EXPERT ANALYSIS OF PROPOSED BORDER WALL AND BUOY SYSTEM ON THE RIO GRANDE RIVER IN WEBB AND ZAPATA COUNTIES, TEXAS, USA

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PURPOSE

The purpose of this technical memorandum is to provide an expert quantitative analysis of the risks posed to Webb and Zapata Counties by the U.S. Customs and Border Patrol's (CBP) plan to construct a massive border wall and buoy system in and along the Rio Grande River.

EXPERT QUALIFICATIONS

I hold B.S. and M.S. degrees in Civil and Environmental engineering from the University of Illinois, Urbana-Champaign, and a Ph.D. in Environmental Planning from the University of California, Berkeley. My Ph.D. training and research was in fluvial geomorphology, specifically the interactions between river channels and their floodplains. My academic research and my applied professional work has focused on river management, specifically in the areas of hydrology, hydraulics, fluvial geomorphology, sediment transport, flood management, and ecosystem restoration. I am a registered professional civil engineer in the States of California and Washington. I have over twenty-eight years of professional consulting experience working on rivers throughout the United States. I have worked extensively on evaluations of the impacts of structures in and adjacent to rivers across the United States, including the Rio Grande and other large rivers in Texas. I recently completed technical analyses and field investigations of a border wall along the Rio Grande River near Mission, Texas, and I observed first-hand failures of that structure shortly after construction.

PROPOSED BORDER WALL AND BUOY SYSTEM

The CBP plans to construct a "border and waterborne barrier system" (system) in and adjacent to the Rio Grande River throughout Webb and Zapata counties, Texas (CBP 2025a). The system is massive and will drastically alter the hydraulic and geomorphic conditions of the Rio Grande River. The system includes approximately 108 miles of "primary border barrier" (wall) and approximately 153 miles of "waterborne barrier system" (buoys). The system also extends for many miles upstream and downstream of the portions in Webb and Zapata Counties. Presumedly due to the waiver issued by the Department of Homeland Security (DHS) regarding this project, basic design documents and supporting analyses typically required for river corridor projects much smaller than this one are not publicly available. Therefore, the exact scale of proposed infrastructure can only be assumed from representative images provided by CBP. Figure 1 and Figure 2 are representative images of the proposed wall, maintenance road, patrol area, buoy, and anchor elements of the proposed system (from CBP 2025b) that include features (e.g. vehicles, roads, river) indicating the scale of the proposed system.

FIGURE 1: REPRESENTATIVE IMAGE DEPICTING THE SCALE OF THE WALL, MAINTENANCE ROAD, AND PATROL AREA COMPONENTS OF THE PROPOSED SYSTEM. SOURCE: HTTPS://WWW.CBP.GOV/DOCUMENT/ENVIRONMENTAL-ASSESSMENTS/BORDER-BARRIER-AND-WATERBORNE-BARRIER-SYSTEM-WEBB-AND-ZAPATA

FIGURE 2: REPRESENTATIVE IMAGE DEPICTING THE SCALE OF THE BUOY AND ANCHOR COMPONENTS OF THE PROPOSED SYSTEM. SOURCE: HTTPS://WWW.CBP.GOV/DOCUMENT/ENVIRONMENTAL-ASSESSMENTS/BORDER-BARRIER-AND-WATERBORNE-BARRIER-SYSTEM-WEBB-AND-ZAPATA

Proposed Border Wall and Buoy System Risk Factors

Any infrastructure constructed in or adjacent to a river poses significant risks. Massive infrastructure systems like the one proposed by CBP constructed in or adjacent to large dynamic rivers like the Rio Grande pose even greater risks. This is why the licensed professional engineers who design such projects use sophisticated models and incorporate extensive technical review before proposing or building such systems. Perhaps the most glaring problem with this project is the lack of publicly available technical information delineating and mitigating the immense set of risks that it poses. In the following risk analysis I assume that a basic professional engineering standard of care supports the design of the proposed system, and that the system has residual risk associated with events that exceed or are outside of reasonable design criteria. However, since there is no publicly available record documenting the design of the proposed system, it is entirely possible that the proposed system could cause even greater risk than my analysis indicates. Even if carefully designed and constructed, the proposed system has the following categories of significant risk.

