Feasibility Analysis for Project 6: Construct New Infrastructure to Address Trash and Sediment

Technical Memorandum

USMCA Mitigation of Contaminated Transboundary Flows Project

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

CBP	United States Customs and Border Protection
CCC	California Coastal Commission
CDFW	California Department of Fish and Wildlife
CWA	Clean Water Act
EID	Environmental Impact Document
ENR	*Engineering News-Record*
EPA	United States Environmental Protection Agency
ERG	Eastern Research Group, Inc.
FEMA	Federal Emergency Management Agency
IBWC	International Boundary and Water Commission
LSA	Lake and Streambed Alteration
MERRAC	Marine Environmental Emergency Preparedness and Response Regional Activity Centre
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
USACE	United States Army Corps of Engineers
USMCA	United States–Mexico–Canada Agreement

EXECUTIVE SUMMARY

PG Environmental conducted a feasibility analysis for Project 6, "Construct New Infrastructure to Address Trash and Sediment," which was one of 10 proposed projects identified to mitigate contaminated transboundary flows that cause impacts in the Tijuana River area and neighboring coastal areas in the U.S. under the United States–Mexico–Canada Agreement. 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.

The project involves the construction of infrastructure in the Tijuana River main channel and Smuggler's Gulch to reduce sediment and trash deposition into the Tijuana River Estuary, and in Yogurt Canyon to reduce flooding. PG evaluated six individual sub-projects, five of which were proposed in reports developed by Stantec, HDR, and AECOM:

1. **Restoration of the Tijuana River main channel sediment basin between the U.S./Mexico border and Dairy Mart Road to its original configuration by removing accumulated sediment,** as recommended in the 2020 Stantec report (Stantec 2020). This restoration was found to be feasible to construct; however, it may not be feasible to operate and maintain because of high disposal costs and trucking requirements. The development and implementation of a wet weather sediment monitoring program is necessary to better characterize sediment transport in the river during wet weather. Based on available data, the restored basin is expected to trap an average of 122,000 cubic yards of sediment annually. This will require identifying a disposal site with the long-term capacity to accommodate the sediment from the river. Further, transporting this sediment would generate 7,630 truckloads of material annually that must pass through developed areas of San Diego. The estimated capital cost of restoration is $49.6 million, and the estimated 40-year life cycle cost is $380 million with sediment disposal at the Miramar Landfill. Sediment disposal at other sites, such as the Nelson Sloan Quarry restoration site, may reduce life cycle costs.

2. **A sediment basin on the U.S. side of the border at Smuggler's Gulch,** as proposed in HDR's *Tijuana River Valley Needs and Opportunities Assessment* (HDR 2020). The HDR assessment presented two basin configurations, an in-channel basin and an in-channel basin with an off-channel basin attached. Both configurations were found to be technically feasible. The in-channel basin is expected to trap an average of 11,000 cubic yards of sediment annually, which is about 61% of the annual sediment load discharged into the estuary from Smuggler's Gulch. Estimated capital cost of the in-channel basin is $2.4 million and estimated 40-year life cycle cost is $32.2 million, based on sediment disposal at the Miramar Landfill. The in-channel plus side-channel basin configuration adds about $5.2 million in capital cost and provides improved flood control for adjoining U.S. areas but does not enhance sediment capture appreciably. However, as noted in the following paragraph, the recent construction of an in-channel basin on the Mexico side of the border may render either U.S.-side basin project unnecessary provided that Mexico can successfully remove collected sediments on a long-term basis.

3. **An in-channel sediment basin on the Mexico side of the border at Smuggler's Gulch.** A sediment basin was recently completed on the Mexico side of the border. PG had evaluated an in-channel sediment basin on the Mexico side of the border and determined that it would be feasible to construct, would prevent an average of 15,000 cubic yards of sediment from entering the estuary annually, and would have lower operation and maintenance costs than

a basin on the U.S. side of the border. The proposed in-channel sediment basin that PG evaluated is functionally similar to the basin that was recently constructed in Mexico. Therefore, PG's evaluation suggests that the recently constructed basin will be effective at reducing the sediment load that enters the estuary provided that accumulated sediment is removed regularly.

4. **A U.S.-side pilot channel in Yogurt Canyon,** as suggested by HDR (2020). This sub-project was determined not to be feasible because it would not reduce wet-weather flooding over Monument Road and because of the potential for adverse impacts to the environmentally sensitive estuary.

5. **A U.S.-side modification to Monument Road just east of International Friendship Park** to raise the roadway above the 100-year flood elevation. This sub-project was determined to be feasible. Estimated capital cost is $2.9 million and estimated 40-year life cycle cost is $3.2 million. The estimated cost could change based on the final routing of the raised roadway, which is being evaluated by California State Parks.

6. **Installation of trash booms in the Tijuana River main channel, Matadero Canyon, and Yogurt Canyon.** The main channel and Smuggler's Gulch booms were found to be technically feasible, although the Mexico-side Smuggler's Gulch boom may not be necessary because of the recently installed sediment basin and trash control infrastructure upstream of the proposed boom in Mexico and the currently installed trash boom on the U.S. side of the border. Trash data are currently limited, so a trash study is necessary to better characterize the trash loads and types of trash in the Tijuana River and Smuggler's Gulch. Based on trash quantity estimates by HDR, main channel and Smuggler's Gulch trash booms are expected to trap 18,700 of trash annually. The boom on the Mexico side of the border was found to be technically feasible, if the sediment and trash control infrastructure recently installed on the Mexico side of the border upstream of the proposed site is effective. Estimated capital costs are $3.57 million for the main channel boom and $420,000 for the Smuggler's Gulch boom. Estimated 40-year life cycle cost is $33.1 million for the main channel boom and $1.2 million for the Smuggler's Gulch boom based on disposal at the Miramar Landfill. Information from California State Parks suggests the trash load that comes from Yogurt Canyon is not large enough to merit a boom.

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 proposed projects to mitigate contaminated transboundary flows that cause impacts in the Tijuana River area and neighboring coastal areas in the U.S. Each feasibility analysis considered an estimate of capital costs; an estimate of design, project, and construction management costs; an estimate of operation and maintenance (O&M) costs; an estimate of total life cycle costs; regulatory, engineering, and any possible implementation issues; and social and environmental impacts.

This feasibility analysis specifically addresses Project 6: "Construct New Infrastructure to Address Trash and Sediment." During the analysis, PG consulted with stakeholders and reviewed previous work including the following:

- *Phase 2 Hydrology, Floodplain, and Sediment Transport Report* (USACE 2020).
- *Feasibility Study for Sediment Basins Tijuana River International Border to Dairy Mart Road Final Feasibility Report* (Stantec 2020).
- *Tijuana River Valley Needs and Opportunities Assessment* (HDR 2020).

PG's *Baseline Conditions Summary: Technical Document,* prepared for EPA under the United States–Mexico–Canada Agreement (USMCA) Mitigation of Contaminated 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, on new information presented to PG and in response to EPA's request to review the USACE and HDR's analysis of sediment impact of Smuggler's Gulch to the Tijuana River and characterize the studies. PG recommends that more information on sediment and trash volumes be collected as part of the preliminary engineering process for design of these facilities:

- Sediment monitoring data from the main channel during wet-weather events.
- Data on the trash loads and types present in transboundary flows.

This additional information could affect both project feasibility and project costs; this report uses best estimates for those costs, based on information available when the report was finalized.

Consistent with the task order scope, PG will work with EPA to develop and analyze several infrastructure alternatives to mitigate the transboundary wastewater and stormwater flows. Each alternative will include a grouping of one or more projects evaluated in the feasibility analyses, scaled if necessary. The alternatives include groupings of one or more projects evaluated in the feasibility analyses, scaled if necessary, and will be presented to EPA in the Water Infrastructure Alternatives Analysis report.

1.1 Project Purpose

Stormwater runoff flowing through the Tijuana River carries with it trash and sediment that are ultimately deposited in the downstream estuary. The purpose of Project 6 is to protect the Tijuana

River Estuary, as well as pumping and treatment facilities in the U.S., from sediment-laden wet-weather flows in the Tijuana River and Smuggler's Gulch and to mitigate flooding in Yogurt Canyon.

1.2 Current Conditions

This section summarizes the current conditions relevant to Project 6. Refer to the *Baseline Conditions Summary: Technical Document* for a more detailed discussion of the current conditions in the Tijuana River Watershed.

During wet-weather events, stormwater runoff from the City of Tijuana collects large amounts of sediment. The runoff flows into the Tijuana River, which transports large sediment loads across the border. Ultimately, the larger grains of sediment are deposited in the estuary while the finer grains of sediment are transported out into the Pacific Ocean. According to the HDR report, the sediment that settles in the estuary is known to cause environmental and public health issues (HDR 2020).

During dry weather, sediment-laden untreated wastewater that is not captured in the sanitary sewer system is the primary source of sediment loads into the river. PG estimated the sediment loading in dry weather flows by multiplying the suspended sediment concentration of the untreated wastewater by the average proportion of the total flows that is untreated wastewater. PG used the 2020 *Minute 320 Binational Water Quality Study of the Tijuana River and Adjacent Canyons and Drains* from International Boundary and Water Commission (IBWC) and South Bay International Wastewater Treatment Plant influent monitoring data to estimate that untreated wastewater in Tijuana has a suspended sediment concentration of 400 mg/L. PG estimates that an average of 10 MGD out of the 24.3 MGD of the average dry weather flows in the Tijuana river are untreated wastewater, which alone would mean the suspended sediment concentration in the river is 160 mg/L. PG assumed that other minor sediment sources bring the suspended sediment concentration in the river during dry weather to 200 mg/L.

During wet weather events, the main source of sediment is stormwater runoff that enters the river. The suspended sediment concentration in wet weather flows increases as flows increase. PG assumed that wet weather flows under 85 MGD have a suspended sediment concentration of 200 mg/L, similar to dry weather flows. PG used a preliminary correlation developed by San Diego State University and Southern California Coastal Water Research Project on sediment samples over 5 m^3/s (114 MGD) to estimate the sediment concentrations at wet weather flow rates above 85 MGD.

PG used the dry weather and wet weather sediment concentrations in the river to calculate the average suspended sediment concentration and the sediment load in the average daily flow rates measured at the IBWC flow gauge January 1st, 2016 through December 31st, 2019. PG used the daily sediment loadings to estimate that the average annual sediment load over that four-year period was 125,000 tons of sediment.

The estimated average annual sediment load between 2016 and 2019 doesn't account for very large storm events that occur infrequently but are a significant source of sediment loading in the Tijuana River. The maximum 24-hour precipitation accumulation measured at National Oceanic and Atmospheric Administration (NOAA) gauge at Brown Field in San Diego (the closest NOAA gauge to the City of Tijuana) between 2016 and 2019 was 2.21 inches. According to the NOAA Atlas 14 Precipitation Frequency Estimates, this event is between the size of a five-year, 24-hour storm (2.04 inches) and a 10-year, 24-hour storm (2.40 inches). PG used the *Phase 2 Hydrology, Floodplain, and Sediment Transport Report* developed by the U.S. Army Corps of Engineers (USACE, 2020) to account for the sediment load from storm events larger than the storms that occurred between 2016 through 2019. The USACE Phase 2 study described modeling used to estimate the sediment loads that are transported to the estuary during storm events with recurrence intervals ranging from two years to 500 years. The USACE study estimated sediment loads in the main channel, Smuggler's Gulch, Goat Canyon, and Yogurt Canyon. The estimated sediment loads from Goat Canyon and Yogurt Canyon were determined not to be significant sources of sediment in the estuary. For the main channel and Smuggler's Gulch, USACE calculated the average sediment load that each storm contributes annually by multiplying the total sediment yield by the probability for a storm of that size to occur in an average year. The estimated sediment yields for the Tijuana River main channel and Smuggler's Gulch are shown in Table 1-1 (USACE 2020).

