Polytechnic University of Puerto Rico
Department of Civil and Environmental Engineering

DEVELOPMENT OF A METHODOLOGY TO APPLY COMPLETE STREETS PROCEDURES IN THE URBAN CORE OF PATILLAS, PR

CE 4920 Engineering Senior Design
Section 09 WI-25
Prof. Ginger Rossy Robles

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Background: Engagement & Policy Frame

Advantage Business Consulting, Inc. (ABC); Prof. Ginger Rossy integrated the project into CE-4920 Engineering Senior Design.

Ten-student team with scope, schedule, and deliverables agreed with the Municipality of Patillas, PR flagged gaps on PR-3 and in the town center.

Complete Streets evolved from best practice to USDOT/FHWA policy.

Puerto Rico Law 201-2010 mandates integration across planning–O&M.

Complete Streets & Current Conditions in Patillas, PR

All users/modes; outcomes: safety, connectivity, equity, resilience.

Accessibility embedded (ADA/PROWAG); PR-MUTCD-compatible signing/marking.

Network view: continuous sidewalks; safe, legible crossings and curbside.

Deficiency in traffic signage, lack of pavement markings for parking spaces (including accessible parking), and roadway striping.

Local issues: sidewalk gaps, noncompliant ramps, conflicts, ponding, curbside/parking disorder.

An Introduction

Figure 1. General conditions of Downtown Patillas.

Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Complete Streets Legal Framework

Complete Streets Manual (2018)	Americans with Disabilities Act (ADA, 2010):	Puerto Rico Regulations	Design Standards
• Defines sidewalks as essential pedestrian elements and promotes safe, continuous, and accessible walkways.	• Requires full accessibility in all public projects and applies to municipal facilities and services.	• The Puerto Rico Highway and Transportation Authority (ACT) sets minimum sidewalk widths of 4–10 ft (1.25–3 m), and the Puerto Rico Building Code 2018 adopts ADA and ICC A117.1-2017 standards.	• Establish maximum slopes of 2% cross and 8.33% longitudinal, requiring firm, stable, and slip-resistant surfaces.

Complete Streets Legal Framework

Law 201 (2010) – Complete Streets Act

- Adopts the *Complete Streets* concept as public policy.
- Requires roads to consider all users: pedestrians, cyclists, drivers, and public transit riders.
- Promotes accessibility, lighting, and safety at bus stops.
- **Limitation:** uneven implementation and limited municipal resources.

Law 74 (1965) – Puerto Rico Highway and Transportation Authority (ACT)

- Establishes ACT as the primary agency for planning, building, and maintaining highways.
- Municipalities (e.g., Patillas) must coordinate with ACT for projects along main routes (e.g., PR-3).
- Common issue: overlapping responsibilities between ACT and municipalities.

Law 22 (2000) – Vehicle and Traffic Law

- Regulates circulation, parking, and road safety.
- Requires transit stops to meet traffic and visibility standards.
- Does not directly address modern transit-stop design; relies on complementary guidelines.

Puerto Rico Complete Streets Design Guidelines

- Translate Law 201 into technical criteria (e.g., sidewalks, crosswalks, signage, lighting, and ADA accessibility).
- Not legally binding; implementation depends on adoption by agencies or municipalities.

Study Area: Urban Core of Patillas, PR

Exact location within Patillas' historic town center (Complete Streets footprint)

Control points (Lambert and Lat/Lon):

Point 1 X: 244357.4843, Y: 219172.5207
(Lat: 18.00610179, Lon: −66.01447527)

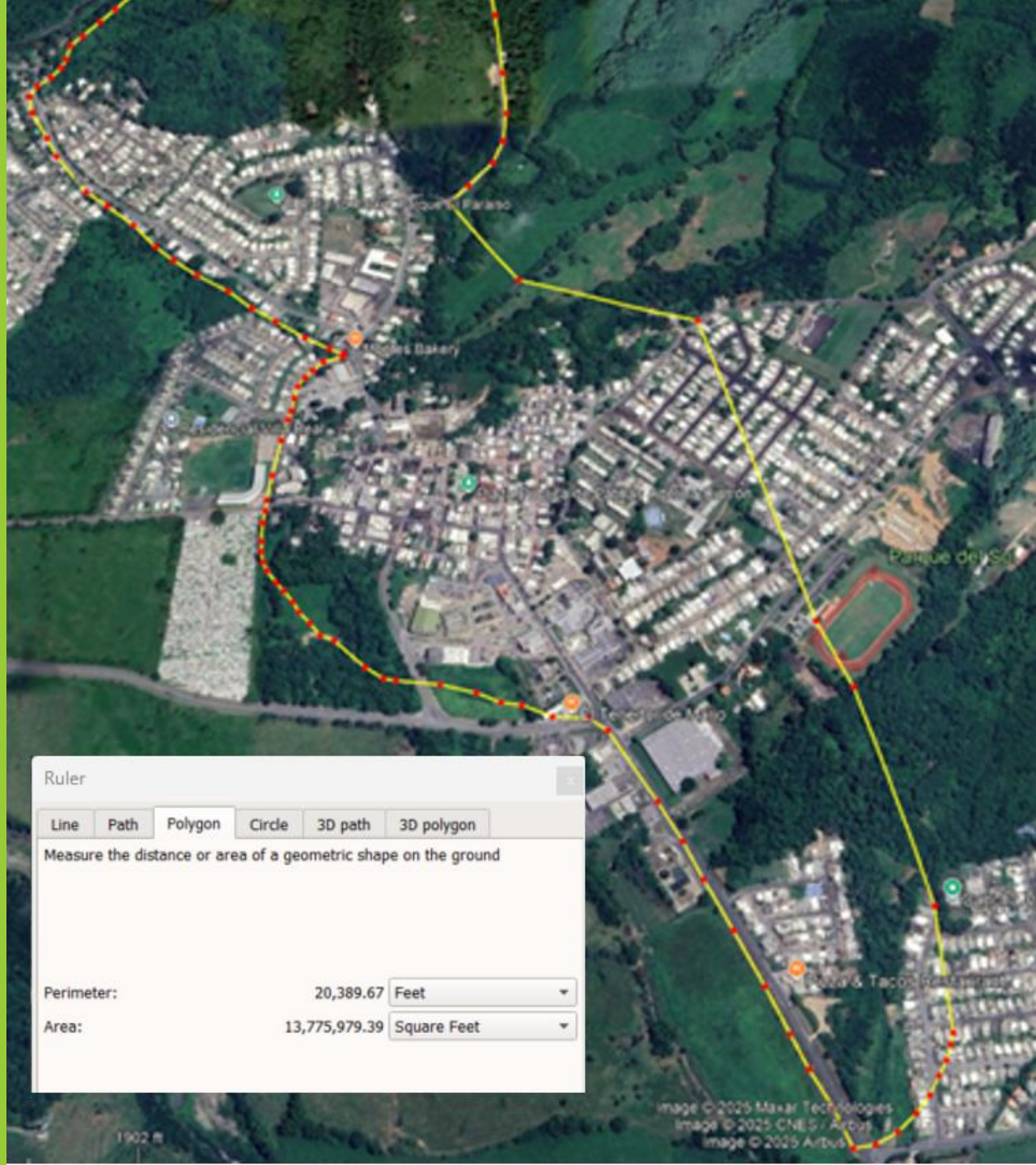
Point 2 X: 244355.7997, Y: 219140.8112
(Lat: 18.00581533, Lon: −66.01449186)

Parcels within the project polygon:

398-078-019-01

398-078-019-02

District area ≈ 13.77 million ft² (per EA maps/metrics)



Environmental Evaluation

- The land use in the areas of proposed improvements are Commercial Residential and General Institutional.
- FEMA has a large portion of the area within flood zones.
- A 400m radius from the plaza identified only one body of water and no caves, sinkholes, reserves or forest.
- The population of Patillas' is in decline since 25 percent of the population in made up older adults.

Environmental Evaluation

Services and Infrastructure:

- Potable water connections and consumption: One floor connection on every level and 2 bathrooms using an average tank size of 5 gallons of water per use.

- Stormwater runoff : The stormwater runoff of the entire project come out to be 7.628 cfs (3,424 gpm).

- Access routes: PR-3 (Highway 3), Terminal Street, and Francisco Ortiz Lebrón Street.

Environmental Evaluation

Social and physical aspects:
Earthwork volume:

- The removal of volume for the multi-story parking structure is around 6380 m^3.
- Estimated noise levels: The CDC recommends a limit of 85 dBA average over an 8-hour workday.
- Light pollution: In this project it is not expected to produce any light pollution.

Wastes:

- Type of waste: Non- hazardous waste
- Estimated volumes: The sidewalks removal is around 11,469.64 m^3.

Scope and Methodology

Corridors: PR-3 segments, the historic town center, and the municipal multi-story parking facility; georeferenced diagnosis.

Concepts: continuity (sidewalks), ADA/PROWAG ramps and crossings, organized curbside and parking.

The methodology includes the field identification of deficiencies in traffic signage and pavement markings, using low-cost solutions aligned with Complete Streets principles.

Implementation: alternatives, cost ranges, phasing, funding and permitting paths.

Outcomes: reduce crossing conflicts and ponding; increase sidewalk continuity and ADA/PROWAG compliance; increase pedestrian illuminance and uniformity; improve curbside legibility.

Data Collection: Multi-Story Parking Structure

- The team documented how parking is currently supplied and used, including the prevalence of on street parking around the plaza area, the degree to which parking behavior is informal, and the frequency of operational issues such as double parking, stopping in travel lanes, and infringements near intersections and pedestrian crossing locations.

- One of the key factors that decided the location of the parking was its proximity to the current public transportation terminal; to make it possible for citizens using the parking facility to access public transportation that could move them throughout the municipality, thus promoting Complete Streets.

Data Collection: Multi-Story Parking Structure

It was necessary to develop a facility that could provide parking for the downtown area because:

- Necessity to expand the current sidewalks.
- Necessity to remove informal curbside parking spaces.
- Conversations with local government officials showed that the current bus terminal does not permit the existing bus fleet to fit in the structure.
- It was determined that the first level of the parking needed to be a space for public buses to park and then connect with the existing routes.
- It was determined that more parking spaces were needed than the space that was previously available.

Further planning led to the identification of a public lot located in front of the existing public transportation terminal, currently being used as a public parking, but not meeting the demand of the downtown area.

Data Collection: Multi-Story Parking Structure

Figure 3. *Location of proposed multi-level parking, Puerto Rico.*

Note. Map prepared by ABC. Used with permission.

Data Collection: Multi-Story Parking Structure

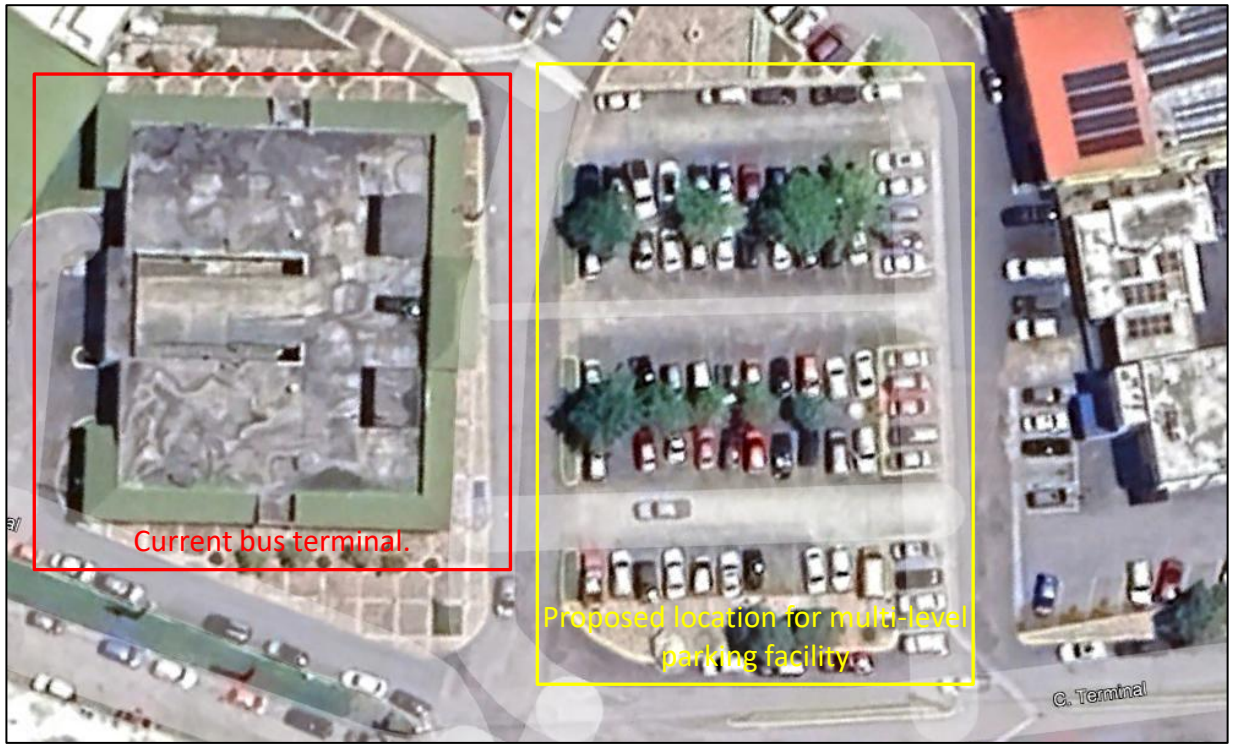


Figure 4. *Aerial view of current public bus terminal, next to the parking lot property being proposed as the new location for the multi-level parking.*

Note. Picture retrieved from Google Earth Pro by José Sanabria.

Existing Problems of Curbside Parking

- Observations show that where curb space is not clearly organized, vehicles park inconsistently, reduce effective roadway width, and create traffic.
- Informal stopping and loading behavior further reduces roadway capacity, especially near commercial areas.
- From an accessibility perspective, curbside parking often conflicts with the need for clear curb ramp access, adequate landing areas, and visibility at pedestrian crossings.
- Where vehicles stop near corners, they reduce sight distance between pedestrians and drivers, increasing crash risk.
- These conditions provide operational justification for shifting a portion of parking demand to a multi-story parking structure.

Existing Problems: Curbside Parking

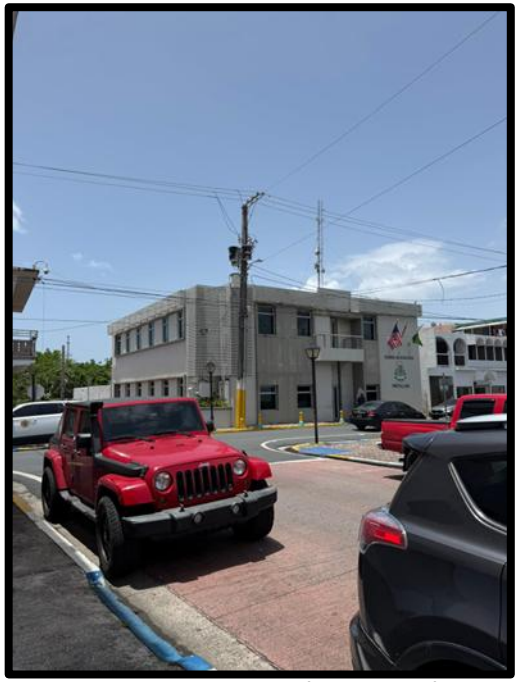


Figure 5. *Existing parking conditions along downtown Patillas, Puerto Rico.*

Note. Photograph taken by Josean Pagán on August 13, 2025, in Patillas, PR. Captured using phone camera.

Figure 6. *Existing parking conditions along downtown Patillas, Puerto Rico.*

Note. Photograph taken by Andrés Martínez on August 29, 2025, in Patillas, PR. Captured using GPS Map Camera.

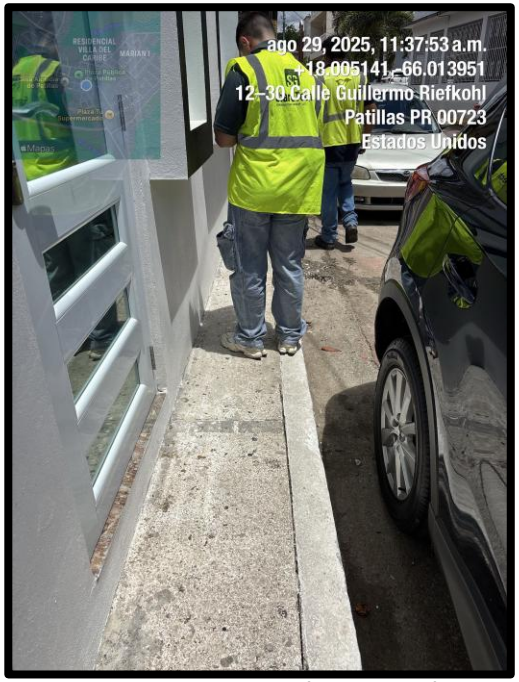


Figure 7. *Existing parking conditions along downtown Patillas, Puerto Rico.*

Note. Photograph taken by Andrés Martínez on August 29, 2025, in Patillas, PR. Captured using GPS Map Camera.

Existing Problems: Curbside Parking

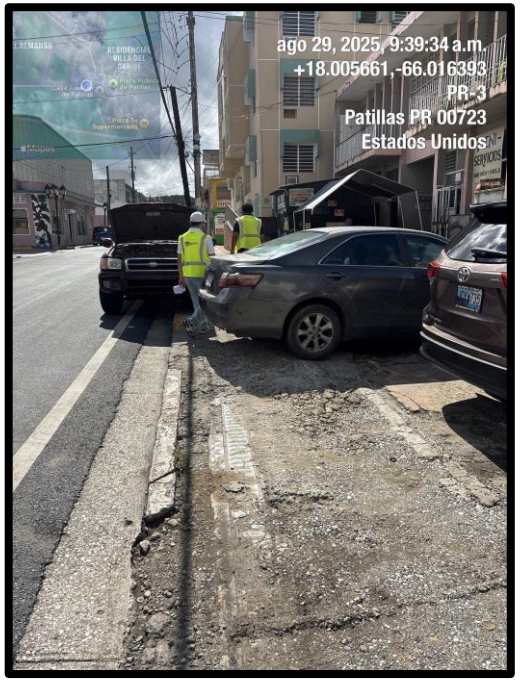


Figure 10. *Existing parking conditions along downtown Patillas, Puerto Rico.*

Note. Photograph taken by Andrés Martínez on August 29, 2025, in Patillas, PR. Captured using GPS Map Camera.