1. Hydraulic Risk
2. Geomorphic Risk
3. Debris Loading and Structural Failure Risk
4. Safety and Property Risk
5. Ecological Risk

Risk Analysis

My approach is intended to provide an analysis of likely upper-range impacts of the proposed wall and buoy system in Webb and Zapata Counties. I infer risks using publicly available project design information, general environmental and infrastructure conditions, and basic river science and engineering principles. This is a standard analysis method when design data and analyses are not publicly available. I collected and reviewed remotely-sensed information including aerial photography, streamflow records, flood mapping, and Geographic Information System (GIS) spatial databases of river corridor infrastructure. Using this information, I digitized and measured key river corridor characteristics and assumed dimensions of the components of the proposed system to calculate the scale of the proposed wall and buoy system relative to the Rio Grande River. I then used the scale of river corridor impact to infer the type and scale of impacts likely from the proposed wall and buoy system. Table 1 summarizes the scale of each element of the proposed wall and buoy system as well as its proportional impact on the Rio Grande River corridor. In addition, I used spatial data on key facilities and infrastructure in Webb and Zapata Counties to identify locations where the proposed project significantly increases risk to human safety and property.

TABLE 1: ASSUMED DIMENSIONS OF PROPOSED SYSTEM COMPONENTS AND IMPACT ON RIVER CHANNEL

System Component	Assumed Width / Diameter (feet)	Surface Area (acres)	Size Relative to River Channel	Cross Sectional Area (square feet)	River Channel Obstruction
Wall	5.0	73.6	1.7%	N/A	N/A
Road / Patrol Area	100.0	1472.5	33.3%	N/A	N/A
Buoys	5.0	N/A	N/A	19.6	1.7%
Buoys / Anchors	15.0	N/A	N/A	176.7	5.0%
Buoys / Anchors / Debris	25.0	N/A	N/A	490.9	8.3%

Hydraulic Risk

Hydraulic risk relates to the ways in which the proposed system will alter how water flows through the Rio Grande River. The wall portion of the system will create vast new areas (equal to approximately 35% of the river area itself) along the river that will be hydraulically smooth. In addition, the buoy portion of the system will result in a large new obstruction to flow (up to approximately 8% of the conveyance area of the river channel) in the Rio Grande. Together, the proposed wall and buoy system will result in increased velocities along the smoothed and cleared bank on the U.S. side of the river, elevated flood stages and backwater effects due to lost conveyance area, and flow redirection and increased turbulence due to the dangerous combination of cleared river bank areas adjacent to the continuous flow obstruction caused by the massive chains of buoys. It seems as though the design of the proposed system is intended to increase erosion of the U.S riverbank and raise water levels throughout the river. During high flows, this system will lead to failures in the already stressed flood control system in Webb and Zapata Counties.

Figure 3 and Figure 4 show the existing flood hazard zones along the Rio Grande for Webb County. In addition, these figures show the locations of bridges, water treatment plants, and wastewater treatment plants. All of this critical infrastructure is in the existing flood hazard zone, meaning that it will be inundated during extreme events. Figure 5 shows how the existing flood control system is already stressed during high flows. The higher flows in the 2010 image in Figure 5 clearly inundate areas well beyond the river edge, including areas where the new wall is proposed. The proposed wall and buoy system will greatly exacerbate the existing hydraulic risk by raising water levels and redirecting flows into the cleared wall area, resulting in more rapid and extensive erosion of the existing flood control system, and more frequent overtopping of the flood control system. The hydraulic risks of the proposed wall and buoy system are dramatic just considering the presence of the new wall, patrol area, and buoys. However, debris loading (discussed below) will greatly compound this risk and almost certainly result in devastating system failures caused by the hydraulic alterations to the Rio Grande that result from the proposed project.