Table 1-1. Estimated Sediment Loads from Storm Events in the Main Channel and Smuggler's Gulch

Storm Recurrence Interval	Main Channel Estimated Sediment Load (at U.S./Mexico Border) (Tons)	Main Channel Average Annual Sediment Load (Tons/Year)	Smuggler's Gulch Estimated Sediment Load (at U.S./Mexico Border) (Tons)	Smuggler's Gulch Average Annual Sediment Load (Tons/Year)
500 years	2,211,000	4,422	74,500	149
200 years	1,075,000	5,375	62,900	315
100 years	696,000	6,960	60,000	600
50 years	644,000	12,880	50,600	1,010
25 years	399,000	15,960	41,200	1,650
10 years	169,000	16,900	31,100	3,110
5 years	89,000	17,800	24,400	4,800
2 years	19,000	9,500	12,600	6,300
Annual average	**N/A**	**90,000**	**N/A**	**17,900**

Source: USACE 2020

PG used the annualized sediment load averages at the U.S./Mexico border shown in Table 1-1 to estimate that storm events with a recurrence interval of 10 years or more have an annualized sediment load of 62,500 tons. PG combined this estimate with the estimated sediment load from 2016 through 2019 to estimate that the annual sediment load in transboundary flows in the river is 187,000 tons.

The USACE Phase 2 study also evaluated the amount of sediment that is discharged into the ocean for each frequency storm event. PG compared the amount of sediment crossing the border to the amount discharged into the ocean to estimate how much sediment is deposited in the estuary annually from both the Tijuana River main channel and Smuggler's Gulch. Table 1-2 shows the results.

Table 1-2. Estimated Sediment Load That Crosses the Border and Enters the Ocean

Storm Recurrence Interval	Total Sediment Load Crossing the Border in the Main Channel and Smuggler's Gulch (Tons)	Total Sediment Discharged to the Ocean (Tons)	Total Sediment Estimated to Be Deposited into the Estuary (Tons)	Annualized Amount of Sediment Deposited into the Estuary (Tons/Year)
500 years	2,290,000	1,420,000	870,000	1,740
200 years	1,138,000	1,242,000	-104,000	-520
100 years	756,000	894,000	-138,000	-1,380
50 years	695,000	376,000	319,000	6,380
25 years	440,000	213,000	227,000	9,080
10 years	200,000	153,000	47,000	4,700
5 years	113,000	75,000	38,000	7,600
2 years	63,000	20,000	43,000	21,500
Estimated annual average sediment deposited into the estuary by storms				**49,000**

Source: USACE 2020

The USACE study noted that the depositional trends for the frequency storm events show that sediment is primarily deposited upstream of Hollister Street on the U.S. side of the border. The study found that the beach areas near the mouth of the ocean showed significant scour during large storm events. The study also found that most sediment discharges into the river were classified as fines (that is, their particle diameter was less than 0.0625 millimeters).

PG reviewed information on sediment transport in Smuggler's Gulch from the USACE Phase 2 study and the HDR report. The sediment transport results from the USACE Phase 2 report are shown in Table 1-1, and the sediment transport results from the HDR report are shown in Table 1-3.

Table 1-3. Estimated Sediment Load That Crosses the Border and Enters the Ocean

Storm Recurrence Interval	Sediment Load in Smuggler's Gulch Transboundary Flows (Tons)	Annualized Sediment Load in Smuggler's Gulch Transboundary Flows (Tons/Year)
5 years	25,728	5,150
25 years	48,313	1,930
100 years	114,311	1,140

Source: HDR 2020

The HDR report estimated that the average annual sediment load in transboundary flows is 18,000 tons of sediment annually. This estimate was based on sediment concentrations of observed sediment concentrations in other steep-sloped arroyos that are similar to Smuggler's Gulch. As shown in Table 1-1 and Table 1-3, the HDR report estimated higher sediment loads for all three frequency storm events than the USACE Phase 2 storm events. In particular, the HDR report's estimate for the sediment load for the 100-year storm (114,311 tons) is significantly higher than the USACE Phase 2 study's estimate (60,000 tons). For the purposes of the feasibility analyses, PG used sediment transport information from the HDR report. More data on sediment should be collected during wet weather to better understand the sediment transport during wet weather.

Data on the trash loadings and the types of trash are currently limited. The HDR report's rough estimate is that the annual trash load in the main channel and Smuggler's Gulch is 10%, by dry volume, of the annual sediment load. This estimate is based on the mass fraction of trash that is collected in Goat Canyon relative to the sediment that is captured. PG converted the estimated annual sediment load from 187,000 tons to 156,000 cubic yards assuming that the density of the dry sediment is 1.2 tons per cubic yard. This density is consistent with the density used in the USACE Phase 2 study for Goat Canyon and Yogurt Canyon. PG used the method HDR used to estimate that the annual trash load in main channel transboundary flows is 15,600 cubic yards, and the annual trash load in transboundary flows in Smuggler's Gulch is 1,800 cubic yards. Goat Canyon and Yogurt Canyon are not considered significant sources of trash in the estuary (HDR 2020).

In Smuggler's Gulch and Matadero Canyon (the name for Smuggler's Gulch on the Mexico side of the border), two projects have recently been completed to control sediment and trash. On the Mexico side, a weir was built in the area south of the International Highway and the area was excavated to create infrastructure to detain stormwater and trap sediment and trash. The new sediment and trash control infrastructure is reportedly effective at reducing trash in stormwater runoff that flows transboundary. Additionally, a trash boom was recently installed in Smuggler's Gulch on the U.S. side of the border, according to the HDR report. Discussions with Urban Corps (the organization that operates the trash boom) during a site visit in May, 2021 indicated that the trash boom is effective at trapping trash during wet weather.

The sections of Monument Road that run across Smuggler's Gulch and Yogurt Canyon are prone to flooding in wet weather. The HDR report states that the 52-inch culvert underneath Monument Road is too small to drain the stormwater runoff that flows through Smuggler's Gulch during wet weather. There is also a large scour hole immediately downstream of the culvert. As a result, the section of Monument Road that runs across Smuggler's Gulch and provides access to the western portion of the estuary often floods during rain events (HDR 2020). Discussions with California State Parks indicated that the section of Monument Road that runs across Yogurt Canyon is generally flooded for the duration of the wet-weather season. This section of road provides access to the International Friendship Park, meaning that visitors to the park would wade across the flooded section of road and be exposed to potentially contaminated stormwater runoff.

1.3 Major Project Elements Considered

Project 6 involves the construction of infrastructure in the Tijuana River, Smuggler's Gulch, and Yogurt Canyon to reduce trash and sediment flows to the estuary and mitigate flooding in Yogurt Canyon. PG assessed the technical feasibility of the following individual infrastructure sub-projects:

1. Restoration of the Tijuana River main channel to its original 1977 design configuration, as proposed in the 2020 Stantec report.
2. A U.S.-side sediment basin in Smuggler's Gulch immediately north of the border, as proposed in the 2020 HDR report. PG evaluated both the in-channel basin configuration and the in-channel basin with side basin configuration suggested by HDR.
3. A Mexico-side, in-channel sediment basin in Smuggler's Gulch immediately south of the border in lieu of a U.S.-side sediment basin.
4. A U.S.-side pilot channel in Yogurt Canyon and north of Monument Road, as proposed in the HDR report.
5. A U.S.-side sub-project to raise Monument Road downstream of Yogurt Canyon to reduce flooding during the wet-weather season.
6. Installation of trash booms in the Tijuana River main channel, Smuggler's Gulch, and Yogurt Canyon to reduce trash migration into the estuary.

2. DESIGN INFORMATION

Sections 2.1 through 2.6 provide an overview of the design features of each of the six proposed sub-projects and their location on the Federal Emergency Management Agency (FEMA) 500-year floodplain map. Figure 2-1 provides an overview of the locations and known elevations of each of the six sub-projects.

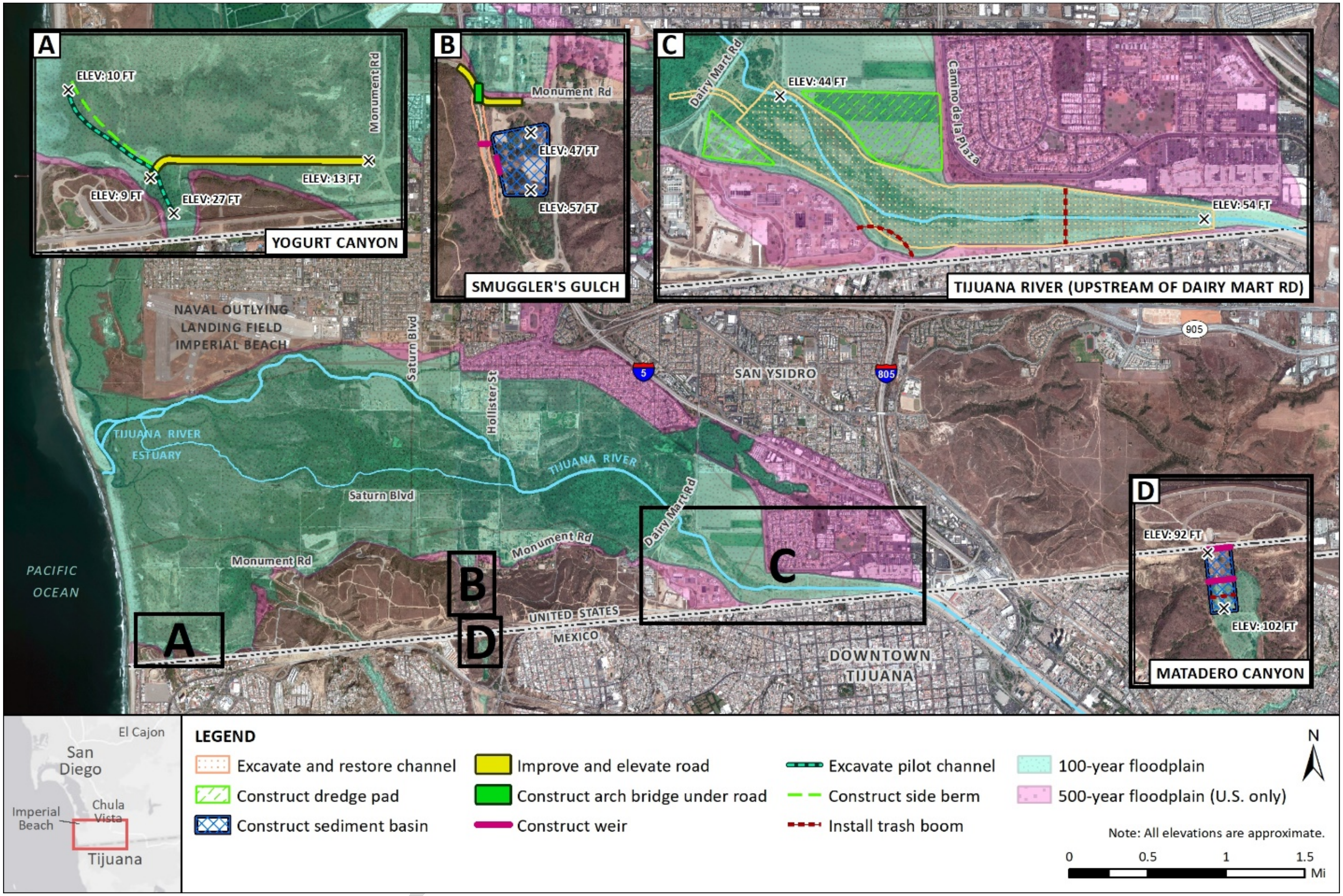

Figure 2-1. Locations and Known Elevations of the Six Sub-Projects

2.1 Sub-Project 1: Main Channel Restoration to Capture Sediment and Trash

2.1.1 Design Features

For the Tijuana River main channel, Stantec (2020) evaluated the feasibility and effectiveness of in-channel basins, off-channel basins, combined in-/off-channel basins, and channel restoration. The main channel restoration was chosen over new in-channel and in-/off-channel combination sediment basins based upon constructability, lowest capital cost, lowest O&M cost, and least disturbance to adjacent lands. The Stantec report also recommended the construction of two dredge pads for temporary sediment and equipment storage. The in-channel basin and the channel restoration offered better trapping efficiencies than the off-channel basin and in-/off-channel basin combination. Overall, the channel restoration offered similar sediment trapping performance to the in-channel basin for smaller storms. In contrast, the in-channel basin only offered a significantly higher trapping efficiency for 10-year storms or larger.