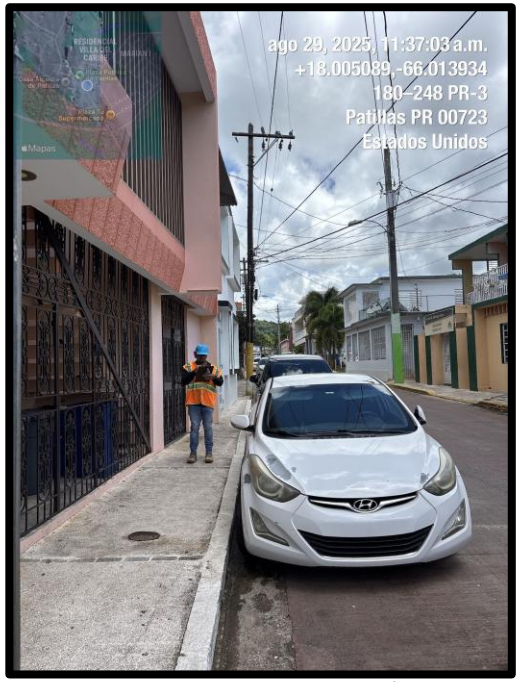


Figure 11. *Existing parking conditions along downtown Patillas, Puerto Rico.*

Note. Photograph taken by Andrés Martínez on August 29, 2025, in Patillas, PR. Captured using GPS Map Camera.

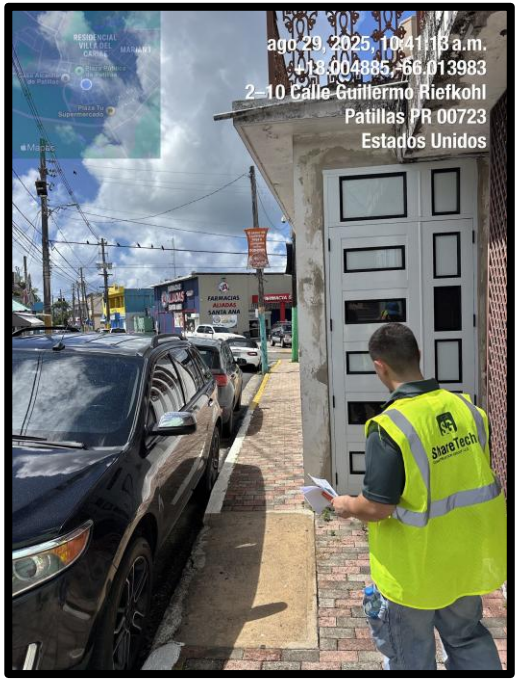


Figure 12. *Existing parking conditions along downtown Patillas, Puerto Rico.*

Note. Photograph taken by Andrés Martínez on August 29, 2025, in Patillas, PR. Captured using GPS Map Camera.

Existing Plan: Current Parking Lot

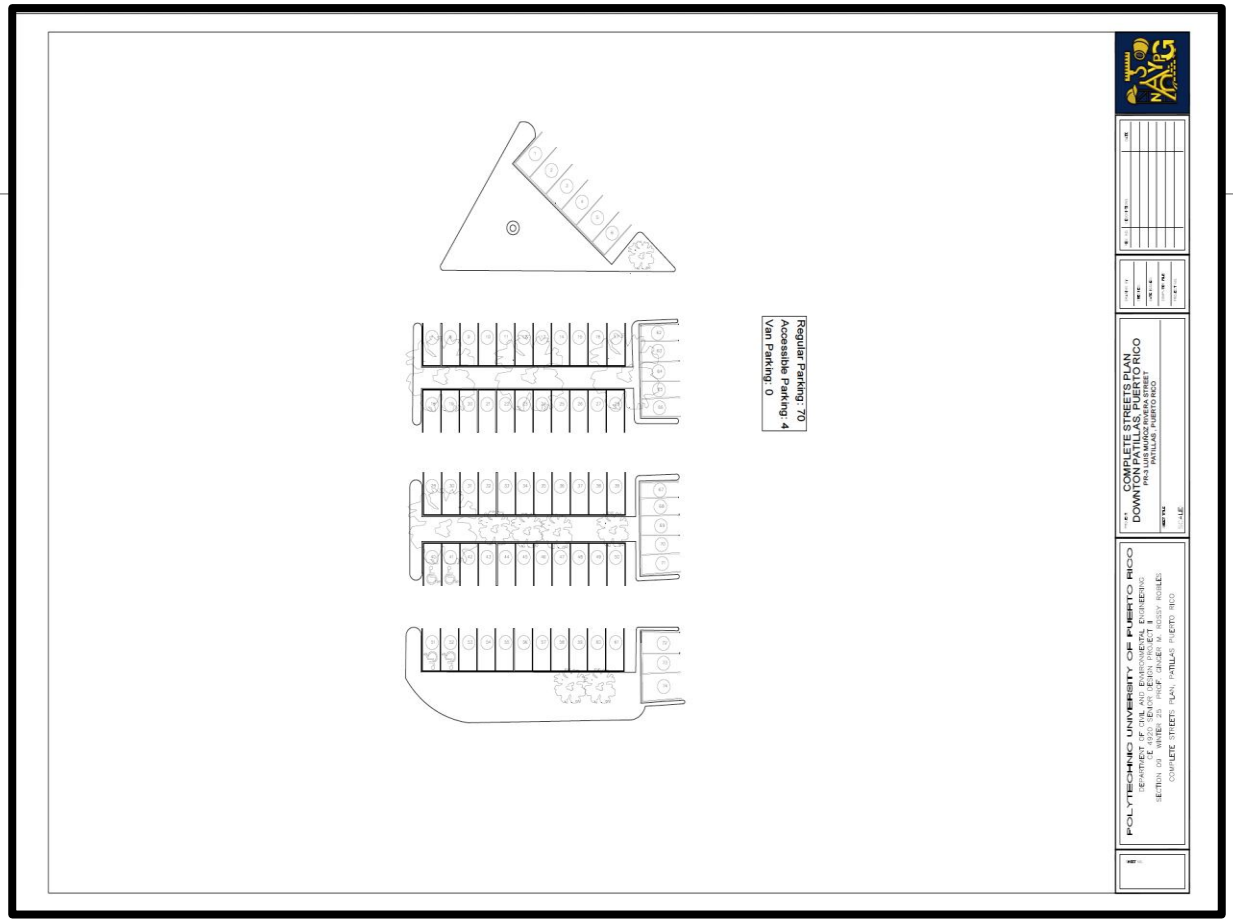


Figure 8. Parking lot *Existing Plan.*

Note. Drawing developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Existing Problems: Curbside Parking

Main findings and identified needs

- A structured facility must be paired with direct pedestrian connections, safe crossings, and accessible routes so that users can comfortably walk from the facility to destinations. This need aligns with ADA requirements for accessible routes and reflects Complete Streets principles that prioritize safe multimodal access (U.S. Department of Justice, 2010).

- The facility must be integrated into curbside management strategy. The purpose of the structure is not only to provide supply, but to enable the municipality to reassign curbside space to functions that improve operations and safety such as no parking zones near corners, protected curb ramps, designated loading zones, and transit stop support areas.

Existing Problems: Curbside Parking

Main findings and identified needs

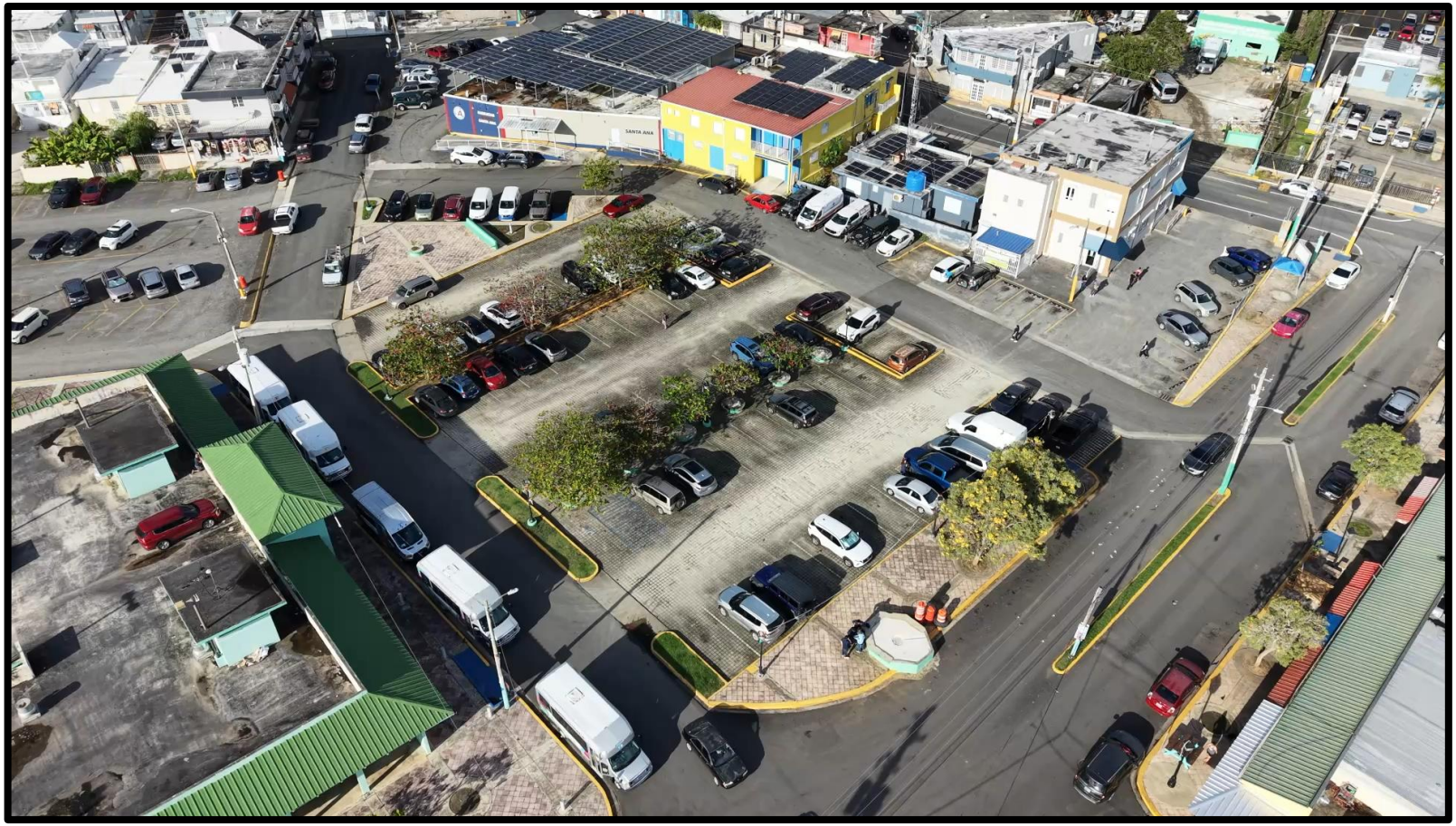


Figure 9. Conditions of existing parking lot.

Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Demolition Plan: Multi-Story Parking Structure

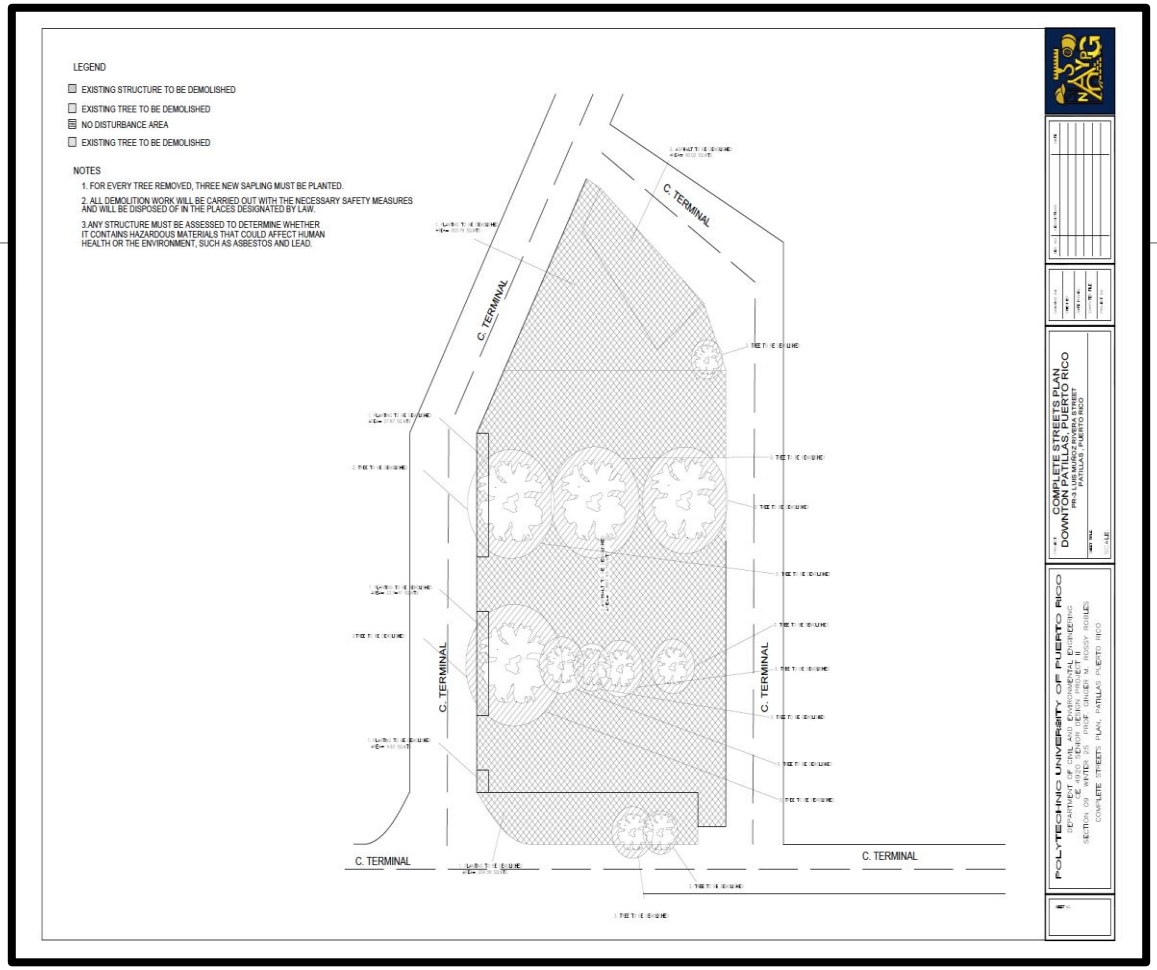


Figure 10. Parking lot *Demolition Plan.*

Note. Drawing developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Design criteria: Multi-Story Parking Structure

- The conceptual design standards and criteria for the multi-level parking facility were selected to ensure that the facility functions as an enabling Complete Streets investment.

- The intent is not to design a parking garage in isolation, but to establish a structured facility concept that improves downtown circulation, supports safer pedestrian conditions, and allows curbside space to be reassigned to higher priority functions such as accessible routes, passenger pick up drop off, loading activity management, and crossing visibility improvements.

Design criteria: Multi-Story Parking Structure

The following principles represent the design criteria for the multi-level parking:

1. The facility must intercept a meaningful share of downtown parking demand that currently competes for curb space.

2. The facility must include pedestrian connections that are direct, visible, and accessible, and it must connect logically to the proposed sidewalk and curb ramp network. ADA compliant path continuity is critical because the facility is meant to serve all users, including visitors with mobility limitations.

3. The facility must reduce downtown circulation by reducing the time searching for parking.

Ultimately, the multi-story parking structure provides a realistic pathway for reducing curbside parking pressure, enabling sidewalk continuity improvements, ADA curb ramp reconstruction, and regulated curbside functions. It also supports a park once and walk behavior pattern that reduces short internal vehicle trips in the downtown.

Final Designs: Multi-Story Parking Structure

The design is focused on these main priorities:

- Operational effectiveness, meaning the facility must meaningfully reduce curbside pressure.
- Safety, including clear circulation, adequate lighting, and minimized conflict points.
- Accessibility, including compliant accessible parking and an accessible route connected to sidewalks and destinations (U.S. Department of Justice, 2010).

Final Designs: Multi-Story Parking Structure

- The final proposed concept is a reinforced concrete multi-level parking facility with internal ramps connecting levels. The facility includes controlled access and egress points designed to minimize conflicts with pedestrian corridors and to avoid creating queues that block adjacent streets. Internal circulation is designed to be intuitive for first time users, using a clear path from entry to parking levels and from parking stalls to pedestrian exits.

- Accessible parking spaces are placed in locations that minimize walking distance to accessible exits and provide an accessible route that avoids stairs. The accessible route is designed to connect to the public right of way and to the broader sidewalk and curb ramp improvements proposed in the project.