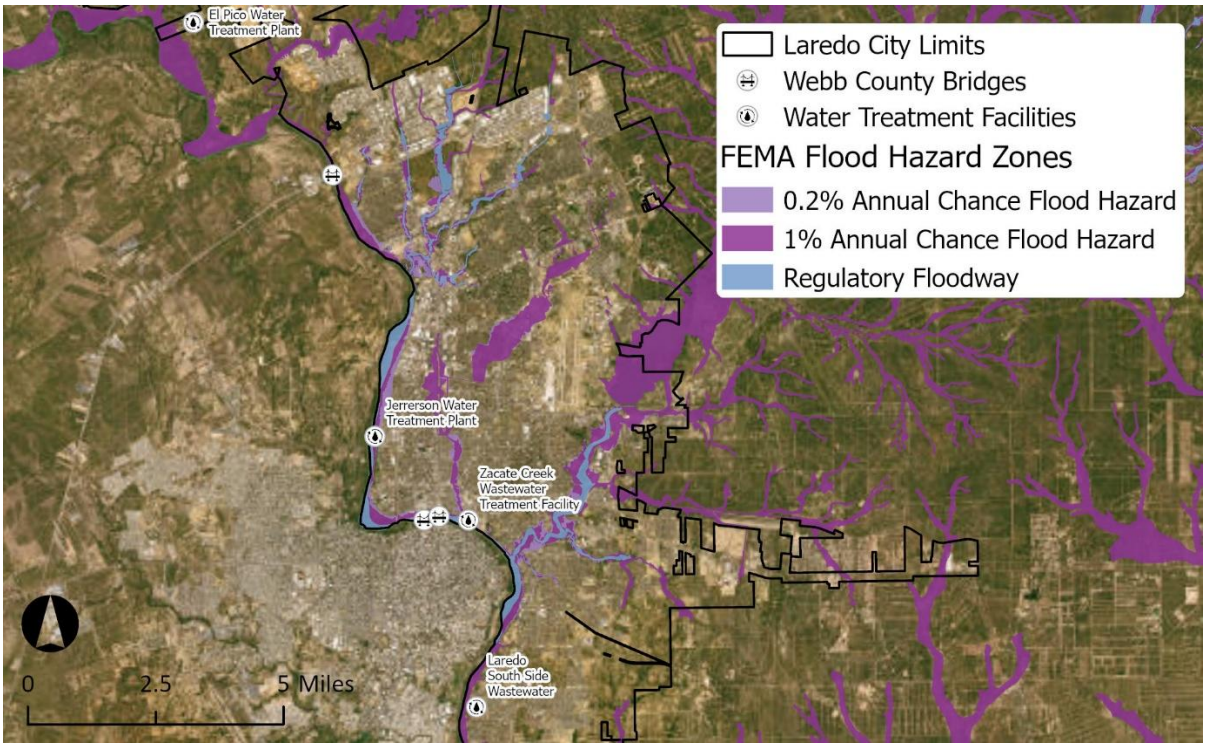

FIGURE 3: MAPPED FLOOD ZONES AND CRITICAL INFRASTRUCTURE ALONG THE RIO GRANDE RIVER IN WEBB COUNTY.