Stantec's proposed in-channel restoration involves 121 acres of land and proposes excavating 615,000 cubic yards of accumulated sediment, regrading of the river channel to the original 1977 design from downstream of the U.S./Mexico border to Dairy Mart Road. The restored channel features an approximately 2,500-foot-long section of riprap-lined channel about 1,000 feet downstream of the border. This riprap section expands from about 250 feet wide on the upstream end to 800 feet wide on the downstream end. The expansion dissipates energy from flows and allows sediment to deposit. After the riprap section, an approximately 5,000-foot-long by 800-foot-wide earth section would be regraded to further allow sediment deposition, ending at the Dairy Mart Road Bridge. The restoration features a new low-flow diversion channel to convey flows under Dairy Mart Road and into the estuary. Figure 2-1 shows the locations of the trash booms and dredge pads along the main channel, relative to the 500-year floodplain.

2.1.2 Engineering Issues

PG used the hydraulic modeling data and sediment characteristics presented in Appendix F of the Stantec (2020) report to evaluate the main channel restoration. The geometry of the proposed main channel restoration, as detailed in Section 2.1.1 of this report, is consistent with the preferred alternative design in the Stantec report. The Stantec report's Appendix F describes the use of a 2D HEC RAS model to estimate the trapping efficiency of the restored main channel compared to the current trapping efficiency. Table 2-1 lists the trapping efficiencies estimated by Stantec.

Table 2-1. Estimated Trapping Efficiency of the Restored Channel for Different Frequency Storms

Storm Recurrence Interval	Sediment Trapping Efficiency
100 years	13.9%
10 years	99.3%
5 years	99.8%
2 Years	99.9%

Source: Stantec 2020

The trapping efficiencies indicate the restoration would be highly effective at trapping sediment from transboundary flows and would mitigate sediment deposition upstream of Hollister Street and in the estuary. The high trapping efficiency of the basin combined with the basin having no reduction in discharges of sediment to the ocean suggests that the ocean discharges are from the beach scour, as discussed above in Section 1.2.

The Stantec report estimated 50,000 cubic yards of sediment that would be trapped annually by restoring the main channel to its original design configuration. PG estimates that the basin will trap approximately 122,000 cubic yards of sediment annually. PG's estimate is based on the sediment sampling data collected by San Diego State University, which show substantially higher sediment loads than assumed in the Stantec report. However, more sediment monitoring data are needed for a more accurate estimate of the annual volume of sediment that the main channel would collect.

2.1.3 Implementation and Regulatory Issues

PG estimates that the restoration of the main channel to its original design is likely to take several years. Construction is limited to the dry season and to the functioning of the dry-weather diversion system in Mexico. The main channel restoration is likely to require a Presidential Permit to construct due to proximity to the U.S.-Mexico border. The basin will also likely require a Section 404 permit and a National Pollutant Discharge Elimination System (NPDES) permit under the Clean Water Act (CWA). Channel restoration is likely to require a California Lake and Streambed Alteration Agreement from the California Department of Fish and Wildlife (CDFW), a process that could result in scope modifications late in the planning process. Obtaining concurrence from the California Coastal Commission (CCC) on a coastal zone consistency determination for the dredge pads, pursuant to the California Coastal Management Program, may be challenging due to potential adverse effects to coastal resources (potentially including land use, floodplain management, aesthetics, and air quality) (CCC 2001). PG considered EPA mandates for the Tijuana River watershed, California State Parks concerns, U.S. Customs and Border Protection (CBP) concerns, state and local regulations, and zoning. The main channel restoration would likely need zoning and other approvals from the local jurisdictions. Due to the immediate proximity to the U.S.-Mexico border, all the proposed improvements would likely need CBP approval.

Disposal of sediment presents both cost and regulatory challenges. Identifying a location that will accept the volume of sediment produced may be challenging. Additionally, PG estimates that 7,630 truck trips will be required annually to transport the sediment to the disposal site, based on the volume of sediment that the basin traps (refer to Section 3.2). The sediment collected at Goat Canyon is currently taken to the Miramar Landfill for disposal. Costs reported by HDR seem high compared to commonly applied costs. Section 2.7 discusses the sediment disposal plan for Project 6 in detail.

Restoration of the main channel, and the associated sediment management activities, could trigger public opposition due to environmental justice concerns. Specific concerns could include odors, visual impacts, increases in heavy vehicle traffic, and the potential for property value impacts in areas that have a disproportionately high prevalence of people of color and/or low-income households.

2.2 Sub-Project 2: Smuggler's Gulch—U.S.-Side Sediment Basin

2.2.1 Design Features

HDR (2020) evaluated three configurations for the sub-project to capture sediment and control flooding on the U.S. side of Smuggler's Gulch. The first involved construction of a weir to create an in-channel sediment basin. The second adds an off-channel basin to the in-channel basin for more sediment trapping and flooding control. The third includes two smaller weirs to create two smaller in-channel basins in series. HDR determined that the third configuration was consistently less effective than the first and therefore did not further evaluate its feasibility.

The first configuration involves the construction of a 10-foot-tall weir about 300 feet upstream from Monument Road and dredging the existing channel to a 1.35% grade to create an in-channel sediment basin. The dredged channel would be about 50 feet wide. This configuration also requires raising Monument Road 6 feet in total: 3 feet to install 8-foot-diameter reinforced concrete pipes under the roadway and another 3 feet to prevent flooding during two-year storm events. The scour hole downstream of Monument Road would need a hard revetment or a cutoff wall.

The second configuration includes an additional off-channel sediment basin together with the in-channel basin. The proposed off-channel basin would be about 540 feet long, 400 feet wide, and 9 feet deep. The proposed off-channel basin would be connected to the in-channel basin by a 100-foot-long, 5-foot-tall weir about 150 feet upstream of the in-channel weir. Figure 2-1 shows the location of the U.S.-side Smuggler's Gulch sediment basin in relation to the 500-year floodplain. Preliminary drawings of the proposed designs can be found in Appendix E of the HDR report. The second configuration would also require raising the road by 3 feet and replacing the existing 52-inch culvert under Monument Road with a 16-foot by 8-foot CON/SPAN arch bridge.

2.2.2 Engineering Issues

PG used the flow data and sediment characteristics from Appendix E of the HDR (2020) report to evaluate the proposed U.S.-side basins in Smuggler's Gulch. The geometry of both the in-channel basin and the combined in-/off-channel basins is discussed in Section 2.2.1 and is consistent with the designs presented in the HDR report's Appendix E. HDR estimated the annual sediment yield through Smuggler's Gulch at 18,000 cubic yards. HDR estimated the annual trapping efficiency of each sediment basin as equal to the trapping efficiency of the basin over the duration of a five-year storm. The five-year storm efficiency was used because the total sediment yield from the storm was similar to the estimated annual sediment yield. PG estimated the annual volume of sediment captured by the U.S.-side basins by multiplying the trapping efficiencies from both the in-channel basin and the combined in-/off-channel basin over the duration of a five-year storm by the annual sediment yield.

Note that HDR's evaluation of the proposed sediment basins was based on the hydraulic and sediment transport characteristics of wet-weather flows in Smuggler's Gulch before the (recent) construction of a sediment basin upstream of the proposed U.S.-side basins on the Mexico side of the border. Since the proposed U.S.-side basins are downstream of the recently constructed basin, the sediment loads that would enter them are likely to be significantly reduced. The sediment particles that escape the upstream basin are also likely to be finer, so they would not be likely settle out in the new, U.S.-side basins either. Therefore, the new basins' sediment trapping effectiveness is likely to be much lower than it would have been before the new Mexico-side basin was constructed.

2.2.3 Implementation and Regulatory Issues

PG estimates that constructing the U.S.-side Smuggler's Gulch sediment basins is likely to take several years. Construction is limited to the dry season and is dependent on the functioning of the dry-weather diversion system in Mexico. The main channel basin is likely to require a Presidential Permit to construct. The basin will also likely require a Section 404 permit and an NPDES permit under the CWA. PG considered EPA mandates for the Tijuana River watershed, California State Parks concerns, CBP concerns, state and local regulations, and zoning. The main channel sediment basin would likely need zoning and other approvals from local jurisdictions. Due to the immediate proximity to the U.S.-Mexico border, all the proposed improvements would likely need CBP approval. Appropriate consideration of CBP concerns, including occupational safety concerns, early in the project planning process is recommended to avoid potential delays in obtaining permissions or agreements with CBP.

Disposal of sediment presents both cost and regulatory challenges. The sediment collected at Goat Canyon is currently taken to the Miramar Landfill for disposal. Costs reported by HDR seem high compared to commonly applied costs. A detailed discussion of the sediment disposal plan for Project 6 is presented in Section 2.7.

2.3 Sub-Project 3: Smuggler's Gulch—Mexico-Side Sediment Basin

2.3.1 Design Features

As discussed in Section 1.2, a new sediment basin and trash control infrastructure were recently built on the Mexico side of the border, south of the international highway. The new basin uses an in-channel weir to detain stormwater flows and to trap sediment and trash. PG had evaluated a functionally similar in-channel sediment basin on the Mexico side of the border, which is discussed below. This evaluation suggests that the in-channel sediment basin will be effective at capturing sediment.

PG's evaluation considered two potential sites for the basin: (1) the valley area immediately south of the border and (2) the plot of open land south of the international highway. The valley area immediately south of the border was chosen due to the site's favorable topography, larger available land area, and natural flood containment features. This will be an in-channel basin, detaining flows to allow sediment to settle out. As a result, constructing it is not likely to further reduce the sediment loads transported to the estuary by wet-weather flows.

2.3.2 Engineering Issues

PG used the flow data and sediment characteristics from Appendix E of the HDR report to evaluate the performance of the Mexico-side basin. PG developed the Mexico-side basin's geometric design for maximum volume within the area's natural topography (and thus lower construction cost). The basin has a volume of 16,000 cubic yards and would require a fall height of 1 foot during a five-year storm. As with the U.S.-side basin, the annual trapping efficiency was approximated by the basin's trapping efficiency over the duration of a five-year storm event. PG multiplied this efficiency by the estimated annual sediment yield from the HDR (2020) report to approximate the annual volume of sediment trapped by the basin.

PG approximated the trapping efficiency of the basin for the duration of the five-year storm event by calculating the instantaneous trapping efficiency at selected time intervals during the storm and integrating the trapping efficiency over the total duration of the storm. PG calculated the instantaneous trapping efficiency by determining the smallest particle that had the necessary fall velocity to settle below the weir height, then using the sediment transport data to determine what percentage of particles were larger.

PG calculated the necessary fall velocity by dividing the maximum height of the sediment overflow weir by the residence time at the instantaneous volumetric flow rate. The smallest sediment particle that had the necessary fall velocity was calculated using the Karamenev method (Wilkes 2006) with a correction applied to the fluid viscosity to account for hinderance (Geankoplis 2003). After determining the fall height, PG estimated the sediment trapping efficiency by calculating the approximate percentage of sediment grains that are larger than the smallest sediment particle the basin is expected to trap. PG then estimated the instantaneous sediment trapping rate by multiplying the calculated efficiency by the instantaneous sediment load. Instantaneous sediment trapping rates and total sediment load rates were integrated over the duration of the storm using the trapezoid method to calculate the estimated total volume of sediment yield, the total volume of sediment trapped, and the basin's trapping efficiency for the storm event. The reduction in basin volume due to trapped sediment was factored in after each time interval.

PG's evaluation of the proposed sediment basin was based on the hydraulic and sediment transport characteristics of wet-weather flows in Smuggler's Gulch before the recent construction of the sediment basin upstream of the basin proposed by PG. The recently constructed basin appears to function similarly to PG's proposed design: it is an in-channel weir constructed to detain flows and allow sediment particles to settle out. Since the new basin is downstream of the recently constructed basin, the sediment loads that would enter the new basin will have already been reduced. The sediment particles that escape the upstream basin are also likely to be finer, and as such, are not likely to settle out in the U.S-side basin evaluated by PG. Therefore, the U.S.-side basin is likely to be much less effective than it would have been before the new, Mexico-side basin was constructed.

2.3.3 Implementation and Regulatory Issues

The basin on the Mexico side of the border is already constructed and in operation. Therefore, PG did not explore additional potential implementation or regulatory issues associated with construction of the proposed basin for sub-project 3.