Proposed Site Plan: Multi-Story Parking Structure

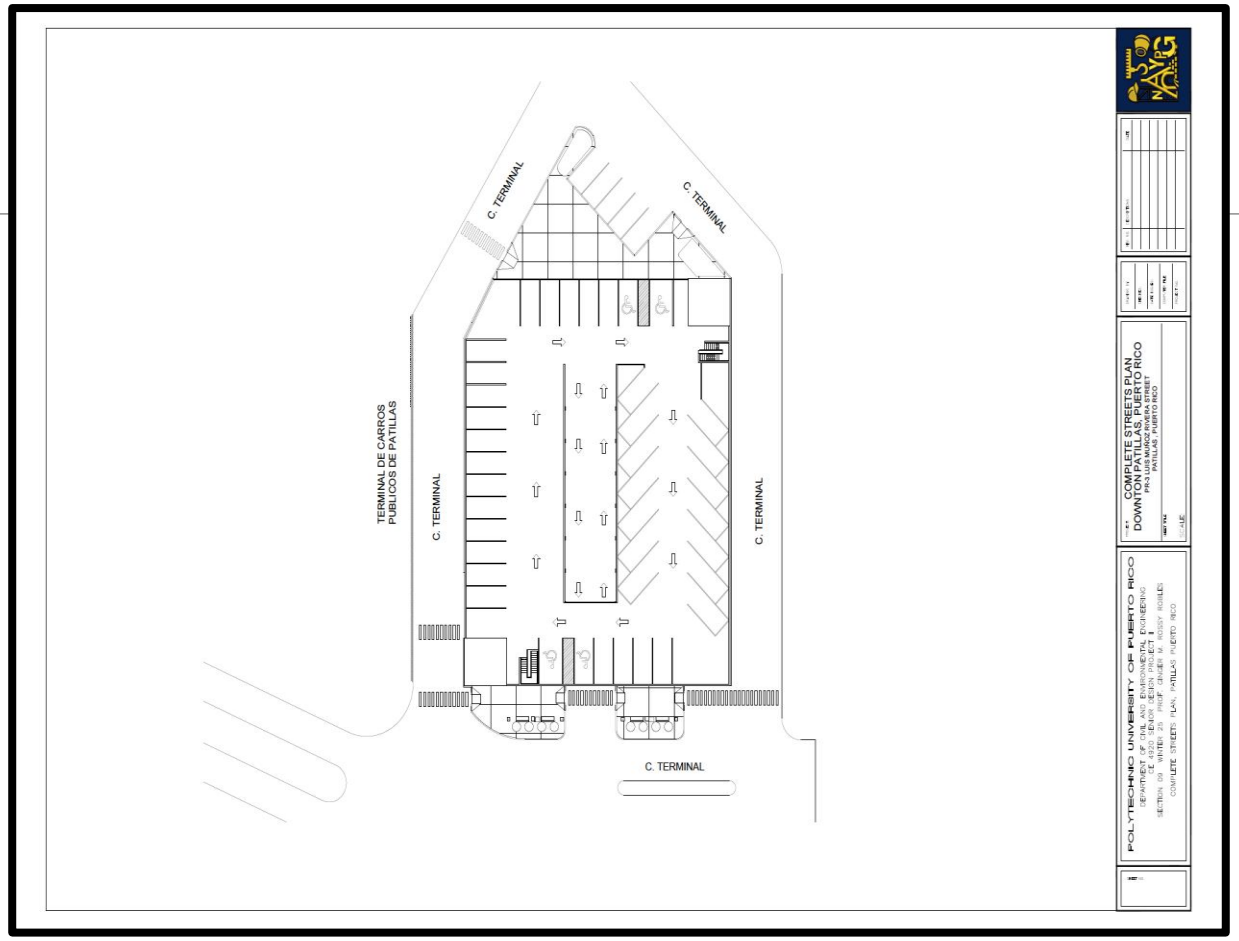


Figure 11. *Proposed Plan of the multi-story parking structure.*

Note. Drawing developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Existing Plan: Multi-story Parking Structure

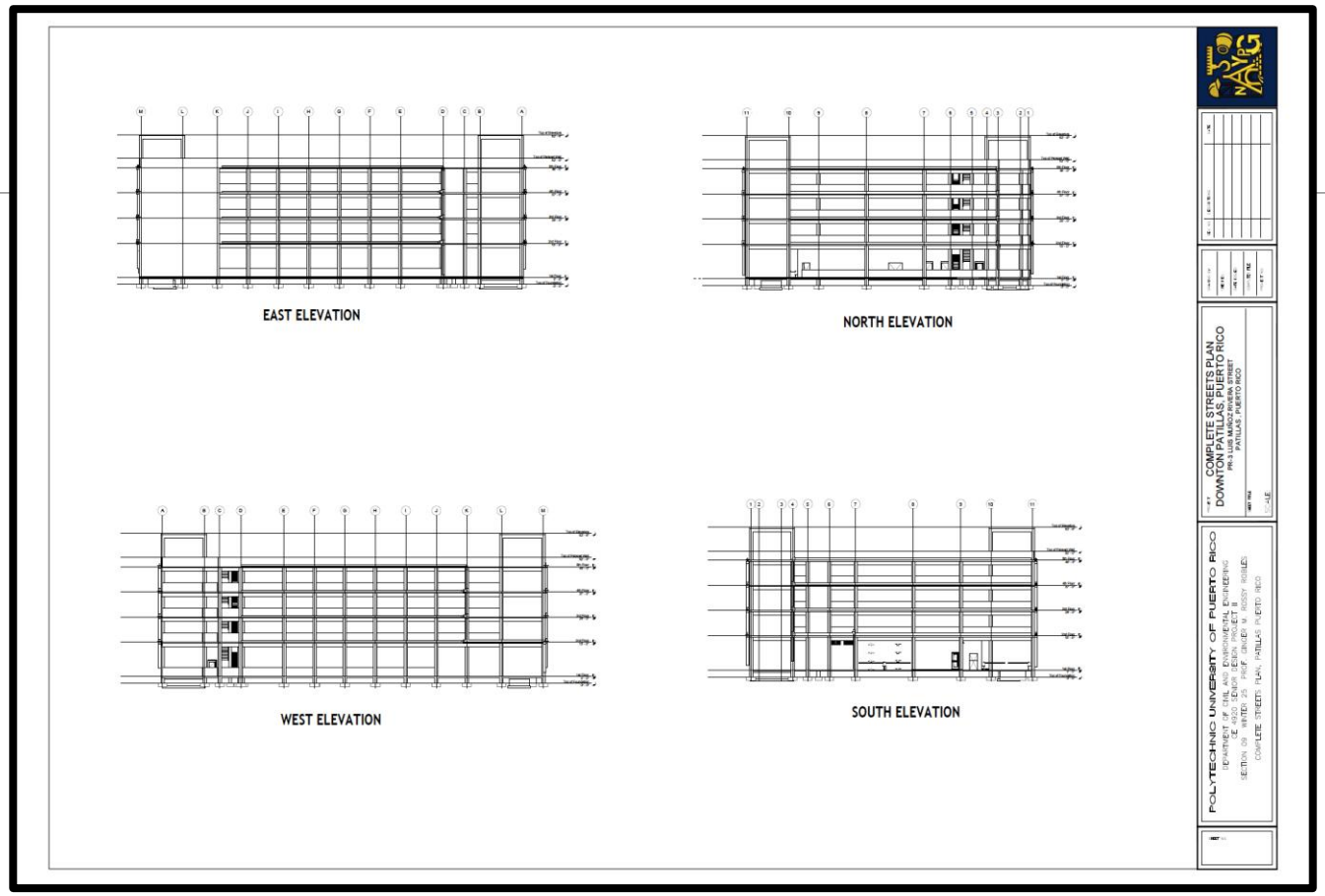


Figure 12. *Elevations of the multi-story parking structure.*

Note. Drawing developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Existing Plan: Multi-Story Parking Structure

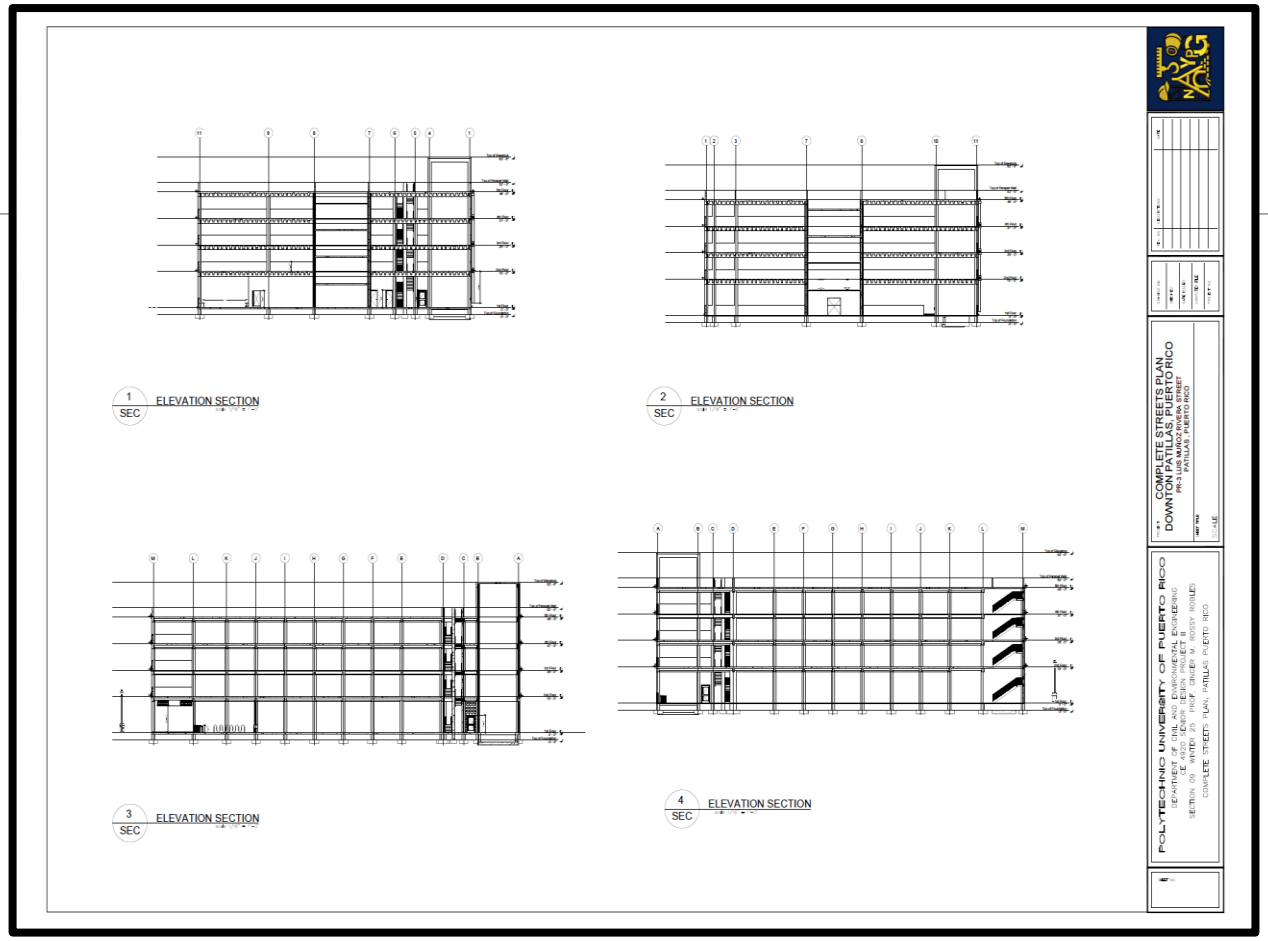


Figure 13. *Elevations Sections of the multi-story parking structure.*

Note. Drawing developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Final Designs: Multi-Story Parking Structure

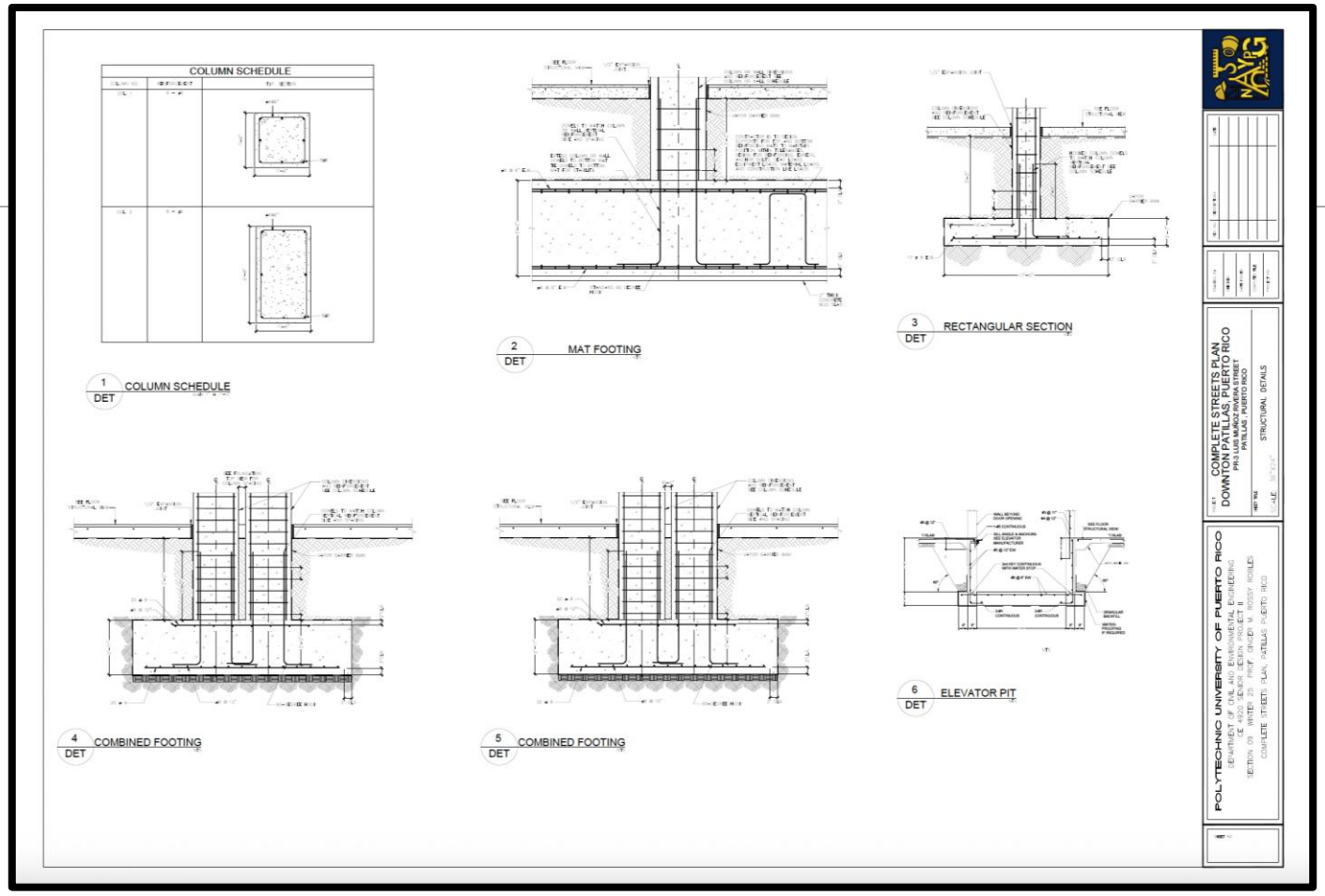


Figure 14. *Structural Details example of the multi-story parking structure.*

Note. Drawing developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Final Designs: Multi-Story Parking Structure

Figure 15. *Front façade view of the multi-story parking structure.*

Note. Render developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Final Designs: Multi-Story Parking Structure

Figure 16. *Worm's-eye view of the multi-story parking structure.*

Note. Render developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Final Designs: Multi-Story Parking Structure

Figure 17. *Aerial view of the multi-story parking structure.*

Note. Render developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Final Designs: Multi-Story Parking Structure

Figure 18. *Rear view of the multi-story parking structure.*

Note. Render developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Final Designs: Multi-Story Parking Structure

Figure 19. *Bus entrance view of the multi-story parking structure.*

Note. Render developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Final Designs: Multi-Story Parking Structure

Figure 20. *First floor inside view of the multi-story parking structure.*

Note. Render developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Final Designs: Multi-Story Parking Structure

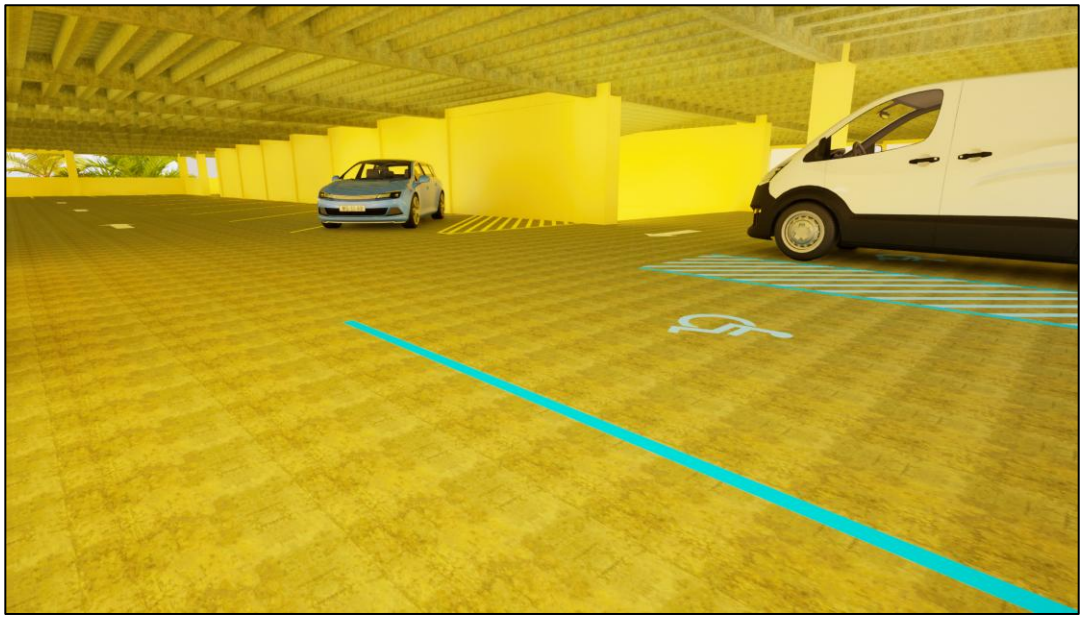


Figure 21. *Second floor view of the multi-story parking structure.*

Note. Render developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Final Designs: Multi-Story Parking Structure

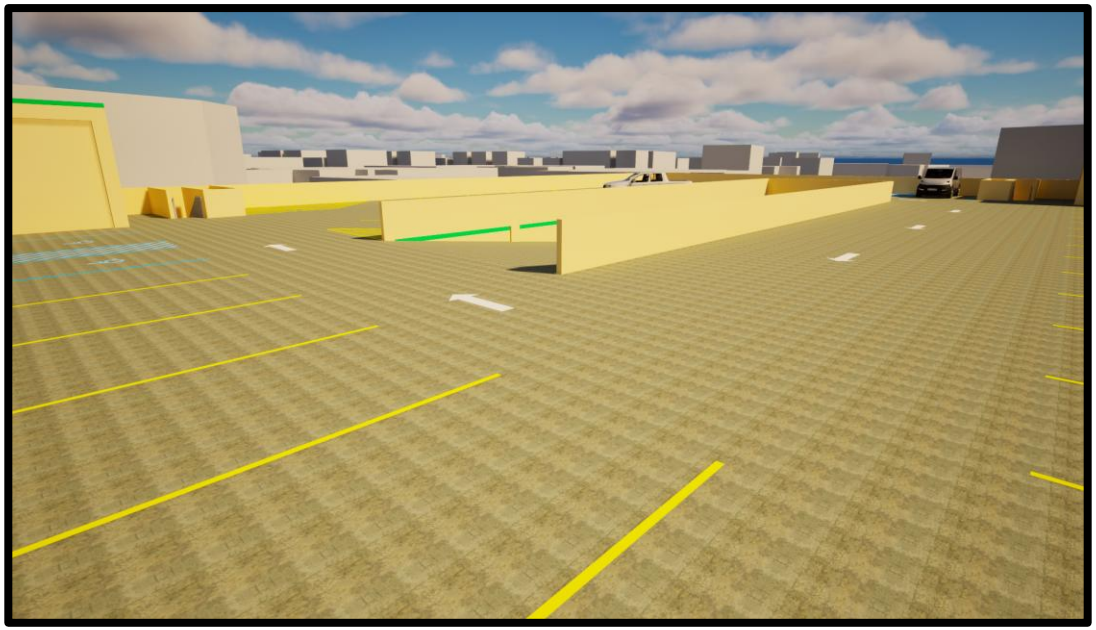


Figure 22. *Fifth floor view of the multi-story parking structure.*

Note. Render developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Final Designs: Multi-Story Parking Structure