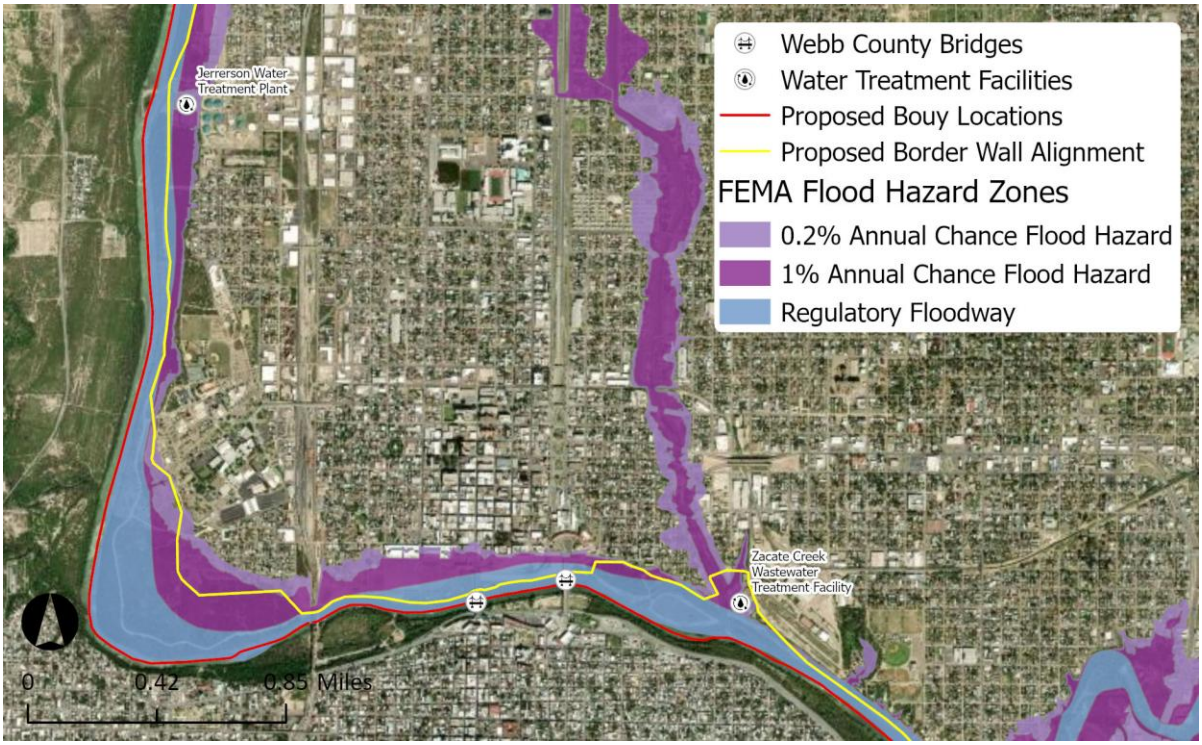

FIGURE 4: DETAILED VIEW OF MAPPED FLOOD ZONES AND CRITICAL INFRASTRUCTURE ALONG THE RIO GRANDE RIVER IN WEBB COUNTY.

FIGURE 5: REPRESENTATIVE AERIAL IMAGES OF THE RIO GRANDE RIVER IN THE PROPOSED PROJECT AREA SHOWING THE EXTENT OF INUNDATION DURING HIGH FLOWS IN 2010 AND LOWER FLOWS IN 2024.

Geomorphic Risk

Geomorphic risk relates to the ways in which the proposed wall and buoy system will alter the long-term evolution of the Rio Grande River. The Rio Grande is a dynamic river that changes in response to the flows, sediment, and debris it conveys. The newly cleared area (approximately 35% of the river channel area) along the proposed wall and the continuous river channel obstruction from the proposed buoys (up to 8% of the river channel width) will induce major changes in the physical processes that shape the Rio Grande. Erosion, scour, and channel migration will all increase. The acceleration of geomorphic processes driven by the proposed project not only puts all of the infrastructure in an along the Rio Grande River at greater risk, it will, over time, alter the location of the border between the U.S. and Mexico, potentially resulting in the loss of U.S. territory.

Figure 6 shows locations of significant historical channel change that has occurred without the proposed project in place. This includes channel migration, bank erosion, and in-channel island formation. Figure 7 and Figure 8 show major island growth and bank erosion, respectively, that has occurred in Laredo. It is extremely important to note that this change has occurred over only fourteen years, which is an extremely small increment of time in the evolution of a river like the Rio Grande. The proposed wall and buoy system will greatly increase the geomorphic risk along the river, with accelerated evolution along the U.S. side. Similar to hydraulic risk, the geomorphic risks will be exacerbated during high flows when debris loading focuses the erosion and scour onto bare channel banks and causes rapid and extensive channel migration along the U.S. bank of the river.