2.4 Sub-Project 4: Yogurt Canyon—Pilot Channel

2.4.1 Design Features

California State Parks reports that the Monument Road access into International Friendship Park can be flooded for long periods and even continuously during the winter rainy season. California State Parks is concerned that these flood waters have at times contained wastewater from the sanitary sewer system serving the developed area south of the U.S.-Mexico border. People entering the park by car, by foot, or by other means must pass through these flood waters and may thus be exposed to untreated wastewater. California State Parks identified the flooding of Monument Road—rather than sediment or trash—as their greatest environmental concern related to wet-weather flows from Yogurt Canyon. California State Parks is considering two approaches to resolving the Monument Road flooding issue: constructing a pilot channel or raising Monument Road eastward of the park entrance as described in Section 2.5.

Sub-project 4 evaluates constructing the pilot channel. HDR (2020) proposed construction of a drainage pilot channel and berm to convey stormwater runoff from Yogurt Canyon to the estuary to dissipate stormwater runoff into the Tijuana estuary more rapidly. The proposed channel would capture canyon wet-weather flows and direct them north through new culverts beneath Monument Road, then northwest into the estuary.

The proposed pilot channel would begin in the current low-flow channel leaving Yogurt Canyon immediately north of the U.S.-Mexico border. About 400 feet downstream of the Canyon, the channel would pass beneath Monument Road via culvert pipes and proceed northwest for 900 feet before ending in the estuary. After crossing Monument Road, the proposed pilot channel would include a berm on the east bank. The berm is about 900 feet long and 3 feet tall and is intended to prevent flooding east of the channel. The path of the channel and berm is shown in Figure 2-1. A conceptual design drawing of the proposed channel can be found in Appendix E of the HDR report.

2.4.2 Engineering Issues

The geometric features of the proposed Yogurt Canyon pilot channel are described in Section 2.4.1 and are consistent with the design presented in Appendix E of the HDR report (HDR 2020). For Yogurt Canyon, consistent with the methodology in the HDR report, PG assumed that the sediment characteristics were similar to the characteristics from Smuggler's Gulch. PG estimated the wet-weather flow rates over the duration of a storm by scaling the flow rates from Smuggler's Gulch during the same event by the proportion of area that drains into each canyon. This approach is consistent with the method used by HDR to calculate the peak flow rates of storms. For a five-year storm, PG estimated sediment yield from Yogurt Canyon was 414 cubic yards, or about 2% of the sediment yield from Smuggler's Gulch for a storm of the same size.

As mentioned above, California State Parks provided additional anecdotal information indicating that sediment and trash loads from Yogurt Canyon are not perceived to be significant. The low calculated sediment yield joins this anecdotal information in supporting a conclusion that flooding of Monument Road is the primary adverse environmental issue associated with Yogurt Canyon, rather than sediment or trash crossing the border into the Tijuana River Estuary area.

2.4.3 Implementation and Regulatory Issues

PG considered EPA mandates for the Tijuana River watershed, California State Parks concerns, CBP concerns, state and local regulations, and zoning. Building the Yogurt Canyon pilot channel through the environmentally sensitive estuary area appears likely to generate significant regulatory agency concerns. California State Parks identified the need for regulatory approval of the pilot channel as a potential significant impediment to feasibility. The pilot channel would require a Section 404 permit under the CWA and may require a California Lake and Streambed Alteration (LSA) Agreement from CDFW. The Yogurt Canyon pilot channel would likely need zoning approvals from local jurisdictions. Due to the immediate proximity to the U.S.-Mexico border, all the proposed improvements would likely need CBP approval.

2.5 Sub-Project 5: Yogurt Canyon—Monument Road Modification

2.5.1 Design Features

As discussed in Section 1.2, California State Parks identified the flooding of Monument Road as their greatest environmental concern related to wet-weather flows from Yogurt Canyon, rather than sediment or trash. California State Parks is considering two approaches to resolving the Monument Road flooding issue: constructing the pilot channel described in Section 2.4 or raising Monument Road eastward of the park entrance. Sub-project 5 evaluates raising Monument Road to prevent it from being flooded. The raised portion of Monument Road would begin at the entrance to the International Friendship Park and continue eastward about 2,000 feet to the point where Monument Road turns northward, as shown in Figure 2-1. The final routing of the raised roadway is being evaluated by California State Parks.

2.5.2 Engineering Issues

Area topography information available on Google Earth (imagery date 8/17/2019) shows that the existing centerline elevation of the east–west portion of Monument Road to the International Friendship Park entrance is generally less than 1 foot higher than the estuary lands through which wet-weather discharges from Yogurt Canyon must flow. Therefore, California State Parks is evaluating raising Monument Road to prevent flooding and, as part of that effort, installing a system of box culverts under the new roadway at the point where discharges from Yogurt Canyon would cross the existing roadway. PG determined the final elevation of the road based on the FEMA floodplain maps, which suggest that the roadway would need to be raised 2 to 3 feet to achieve a 100-year flood protection level.

2.5.3 Implementation and Regulatory Issues

PG considered EPA mandates for the Tijuana River watershed, California State Parks concerns, CBP concerns, state and local regulations, and zoning. The road modifications would require a Section 404 permit under the CWA and may require a California LSA Agreement from CDFW. The sub-projects would likely need zoning approvals from local jurisdictions. Due to the immediate proximity to the U.S.-Mexico border, all the proposed improvements would likely need CBP approval.

2.6 Sub-Project 6: Tijuana River Main Channel, Smuggler's Gulch, and Yogurt Canyon—Trash Collection

2.6.1 Design Features

Trash has been identified as a substantial environmental concern; therefore, trash capture facilities have been included in PG's evaluations for the Tijuana River main channel and the Mexico-side Smuggler's Gulch sediment basin. According to the HDR report, a trash boom was recently installed on the U.S. side of Smuggler's Gulch (HDR 2020). Therefore, PG did not include placement of a trash boom on the U.S. side of the border at Smuggler's Gulch as part of this feasibility analysis.

Stantec's 60% feasibility report (Stantec 2019) considered several trash control device types for the main channel including bar screens, self-cleaning screens (such as continuous deflective separation units), and trash booms. The report identified trash booms as the preferred trash capture method due to their reliability and effectiveness at capturing trash from large drainage areas at low flow velocities. Trash control structures were removed from the preferred alternative in the 90% feasibility report, however (Stantec 2020). No explanation has been provided to date for this deletion.

The restored Tijuana River channel upstream of Dairy Mart Road (sub-project 1) appears to be the most effective location for trash boom placement between the U.S.-Mexico border and the estuary because of the slowing of river velocity that will occur through that basin. The Stantec 60% report proposed that two trash booms be installed in the main channel sediment basin. The first boom was proposed to be located 3,500 feet downstream of the U.S.-Mexico border and was to be 800 feet long. The second boom was proposed to be located along the southern bank of the channel to capture trash from the IBWC flood control drain (Stewart's Drain) and was also to be about 800 feet long. In lieu of locating a trash boom at Stewart's Drain, the second boom could be located in the main channel to provide redundancy and additional trash capture. Both trash booms were to be placed in the restored section of the channel to take advantage of the low energy flows. The locations of the two trash booms are shown in Figure 2-1. The trash booms would be connected to each other using a cable that spans the width of the channel. The trash booms are designed to float on the surface and capture floatable trash, such as plastics.

The existing trash boom on the north side of the U.S.-Mexico border at Smuggler's Gulch blocks trash in the gulch from flowing northward to the Tijuana River and estuary. However, this boom does not address trash issues occurring directly at the border crossing culvert and security gate system. Therefore, PG evaluated the installation of an additional trash boom as part of the Mexico-side sediment basin at Smuggler's Gulch described in Section 2.3. The proposed trash boom would be installed 100 to 150 feet south of the southernmost weir wall. Its overall length would be about 200 feet. Figure 2-1 shows this boom's location.

2.6.2 Engineering Issues

As discussed in Section 1.2, PG estimates that the annual trash load in transboundary flows in the main channel is 11,300 tons. To conservatively approximate annual maintenance requirements, the booms were assumed to remove all incoming trash loads (HDR 2020). The trash from Yogurt Canyon was assumed to be negligible compared to trash from the upstream sources, based on conversations with California State Parks. PG identified improved sediment basin performance as a potential benefit of the installation of upstream trash control. More trash data are needed to identify how much and what type of trash is entering the U.S. from Mexico. Higher loads of trash with a high percentage of large items such as tires may alter the feasibility of this sub-project.

The trash boom in Smuggler's Gulch is currently operated by Urban Corps. During a site visit in May of 2020, representatives from Urban Corps indicated that the boom captures 65% to 85% of trash loads. Representatives from Urban Corps speculated that the trash booms could be similarly effective at trapping trash in the main channel. PG used the effectiveness of the Smuggler's Gulch boom to estimate that the proposed trash booms in the main channel and the Mexico side of Smuggler's Gulch will remove 75% of the annual trash load in transboundary flows.

Trash booms are used in other large-flow rivers as a method of trash control. A report on the marine litter management approach in Incheon City, Korea (MERRAC 2008) identified trash booms successfully capturing plastic litter and other floatable out of the Han River (MERRAC 2008). Additionally, trash booms have been used effectively to remove plastic trash from several rivers near Rio De Janeiro (Franz and Freitas 2011).

2.6.3 Implementation and Regulatory Issues

PG considered EPA mandates for the Tijuana River watershed, California State Parks concerns, CBP concerns, state and local regulations, and zoning. The sub-projects would likely need zoning approvals from local jurisdictions. Due to the immediate proximity to the U.S.-Mexico border, the main channel trash boom would likely need CBP approval. Appropriate consideration of CBP concerns, including occupational safety concerns, early in the project planning process is recommended to avoid potential delays in obtaining permissions or agreements with CBP.

Operation of trash booms in the main channel, and the associated trash management activities, could trigger public opposition due to environmental justice concerns. Specific concerns could include disease vectors, odors, visual impacts, increases in heavy vehicle traffic, and the potential for property value impacts in areas that have a disproportionately high prevalence of people of color and/or low-income households.

2.7 Sediment and Trash Management Plan

Disposing of the volume of sediment and trash that is collected presents logistical and financial challenges. Stantec reports that the main channel sediment basin will require biennial cleaning and additional cleaning after rainfalls more severe than a 10-year recurrence interval event (Stantec 2020). Site limitations hamper sediment storage capacity at each of the U.S.- and Mexico-side Smuggler's Gulch sediment basin locations. Therefore, either basin option will need annual cleaning and further cleaning after rainfalls more severe than a 10-year event. Getting a commitment to reliably perform sediment removal and disposal for any of the sediment basin or trash boom sub-projects is key to the viability of this infrastructure, whether on the U.S. side of the border or the Mexico side of the border.

It is expected that biennial or annual sediment basin cleaning will be performed during the summer dry season using standard wheeled or crawler-mounted excavation equipment. Depending on the disposal location, it may also be necessary to separate trash material from the sediment captured. Appendix G of the Stantec (2020) report recommends the construction of two onsite temporary sediment storage pads adjacent to the main channel sediment basin for temporary sediment storage due to the exceptionally large volume of sediment that must be removed. It does not appear that such pads are needed at either of the potential Smuggler's Gulch sediment basin locations because of the smaller sediment volume that will be removed, but land is available at both the U.S.-side and Mexico-side sites should temporary sediment storage pads ultimately be deemed necessary.

The Miramar Landfill is presently being used for disposal of sediment from the Goat Canyon sediment basin. The current lowest advertised tipping price at the Miramar Landfill is $30/ton or $36.00 per cubic yard of sediment (at 90 pounds per cubic foot), which is the rate that both Stantec and PG have used to estimate sediment disposal unit costs. Based on current sediment disposal unit costs for the Goat Canyon sediment basin, Stantec estimated that the net unit cost for excavating the sediment was $11.90 per cubic yard and the net unit cost for hauling off the sediment from the U.S.-side basins to the Miramar Landfill was $12.54 per cubic yard. A 33.9% contractor markup factor was applied to these excavation, haul-off, and disposal unit costs, yielding a total estimated sediment removal and disposal cost of about $80.00 per cubic yard (Stantec 2020).

Note that the annual sediment volume removed from Goat Canyon (upon which Stantec's estimates were based) is very small compared to the volumes from the main channel sediment basin and U.S.-side Smuggler's Gulch sediment basin. PG estimates that, if sediment removal were performed as an annual large-scale excavation and trucking operation, the sediment removal and disposal unit cost could be as low as $60.00 per cubic yard. Stantec also suggested that the tipping price for sediment disposal at the Miramar Landfill may be negotiable due to the high volume of sediment and trash, the City of San Diego's interest in improving the water quality of the Tijuana River, and the usefulness of sediment as a covering material for landfills; this would reduce the total unit cost for sediment disposal proportionately.