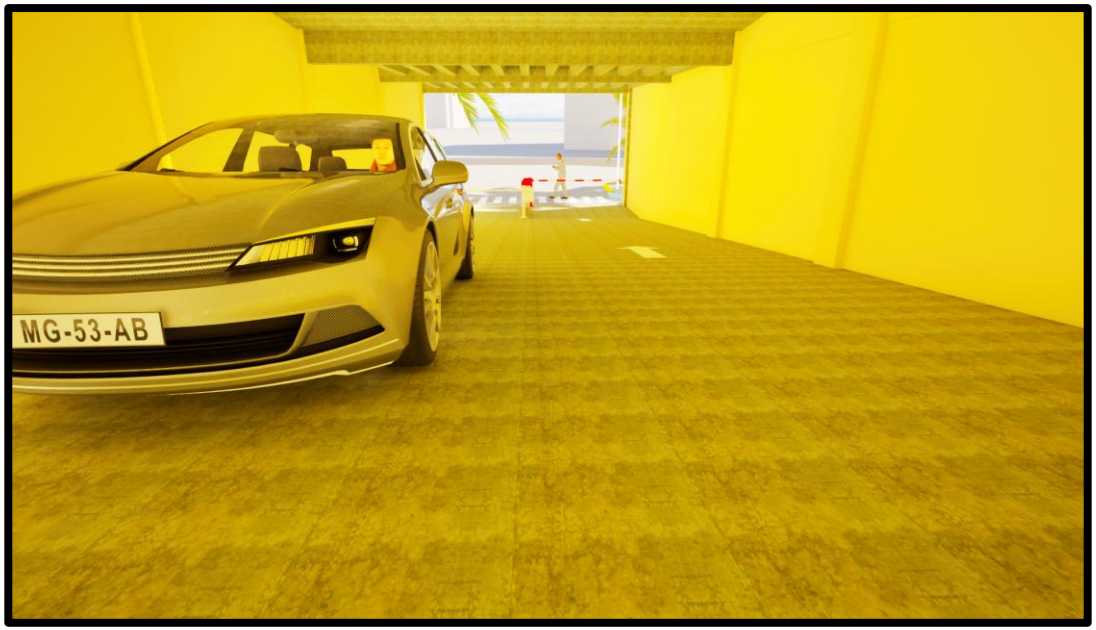


Figure 23. *Ramp view of the multi-story parking structure.*

Note. Render developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Final Designs: Multi-Story Parking Structure

Figure 24. Render video *of the multi-story parking structure.*

Note. Renders developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Final Designs: Multi-Story Parking Structure

Some of the features and advantages of the new structure are:

- Increases lot parking capacity from 74 parkings to 156 parkings. A 111% increase.
- Increases the quantity and quality of accessible parking, providing 16 ADA compliant handicap parkings across the facility. The current lot only has 4 handicap parkings. This represents a 300% increase.
- Creates a designated parking and storage space for the public bus fleet, increasing the security and reliability of the system.

Final Designs: Multi-Story Parking Structure

Some of the features and advantages of the new structure are:

- Frees the downtown area from most of the curbside parking, allowing for the new ADA compliant sidewalks design, embracing Complete Streets.
- It is fully integrated with the redirection of the right of way in the downtown area, along with the new Sidewalks and Public Transportation Stops design.
- Provides a safe connection with the current bus terminal, so the public can use the new parking facility along with the public transportation system.

Estimated Project Cost: Multi-Story Parking Structure

Estimated Cost of the Multi-Story Parking Facility

ITEMS	UNITS	DESCRIPTION	QTY	UNIT PRICE	AMOUNT
0	LS	General Condition (Taxes, B2B, PPBOND, CFSE, Other cost)	1.00	$ 4,989,000.00	$ 4,989,000.00
1	LS	Moblization	1.00	$ 261,504.76	$ 261,504.76
2	LS	Removal of Structure and Obstructions	1.00	$ 37,110.00	$ 37,110.00
3	CuM	Excavation Multipiso	6380.00	$ 63.83	$ 407,250.00
4	CuM	Borrow Class B (A-2-4) "Backfill"	5469.00	$ 70.94	$ 387,967.00
5	Pound	Structural Reinforcements	358892.14	$ 5.86	$ 2,104,543.51
6	LnM	Sanutary drainage 6"	33.00	$ 389.98	$ 12,869.47
7	LnM	Pluvial Drainage 6"	328.38	$ 190.47	$ 62,545.89
8	LnM	Pluvial Drainage 12"	397.84	$ 213.72	$ 85,027.37
9	LnM	Cooper Tube 3/4"	79.42	$ 51.63	$ 4,100.22
10	CuYd	Concrete: Slab Edge, Basic Wall, Beam, Column, Floor and Footing	4303.19	$ 541.83	$ 2,331,587.51
11	SqFt	Basic Wall: Generic - 6" Masonry	4518.00	$ 25.17	$ 113,711.37
12	SqFt	Paint: Beige, White, Green	95336.00	$ 1.23	$ 117,235.00
13	Ea	Door-Exterior-Single-Two_Lite: 36" x 84": 2	2.00	$ 2,500.00	$ 5,000.00
14	Ea	Door-Exterior-Single-Two_Lite: 42" x 84": 2	2.00	$ 2,886.00	$ 5,772.00
15	Ea	Door-Opening: 42" x 84": 1	1.00	$ 2,289.00	$ 2,289.00
16	Ea	Door-Opening: 72" x 84": 1	1.00	$ 4,900.00	$ 4,900.00
17	Ea	Door-Passage-Single-Flush: 36" x 84": 3	3.00	$ 1,616.67	$ 4,850.00
18	Ea	Window-Awning-Double-Horizontal: 48" x 17": 2	2.00	$ 688.62	$ 1,377.23
19	Ea	Window-Awning-Triple-Horizontal: 60" x 17": 2	2.00	$ 878.00	$ 1,756.00
20	Ea	Planting	33.00	$ 330.76	$ 10,915.00
23	LS	Electrical Works (Allowances)	1	$ 3,548,265.00	$ 3,548,265.00
24	LS	Fire protection system (Allowances)	1	$ 600,000.00	$ 600,000.00

Precio Total Est.	$ 15,099,576.32
Tiempo Est. (Dia)	566

Figure 25. *Estimated Cost of the Multi-Story Parking Facility.*

Note. Table developed by Andres Martinez.

Strategies and Proposals: Multi-story Parking

Some additional recommendations for the new parking structure are:

1. Conduct a thorough geotechnical analysis for the proposed site.
2. Establish a fare for the multi-story parking to cover operational expenses.
3. To promote sustainability and resilience, install solar panels on the 5th floor of the structure.
4. Add EV charging infrastructure.
5. Install security cameras and provide 24-hour security service.

Existing Problems:
Sidewalks, Signage and Pavement Markings

Figure 26. Conditions of existing parking lot.
Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Existing Problems:
Sidewalks, Signage and Pavement Markings

Signage is largely absent, limiting wayfinding and providing insufficient guidance for drivers and visitors.

Curbside parking deficiencies: lack of pavement markings leads to unregulated parking and inefficient curb use.

Yellow-curb violations: vehicles park in restricted areas, affecting operations and sight distance.

The coexistence of arterial through-movement and local curbside access within a constrained downtown footprint amplifies multimodal conflicts.

Two-sided parking on narrow streets reduces roadway width and restricts large-vehicle movement.

Turning radius/corner clearances are compromised by insufficient corner control and lack of restricted curb space.

Widespread accessibility deficiencies: non-compliant curb ramps and improperly applied blue markings that create safety risks.

PR-3 lacks marked crosswalks, increasing pedestrian exposure and conflict risk.

Existing Problems:
Sidewalks, Signage and Pavement Markings

Figure 27. Conditions of existing sidewalks.

Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Existing Problems:
Sidewalks, Signage and Pavement Markings

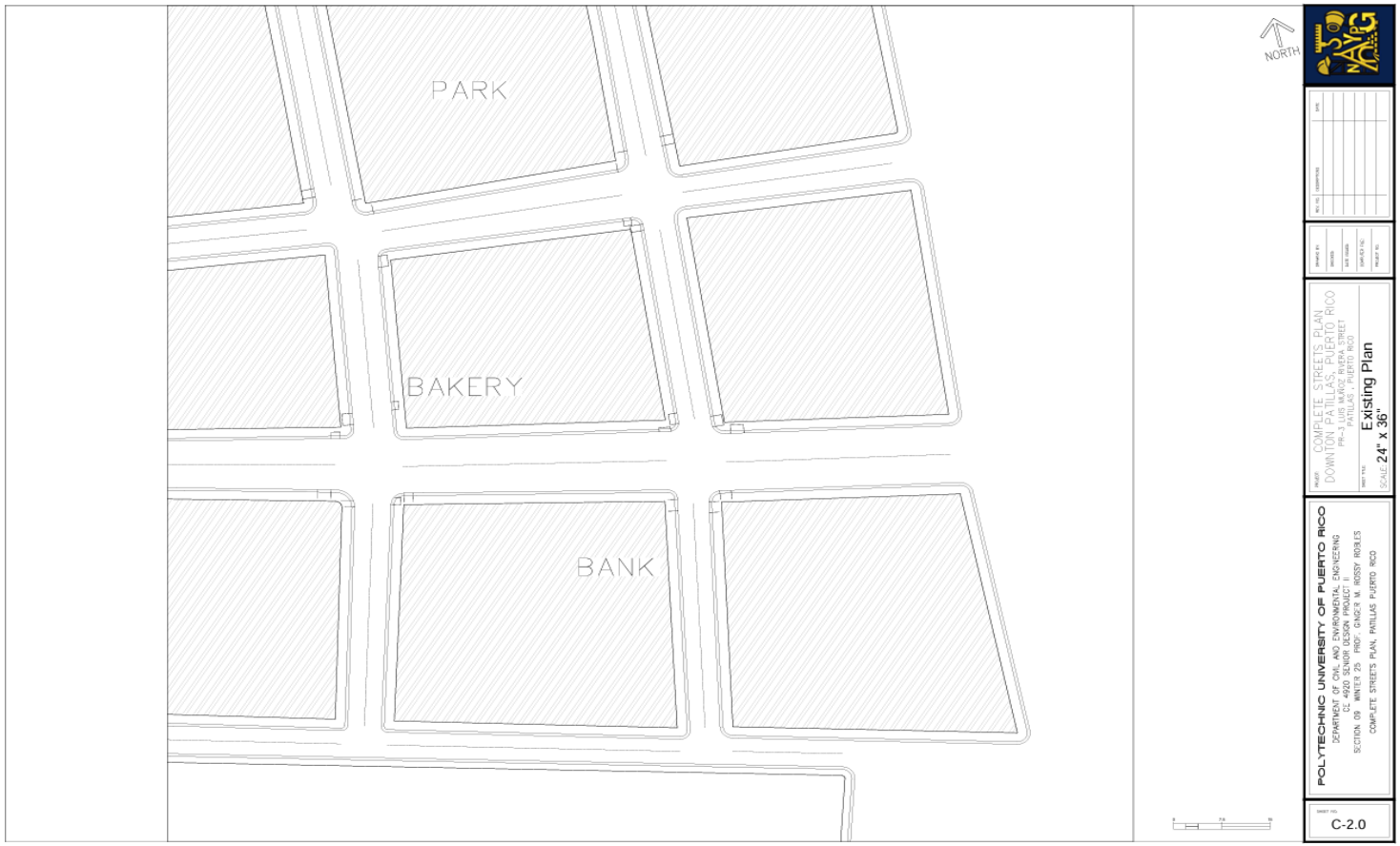


Figure 28. Conditions of existing sidewalks.

Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Existing Problems: Public Transportation Stops

- Most public transportation stops are informal meaning passengers are picked up in unmarked roadside locations, or in deteriorated condition which reduce comfort and safety.
- Many locations lack basic infrastructure, including benches, shelters, lighting, and signage.
- Informal stop locations create operational inefficiencies, as drivers rely on personal knowledge rather than clearly defined stop locations.

Existing problems images of Public Transportation Stops

Figure 29
Current conditions at the bus stop.
Note: Picture by Jean Calderón (2025).

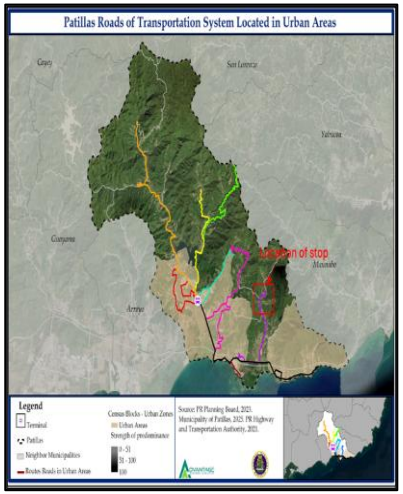


Figure 30
Location of the bus stop shown in Figure ? (Patillas, Puerto Rico)
Note: Source: ABC (2025).

Figure 31
Current conditions at the bus stop.
Note: Picture by Jean Calderón (2025).

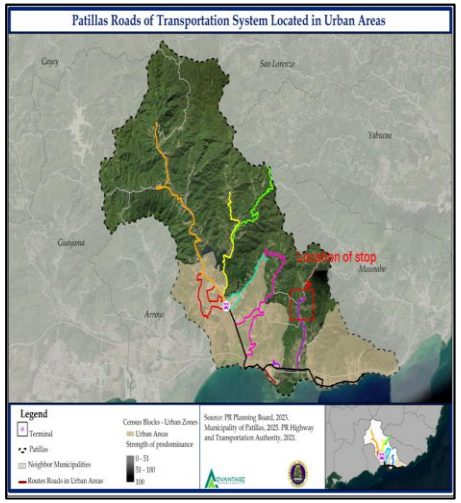


Figure 32
Location of the bus stop shown in Figure ?/, Patillas, Puerto Rico
Note: Source: ABC (2025).

Final Designs: Public Transportation Stops

- The final design proposes a monolithic precast concrete bus stop, where the roof, floor slab, walls and columns act as one integrated structural system providing a precast bench for resting during the waiting time.
- The monolithic configuration improves structural efficiency, allowing reduced material and reinforcement quantities for a low-cost, constructible design.
- Precast construction enables rapid installation, durability, and reduced long-term maintenance.

Final Designs: Public Transportation Stops

- The structure is designed to resist applicable dead and live loads, including self-weight, using SkyCiv Software as the reference for structural analysis tool and appropriate load combinations.
- The design is ADA compliant, providing required clear floor space and safe access for wheelchair users.
- The design incorporates a logo for the Municipality of Patillas which will be integrated directly into the precast concrete structures to reinforce local identity and provide consistent recognition across public transportation stops.

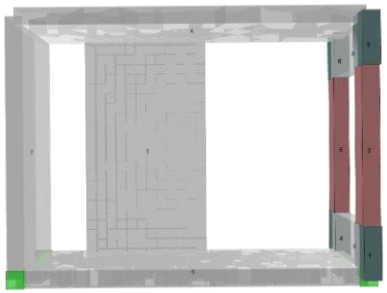
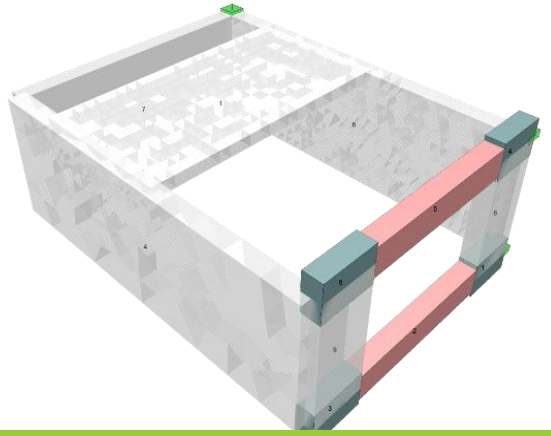


Figure 33
3D Render view from Skyciv Structural Analysis Program.
Note: Provided by Paulo Quintana Ríos



Final Architectonic Plans for Public Transportation Stops.