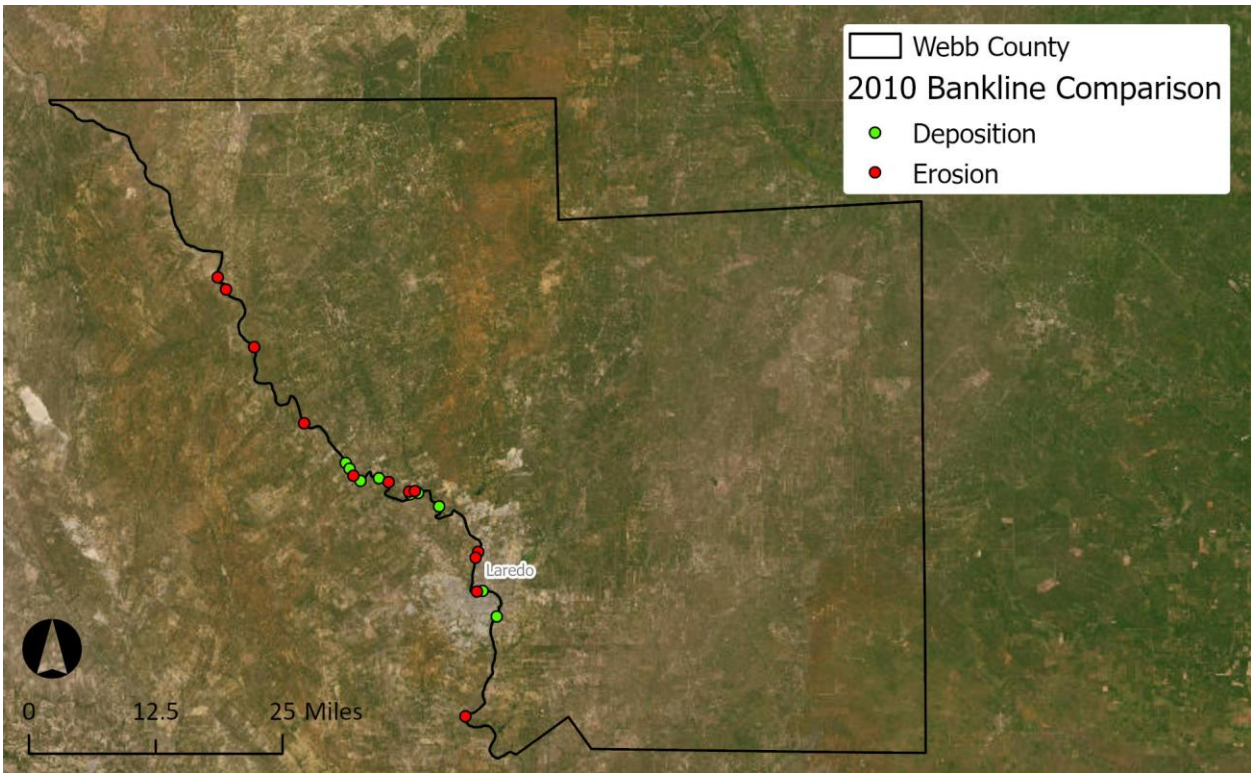

FIGURE 6: HISTORICAL LOCATIONS OF SIGNIFICANT CHANNEL CHANGE ON THE RIO GRANDE RIVER ALONG WEBB COUNTY.