AECOM's *Nelson Sloan Management and Operations Plan and Cost Analysis* evaluated the feasibility of using sediment from the Tijuana River or the canyons to fill and restore the Nelson Sloan Quarry (AECOM 2016). The report analyzed three total volumes of sediment disposal: 100,000 cubic yards, 1,000,000 cubic yards, or 2,000,000 cubic yards. Sediment processing would be required to separate trash from the sediment that is used to fill the quarry. Additionally, a grading permit would likely be required to use the sediment to fill the quarry. Stantec estimates that excavation of the sediment would cost $11.90 per cubic yard. AECOM estimates that the total cost per cubic yard for transporting and disposing of the excavated sediment at the 100,000-cubic-yard, 1,000,000-cubic-yard, and 2,000,000-cubic-yard tiers is $40.23, $23.09, and $19.74 respectively. Therefore, the total cost for excavating, transporting, and disposing of sediment at the Nelson Sloan Quarry is estimated to range from $52.13 to $31.64 per cubic yard, depending on sediment volume and delivery timing. All three disposal costs represent a significant savings over the $80.00 sediment excavation, transport, and disposal cost at the Miramar Landfill (AECOM 2016).

Like the U.S.-side sediment basin at Smuggler's Gulch, the proposed Mexico-side sediment basin would require annual routine cleaning and cleaning after rainfalls more severe than a 10-year recurrence interval event. The total unit cost for routine annual sediment excavation, trucking, and disposal in Mexico is thought to be in the range of $20.00 to $30.00 per cubic yard, but actual costs and locations for disposal remain to be identified.

Trash from trash booms can be cleared using standard wheeled or crawler-mounted equipment. For the trash boom in the main channel, maintenance will likely have to be conducted in the dry season to avoid transboundary flows. In Smuggler's Gulch, the cleaning could be conducted in either the dry season or the wet season when rain is not forecast. Maintenance will likely need to be performed annually to avoid excessive trash buildup. The trash removed from the booms would likely be sent to the Miramar Landfill for disposal. PG applied the $80.00 per cubic yard sediment disposal cost to the trash as well, due to the similar excavation and disposal procedures.

3. PROJECT IMPACT

3.1 Water Quality Impacts

The components of Project 6 target sediment, trash, and/or flooding in the Tijuana River and its tributaries. These impacts are described in separate sections below. This project does not primarily focus on addressing wastewater-related water quality concerns in the Tijuana River or the Pacific Ocean. None of the six sub-projects are expected to directly affect the volume of untreated wastewater discharged into the estuary or the Pacific Ocean.

3.2 Sediment Impacts

For sub-project 1, PG estimated the annual volume of sediment trapped in the restored Tijuana River main channel by applying the trapping efficiencies from the storm events listed in Section 2.1.2 to the storm frequency values presented in the USACE Phase 2 study (Stantec 2020; USACE 2020). PG assumed that the main channel traps a negligible volume of sediment for storms larger than the 100-year storm. The efficiencies for the 50-year and 25-year storms were not provided in the Stantec report. Therefore, PG used the 100-year storm trapping efficiency as a conservative estimate for the 50-year and 25-year storms. For flows smaller than a 10-year storm event, PG applied the two-year trapping efficiency of 99.9%.

To estimate the volume of sediment trapped annually in the two Smuggler's Gulch basin configurations (sub-project 2), PG conducted analyses using HEC-RAS modeling, hydrology data, and sediment transport data from Appendix E of the HDR report, as discussed in Section 2.2.2. The flow and sediment transport data from Appendix E of the HDR report were also used to estimate the trapping efficiency of the Mexico-side, in-channel sediment basin using the method discussed in Section 2.3.2 (sub-project 3).

Table 3-1 summarizes the estimated annual sediment reduction and sediment trapping efficiencies for sub-projects 1–3.

Table 3-1. Impact of Project 6 on Sediment Loads to the Tijuana River Estuary

Impacts of Sediment Loads in Transboundary Flows	Sub-Project			
	1	2	2	3
	Tijuana River Main Channel Restoration (Stantec 2020)	Smuggler's Gulch: U.S.-Side In-Channel Basin Only (HDR 2020)*	Smuggler's Gulch: U.S.-Side Combined In-/Off-Channel Basin (HDR 2020)*	Smuggler's Gulch: Mexico-Side In-Channel Basin*
Estimated annual sediment load entering infrastructure (cubic yards)	156,000	18,000	18,000	18,000 (HDR 2020)
Estimated annual sediment load trapped by infrastructure (cubic yards)	122,000	11,000	11,200	14,900
Estimated annual sediment load that enters the estuary (cubic yards)	34,000	7,000	6,800	4,100
Trapping efficiency	76%	61%	62%	83%

* Existing infrastructure in Smuggler's Gulch has been modified since the development of the HDR report.

3.3 Trash Removal

As discussed in Section 2.6.2, PG estimates that the trash booms will capture 75% of the trash load in the main channel. PG applied the 75% trapping efficiency to the trash loads in the main channel transboundary flows to estimate that the trash boom in the main channel will trap 11,700 cubic yards trash annually.

Table 3-2. Impacts of the Trash Booms on Trash Loads in the Main Channel and Smuggler's Gulch

Parameter	Main Channel Trash Boom	Mexico-Side Smuggler's Gulch Trash Boom
Annual trash load (cubic yards)	15,600	1,800
Trash trapped in the trash boom (cubic yards)	11,700	1,350
Trash load that escapes the trash boom (cubic yards)	3,900	450

As shown in Table 3-2, the main channel trash boom will reduce the trash loadings that the main channel transboundary flows transport into the Tijuana River Valley and the Tijuana River Estuary. More information on the types and volumes of trash that are present in transboundary flows is needed for a more accurate estimate of the effectiveness of the trash booms.

In Smuggler's Gulch, the Mexico-side trash boom would reduce the trash loads in transboundary flows by 1,350 cubic yards. Reducing the trash load that is flowing transboundary may help prevent the gates underneath the border from clogging. However, the Mexico-side trash boom is not expected to reduce the trash load that enters the Tijuana River Valley, because the U.S.-side boom is already effectively trapping the trash the Mexico-side boom would collect.

More information on the types and volumes of trash that are present in transboundary flows is needed to develop a more accurate estimate of the effectiveness of the trash booms.

3.4 Non-Water-Quality Environmental Impacts

In conjunction with the feasibility analysis, ERG is currently preparing an Environmental Impact Document (EID) that will describe the potential environmental impacts of the 10 proposed projects (including Project 6), focusing on impacts in the U.S. or caused by activities in the U.S. Based on a review of existing available information, Project 6 would have the potential to result in impacts of concern.[1] Several sub-projects would have potential adverse impacts on federally listed species and least Bell's vireo critical habitat; the ability to avoid adverse effects through mitigation is not yet

[1] 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.

determined. Sub-project 1 could result in adverse effects on important natural resource areas such as wetlands, floodplains (placement of dredge pads), and the coastal zone, and could modify the main course of the Tijuana River. Sub-projects 1 and 6 could also face opposition from the public and various stakeholders about the potential environmental impacts in proximity to residential areas.

The EID will include a more thorough evaluation of potential non-water-quality impacts in the U.S.

3.5 Social Impacts

Sub-projects 1 and 6 would potentially increase the negative socioeconomic impacts to affected populations, both during construction (e.g., more extensive noise, emissions, and traffic in closer proximity to residential areas) and during long-term operation (e.g., potential odor, vector-borne illness, and visual impacts; associated potential impact to nearby property values; potential disproportionate adverse impact to minority populations; increase in truck traffic for sediment and trash disposal). It is unclear whether the long-term positive socioeconomic impacts driven by improved water quality in downstream areas would outweigh these negative socioeconomic impacts.

The social impacts of sub-projects 4 and 5 are primarily related to improved flood management by reducing the overtopping of Monument Road during wet weather. Construction of the off-channel sediment basin on the U.S. side of the border reduces the overtopping height of Monument Road by about 1 foot. Based on discussions with California State Parks, the pilot channel in Yogurt Canyon is not adequate to contain the flooding that overtops Monument Road and offers minimal flood control benefits. Raising the road elevation to the 13-foot U.S. Geological Survey datum would significantly reduce flooding overtop Monument Road during the wet season. The reduction in flooding on Monument Road provides increased access to the culturally significant International Friendship Park and reduces direct human contact with the flood waters on the road.

For other sub-projects, the long-term positive socioeconomic impacts to affected populations (e.g., reduced flooding and public health risk) are expected to outweigh the negative, localized impacts during construction (e.g., temporary increase in noise, equipment/dust emissions, and traffic) and long-term operation (e.g., increase in truck traffic from the canyon sediment basins).

The Smuggler's Gulch sediment basin (sub-project 2) and the trash boom in the Tijuana River (sub-project 6) would potentially result in the consolidation and management of transboundary sediment and trash flows in locations near border infrastructure managed by CBP.

The EID will include a more thorough evaluation of potential socioeconomic impacts associated with Project 6.

4. COST IMPACT ANALYSIS

PG reviewed the cost estimate prepared by Stantec for the main channel sediment basin (Stantec 2020). Stantec reported that its estimate had been prepared to a Class IV level of accuracy in accordance with AACE International Recommended Practice No. 17R-97 (AACE International 2020). PG reviewed this estimate and generally concurs with the capital and operating costs presented.

The comparative project construction cost estimates prepared by PG for the Smuggler's Gulch sediment basins, the Yogurt Canyon pilot channel, the Monument Road reconstruction, and the installation of trash booms were developed to a Class V level of accuracy (AACE International 2020). According to this system, Class V estimate accuracy can range from +40%/-20% to as high as +200%/-100%. Based on the information that was reviewed, the estimate accuracy goal for construction in the U.S. is +50%/-25%, meaning actual construction costs may range from 50% higher than estimated cost to 25% lower. Because there are fewer sources of cost data for construction in Mexico, the estimated accuracy goal for construction in Mexico was +100%/-50%, meaning actual construction costs may range from 100% higher than the estimated value to 50% lower.

PG used existing cost estimates from Stantec and HDR for the U.S.-side infrastructure to develop project capital costs for the Mexico-side sediment basin in Smuggler's Gulch. Capital costs included component costs such as culverts, barriers, and paving; non-component costs such as grading, excavating, dirt removal, and disposal; and non-construction costs such as engineering and construction supervision, land, and contingencies. 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 (RSMeans, 2020), and adjustments for a 2020 *Engineering News-Record* (ENR) construction cost index of 11,455.

The sum of project construction cost plus equipment/material cost was multiplied by 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 the sum of project construction cost and equipment/material cost × 1.4 × 1.5, which is equivalent to the sum of project construction cost and equipment/material cost × 2.1.

O&M costs include equipment and labor costs associated with removing and disposing of sediment and trash from the basins and booms and to perform general maintenance. PG used previous feasibility studies by Stantec and HDR, manufacturers' information, and EPA cost curves to develop O&M costs. An inflation factor of 2% annually, as well as an interest rate of 3% annually, was applied to calculate the life cycle cost for each sub-project over a 40-year lifespan.

Tables 4-1 through 4-8 summarize the capital and life cycle costs that were estimated for each sub-project. An itemized cost impact analysis for each project is provided in Appendix A.

