,550,000
	Indirect costs (engineering, project administration, general contingency)	$40,800,000
	Total capital cost	**$77,900,000**
O&M	Personnel labor	$8,100
	Vehicle usage and maintenance	$11,000
	Piping and valve maintenance	$13,600
	Miscellaneous	$6,600
	Annual O&M costs	**$39,000**
Life cycle factors	Interest rate	3%
	Inflation rate	2%
	Total life cycle used	40 years
Total cost		**$79,000,000**

5. DISCUSSION

5.1 Feasibility

Both projects are equally effective in reducing transboundary flow in the Tijuana River. However, capital cost, O&M, and the impacts of where the WWTPs' effluent ultimately ends up will be more important for selecting one project over the other. Construction of both sub-projects are of similar difficulty as they share the sections of piping runs, and construction for both projects would need to be done during the dry season to reduce the risk of wet weather flows in the river channel. However, the pipeline routing to the SBOO is greater in distance than to Rodriguez Dam, resulting in a significantly longer construction time that increases the likelihood of impacts from precipitation events. As both projects reside primarily in Mexico, management of construction and ongoing O&M would be controlled by Mexico, leaving it outside the control of U.S. interests. Ownership and responsibility for O&M is undetermined for both sub-projects.

5.1.1 Discharge to Rodriguez Dam Impoundment for Potential Indirect Potable Reuse

PG determined this sub-project to be feasible and to accomplish the stated purpose of the project, though concerns around the need for additional treatment, water storage, and the structural capacity of Rodriguez Dam, are considerable. This sub-project relies on the need to operate and maintain several pump stations in a sufficient manner as to not impact the project's capabilities to remove the WWTP's effluent from the Tijuana River. Any issues that arose from this need and resulted in the pump stations being shut down for any period of time would negate the ability of the sub-project to accomplish the stated project purpose.

PG did not conduct a structural assessment of the dam, but this should be done prior to initiating the next phase of project design. In the event the water is not able to be removed from the dam and used as a potable water supply to prevent overfilling the dam and possible failure, the feasibility of the project may be impacted.

5.1.2 Piping of Treated Wastewater from La Morita and Arturo Herrera WWTPs Directly to the SBOO

The sub-project of piping the WWTP effluents to the SBOO for discharge to the Pacific Ocean was determined to be feasible but higher in cost than pumping the effluent to the Rodriguez Dam Impoundment due to the WWTP's proximity to the reservoir. O&M concerns are lessened compared to the other sub-project due to the lack of pumping requirements; once built, the pipeline will have low annual costs and minimal required maintenance. However, it presents another potential set of challenges with U.S.-side permitting requirements that are not a factor when the water is kept in Mexico. The current effluent quality is known, but changes in operators in the future create the potential for varying effluent quality that may not meet U.S. required limits.

5.2 Other Stakeholder Information

Arcadis identified non-potable reuse as a possible scenario with the water being sent to the SBOO. No additional details were provided in their report. PG did not identify, or was presented with, other stakeholders that would benefit or be impacted by either sub-project, but there may be stakeholders within Mexico that could benefit from either potable or non-potable reuse.

6. CONCLUSION

The overall objective of Project 7 is to reduce flows in the Tijuana River upstream of PB-CILA, thereby reducing the need to divert and treat as much river water at the border, and additionally providing a source for indirect potable reuse in Tijuana. Both sub-projects were identified to accomplish the first objective and piping the effluent to the Rodriguez Dam impoundment accomplishes the second. PG assessed the feasibility of these sub-projects and arrived at the following conclusions:

1. Both sub-projects are feasible and effectively remove the flows of Arturo Herrera and La Morita WWTPs from the Tijuana River, reducing the need to divert and treat the wastewater for a second time, which has an added benefit of reducing pumping costs through PB-CILA and PB1-B. PG estimates the savings from implementing either sub-project to be $4.0 to 4.3 million. The capital costs of piping the effluent to the SBOO are higher than piping to the Rodriguez Dam impoundment by $41 million; however, the SBOO sub-project has lower annual O&M costs by $327 thousand.

2. Both sub-projects are effective at reducing transboundary flows. PG determined that at the current WWTPs' effluent flow rates, transboundary flows are reduced by 79 days (52%); at the operational capacity, flow rates are reduced by 84 days (5%). Transboundary flow volumes are reduced by 700 million gallons and 900 million gallons, respectively.

3. Piping the WWTPs' effluent to the Rodriguez Dam impoundment creates an opportunity for potable reuse, though additional treatment will be required. Negotiations with CONAGUA should take place to ensure their commitment to operating the system as well as providing treatment of the water that will be stored in the reservoir. This would include finding customers for the reuse water before developing this project due to concerns with overfilling the Rodriguez Dam impoundment.

7. SUGGESTED NEXT STEPS

1. Conduct a structural assessment of Rodriguez Dam to determine the available capacity, as well as quantify losses to predict the time it will take to fill the reservoir more accurately.