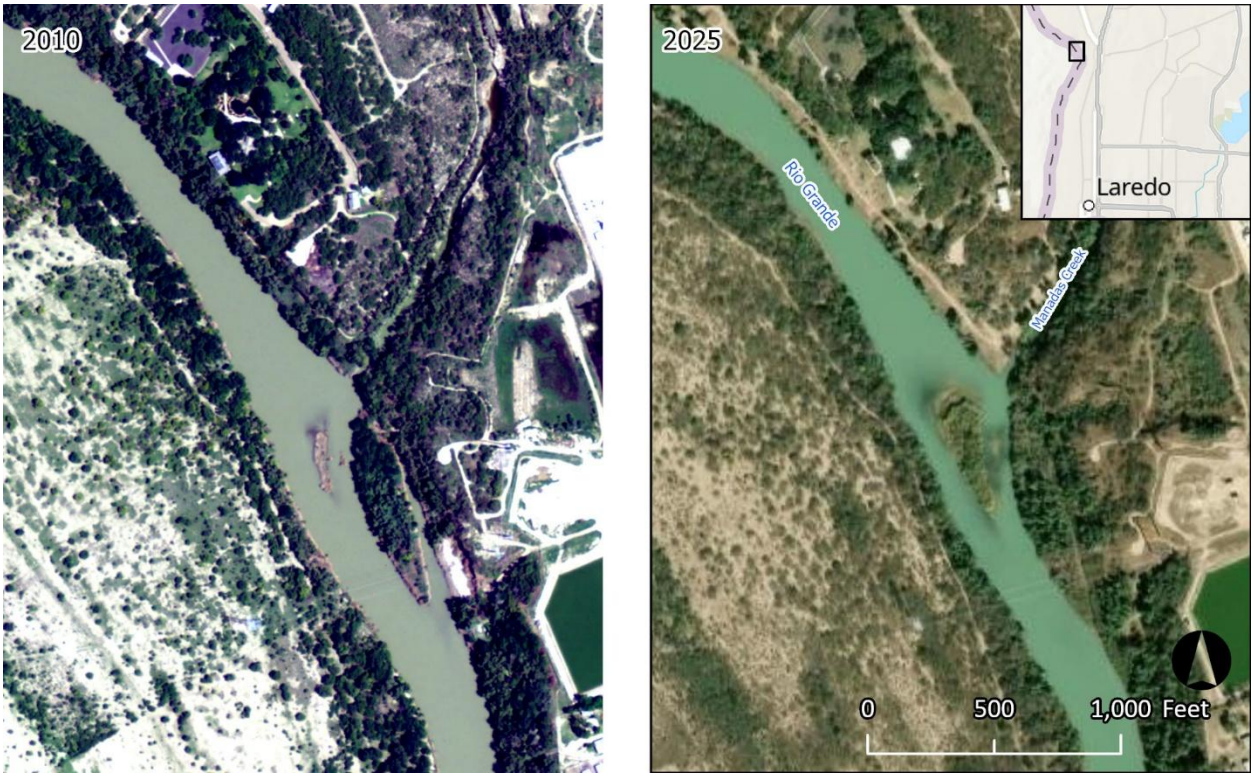

FIGURE 7: CHANNEL EVOLUTION ON THE RIO GRANDE RIVER NEAR LAREDO, TEXAS.

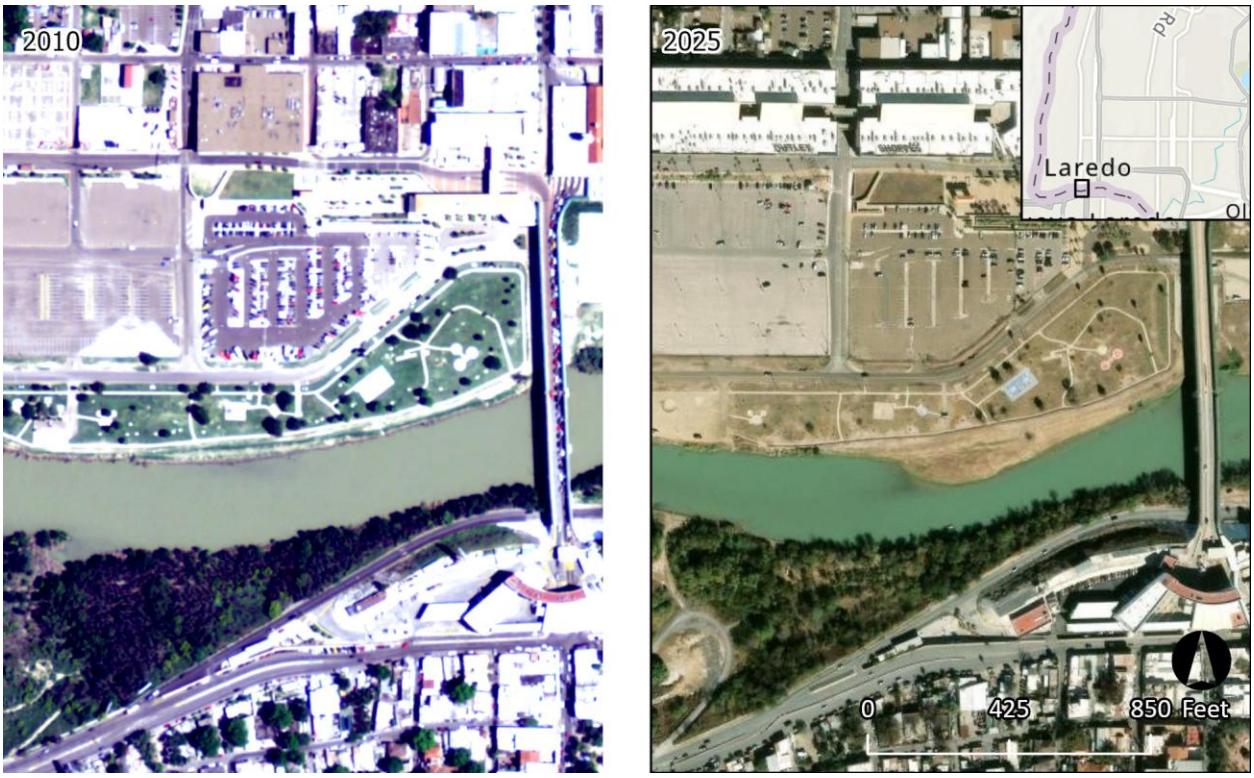

FIGURE 8: CHANNEL EVOLUTION ON THE RIO GRANDE RIVER NEAR LAREDO, TEXAS.