Table 4-1. Tijuana River Main Channel: Channel Restoration Capital and Life Cycle Cost Summary

Category	Item	Estimated Cost
Capital costs	Equipment/material costs	$4,460,000
	Construction costs	$28,900,000
	Indirect costs (engineering, project administration, general contingency)	$16,200,000
	Total capital cost	**$49,600,000**
O&M	Sediment/trash collection/disposal	$6,600,000
	General maintenance	$263,000
	Monitoring	$125,000
	Reliability in O&M	$2,900,000
	Annual O&M costs	**$9,900,000**
Life cycle factors	Interest rate	3%
	Inflation rate	2%
	Total life cycle used	40 years
Total life cycle cost		**$380,000,000**

Source: Stantec 2020

Table 4-2. Smuggler's Gulch: U.S.-Side In-Channel Sediment Basin Capital and Life Cycle Cost Summary

Category	Item	Estimated Cost
Capital costs	Equipment/material costs	$533,000
	Construction costs	$628,000
	Indirect costs (engineering, project administration, general contingency)	$1,280,000
	Total capital cost	**$2,400,000**
O&M	Sediment/trash collection/disposal	$880,000
	General maintenance	$27,800
	Annual O&M cost	**$908,000**
Life cycle factors	Interest rate	3%
	Inflation rate	2%
	Total life cycle used	40 years
Total life cycle cost		**$32,200,000**

Source: HDR 2020

Table 4-3. Smuggler's Gulch: U.S.-Side In-/Off-Channel Sediment Basin Capital and Life Cycle Cost Summary

Category	Item	Estimated Cost
Capital costs	Equipment/material costs	$1,390,000
	Construction costs	$2,250,000
	Indirect costs (engineering, project administration, general contingency)	$4,000,000
	Total capital cost	**$7,600,000**
O&M	Sediment/trash collection/disposal	$880,000
	Maintenance	$62,000
	Annual O&M costs	**$942,000**
Life cycle factors	Interest rate	3%
	Inflation rate	2%
	Total life cycle used	40 years
Total life cycle cost		**$38,500,000**

Source: HDR 2020

Table 4-4. Smuggler's Gulch: Mexico-Side Sediment Basin Capital and Life Cycle Cost Summary

Category	Item	Estimated Cost
Capital costs	Equipment/material costs	$250,000
	Construction costs	$278,000
	Indirect costs (engineering, project administration, general contingency)	$581,000
	Total capital cost—2020—ENR 11400	**$1,100,000**
O&M	Sediment/trash collection/disposal	$222,000
	Maintenance	$11,100
	Annual O&M costs	**$233,000**
Life cycle factors	Interest rate	3%
	Inflation rate	2%
	Total life cycle used	40 years
Total life cycle cost		**$8,500,000**

Table 4-5. Yogurt Canyon: Pilot Channel Capital and Life Cycle Cost Summary

Category	Item	Estimated Cost
Capital costs	Equipment/material costs	$588,000
	Construction costs	$998,000
	Indirect costs (engineering, project administration, general contingency)	$1,740,000
	Total capital cost	**$3,300,000**
O&M	Maintenance	$5,000
	Total O&M costs	**$5,000**
Life cycle factors	Interest rate	3%
	Inflation rate	2%
	Total life cycle used	40 years
Total life cycle cost		**$3,500,000**

Table 4-6. Yogurt Canyon: Monument Road Modification Capital and Life Cycle Cost Summary

Category	Item	Estimated Cost
Capital costs	Equipment/material costs	$908,000
	Construction costs	$478,000
	Indirect costs (engineering, project administration, general contingency)	$1,520,000
	Total capital cost	**$2,900,000**
O&M	Annual maintenance	$2,000
	Repave after 20 years	$269,000
	Total O&M costs	**$2,000**
Life Cycle Cost	Interest Rate	3%
	Inflation rate	2%
	Total life cycle used	40 years
Total life cycle cost		**$3,200,000**

Table 4-7. Tijuana River: Main Channel Trash Boom Capital and Life Cycle Cost Summary

Category	Item	Estimated Cost
Capital costs	Equipment/material costs	$1,700,000
	Indirect costs (engineering, project administration, general contingency)	$1,870,000
	Total capital cost—2020—ENR 11400	**$3,570,000**
O&M	Sediment/trash collection/disposal	$904,000
	Total O&M costs—2020	**$900,000**
Life cycle factors	Interest Rate	3%
	Inflation rate	2%
	Total life cycle used	40 years
Total life cycle cost		**$33,100,000**

Table 4-8. Smuggler's Gulch: Mexico-Side Trash Boom Capital and Life Cycle Cost Summary

Category	Item	Estimated Cost
Capital costs	Equipment/material costs	$200,000
	Indirect costs (engineering, project administration, general contingency	$220,000
	Total capital cost—2020—ENR 11400	**$420,000**
O&M	Sediment/trash collection/disposal	$27,300
	Total O&M costs	**$27,300**
Life cycle factors	Interest Rate	3%
	Inflation Rate	2%
	Total life cycle used	40 years
Total life cycle cost		**$1,200,000**

5. DISCUSSION

5.1 Feasibility

5.1.1 Sub-Project 1: Tijuana River Main Channel—Channel Restoration

Overall, the restoration of the main channel was determined by Stantec to be the most effective option at trapping sediment that would otherwise enter the estuary. As shown in Table 3-1, the estimated annual sediment load that the restored channel prevents from entering the estuary is 122,000 cubic yards.

Although PG concurs that the channel restoration is technically feasible to construct, the sediment disposal requirements may adversely impact overall feasibility. PG estimated the annual cleaning of the channel would require disposal of 122,000 cubic yards of sediment, which results in very high O&M costs and 40-year life cycle costs, based on the limited sediment data available. As discussed in Section 4.1, PG estimates that the annual O&M costs are $9.9 million, and the 40-year life cycle costs are $380 million if the average annual sediment load is 122,000 cubic yards. As discussed in Section 2.7, removing sediment from the restored channel would require 7,630 truck trips annually—an average of 21 trips per day. Not only would this likely require an extensive environmental review process, but it would be a challenge to identify a partner that can truck such a large volume of material.

As discussed in Section 1.2, the sediment data from flows that are smaller than the frequency events described in the USACE Phase 2 study are very limited (USACE 2020). Developing and implementing a long-term sediment monitoring plan will provide more accurate estimates of the sediment transport at lower flow rates. More accurate sediment data to characterize the sediment loads at different flow rates may have substantial implications for the feasibility of the project.

5.1.2 Sub-Project 2: Smuggler's Gulch—U.S.-Side Sediment Basin

Recently, Mexico installed sediment and trash control infrastructure north of the international highway. PG's analysis of its design, presented in Section 2.3, suggests that the new basin is likely to be effective at capturing trapping sediment grains with sizes that would be captured in the proposed U.S.-side basin. Therefore, the recently constructed Mexico-side basin would eliminate the need for the U.S.-side basin provided that captured sediment is removed no less often than annually. If this annual maintenance is provided, implementing either U.S.-side basin configuration presented in the HDR report would not likely provide any additional sediment trapping benefits. (HDR 2020).

As shown in Table 3-1, HDR modeled both U.S.-side in-channel and combined in-channel/off-channel sediment basin options and found both to be effective at trapping sediment that otherwise would enter the estuary from Smuggler's Gulch runoff. During a simulated five-year storm event, the in-channel basin had an estimated trapping efficiency of 61%. This efficiency was applied to the annual sediment yield of 18,000 cubic yards expected from Smuggler's Gulch and resulted in an estimated annual sediment capture of 11,000 cubic yards. The addition of the off-channel basin increased the trapping efficiency during a five-year event by only 1%, resulting in the capture of an additional 189 cubic yards per year. The larger basin does provide a more significant difference in trapping efficiency for extreme rainfalls, however. During a 100-year simulated storm event, the combined in-channel/off-channel basin trapping efficiency was 57% as compared to 52% for the in-channel basin. However, the rarity of extreme events does not appear to merit the additional capital expense of adding the off-channel basin strictly from a sediment capture perspective.

Adding the off-channel basin would significantly affect local area flooding. Modeling from HDR estimated that it lowered the water level by 1 foot through storms of all frequencies and prevented two-year storms from overtopping Monument Road at the Smuggler's Gulch flow channel crossing. The capital costs to construct the in-channel basin were estimated at $2.4 million, and the annual O&M costs were estimated at $908,000. The addition of the off-channel basin added $ 5.2 million to the capital cost of the basin. The 40-year life cycle cost was estimated at $32.2 million for the in-channel basin and $38.5 million for the combined in-/off-channel basin, based on a 2% annual inflation rate. Similar to the main channel restoration, the high life cycle cost is primarily due to current sediment removal and disposal costs estimated by Stantec at $80 per cubic yard. Stantec suggests that it may be possible to negotiate more advantageous sediment removal and disposal fees for both the Tijuana River main channel and Smuggler's Gulch U.S.-side sediment basins, as discussed in Sections 2.1 and 2.2.

PG reviewed the documentation presented in the HDR report and concurs that both of the sediment basin configurations presented are technically feasible. However, neither configuration is expected to be effective at trapping additional sediment that escapes the recently constructed Mexico-side sediment basin discussed in Section 2.3.

The U.S.-side in-channel/off-channel basin offers expanded flood protection over the in-channel sediment basins on either the U.S. side or the Mexico side, albeit at higher capital and O&M costs. It is not clear whether the recently constructed sediment and trash control on the Mexico side of the border will reduce flooding in the U.S. Reviewing agencies should evaluate whether the additional flood protection benefit of the in-channel/off-channel sediment basin on the U.S. side merits the higher expenditures required.

5.1.3 Sub-Project 3: Smuggler's Gulch—Mexico-Side Sediment Basin

The recently constructed sediment basin and trash control infrastructure north of the international highway is functionally similar to the basin that Mexico has constructed. Therefore, the analysis presented in Section 3.1 suggests that the recently constructed, Mexico-side basin is likely to be effective at reducing sediment loads in flows from Smuggler's Gulch that enter the estuary. Since the proposed Mexico-side basin is downstream of the recently constructed Mexico-side basin, the sediment loads that would enter the new basin will likely have been reduced. The sediment particles that escape the newly constructed upstream basin are also likely to be finer, and as such are not likely to settle out. Therefore, the proposed Mexico-side basin is likely to be much less effective than it would have been before the recently constructed Mexico-side basin was installed.

5.1.4 Sub-Project 4: Yogurt Canyon—Pilot Channel

Construction of the pilot channel offers some flood control in the estuary; however, the channel appears to be ineffective at preventing flooding along Monument Road in the vicinity of International Friendship Park. The elevation and depth of the cross-section shown on page 33 of the HDR report, Appendix E, suggests that the channel is at a higher elevation than Monument Road. The construction of the channel running through the estuary also appears to have a significant negative impact on estuary flora, fauna, and perhaps general functioning. Based on discussions with California State Parks, constructing the full pilot channel is unlikely to receive regulatory approval. The initial capital cost of the channel was estimated at $3.3 million and the

O&M costs were estimated at $5,000 annually. The 40-year life cycle costs were estimated at $3.5 million (HDR 2020).

5.1.5 Sub-Project 5: Yogurt Canyon—Monument Road Modification

California State Parks reports that the Monument Road access into International Friendship Park can be flooded for long periods, even continuously during the winter rainy season. California State Parks is considering two approaches to resolving the Monument Road flooding issue: (1) constructing the pilot channel described in Section 2.4 or (2) raising the 3,000-foot, east–west portion of Monument Road to the beach front, as described in Section 2.5.

In lieu of a pilot channel to convey stormwater under Monument Road, PG estimates that raising the roadway surface about 2 to 3 feet would prevent roadway flooding up to the 100-year flood stage. The raised portion of Monument Road would begin at the entrance to the International Friendship Park and continue eastward about 2,000 feet to the point where Monument Road turns north. The initial capital cost to raise this portion of Monument Road is estimated to be $2.9 million and the annual O&M cost is estimated to be $2,000. The life cycle costs were estimated at $3.2 million over 40 years.

5.1.6 Sub-Project 6: Trash Booms in the Main Channel and Smuggler's Gulch

Trash booms have been shown to be effective at preventing trash from entering the estuary in Goat Canyon and are feasible to construct in the main channel. As discussed in Section 2.6, trash booms have been effectively used in high-flow river situations and can handle flows exceeding those that occur during a 100-year storm event in the main channel. The area of the main channel where the trash boom would be located is accessible to the machinery that would be needed to clean the booms annually. Cleaning would need to be conducted during the dry season to avoid cleaning on days when transboundary flows are occurring. The high O&M costs are mainly due to trash tipping fees. Therefore, potential alternate disposal sites should be sought as part of ongoing preliminary engineering.

Based on research from the Stantec report and operating experience of the Goat Canyon trash boom as reported by HDR, trash booms appear to be the most cost-effective way to reduce the volume of trash entering the Tijuana River Estuary. PG estimates the capital cost of the booms in the main channel at $3.57 million, slightly higher than HDR's capital cost estimate of $2.5 million (HDR 2020). The annual O&M cost of a trash boom in the main channel is estimated at $900,000 and the estimated 40-year life cycle cost is $33.1 million. As with the U.S.-side sediment basins, trash disposal costs ($80 per cubic yard) are high on the U.S. side of the border, which makes O&M higher.