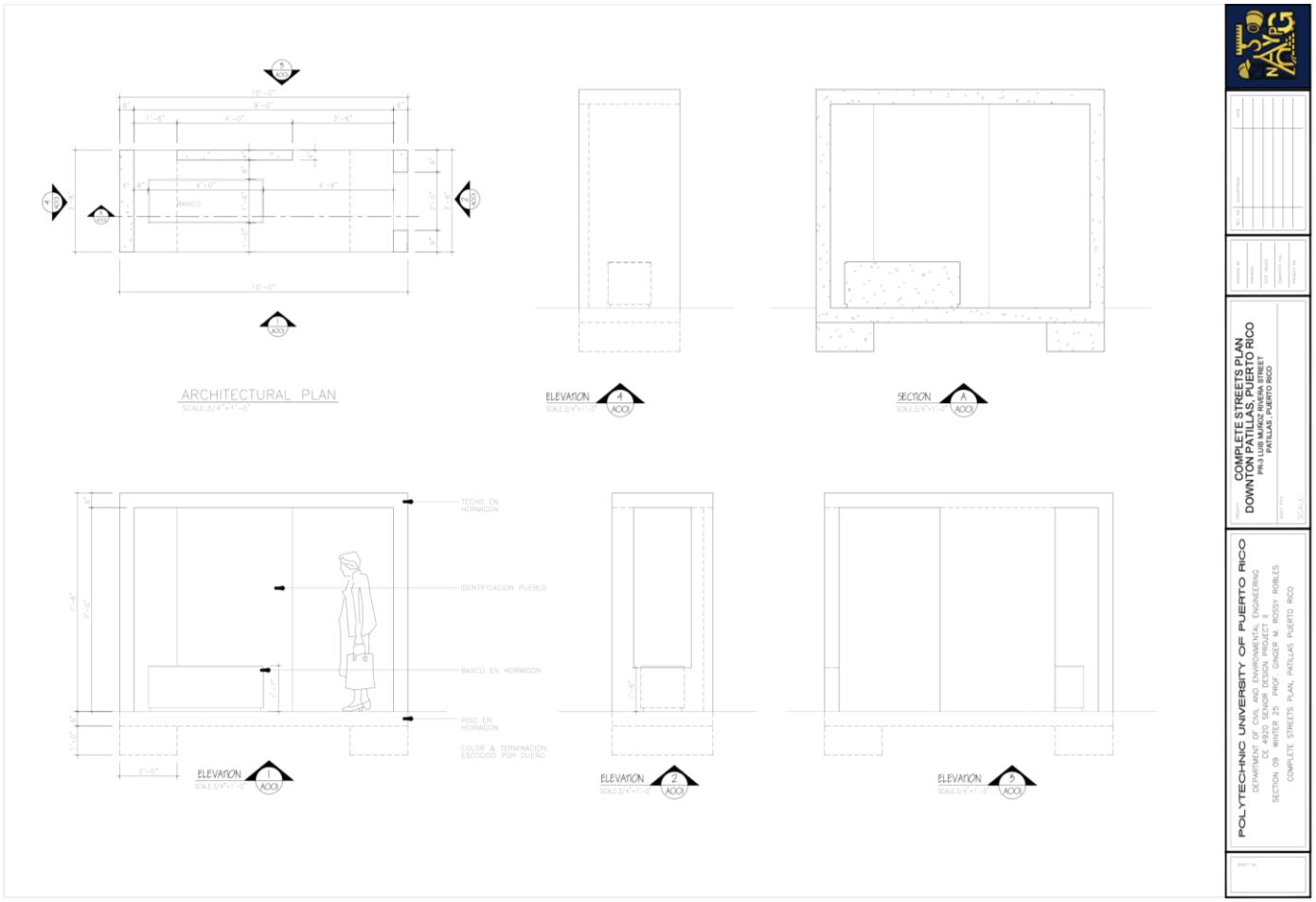


Figure 34
Final Design Architectonic Plan.
Note: AutoCAD plan provided by Paulo Quintana.

Final Structural Plans for Public Transportation Stops.

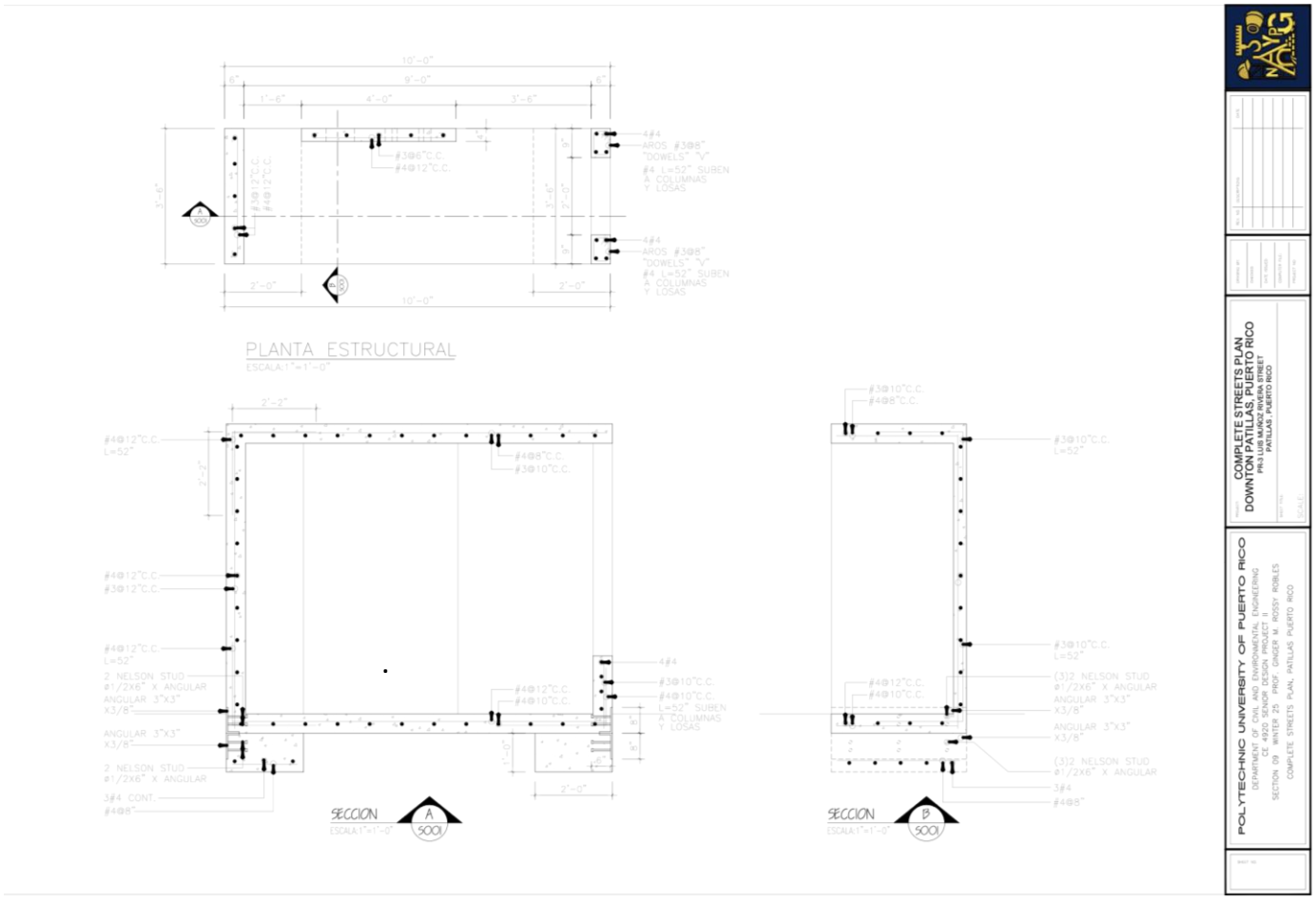


Figure 35
Final Design Structural detail Plan.
Note: AutoCAD Plan provided by Paulo Quintana.

Final Design for Municipality Logo.

Figures 36
Proposed Municipality Identity Logo for Patillas, Puerto Rico.
Note: Proposed design provided by Paulo Quintana.

Final Render Design for Public Transportation Stops Model A

Figures 37

Final Render Design with Identity Logo for Patillas, Puerto Rico.

Note: Renders for Public Transportation Model A provided by Paulo Quintana.

Final Render Design for Public Transportation Stops Model B.

Figures 38

Final Render Design with Identity Logo for Patillas, Puerto Rico.

Note: Renders for Public Transportation Model B provided by Paulo Quintana

Schedule: Public Transportation Stops

Public Transportation Stops (60 Days)

- Design & Coordination: 10 days
- Precast Fabrication & Finishing: 20 days
- Jobsite Preparation : 10 days
- Transportation & Installation: 10 days
- Final Adjustments & Site Cleanup: 5 days

Estimated Project Cost:
Public Transportation Stops

Estimated Cost of the Proposed Public Bus Stop

Cost Category	Description / Scope	Unit	Estimated Cost (Single Unit)($)	Notes / Assumptions
Permission	*Construction Permit*	*Ea*	$ *1,500.00*	-It is assumed that all bus stops are submitted together under a single construction package,
Permission	*DTOP Excavation Permit*	*Ea*	$ *2,500.00*	so permits and certifications are estimated as a one-time, project-wide cost (including
Permission	*Utility Excavation Notification*	*Ea*	$ *2,500.00*	construction, DTOP excavation, 811 notification, and construction/use certification); final
Permission	*Construction Certificacion / Use Permit*	*Ea*	$ *6,000.00*	costs may vary based on complexity, phasing, and site conditions.
Reinforcement Concrete Materials	2.8 yd3 for concrete.	CuYd	$ 4,215.00	-This cost covers all the concrete and rebar for manufacture materials for each unit.
Molds	Molding for precast manufacture (Total cost for molds)	Ea	$ 9,800.00	-Cost is divided by the total units.
Transportation		Ea	$ 600.00	-Cost is based on 6 units (Capacity of flatbed truck).
Site works	Footing concrete -Anchoring Plates -Excavation	Ea	$ 730.00	-Cost is based on each unit.
Installation Equipment	Crane Service -Welding Equipment	Ea	$ 3,400.00	-Cost is based on 6 units.

Total Estimate (Ea)	*Qty*	*Amount*
$ 31,245.00	1	$ 31,245.00

Figure 39. *Estimated Cost of the Proposed Public Transportation Stops*

Note. Table developed by Andres Martinez.

Strategies Public Transportation Stops

- Propose the installation of precast concrete public transportation stops within the Municipality of Patillas.
- The proposed precast concrete stops provide a low-cost, structurally safe solution designed to withstand harsh weather conditions and saline coastal environments due to the proximity to the sea.
- The system is intended to replace informal and deteriorated unsafe boarding locations with durable, clearly defined transit infrastructure.
- The proposed design prioritizes structural safety, durability, and long-term performance while maintaining cost efficiency.

Proposals for Public Transportation Stops.

- Install precast concrete stops to replace unsafe or informal existing stops and to introduce new stops at strategically selected locations to improve safe pedestrian access.
- Reduce walking distances and improve direct access to the existing public transportation network.
- Optimize route efficiency and overall travel time by formalizing boarding locations and reducing informal pick-up activity.
- Implement simple, cost effective, functional, and ADA-compliant designs suitable for municipal installation and operation.

Strategies and Proposals: Sidewalks, Signage and Pavement Markings

- The one-way configuration reduces conflict points, improves flow continuity, and minimizes vehicle-vehicle and vehicle-pedestrian interaction.
- Conflict points are reduced from X to Y under the proposed configuration.
- Narrowed travel lanes.
- The improved pedestrian crossings reduce exposure time and improve safety perception.

Strategies and Proposals:
Sidewalks, Signage and Pavement Markings

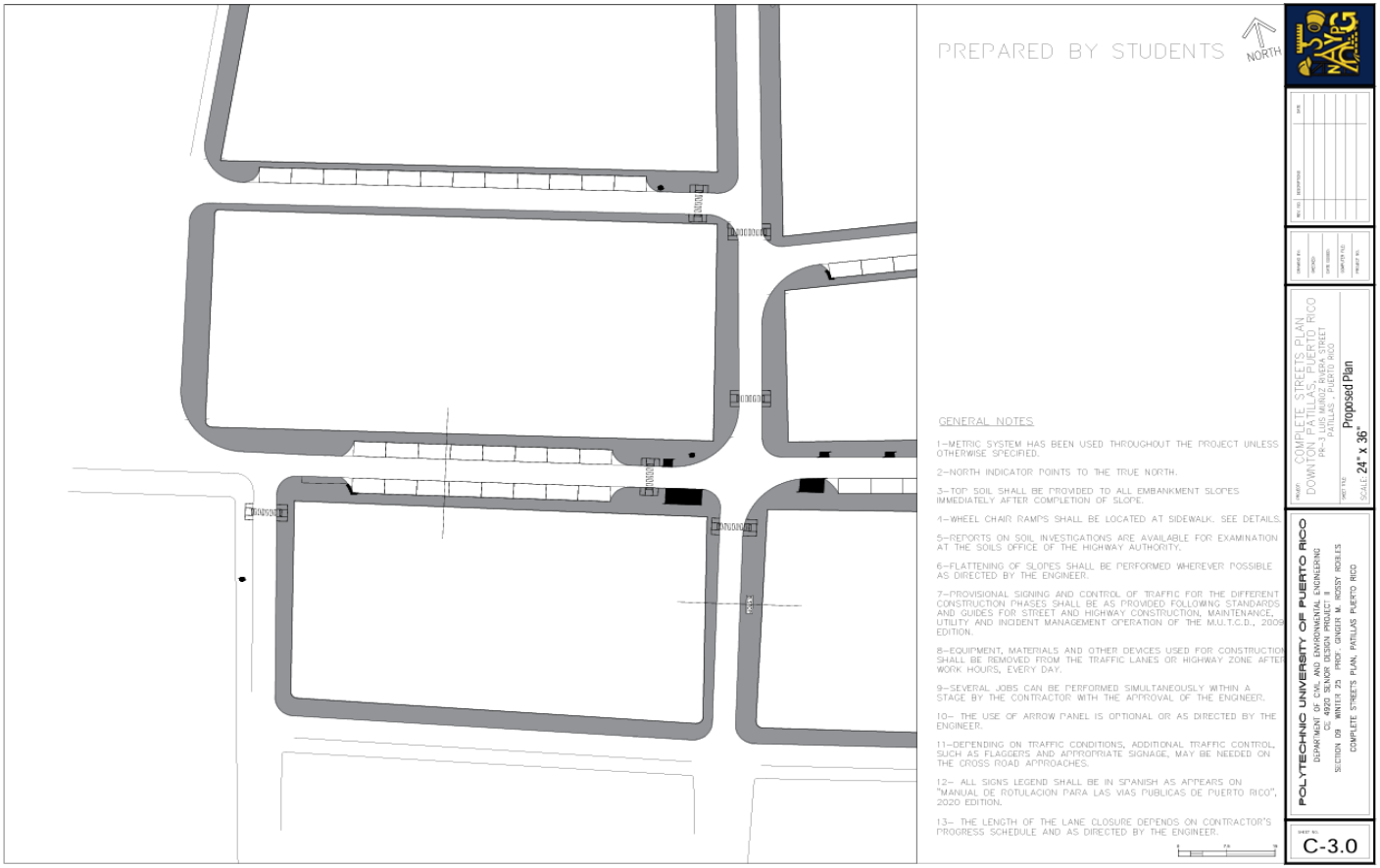


Figure 40. Proposals sidewalks.

Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Strategies and Proposals:
Sidewalks, Signage and Pavement Markings

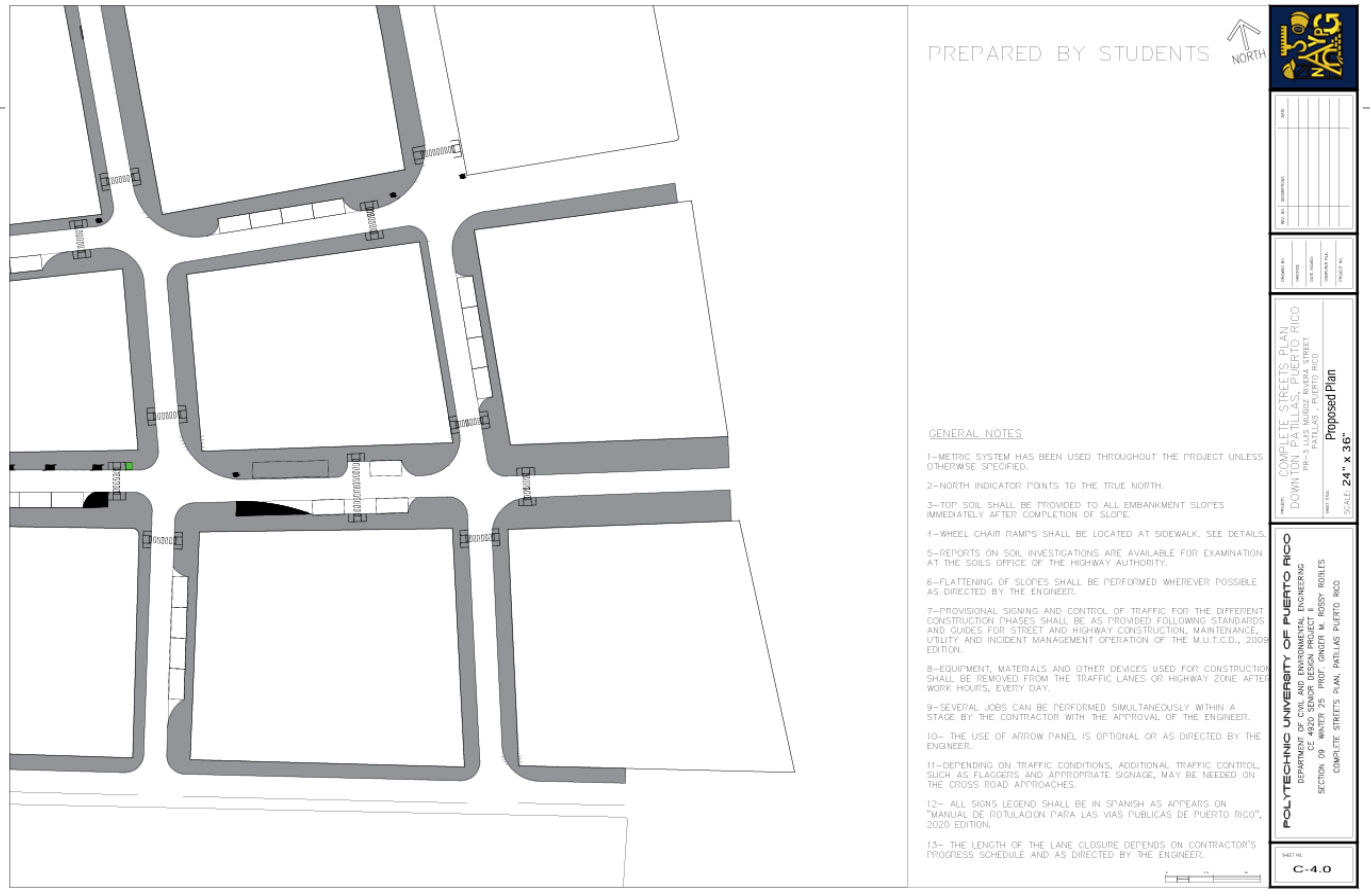


Figure 41. Proposals sidewalks.

Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Strategies and Proposals:
Sidewalks, Signage and Pavement Markings

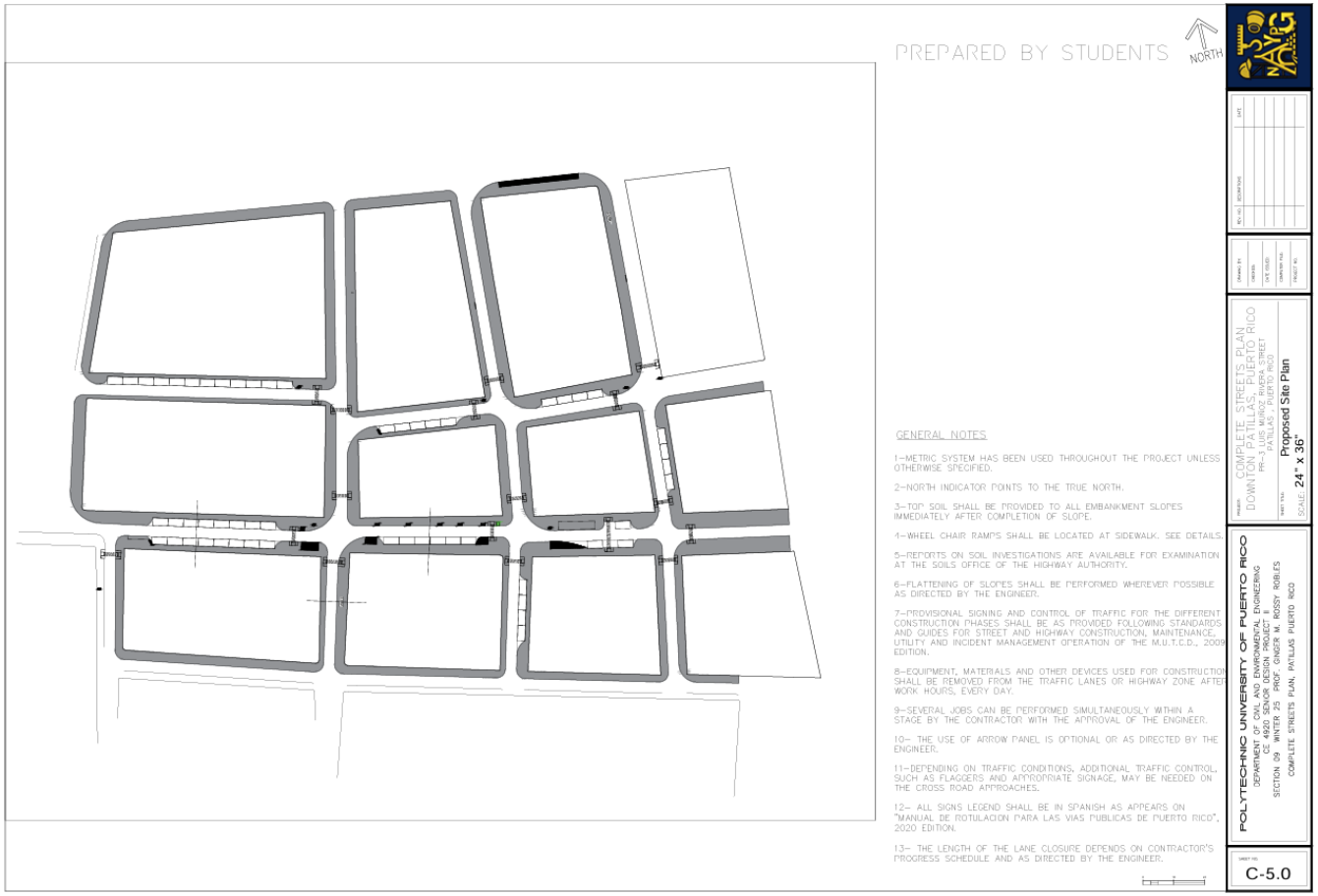


Figure 42. Proposals sidewalks side-plan.

Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Strategies and Proposals:
Sidewalks, Signage and Pavement Markings

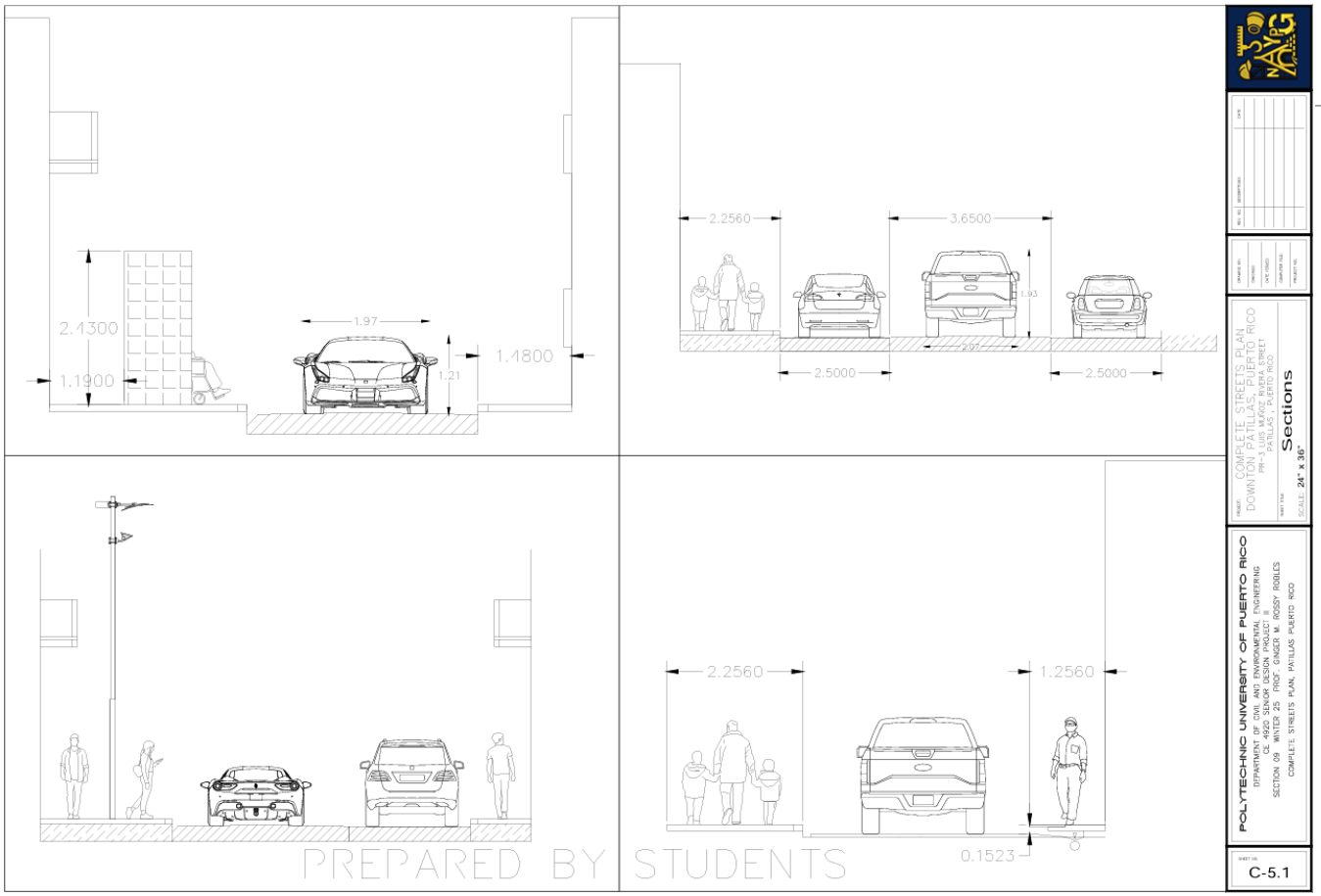


Figure 43. Sections.

Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Strategies and Proposals: Details
Sidewalks, Signage and Pavement Markings

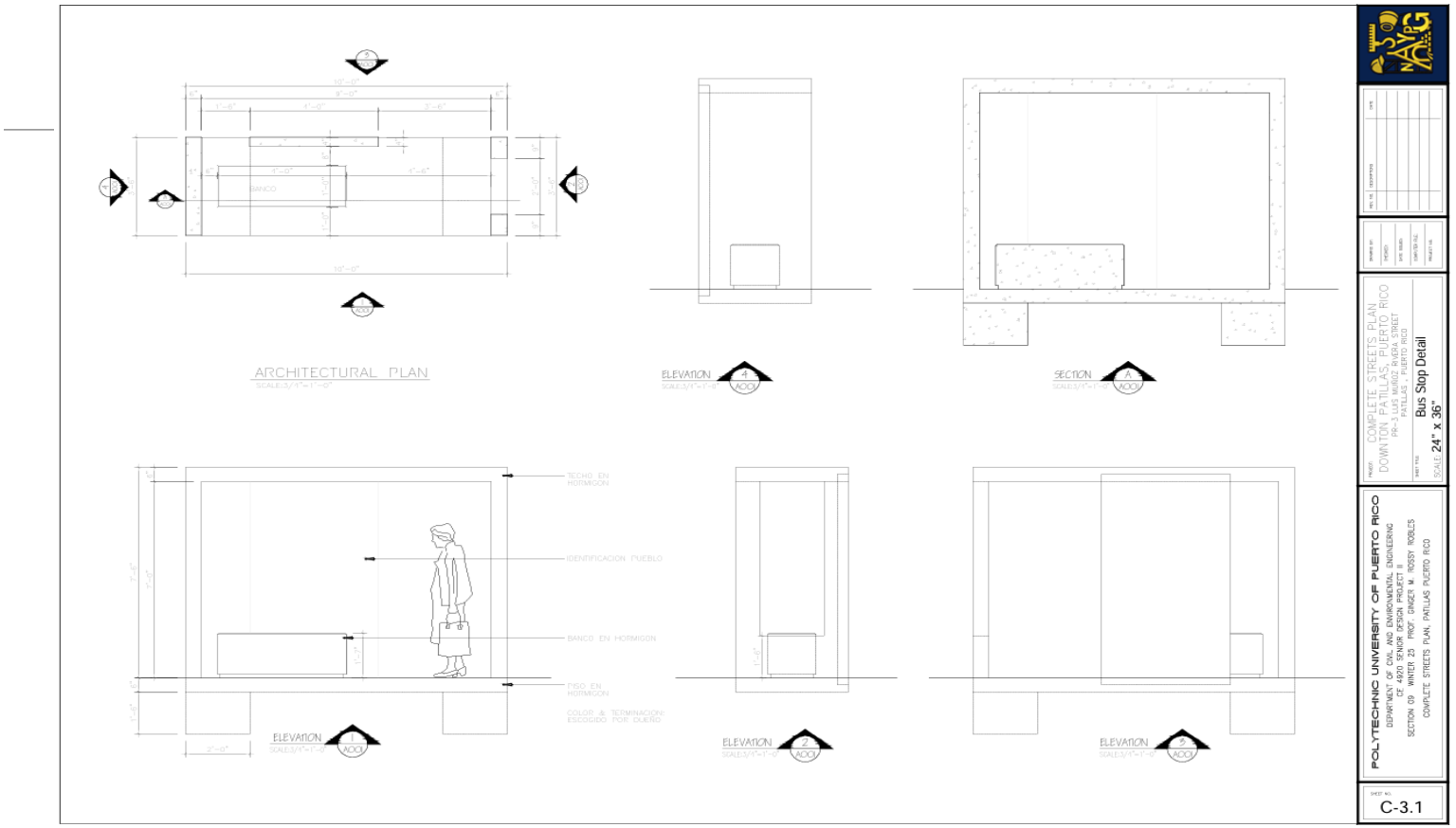


Figure 44. Bus stop proposals (sections).
Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Strategies and Proposals: Details
Sidewalks, Signage and Pavement Markings

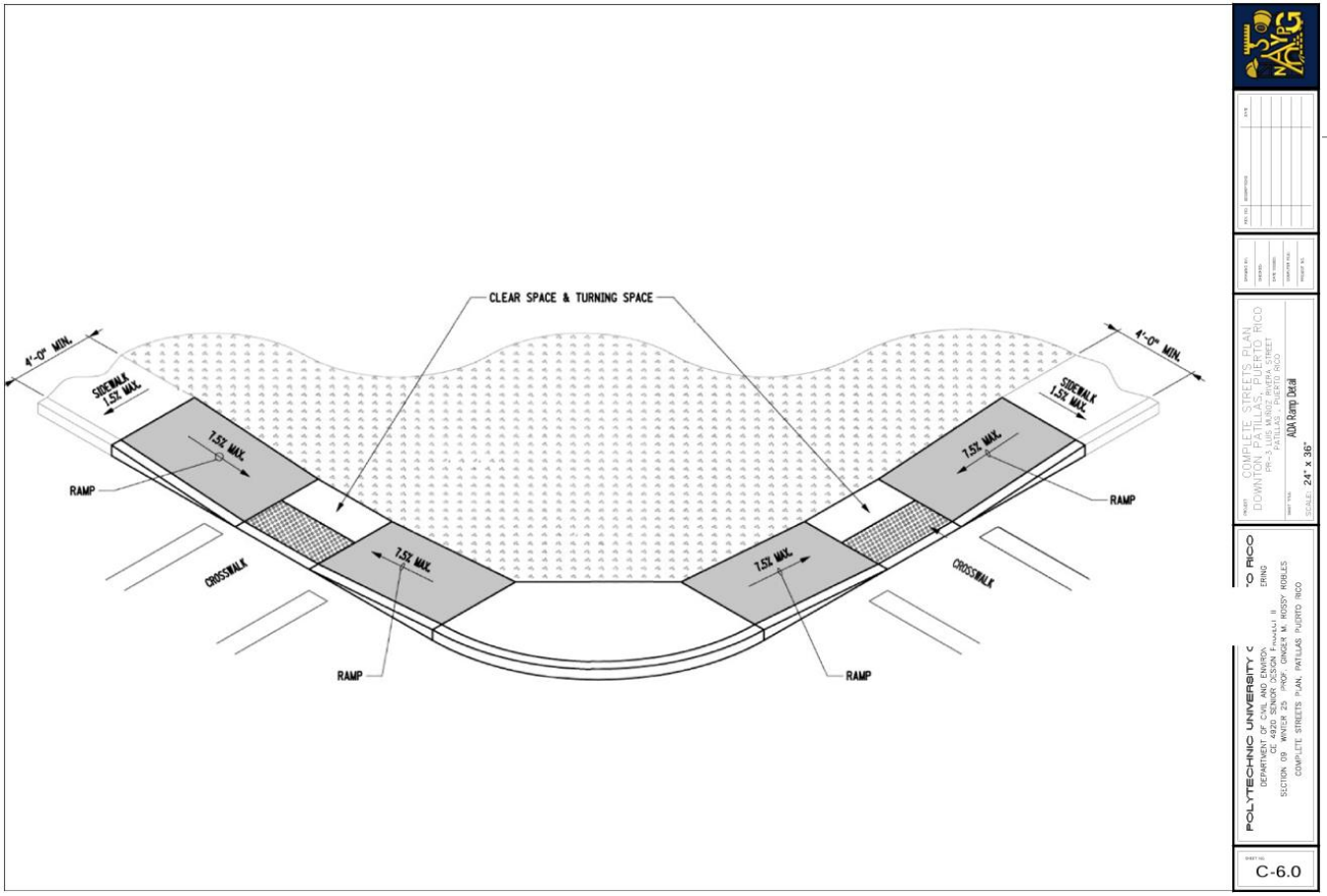


Figure 45. Ramps & curves for pedestrians.
Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Strategies and Proposals: Details
Sidewalks, Signage and Pavement Markings

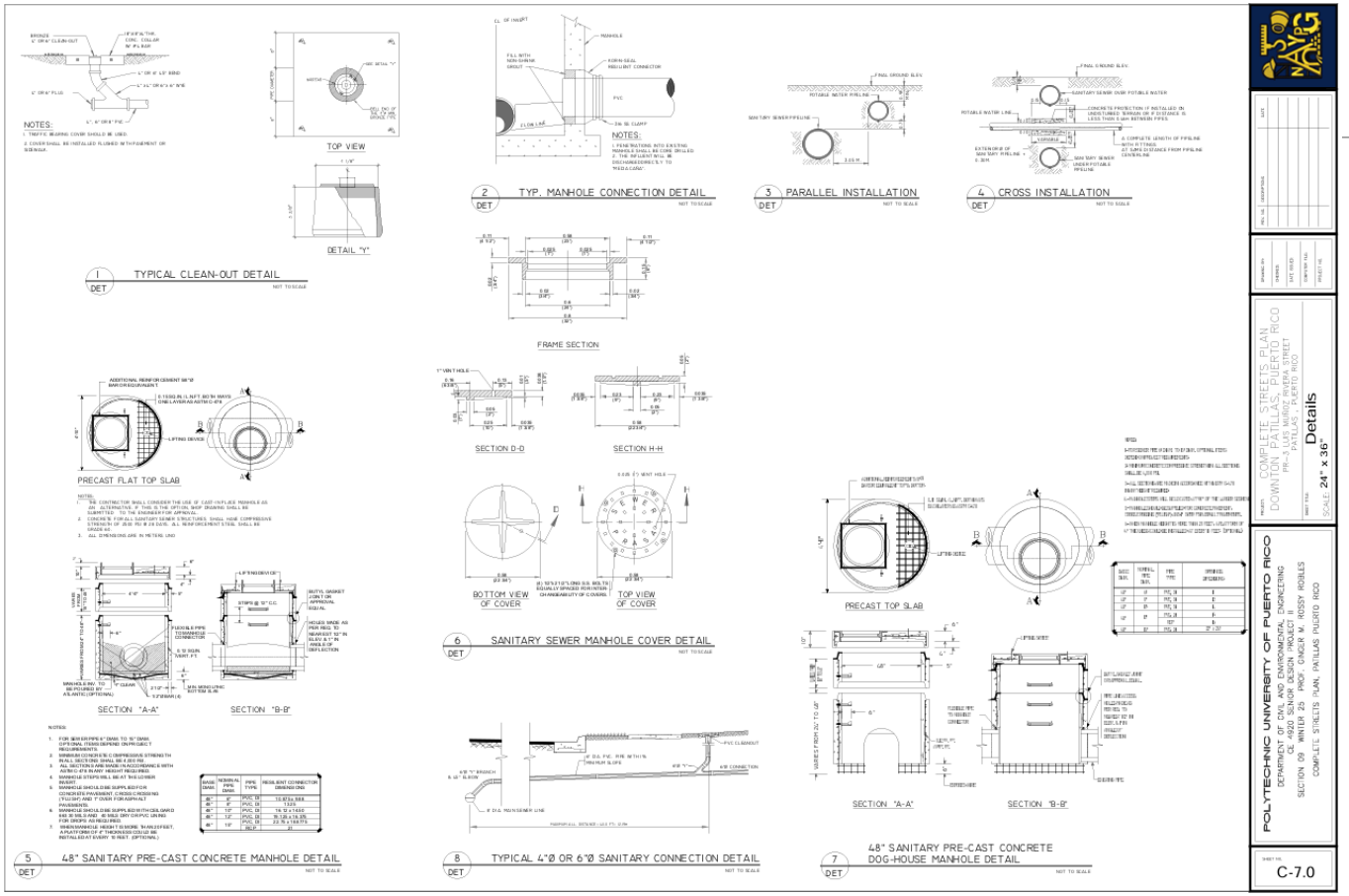


Figure 46. Manhole section details.

Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Strategies and Proposals: Details
Sidewalks, Signage and Pavement Markings

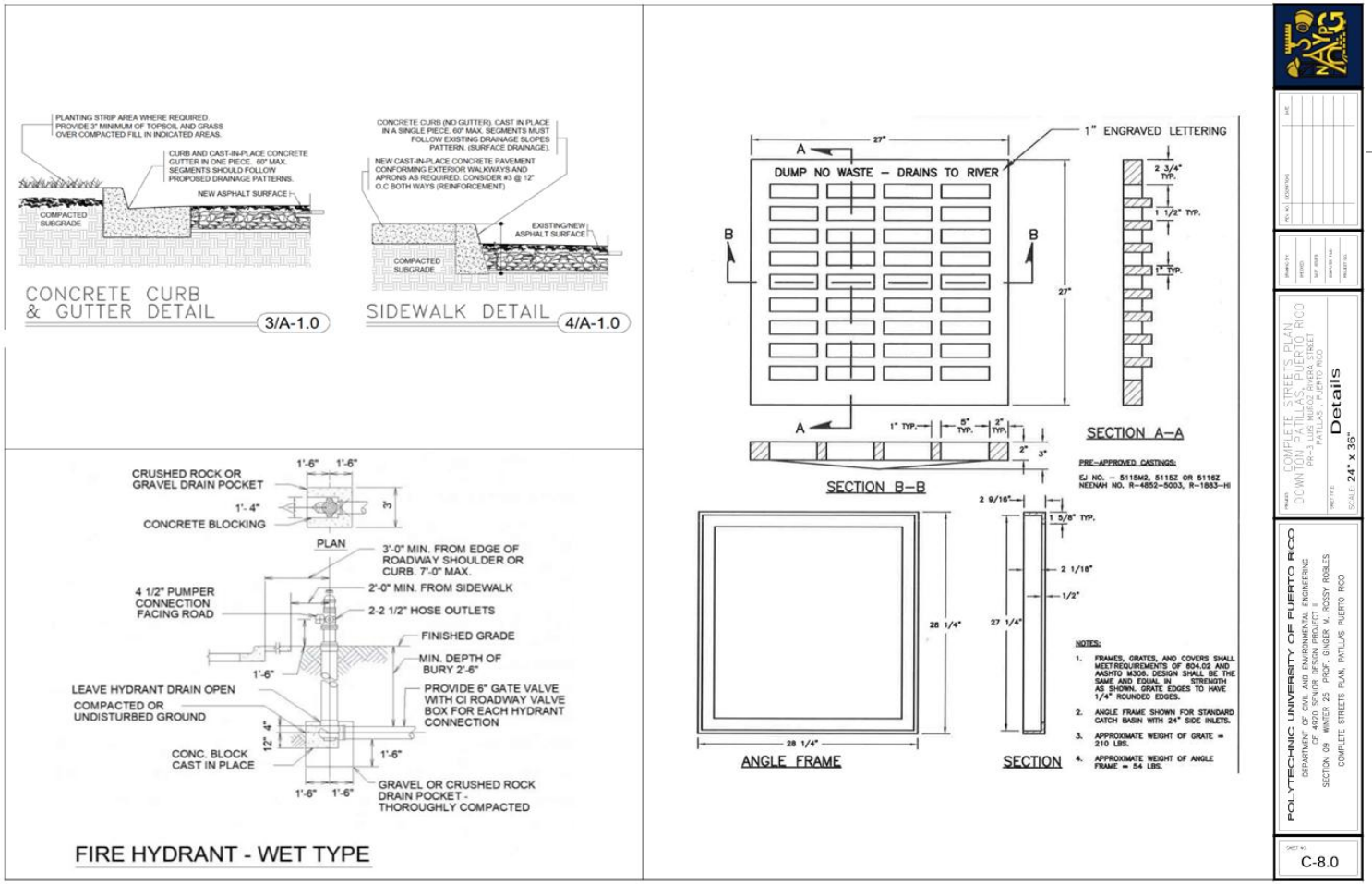


Figure 47. Hydrants , Concrete curb & linear drainage grate.
Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Strategies and Proposals:
Visual signage scenery

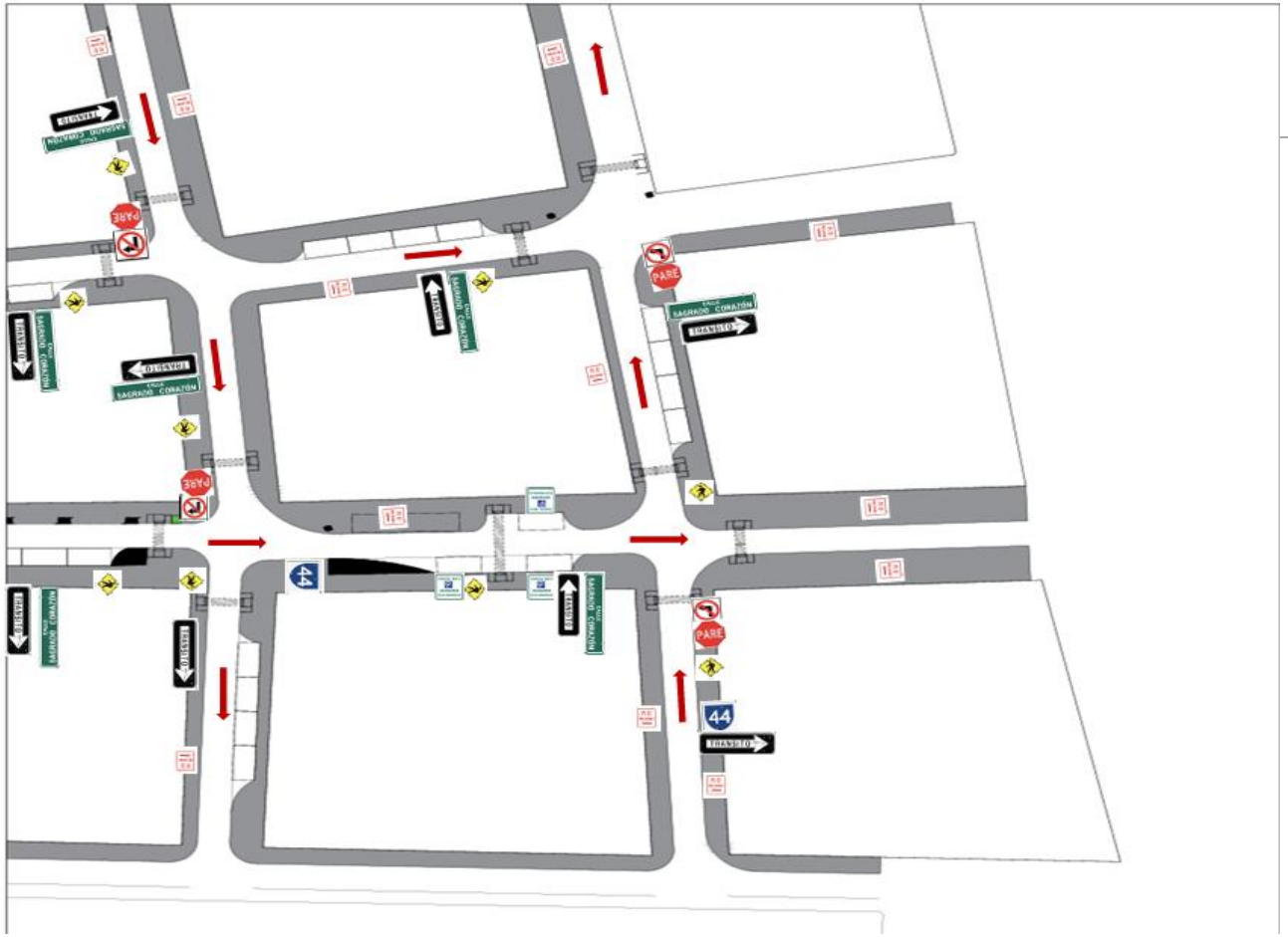


Figure 48. Signage.

Note. Video shot by Civil Engineering students of the Patillas Complete Streets Capstone Project, with the help of Sharetech Group. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Strategies and Proposals:
Sidewalks, Signage and Pavement Markings

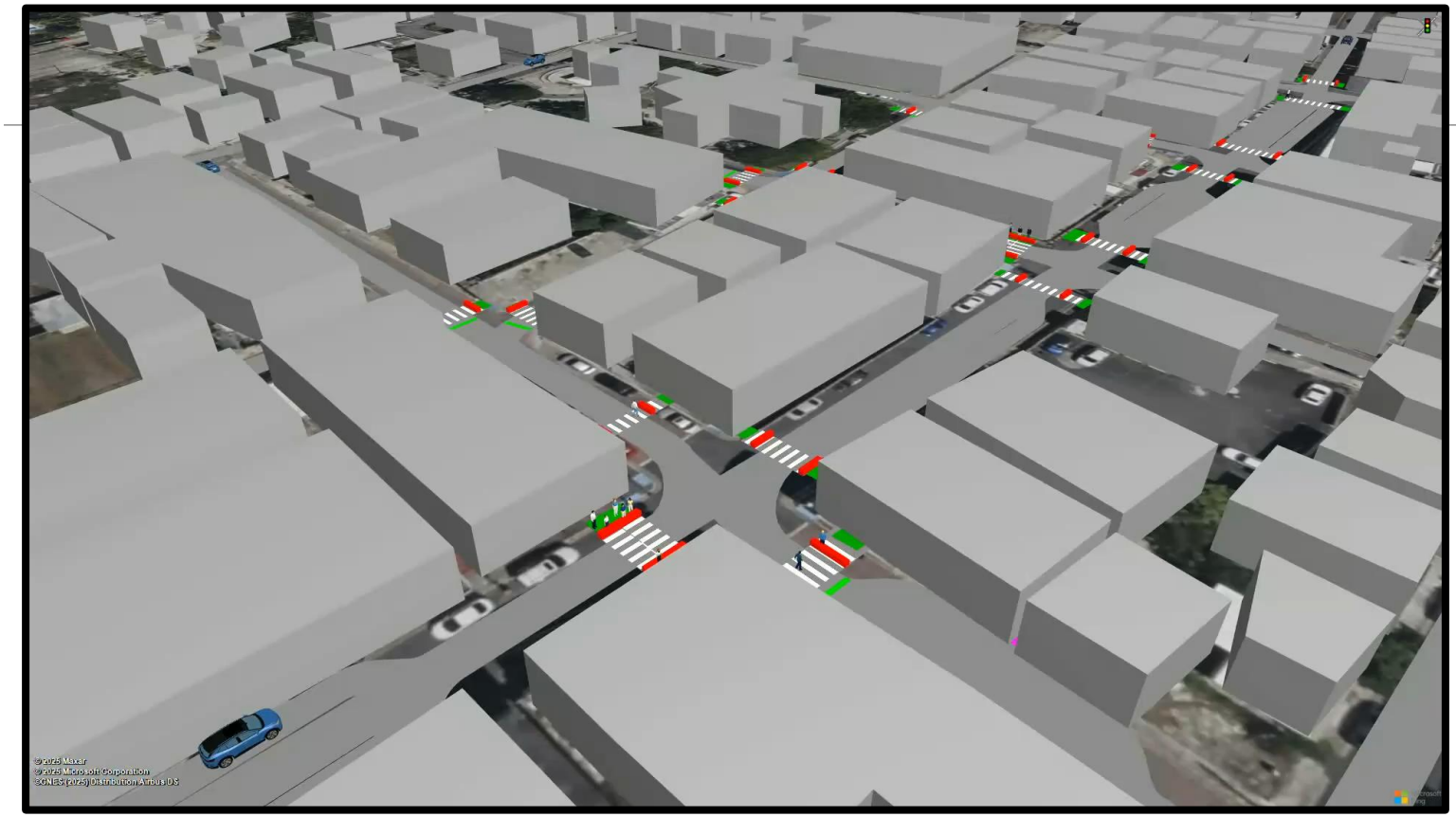


Figure 49. VISSIM Simulation of the proposed redirection of transit.

Note. Simulation developed by the Civil Engineering students of the Patillas Complete Streets Capstone Project. Property of the Polytechnic University of Puerto Rico, Civil Engineering Department.

Strategies and Proposals:
Sidewalks, Signage and Pavement Markings

Signage and Markings Maintenance Program (DTOP/MUTCD)

- Implement a scheduled maintenance program with routine inspections and preventive repairs.
- Ensure adequate daytime/nighttime visibility and retroreflectivity of signs and markings.
- Use high-durability materials (e.g., retroreflective thermoplastic) to extend service life.
- Prioritize treatments at critical locations (intersections, high-pedestrian areas, regulated curbs).
- Maintain compliance with DTOP/MUTCD standards for placement, color, and dimensions.
- Coordinate sidewalk and curb treatments with ADA/PROWAG requirements (ramp upgrades in later phases).

Strategies and Proposals:
Sidewalks, Signage and Pavement Markings

Compliance & Pedestrian Safety (PR-3 Focus)

- Strengthen coordination with law enforcement to support implementation and sustained compliance.
- Conduct targeted enforcement during initial rollout, focusing on loading zones and “No Parking” areas.
- Apply citations as needed to preserve operational capacity and orderly curbside management.
- Provide a short education/transition period using clear messaging and supplemental signs/markings.
- Install high-visibility crosswalk markings and pedestrian warning signs along PR-3 (no signalization required).
- Locate crossings along pedestrian desire lines, ensuring sidewalk continuity and adequate sight distance.

Estimated Project Cost: Sidewalks, Signage and Pavement Markings

Estimated Cost of Sidewalk Improvements in the Town of Patillas

ITEMS	UNITS	DESCRIPTION	QTY	UNIT PRICE	AMOUNT
		Permission			
0	LS	PCOC	1	$ 6,000.00	$ 6,000.00
1	LS	General Condition (Taxes, B2B, PPBOND, CFSE, Other cost)	1	$ 1,738,320.00	$ 1,738,320.00
		Removal of Old Structure			
2	LS	Mobilization	1	$ 338,914.29	$ 338,914.29
3	LS	Removal of Structure and Obstructions	1	$ 82,160.00	$ 82,160.00
4	CuM	Removal Asphalt, Base and Subbase	10913.19	$ 83.34	$ 909,457.38
5	CuM	Removal Sidewalks	556.45	$ 248.04	$ 138,020.28
6	LnM	Removal Paviment Marking	9680.07	$ 6.63	$ 64,200.00
7	SqM	Removal of traffic signal	50	$ 664.00	$ 33,200.00
		MOT			
8	SqM	Construction Signs	50	$ 500.00	$ 25,000.00
9	Month	Portable Changeable Message Sign (PCMS)	4	$ 5,000.00	$ 20,000.00
10	Ea	Drums	100	$ 254.03	$ 25,402.80
11	LnM	Temporary Concrete Barrier	152.5	$ 268.92	$ 41,010.00
		Design-Based Construction			
12	CuM	"Subbase Course" (Spec 301)	8081.43	$ 113.53	$ 917,488.88
13	CuM	"Aggregate Base Course" (Spec 304)	1515.27	$ 154.22	$ 233,680.88
14	Ton	Hot Plant Bituminous Pav. (B-1)	1010.18	$ 88.24	$ 89,140.92
15	Ton	Hot Plant Bituminous Pav. (S-1)	505.09	$ 135.00	$ 68,187.08
16	LnM	18" Channel & Grate	45.3	$ 2,502.70	$ 113,372.10
17	CuYd	Concrete Sidewalks	724.66	$ 318.09	$ 230,509.47
18	LnM	Thermoplastic Pvt "White"	6453.38	$ 36.76	$ 237,256.62
19	LnM	Thermoplastic Pvt "Yellow"	3226.69	$ 7.50	$ 24,200.18
20	LnM	Crosswalks Thermoplastic	227.15	13.12	$ 2,980.21
21	LnM	Thermoplastic Parking lines	1768.27	13.12	$ 23,199.70
22	Ea	Hydrants	6	3979.61	$ 23,877.66
23	Ea	Manholes	10	5550.8	$ 55,508.00
24	LnM	Linear grates	45.3	$ 2,502.70	$ 113,372.10

Total Price Est.	$ 5,554,458.54
Time Est. (Days)	720

Figure 50. *Estimated Cost of the Sidewalk Improvement in the Town of Patillas*

Note. Table developed by Andres Martinez.

Final Designs:

Low-Cost Improvement Plan for the Municipality of Patillas, PR

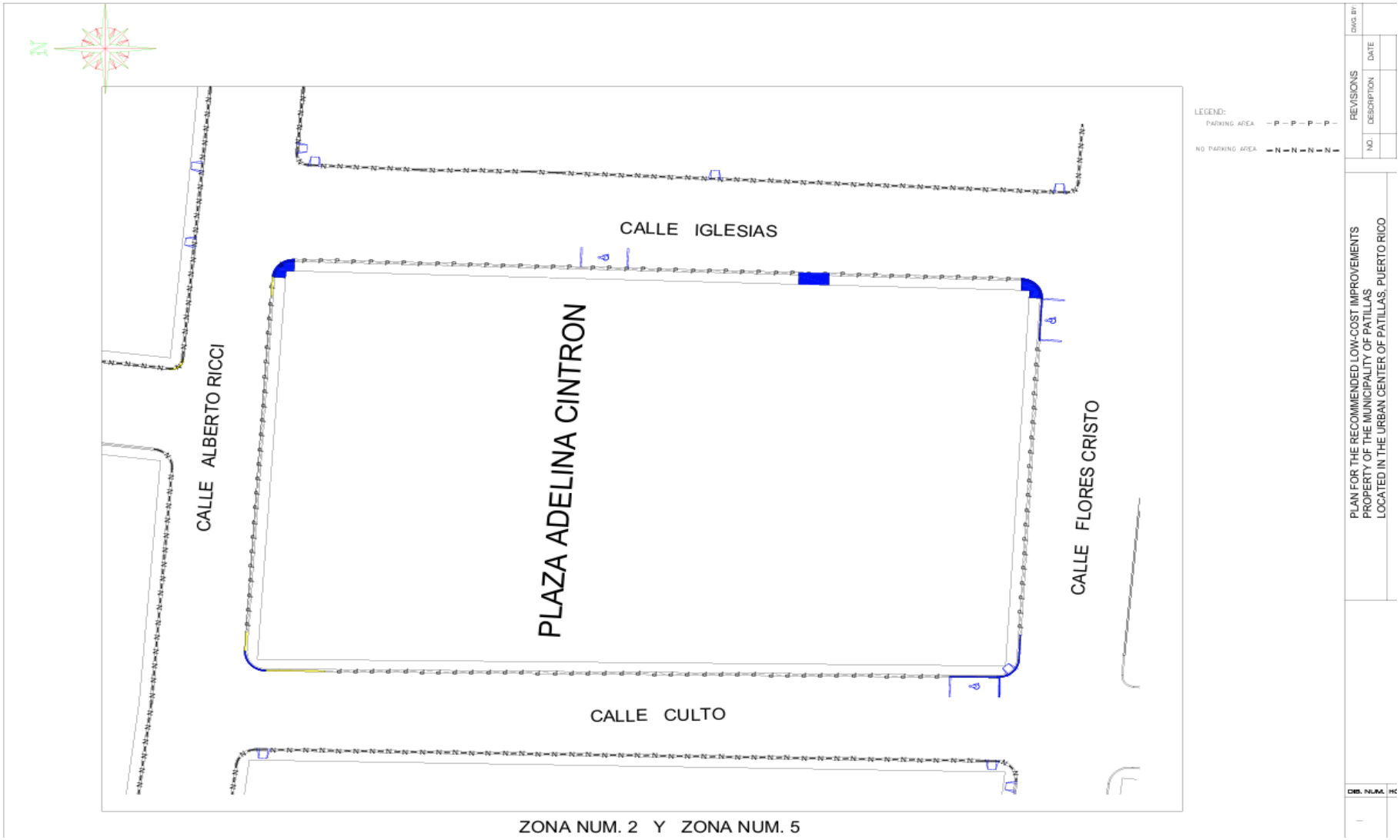


Figure 51. *Existing (as-built) conditions of the public square area.* Note. AutoCAD map created by Nyrma Ortiz.