Debris Loading and Structural Failure Risk

Debris loading and structural failure risk relates to the propensity of structures placed in and along rivers to catch debris during high flows and increase the hydraulic forces acting on those structures and adjacent areas in unpredictable and damaging ways. It will be impossible to monitor and manage the debris loading that occurs along more than 100 miles of wall and buoys during the extremely dangerous river conditions that accompany extreme high flow events. The Rio Grande drains extensive and diverse areas that range from heavily vegetated to heavily developed. During flood flow conditions, the Rio Grande likely conveys thousands of trees as well as thousands of cubic yards of trash and debris that can form interconnected rafts. There will be no way to prevent this debris from accumulating along the proposed wall and on portions of the buoy chains. When combined with the certain geomorphic change induced by the proposed system, it is inevitable that portions of the buoy system will break free and portions of the wall will fail.

Figure 9 is an illustrative image that shows how debris loading coupled with channel scour could dislodge sections of the proposed buoy chain and transport them to the cleared and erosion-prone channel banks along the proposed wall. Such a failure would accelerate channel migration into the wall and potentially cause portions of the wall to fail. I observed similar erosion along a new border wall near Mission, Texas after relatively low flows and fully expect much more damaging erosion and channel migration when extreme high flows interact with the massive proposed wall and buoy system.

FIGURE 9: ILLUSTRATIVE IMAGE DEMONSTRATING POTENTIAL BUOY BEHAVIOR UNDER HIGH-FLOW CONDITIONS ON THE RIO GRANDE RIVER.

Safety and Property Risk

Safety and property risk relates to the increased exposure of the public to dangerous conditions and increased damage to property caused by the proposed wall and buoy system. Large rivers like the Rio Grande always pose significant risks to safety and property, especially during and after extreme high flow and flood events. Therefore, the hydraulic, geomorphic, debris, and structural failure risks described above will result in a more dangerous place for people and property along the Rio Grande River in Webb and Zapata Counties. Figure 10 and Figure 11 show two of the most likely risks posed by the proposed project to safety and property: flooding and bridge stability. Sections of the proposed buoy chains will inevitably break free when loaded with debris and stressed by high flows. These failed sections will almost certainly get caught on sections of levee and around bridge piers. This will focus the immense energy of the Rio Grande and cause extensive erosion and scour that infrastructure built before the proposed system will not have been designed to resist, putting people and property in harms way.

FIGURE 10: ILLUSTRATIVE IMAGE DEMONSTRATING POTENTIAL FLOODING AND BUOY SYSTEM FAILURE UNDER HIGH-FLOW CONDITIONS IN LAREDO, TEXAS.

FIGURE 11: ILLUSTRATIVE IMAGE DEMONSTRATING POTENTIAL BUOY BEHAVIOR AT BRIDGES UNDER HIGH-FLOW CONDITIONS.

Ecological Risk

Ecological risk relates to negative changes to the river corridor ecosystem of the Rio Grande that will be caused by the proposed wall and buoy system. The stretch of the Rio Grande near Webb and Zapata Counties is an ecologically rich corridor at the transition between the Tamaulipan thornscrub, Chihuahuan Desert, and Gulf Coastal Plain regions. The river corridor provides critical habitat and migration corridors for highly valued populations of fish, birds, and other wildlife. The physical changes of denuding an area equal to approximately 35% of the river channel area for the proposed wall and patrol zone and anchoring long chains of plastic balls covering up to 8% of the channel width will directly destroy habitat. The accelerated river corridor evolution driven by the proposed wall and buoy system will continuously destroy additional habitat as the conditions required by species using the corridor are replaced with more rapid and extensive channel change. In addition, new infrastructure and repairs to existing infrastructure required to mitigate the damage caused by the proposed wall and buoy system will continuously remove and degrade more habitat.

SUMMARY

CBP's proposed border wall and buoy system is massive. It will change the river corridor dramatically. Change will occur immediately as the project is built, and continuously as the project causes the river to evolve in response to over 100 miles of cleared river banks and debris-trapping channel obstructions. River flows, erosion, and scour will be exacerbated and redirected towards the U.S. bank of the Rio Grande in unpredictable, damaging, and potentially catastrophic ways. Portions of the proposed wall and buoy system will fail during extreme high flows. Failures will cause catastrophic flooding, damage and destruction to property, and risks to the health and safety of people near the river corridor. Constructing the proposed system without publicly documenting its design and incorporating appropriate risk mitigation measures violates the basic professional standard of care that must be met for projects with such high risks.