The recently constructed sediment basin and trash control infrastructure in Smuggler's Gulch on the Mexico side of the border is reportedly effective at capturing trash and preventing it from crossing the border. This, combined with the bar screens at the border and the trash boom installed in Smuggler's Gulch, likely renders the proposed trash booms on the Mexico side of the border unnecessary.

5.2 <u>Other Stakeholder Information</u>

Several project components would take place on federally owned land used for CBP operations During a stakeholder discussion, CBP expressed a preference for Mexico-side projects but noted concerns with the construction of dam-like structures such as the downstream weir of the Mexico-side Smuggler's Gulch sediment basin. The concerns stem from interference with their operations and possible creation of flooding issues. Communication on ways to alleviate these concerns should continue. The proposed projects may benefit CBP by reducing vegetation near the border and lowering the risk of flooding when the culverts under the border clog from trash buildup. Appropriate consideration of CBP concerns, including occupational safety concerns, early in the project planning process is recommended to avoid potential delays in obtaining permissions or agreements with CBP.

6. CONCLUSION

The purpose of Project 6 is to protect the Tijuana River Estuary, as well as pumping and treatment facilities in the U.S., from sediment-laden wet-weather flows in the Tijuana River and Smuggler's Gulch and to mitigate flooding in Yogurt Canyon. This project includes six sub-projects: three to reduce sediment loads in the Tijuana River, two to address flooding in Yogurt Canyon, and one to reduce trash loads in the river. PG evaluated the technical feasibility, impacts, and cost of the six sub-projects and arrived at the following conclusions:

1. Restoring the main channel to the original 1977 design (sub-project 1) is technically feasible from a construction standpoint; however, the large volume of sediment that would need annual removal and disposal may make O&M excessively costly. More sediment monitoring at lower flow rates should be conducted to more accurately estimate the annual of sediment load conveyed by transboundary flows. Alternative sites should be identified for sediment disposal to reduce O&M costs.

2. A U.S.-side, in-channel sediment basin or an in-/off-channel sediment basin combination (sub-project 2) is feasible from a construction standpoint; however, it likely will not significantly reduce the sediment load that enters the estuary because of the recently constructed sediment and trash control infrastructure on the Mexico side of the border. PG did determine that installing a new culvert and raising Monument Road would increase drainage from the canyon and prevent up to a two-year storm from overtopping Monument Road in Smuggler's Gulch.

3. The proposed in-channel sediment basin on the Mexico side of the border at Smuggler's Gulch (sub-project 3) is functionally the same as the recently installed basin and would be downstream of it—making the proposed basin unnecessary. PG's evaluation of the proposed in-channel basin suggests that the recently constructed basin will be effective at reducing the sediment load that enters the estuary. However, captured sediments will need to be removed no less often than annually for the sediment basin to remain effective.

4. Constructing a U.S.-side pilot channel in Yogurt Canyon (sub-project 4) is not feasible, since it would not reduce flooding on Monument Road appreciably and its construction could create significant environmental risks to the Tijuana River Estuary lands through which it passes.

5. Raising Monument Road out of the 100-year floodplain (sub-project 5) is technically feasible and substantially less costly that the U.S.-side pilot channel also being considered by California State Parks.

6. Based on the limited data available, installing trash booms in the Tijuana River main channel (sub-project 6) is technically feasible and will reduce trash in the Tijuana River Valley and the Tijuana River Estuary. These booms are similar to the booms already in service at Goat Canyon and on the U.S. side of the border at Smuggler's Gulch. More information on the nature and volume of trash coming across the border is needed to fully evaluate trash boom performance and thus overall feasibility. The already-installed sediment and trash control infrastructure in Smuggler's Gulch on the Mexico side is effective in capturing trash provided that it will be properly maintained; therefore, installing a new trash boom in Smuggler's Gulch is not likely to further reduce trash entering the estuary.

7. SUGGESTED NEXT STEPS

1. Develop and implement a sediment monitoring plan to better understand sediment transport within the Tijuana River watershed during wet-weather events.
2. Develop and implement a trash monitoring plan to better understand trash loads within the Tijuana River watershed during wet-weather events.
3. Initiate negotiations with Miramar Landfill for a lower tipping fee for sediment disposal; initiate negotiations to secure the Nelson Sloan Quarry as an option for sediment disposal; identify other options for sediment disposal.
4. Identify potential partners to conduct O&M on the Mexico side of the border; identify potential sediment and trash disposal sites and determine tipping fees.
5. Conduct studies to enhance the modeling of sediment loading and grain size distribution for the Tijuana River main channel and Smuggler's Gulch sediment basin final designs.
6. Conduct studies to better characterize the volume and nature of trash flows over the border.

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APPENDIX A: Itemized Cost Impact Analysis

Project 6, sub-project 1: Tijuana River Main Channel Restoration for Sediment Control - Opinion of Probable Cost

***NOTE:* All Capital Cost and O&M Costing Information is from Stantec's Main Channel Sediment Basin Feasibility Analysis**

Category	Item	Quantity	Unit	Unit Price	Cost ($)
Equipment/Materials Costs	Filter Blanket 8 in.				$105,000
	Grouted riprap 30 in.				$702,000
	Dumped Riprap				$1,184,500
	Filter Blanket 12 in.				$157,500
	Dumped Riprap for Slope Detailing				$2,300,000
	Rock Trackout				$6,000
	Total Equipment/Materials Cost				**$4,460,000**
Construction Costs	Channel/Dredge Pad Misc. Removals/Prep				$236,365
	Excavate/load/haul waste earth				$27,675,000
	Haul Road Maintenance				$432,837
	Earthwork on Basin Outlet Channel				$360,000
	Berm Grading and Misc. Earthwork				$13,500
	O&M Road grading/compacting				$133,332
	Total Construction Costs				**$28,900,000**
Indirect Costs	Subtotal				$37,766,034
	Quality Control, 1% of subtotal.				$377,660
	Hazardous materials sampling, 1% of subtotal				$377,660
	Pre-Construction/Mobilization/Temporary Works, 1% of subtotal.				$377,660
	Direct Cost Allowances, 6% of subtotal.				$2,265,962
	Contractor Markups, 33.9% of subtotal				$12,802,686
	Total Indirect Costs				**$16,200,000**
	Total Capital Costs				**$49,600,000**
Sediment/Trash Collection and Disposal	Sediment/trash dredging from basin	119000	CY	11	$1,309,000
	Sediment disposal	119000	CY	43	$5,117,000
	Other trash and debris removal	1			$149,350
	Total Sediment/Trash Collection and Disposal Costs				**$6,600,000**
Maintenance	Repair/replace grouted riprap	50			$6,750
	Repair/replace dumped riprap	300			$34,500
	Haul Road Maintenance and Dust Control	60			$210,000
	O&M Road Maintenance	600			$12,000
	Total Maintenance Costs				**$263,000**

Monitoring	SWPPP development and implementation	1	$25,000
	Hazardous Material Sampling/testing/removal	1	$100,000
	Total Monitoring Costs		**$125,000**
Reliability in O&M	Subtotal		$6,988,000
	Contractor Quality Control, 1% of Total.		$69,880
	Pre-Construction/Mobilization/Temporary Works, 1% of subtotal.		$69,880
	Direct Cost Allowances, 6% of subtotal.		$419,280
	Contractor Markups, 33.9% of subtotal		$2,368,932
	Total Reliability in O&M Costs		**$2,900,000**
	Total O&M Costs		**$9,900,000**
	Service Life		40
	Interest Rate		3%
	Inflation Rate		2%
	Major Upgrade(s) Cost		$0
	Present Value of Major Upgrade(s) Cost		$0
	Location Adjustment Factor		1.0
	Total Life Cycle Costs		**$380,000,000**

Project 6, Sub-Project 2: US Side Smugglers Gulch In-Channel Sediment Basin - Opinion of Probable Cost

Category	Item	Quantity	Unit	Unit Price	Cost ($)	Source
Equipment/Materials Costs	Gabions, galvanized steel mesh mats, stone filled, 12 in deep	2600	SY	$70.50	$183,300	RS Means 2020 - page 289 - 31 36 13.10 Line 0600
	3/8 to 1/4 C.Y. Pieces, Grouted	277	CY	$60.00	$16,620	RS Means 2020 - page 289 - 31 37 13.10 Line 0110
	18 in minimum thickness, not grouted	2600	SY	$107.00	$278,200	RS Means 2020 - page 289 - 31 37 13.10 Line 0200
	Allowance for Unquantified Line Items			5%	$55,319	
	Total Equipment/Materials Cost				**$533,000**	
Construction Costs	Sediment, excavation/loading	8264	CY	$11.00	$90,904	Stantec (From Bids)
	Sediment, Hauling/disposal	8264	CY	$43.00	$355,352	Stantec (From Bids)
	Machine Place for slope protection	2600	LCY	$70.00	$182,000	RS Means 2020 - page 289 - 31 37 13.10 Line 0100
	Total Construction Cost				**$628,000**	
Indirect Costs	Subtotal (Equipment/Materials + Construction)				$1,161,000	
	Engineer and Administration, 40% of subtotal	0.4			$464,400	
	Total Construction Costs (With Engineering)				$1,625,400	
	Contingency 50%	0.5			$812,700	
	Total Indirect Costs				**$1,280,000**	
	Total Capital Costs				**$2,400,000**	
Sediment/Trash Collection and Disposal	Sediment/trash dredging/loading	11,000	CY	$16.00	$176,000	Stantec (From Bids)
	Sediment hauling/disposal	11,000	CY	$64.00	$704,000	Stantec (From Bids)
	Total Sediment/Trash Collection and Disposal Costs				**$880,000**	
Maintenance	Repair/replace Loose Riprap (Assume 10% annually)	260	SY	$107.00	$27,820	RS Means 2020 - page 289 - 31 37 13.10 Line 0200
	Total Maintenance Cost				**$27,800**	
	Total O&M Costs				**$908,000**	
	Service Life				40	
	Interest Rate				3%	
	Inflation Rate				2%	
	Major Project(s) Upgrades				$0	
	Present Value of Major Project(s) Upgrades				$0	
	Location Adjustment Factor				1.0	
	Total Life Cycle Cost				**$32,200,000**	

Project 6, Sub-Project 2: US Side Smugglers Gulch In/Off Channel Sediment Basin - Opinion of Probable Cost

Category	Item	Quantity	Unit	Unit Price	Cost ($)	Source
Equipment/Materials Costs	Gabions, galvanized steel mesh mats, stone filled, 12 in deep	7200	SY	$70.50	$507,600	RS Means 2020 - page 289 - 31 36 13.10 Line 0600
	3/8 to 1/4 C.Y. Pieces, Grouted	1388	CY	$60.00	$83,280	RS Means 2020 - page 289 - 31 37 13.10 Line 0110
	18 in minimum thickness, not grouted	5812	SY	$107.00	$621,884	RS Means 2020 - page 289 - 31 37 13.10 Line 0200
	Allowance for Unquantified Line Items			5%	$173,320	
	Total Equipment/Materials Cost				**$1,390,000**	
Construction Costs	Sediment, excavation/loading	34200	CY	$11.00	$376,200	Stantec (From Bids)
	Sediment, Hauling/disposal	34200	CY	$43.00	$1,470,600	Stantec (From Bids)
	Machine Place for slope protection	5812	LCY	$70.00	$406,840	RS Means 2020 - page 289 - 31 37 13.10 Line 0100
	Total Construction Cost				**$2,250,000**	
Indirect Costs	Subtotal (Equipment/Materials + Construction)				$3,640,000	
	Engineer and Administration, 40% of subtotal	0.4			$1,456,000	
	Total Construction Costs (With Engineering)				$5,096,000	
	Contingency 50%	0.5			$2,548,000	
	Total Indirect Costs				**$4,000,000**	
	Total Capital Costs				**$7,600,000**	
Sediment/Trash Collection and Disposal	Sediment/trash dredging/loading	11,000	CY	$16.00	$176,000	Stantec (From Bids)
	Sediment hauling/disposal	11,000	CY	$64.00	$704,000	Stantec (From Bids)
	Total Sediment/Trash Collection and Disposal Costs				**$880,000**	
Maintenance	Repair/replace Loose Riprap (Assume 10% annually)	581	SY	$107.00	$62,167	RS Means 2020 - page 289 - 31 37 13.10 Line 0200
	Total Maintenance Cost				**$62,200**	
	Total O&M Costs				**$942,000**	
	Service Life				40	
	Interest Rate				3%	
	Inflation Rate				2%	
	Major Project(s) Upgrades				$0	
	Present Value of Major Project(s) Upgrades				$0	
	Location Adjustment Factor				1.0	
	Total Life Cycle Cost				**$38,500,000**	