2. Meet with Arcadis to understand and validate the differences in transboundary flow reductions and cost estimates.

3. Evaluate the impacts of reduced capacity of the SBOO.

8. REFERENCES

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APPENDIX A: Itemized Cost Impact Analysis

Project 7, Sub-project 1: Discharge to Rodriguez Dam Impoundment for Potential Indirect Potable Reuse - Opinion of Probable Cost

Category	Item	Quantity	Unit	Unit Price	Cost ($)	Source/Description
Equipment, Materials, and Construction Costs	18-inch HDPE Interceptor in Pavement - 8-foot Burial Depth	17100	Ft	$ 363	$6,300,000	PG Herrera Pump Station Cost
	5.8 MGD Pump Station	1	Each	$ 1,710,000	$1,800,000	PG Unit Price Summary
	24-inch HDPE Interceptor in Pavement - 8-foot Burial Depth	6300	Ft	$ 386	$2,500,000	PG La Morita Pump Station Cost
	10.5 MGD Pump Station	1	Each	$ 2,860,000	$2,900,000	PG Unit Price Summary
	General Contractor, Mob/Demob, Ins, Bonds, Gen Admin, Profit	30%			$4,050,000	
	Total Equipment, Materials, and Construction Costs				**$17,550,000**	
Indirect Costs	Engineer and Administrative Contingency, 40% of subtotal	40%			$7,020,000	
	Contingency 50%	50%			$12,285,000	
	Total Indirect Costs				**$19,300,000**	
	Total Capital Costs				**$36,900,000**	
O&M Costs	La Morita Pump Station Operational Labor	1	Each	$ 40,700	$40,700	CapdetWorks ENR Adjusted
	La Morita Pump Station Maintenance Labor	1	Each	$ 23,000	$23,000	CapdetWorks ENR Adjusted
	La Morita Pump Station Materials and Supplies	1	Each	$ 7,800	$7,800	CapdetWorks ENR Adjusted
	La Morita Pump Station Energy	1	Each	$ 15,900	$15,900	CapdetWorks ENR Adjusted
	Herrera Pump Station Operational Labor	1	Each	$ 42,700	$42,700	CapdetWorks ENR Adjusted
	Herrera Pump Station Maintenance Labor	1	Each	$ 28,700	$28,700	CapdetWorks ENR Adjusted
	Herrera Pump Station Materials and Supplies	1	Each	$ 13,700	$13,700	CapdetWorks ENR Adjusted
	Herrera Pump Station Energy	1	Each	$ 174,000	$174,000	CapdetWorks ENR Adjusted
	Pipelines Personnel Labor	1	Each	$ 1,800	$1,800	PG Estimate
	Pipelines Vehicles usage and Maintenance	1	Each	$ 11,000	$11,000	PG Estimate
	Pipelines Piping and Valve Maintenance	1	Each	$ 3,000	$3,000	PG Estimate
	Pipelines Miscellaneous	1	Each	$ 3,200	$3,200	20% of Piping O&M Sub-total
	Total Annual O&M Costs				**$365,500**	
Life Cycle Cost	Total Capital Cost				$36,900,000	
	Annual O&M Costs				$365,500	
	Service Life				40	
	Present Value of Service Life O&M				$12,121,089	
	Major Upgrade(s) Cost at 20 years				$1,350,000	CapdetWorks ENR Adjusted
	Present Value of Major Upgrade(s)				$1,107,000	
	Interest Rate				3%	
	Inflation Rate				2%	
	Location Adjustment Factor				1.0	United States
	Total Life Cycle Cost				**$50,200,000**	

Project 7, Sub-project 2: Piping of Treated Wastewater from La Morita and Arturo Herrera WWTPs Directly to the SBOO - Opinion of Probable Cost

Category	Item	Quantity	Unit	Unit Price	Cost ($)	Source/Description
Equipment, Materials, and Construction Costs	24-inch Heavy Wall PVC Interceptor in Pavement - 8-foot Burial Depth	20000	Ft	$ 450	$9,000,000	PG Unit Price Summary
	36-inch HDPE Interceptor in Pavement - 8-foot Burial Depth	65000	Ft	$ 300	$19,500,000	PG Unit Price Summary
	General Contractor, Mob/Demob, Ins, Bonds, Gen Admin, Profit	30%			$8,550,000	
	Total Equipment, Materials, and Construction Costs				**$37,100,000**	
Indirect Costs	Engineer and Administrative Contingency, 40% of subtotal	40%			$14,840,000	
	Contingency 50%	50%			$25,970,000	
	Total Indirect Costs				**$40,800,000**	
	Total Capital Costs				**$77,900,000**	
O&M Costs	Personnel Labor	1	Each	$8,100	$8,100	PG Estimate
	Vehicles usage and Maintenance	1	Each	$11,000	$11,000	PG Estimate
	Piping and Valve Maintenance	1	Each	$13,600	$13,600	PG Estimate
	Miscellaneous	1	Each	$6,600	$6,600	20% of Piping O&M Sub-total
	Total Annual O&M Costs				**$39,000**	
Life Cycle Cost	Total Capital Cost				$77,900,000	
	Annual O&M Costs				$39,000	
	Service Life				40	
	Present Value of Service Life O&M				$1,293,358	
	Major Upgrade(s) Cost at 20 years				$100,000	PG Estimate
	Present Value of Major Upgrade(s)				$82,000	
	Interest Rate				3%	
	Inflation Rate				2%	
	Location Adjustment Factor				1.0	United States
	Total Life Cycle Cost				**$79,000,000**	