Final Designs:
Low-Cost Improvement Plan for the Municipality of Patillas, PR

Signage Example:
Public Square Area – Proposed signage plan illustrating recommended low-cost improvements

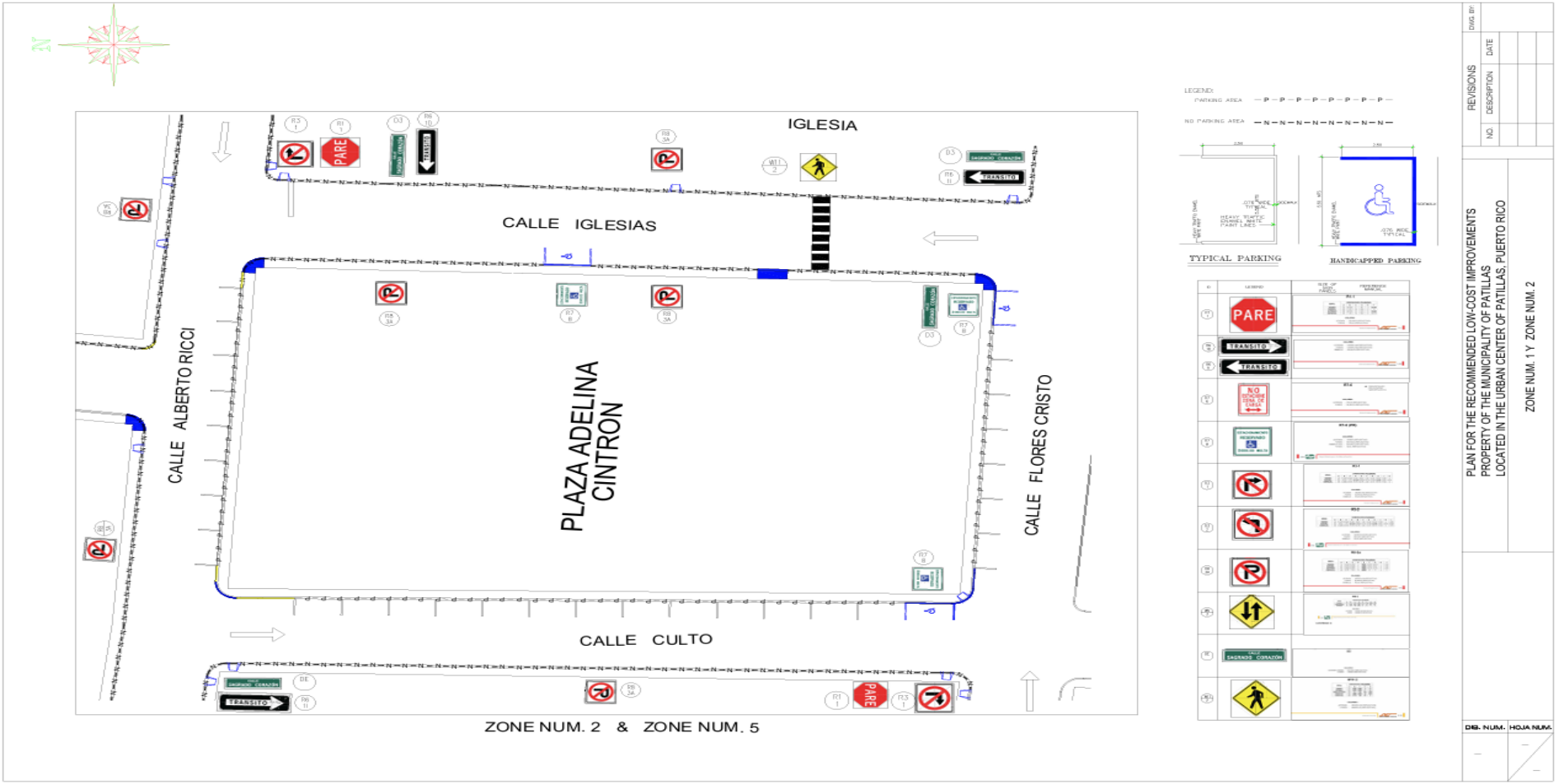


Figure 52. *Existing (as-built) conditions of the public square area.*
Note. AutoCAD plan developed by Nyrma Ortiz.

Estimated Project Cost:
Low-Cost Improvement Plan for the Municipality of Patillas, PR

Estimated Project Cost: Traffic Control Device Installation, Roadway Delineation, and Pavement Markings

ITEMS	*UNITS*	*DESCRIPTION*	*QTY*	*UNIT PRICE*	*AMOUNT*
0	LnM	Thermoplastic Pvt "White"	6453.38	$ 15.00	$ 96,800.70
1	LnM	Thermoplastic Pvt "Yellow"	3226.69	$ 7.50	$ 24,200.18
2	LnM	Crosswalks Thermoplastic	227.15	$ 13.12	$ 2,980.21
3	LnM	Thermoplastic Parking lines	1768.27	$ 13.12	$ 23,199.70
4	SqM	Traffic signs	32.00	$ 500.00	$ 16,000.00

Precio Total Est.	$ 163,180.79

Figure 53. *Estimated Cost of the Low-Cost Improvement Plan for the Municipality of Patillas, PR.*
Note. Table developed by Andres Martinez.

Implementation Scenarios and Phased Engineering Interventions: Scenario 1

Phase 1- Traffic Control Device Installation, Roadway Delineation, and Pavement Markings

Phase 2- Sidewalks

Phase 3- Public Transportation Stops

Phase 4- Multi-Story Parking Structure

Phase duration:	Phase duration:	Phase duration:	Phase duration:
~6.5 months	~3 year	~2 months	~2.8 years

Total Project Cost Estimate: Multi-Story Parking Facility, Sidewalk Improvements, and Proposed Public Bus Stop

ITEMS	UNITS	DESCRIPTION	QTY	UNIT PRICE	AMOUNT
		Multi-Story Parking Facility			
0	LS	General Condition (Taxes, B2B, PPBOND, CFSE, Other cost)	1.00	$ 4,989,000.00	$ 4,989,000.00
1	LS	Moblization	1.00	$ 261,504.76	$ 261,504.76
2	LS	Removal of Structure and Obstructions	1.00	$ 37,110.00	$ 37,110.00
3	CuM	Excavation Multipiso	6380.00	$ 63.83	$ 407,250.00
4	CuM	Borrow Class B (A-2-4) "Backfill"	5469.00	$ 70.94	$ 387,967.00
5	Pound	Structural Reinforcements	358892.14	$ 5.86	$ 2,104,543.51
6	LnM	Sanutary drainage 6"	33.00	$ 389.98	$ 12,869.47
7	LnM	Pluvial Drainage 6"	328.38	$ 190.47	$ 62,545.89
8	LnM	Pluvial Drainage 12"	397.84	$ 213.72	$ 85,027.37
9	LnM	Cooper Tube 3/4"	79.42	$ 51.63	$ 4,100.22
10	CuYd	Concrete: Slab Edge, Basic Wall, Beam, Column, Floor and Footing	4303.19	$ 541.83	$ 2,331,587.51
11	SqFt	Basic Wall: Generic - 6" Masonry	4518.00	$ 25.17	$ 113,711.37
12	SqFt	Paint: Beige, White, Green	95336.00	$ 1.23	$ 117,235.00
13	Ea	Door-Exterior-Single-Two_Lite: 36" x 84": 2	2.00	$ 2,500.00	$ 5,000.00
14	Ea	Door-Exterior-Single-Two_Lite: 42" x 84": 2	2.00	$ 2,886.00	$ 5,772.00
15	Ea	Door-Opening: 42" x 84": 1	1.00	$ 2,289.00	$ 2,289.00
16	Ea	Door-Opening: 72" x 84": 1	1.00	$ 4,900.00	$ 4,900.00
17	Ea	Door-Passage-Single-Flush: 36" x 84": 3	3.00	$ 1,616.67	$ 4,850.00
18	Ea	Window-Awning-Double-Horizontal: 48" x 17": 2	2.00	$ 688.62	$ 1,377.23
19	Ea	Window-Awning-Triple-Horizontal: 60" x 17": 2	2.00	$ 878.00	$ 1,756.00
20	Ea	Planting	33.00	$ 330.76	$ 10,915.00
23	LS	Electrical Works (Allowances)	1.00	$ 3,548,265.00	$ 3,548,265.00
24	LS	Fire protection system (Allowances)	1.00	$ 600,000.00	$ 600,000.00
		Sidewalks in the town of Patillas			
0	LS	*PCOC*	1.00	$ 6,000.00	$ 6,000.00
1	LS	General Condition (Taxes, B2B, PPBOND, CFSE, Other cost)	1.00	$ 1,738,320.00	$ 1,738,320.00
2	LS	Mobilization	1.00	$ 338,914.29	$ 338,914.29
3	LS	Removal of Structure and Obstructions	1.00	$ 82,160.00	$ 82,160.00
4	CuM	Removal Asphalt, Base and Subbase	10913.19	$ 83.34	$ 909,457.38
5	CuM	Removal Sidewalks	556.45	$ 248.04	$ 138,020.28
6	LnM	Removal Paviment Marking	9680.07	$ 6.63	$ 64,200.00
7	SqM	Removal of traffic signal	50.00	$ 664.00	$ 33,200.00
8	SqM	Construction Signs	50.00	$ 500.00	$ 25,000.00
9	Month	Portable Changeable Message Sign (PCMS)	4.00	$ 5,000.00	$ 20,000.00
10	Ea	Drums	100.00	$ 254.03	$ 25,402.80
11	LnM	Temporary Concrete Barrier	152.50	$ 268.92	$ 41,010.00
12	CuM	"Subbase Course" (Spec 301)	8081.43	$ 113.53	$ 917,488.88
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20	LnM	Crosswalks Thermoplastic	227.15	$ 13.12	$ 2,980.21
21	LnM	Thermoplastic Parking lines	1768.27	$ 13.12	$ 23,199.70
22	Ea	Hydrants	6.00	$ 3,979.61	$ 23,877.66
23	Ea	Manholes	10.00	$ 5,550.80	$ 55,508.00
24	LnM	Linear grates	45.30	$ 2,502.70	$ 113,372.10
		Public Bus Stop			
0	*Ea*	*Permission (Construction Permit)*	1	*$ 1,500.00*	$ 1,500.00
1	*Ea*	*Permission (DTOP Excavation Permit)*	1	*$ 2,500.00*	$ 2,500.00
2	*Ea*	*Permission (Utility Excavation Notification)*	1	*$ 2,500.00*	$ 2,500.00
3	*Ea*	*Permission (Construction Certificacion / Use Permit)*	1	*$ 6,000.00*	$ 6,000.00
4	CuYd	Reinforcement Concrete Materials	2.8	$ 1,505.36	$ 4,215.00
5	Ea	Molds (Molding for precast manufacture)	1	$ 9,800.00	$ 9,800.00
6	Ea	Transportation	1	$ 600.00	$ 600.00
7	Ea	Site works (Footing concrete -Anchoring Plates -Excavation)	1	$ 730.00	$ 730.00
8	Ea	Installation Equipment (Crane Service -Welding Equipment)	1	$ 3,400.00	$ 3,400.00

Total Price Est.	$ 20,697,602.49
Time Est. (Days)	1286

Total Estimated Project Cost

Figure 54. *Total Estimated Project Cost.*
Note. Table developed by Andres Martinez.

Implementation Scenarios and Phased Engineering Interventions: Scenario 1

Advantages

- Accessible sidewalks are completed earlier, providing an ADA-compliant downtown environment in a shorter timeframe and benefiting people with disabilities.
- Public transportation stops are implemented early, offering shelter and adequate service to transit users.
- Delaying the multi-story parking structure allows additional time to secure funding or grants to finance the project.

Implementation Scenarios and Phased Engineering Interventions: Scenario 1

Disadvantages

- Constructing sidewalks before having replacement parking available may cause traffic congestion and a temporary shortage of parking spaces during construction.
- Delayed installation of traffic signage may result in insufficient wayfinding, causing confusion and potential traffic disorder in the downtown area.
- Postponing the construction of the multi-story parking structure delays the availability of organized parking, affecting traffic circulation during earlier phases.
- Constructing sidewalks prior to the public transportation stops may limit the optimal placement of ADA ramps and platforms, whereas installing transit stops first allows sidewalks to be designed directly around them.

Implementation Scenarios and Phased Engineering Interventions: Scenario 2

Phase 1- Sidewalks

Phase 2- Public Transportation Stops

Phase 3- Traffic Control Device Installation, Roadway Delineation, and Pavement Markings

Phase 4- Multi-Story Parking Structure

Phase 1	Phase 2	Phase 3	Phase 4
Phase duration: ~3 years	Phase duration: ~2 months	Phase duration: ~6.5 months	Phase duration: ~2.8 years

Implementation Scenarios and Phased Engineering Interventions: Scenario 2

Advantages

- Sidewalk improvements are implemented first, delivering early ADA compliance and immediate pedestrian safety benefits.
- Public transportation stops are constructed shortly after, enabling early multimodal access and improved user comfort.
- Implementing traffic control devices after sidewalk and transit stop construction allows for final alignment with the completed geometry.
- Deferring the multi-story parking structure provides additional time to secure funding and grants for a capital-intensive facility.

Implementation Scenarios and Phased Engineering Interventions: Scenario 2

Disadvantages

- Constructing sidewalks prior to implementing traffic control measures may create temporary conflicts between pedestrians and vehicles.
- Delayed installation of traffic control devices and pavement markings may result in reduced wayfinding clarity during earlier phases.
- Postponing the parking structure delays the availability of organized parking, potentially affecting traffic circulation and local access.
- Implementing sidewalks before final traffic control layouts may require minor rework or adjustments once signage and markings are installed.

Implementation Scenarios and Phased Engineering Interventions: Scenario 3

Phase 1- Multi-Story Parking Structure

Phase 2- Sidewalks

Phase 3- Public Transportation Stops

Phase 4- Traffic Control Device Installation, Roadway Delineation, and Pavement Markings

Phase duration: ~2.8 years

Phase duration: ~3 years

Phase duration: ~2 months

Phase duration: ~ 6.5 months

Implementation Scenarios and Phased Engineering Interventions: Scenario 3

Advantages

- Early construction of the multi-story parking structure ensures adequate parking capacity from the outset, helping reduce congestion in the downtown area.
- Providing a centralized parking facility allows public transit users and visitors to park safely, improving overall traffic circulation.
- Constructing sidewalks after parking availability is established enables sidewalk demolition and reconstruction with fewer disruptions.
- Implementing sidewalks prior to the installation of transit stops facilitates direct and continuous ADA-compliant connections between sidewalks, ramps, and platforms.

Implementation Scenarios and Phased Engineering Interventions: Scenario 3

Disadvantages

- Deferring the installation of traffic control devices and pavement markings until the final phase leaves the downtown area with limited wayfinding and traffic guidance during earlier stages.
- The absence of early pavement markings and signage may result in temporary parking disorder, including undefined stall limits and reduced pedestrian visibility.
- Delaying full ADA-compliant sidewalks limits accessible pedestrian mobility for people with disabilities until later phases.
- If public transportation stops become operational before final traffic control measures are installed, safety and visibility at stop locations may be reduced due to insufficient warnings and traffic guidance.

Implementation Scenarios and Phased Engineering Interventions: Scenario 3

Scenario 3 – Recommended Alternative

- This scenario represents the optimal sequence for implementing the proposed interventions.
- Building the multi-story parking garage first helps manage vehicle demand and makes it easier to carry out the subsequent phases.
- Sidewalk rehabilitation and the installation of public transit stops ensure universal accessibility and improve both pedestrian and public transportation mobility.
- Finally, traffic signage and pavement markings are implemented once the main construction work is completed, ensuring a safe, orderly traffic system that is consistent with the final downtown configuration.

Conclusion

In this Capstone, we integrated the five branches of engineering in a holistic project. In Project Management, we learned to plan phases, manage resources, and adapt to challenges. In Structures, we designed the multi-story parking, sidewalks, and transit stops, working with detailed plans and structural coordination. In Transportation, the Complete Streets development along Urban Core in Patillas- PR, integrated signage and accessibility. In Water, we designed efficient drainage within the sidewalks. In Soils, we ensured solid foundations for each infrastructure.

We learned to collaborate as a multidisciplinary team, master complex plans, and apply solutions with community impact. This project helped us see how engineering shapes our communities, emphasizing accessibility and safety.

For future projects, we suggest continuing with the design of bike lanes and exercise spaces, allowing people to move safely along PR-3. Street lighting (luminaria) will also be addressed along the corridor to improve safety and visibility for all users. In addition, we hope to advocate for budget allocations so that all municipalities can implement Complete Streets, ensuring safe and equitable mobility across Puerto Rico.

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ShareTech GROUP ENGINEERING, P.S.C.

ShareTech CONSTRUCTION GROUP, LLC

CIVILTEK PUERTO RICO

PE PROFESSIONAL ENGINEERS, P.S.C.

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