Project 6, Sub-Project 3: Mexico Side Smugglers Gulch In-Channel Sediment Basin - Opinion of Probable Cost

Category	Item	Quantity	Unit	Unit Price	Cost ($)	Source
	Gabions, galvanized steel mesh mats, stone filled, 12 in deep	1035	SY	$70.50	$72,968	RS Means 2020 - page 289 - 31 36 13.10 Line 0600
	Material for Concrete Weir (trapezoidal b1=20 ft, b2=2ft, h=9ft ft, w=200ft)	733	SY	$90.00	$65,970	RS Means 2020 - page 289 - 31 37 13.10 Line 0110
Equipment/Materials Costs	18 in minimum thickness, not grouted	1035	SY	$107.00	$110,745	RS Means 2020 - page 289 - 31 37 13.10 Line 0200
	Allowance for Unquantified Line Items			5%	$232	
	Total Equipment/Material Cost				**$250,000**	
	Sediment, excavation/loading	7000	CY	$5.20	$36,400	Stantec (From Bids) Assumed labor in Tijuana was half of US
Construction Costs	Sediment, Hauling/disposal	7000	CY	$15.00	$105,000	Estimate based on $15/CY Sediment Disposal Cost. Additional data needed for a more accurate cost.
	Machine Place for slope protection	1035	LCY	$70.00	$72,450	RS Means 2020 - page 289 - 31 37 13.10 Line 0100
	General Contractor, Mob/Demob, Ins, Bonds, Gen Admin, Profit	0.3			$64,155	
	Total Construction Cost				**$278,000**	
	Subtotal (Equipment/Materials + Construction)				$528,000	
	Engineer and Administration, 40% of subtotal	0.4			$211,200	
Indirect Costs	Total Construction Costs (With Engineering)				$739,200	
	Contingency 50%	0.5			$369,600	
	Total Indirect Costs				**$581,000**	
	Total Capital Costs				**$1,100,000**	
	Sediment/trash dredging/loading	11,000	CY	$5.20	$57,200	Stantec (From Bids) Assumed labor in Tijuana was half of US
Sediment Trash Collection/Disposal	Sediment hauling/disposal	11,000	CY	$15.00	$165,000	Estimate based on $15/CY Sediment Disposal Cost. Additional data needed for a more accurate cost.
	Sediment Trash Collection/Disposal Cost				**$222,000**	
Maintenance	Repair/replace Loose Riprap (Assume 10% annually)	103.5	SY	$107.00	$11,100	RS Means 2020 - page 289 - 31 37 13.10 Line 0200
	Total Maintenance Costs				**$11,100**	
	Total O&M Costs				**$233,000**	
	Service Life				40	
	Interest Rate				3%	
	Inflation Rate				2%	
	Major Upgrade(s) Cost				$0	
	Present Value of Major Upgrade(s)				$0	
	Location Adjustment Factor				1.0	
	Total Life Cycle Cost				**$8,500,000**	

Project 6, Sub-Project 4: Yogurt Canyon - Pilot Channel - Opinion of Probable Cost

Category	Item	Quantity	Unit	Unit Price	Cost ($)	Source
	Gabions, galvanized steel mesh mats, stone filled, 12 in deep	2947	SY	$70.50	$207,740	RS Means 2020 - page 289 - 31 36 13.10 Line 0600
Equipment/Materials Costs	18 in minimum thickness, not grouted	2947	SY	$107.00	$315,329	RS Means 2020 - page 289 - 31 37 13.10 Line 0200
	Allowance for Unquantified Line Items	5	%		$64,555	
	Total Equipment/Maintenance Costs				**$588,000**	
	Sediment, excavation/loading	11000	CY	$11.00	$121,000	Stantec (From Bids)
	Sediment, Hauling/disposal	10250	CY	$43.00	$440,750	Stantec (From Bids) Assumed Spare Earth was used for berm
Construction Costs	Machine Place for slope protection	2947	LCY	$70.00	$206,290	RS Means 2020 - page 289 - 31 37 13.10 Line 0100
	General Contractor, Mob/Demob, Ins, Bonds, Gen Admin, Profit	0.3			$230,412	
	Total Construction Cost				**$998,000**	
	Subtotal (Equipment/Materials + Construction)				$1,586,000	
	Engineer and Administration, 40% of subtotal	0.4			$634,400	
Indirect Costs	Subtotal (With Engineering)				$2,220,400	
	Contingency 50%	0.5			$1,110,200	
	Total Indirect Costs				**$1,740,000**	
	Total Capital Costs				**$3,300,000**	
Maintenance	General Maintenance Processes	1	$	$5,000	$5,000	HDR
	Total O&M Costs				**$5,000**	
	Service Life				40	
	Interest Rate				3%	
	Inflation Rate				2%	
	Major Project Upgrade(s)				0	
	Present Value Major Project Upgrade(s)				0	
	Location Adjustment Factor				1.0	
	Total Life Cycle Cost				**$3,500,000**	

Project 6, Sub-Project 5: Yogurt Canyon - Raising Monument Road - Opinion of Probable Cost

Cost Type	Item	Quantity	Unit	Unit Price	Cost ($)	Source
	Furnish/place/compact gravel base	17037	CY	$38.00	$647,000	RS Means 32.11.23.23 pg 320 line 1513
	Place bituminous paving material	6667	SY	$15.40	$103,000	RS Means 32.12.16.13 pg 321 line 460
Equipment/Material	Concrete box culvert 6-Ft W X 3-Ft H - assume triple-culvert crossing @ Yogurt Canyon & single-culvert crossing at 3 locations upstream	480	Ft	$330.00	$158,000	RS Means 32.11.42.60 pg 390 line 100
	Total Equipment/Material Costs				**$908,000**	
	Remove old roadway - bituminous up to 3-in thick	3556	SY	$6.10	$22,000	RS Means 02.41.13.17 pg 27 line 5010
	Existing roadway material disposal - 10 mile cycle/30 mph/15 min wait	4622	CY	$5.95	$28,000	RS Means 31.23.23.20 pg 265 line 3056
	Roadway material disposal tipping fee	4622	CY	$36.00	$166,000	Miramar Landfill
	Prepare & roll sub-base	20444	SY	$1.07	$22,000	RS Means 32.11.23.23 pg 320 line 7000
	Gravel delivery - 10 mile cycle/30 mph/15 min wait	22148	CY	$5.95	$132,000	RS Means 31.23.23.20 pg 265 line 3056
	Bituminous material delivery - 10 mile cycle/30 mph/15 min wait	2167	CY	$5.95	$13,000	RS Means 31.23.23.20 pg 265 line 3056
	Final embankment grading & clean-up	15556	SY	$1.53	$24,000	RS Means 31.22.16.10 pg 240 line 1200
	Itemized Work Task Costs (Including O&P) - Assume general contractor self performs task.				$407,000	
Construction	Allowance for unqualified work tasks	10%			$41,000	
	Project Work Task Cost				$448,000	
	Project mobilization/demobilization, bonds, insurance and central office costs	20%			$89,600	
	Unadjusted Construction Cost				$537,600	
	Area Factor Adjustment	0.09			$48,384	
	Site Complexity Factor Adjustment	-0.2			-$107,520	
	Geotechnical Construction Cost 2020	0			$0	
	Estimated Construction Cost 2020				$478,000	
	Project Year Adjustment (Baseline 2020) Bassline ENR	11400	11400	0	$0	
	Total Construction Cost				**$478,000**	
	Subtotal (Equipment/Materials + Construction)				$1,386,000	
	Project Engineering & Owner Administration	40%			$554,400	
Indirect Costs	Subtotal (Including Engineering)				$1,940,400	
	General Construction and Engineering Contingency	50%			$970,200	
	Total Indirect Cost				**$1,520,000**	
	Total Capital Cost				**$2,900,000**	
Maintenance	Annual Routine Maintenance Allowance				$2,000	
	Total O&M Costs				**$2,000**	
	Bituminous material delivery - 10 mile cycle/30 mph/15 min wait	1083	CY	5.95	$6,444	
	Place bituminous paving material	6667	SY	15.4	$102,672	
	Itemized Work Task Costs (Including O&P) - Assume general contractor self performs task.				$109,116	
	Allowance for unqualified work tasks	0.1			$10,912	
	Project Work Task Cost				$120,027	
	Project mobilization/demobilization, bonds, insurance and central office costs	0.2			$24,005	
Replacement After 20 Years	Unadjusted Construction Cost				$144,033	
	Area Factor Adjustment	0.09			$12,963	
	Site Complexity Factor Adjustment	-0.2			-$28,807	
	Geotechnical Construction Cost 2020	0			$0	
	Estimated Construction Cost 2020				$128,000	

Project Year Adjustment (Baseline 2020)	11400 Base	11400	$0
Total Estimated Construction Cost			$128,000
Project Engineering & Owner Administration Cost	40%		$51,200
General Contingency on Construction, Engineering and Owner Administration Costs	50%		$89,600
Total Replacement Costs			**$269,000**
Service Life			40
Interest Rate			3%
Inflation Rate			2%
Major Upgrade Cost			$269,000
Major Upgrade Year			20
Present Value of Major Upgrade			$220,457
Total Life Cycle Cost			**$3,200,000**

Project 6, Sub Project 6: Main Channel Trash Booms - Opinion of Probable Cost

Category	Item	Quantity	Unit	Unit Price	Cost ($)	Source
Equipment/Material Cost	Trash Boom, In Channel	850	ft	$1,000	$850,000	HDR, assuming the quoted price is inclusive of installation costs
	Trash Boom, Flood Control Boom	850	ft	$1,000	$850,000	HDR, assuming the quoted price is inclusive of installation costs
	Total Equipment/Material Cost				**$1,700,000**	
Indirect Costs	Subtotal (Equipment/Material + Construction)				$1,700,000	
	Construction Cost Factor			40%	$680,000	
	Subtotal (With Engineering)				$2,380,000	
	General Contingency Factor			50%	$1,190,000	
	Total Indirect Costs				**$1,870,000**	
	Total Capital Costs				**$3,570,000**	
Sediment/ Trash Collection and Disposal	Collect/Load Trash From Booms	11300	Cu Yd	$16	$181,000	Stantec
	Haul/Disposal of Trash from Booms	11300	Cu Yd	$64	$723,000	Stantec
	Sediment/trash collection/disposal				$904,000	
	Total O&M Costs				**$900,000**	
	Service Life				40	
	Interest Rate				3%	
	Inflation Rate				2%	
	Major Project Upgrades				$0.00	
	Present Value of Major Project Upgrades				$0.00	
	Location Adjustment Factor				1.0	
	Total Life Cycle Cost				**$33,100,000**	

Project 6, Sub-Project 6: Mexico Side Smugglers Gulch Trash Booms - Opinion of Probable Cost

Category	Item	Quantity	Unit	Unit Price	Cost ($)	Source
Equipment/Material Cost	Trash Boom, In Channel	200	ft	1000	$200,000	HDR, assuming the quoted price is inclusive of installation costs
	Total Equipment/Material Cost				**$200,000**	
	Subtotal (Equipment/Materials + Construction)				$200,000	
Indirect Costs	Construction Cost Factor			0.4	$80,000	
	Subtotal (With Engineering)				$280,000	
	General Contingency Factor			0.5	$140,000	
	Total Indirect Costs				**$220,000**	
	Total Capital Costs				**$420,000**	
Sediment/ Trash Collection/Disposal	Collect/Load Trash From Booms	1350	Cu Yd	5.2	$7,020	
	Haul/Disposal of Trash from Booms	1350	Cu Yd	15	$20,250	
	Sediment/Trash Collection/Disposal				**$27,300**	
	Total O&M Costs				**$27,300**	
	Service Life				40	
	Interest Rate				3%	
	Inflation Rate				2%	
	Major Project Upgrades				$0.00	
	Present Value of Major Project Upgrades				$0.00	
	Location Adjustment Factor				1.0	
	Total Life Cycle Cost				**$1,200,000**	