



FULL REPORT  
EVALUACIÓN  
COMPLETA

HEALTH  
IMPACT  
ASSESSMENT

ENVIRONMENTAL RESTORATION OF THE CAÑO MARTÍN PEÑA

2014

EVALUACIÓN DEL  
IMPACTO  
EN LA SALUD

REHABILITACIÓN AMBIENTAL DEL CAÑO MARTÍN PEÑA



# *Health Impact Assessment of the Environmental Restoration of Caño Martín Peña*



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Figure 1. Debris clogging part of the Caño Martín Peña. Source: Proyecto ENLACE.

## ***Introduction***

This project aims to help inform Puerto Rican Legislature's decision regarding the implementation of the Comprehensive Development Plan (CDP) in the Caño Martín Peña (CMP). The CMP is a waterway in San Juan, Puerto Rico that has become clogged with sediment and debris over the years. The CMP is surrounded by eight of the poorest and most disenfranchised communities in San Juan with over 25,000 residents. The CDP includes aspects that address 1) environment; 2) socioeconomic development; 3) institutional capacities; and 4) mobility, transportation, and tourism development before, during, and after the environmental restoration. The three aspects of the plan within the scope of this Health Impact Assessment (HIA) are 1) the dredging of 2.2 miles of the CMP; 2) infrastructure improvements to the roadway adjacent the channel, the storm water drainage, and the sewer system; and 3) the demolition of almost 400 residential structures and the relocation of displaced community members. Even though a number of human health studies of the affected communities indicate that people living in the area suffer a disproportionate health burden, health has not been a central part of the debate around financing the CDP. This 15-month HIA used health data from previous studies, a literature review of epidemiologic data, surveys regarding flooding impacts, and focus groups with community members to understand the potential health effects of implementing the CDP on the communities surrounding the CMP and to make recommendations to protect the health of these communities. This assessment describes existing community conditions and evaluates potential impacts related to the proposed dredging, road, sewage, and storm drain infrastructure changes, and the housing changes from demolition of structures, relocation of residents, and potential land value changes. In addition to informing stakeholders regarding the human health impacts of the CDP, this project endeavors to

highlight the value of HIAs locally for other projects in this jurisdiction. This HIA is the first known HIA to be conducted in Puerto Rico.

## ***Background***

### *History of CMP*

Migrants from rural Puerto Rico initially inhabited this area of San Juan following the devastating hurricane of San Ciprian in 1932. Over time the mangrove wetlands and even the channel body have become filled with debris (See Figure 1) – sometimes intentionally added to create surfaces on which residences could be constructed, and now increasingly as a covert trash dumping location. Located between the San Juan Bay and the San Jose Lagoon, the eastern portion of the channel is no longer navigable and has become a flooding risk and source of stagnant water. Over 25,000 people now occupy the area along the channel. Today, the Caño Martín Peña is a heavily polluted, 3.75-mile-long tidal channel, 2 miles from the financial center of San Juan, PR. The residents include some of the original migrants from rural Puerto Rico and newer arrivals now, increasingly, from the Dominican Republic. See Figure 2 for orientation of CMP in relation to the San Juan metropolitan area and other significant bodies of water.



Figure 2: CMP is located in the San Juan metropolitan area. SOURCE: ENLACE, Puerto Rico Planning Board and PRGAP Project.

This area surrounding the CMP has a complicated history of both environmental problems as well as legal land disputes. In terms of environmental issues, as the channel has become filled with debris and San Juan has continued to develop, leading to an increase in

impervious surfaces that speeds water runoff, flooding has become both frequent and severe in the communities adjacent the channel. Historically, the channel was filled primarily by specific government initiatives such as the San Juan municipality incentivizing local residents to dump into the channel and also the U.S. Navy who transported and dumped fill into the channel in the 1970's. However, in recent history the CMP community has become a dumping ground for people outside the community. The channel is the naturally existing low-lying area for the watershed of this region. As a consequence of development to this region over the last century, during heavy rain events the channel has less capacity for holding the water, causing the nearby inhabited areas to flood.

In addition to the environmental problems, the communities have had no formal ties to the land. The land rights issue is further complicated by the fact that this area is located next to some of the most valuable real estate in San Juan – an area known as “the Golden Mile” due to the high concentration of financial institutions in this Central Business District.

The need to address the environmentally hazardous conditions caused by the accumulated in-fill, on-going illegal dumping, historical neglect, and lack of planning and the need to protect the community from land disputes and rising land values led the Puerto Rico legislature, in 2004, to create the quasi-public Caño Martín Peña ENLACE Project (ENLACE Project) – in existence since 2001 as a “program/project” - under the Puerto Rico Highway and Transportation Authority (PRHTA). ENLACE’s mission is to coordinate and implement public policy relating to the rehabilitation of Caño Martín Peña and urban, social and economic development of the surrounding communities with effective and active participation of residents and community-based organizations and through partnerships between communities, the public sector and the private sector.

In 2002, the Puerto Rico Planning Board designated the CMP Special Planning District and delegated the elaboration of a Land Use and Comprehensive Development Plan (described in more detail in the Appendix) to the PRHTA which was subsequently undertaken by ENLACE. This Special Planning District on which ENLACE focuses includes the following seven communities: (1) Barrio Obrero (West and San Ciprián); (2) Barrio Obrero-Marina; (3) Buena Vista-Santurce; (4) Parada 27, (5) Las Monjas; (6) Buena Vista-Hato Rey; and (7) Israel-Bitumul. An eighth community, Cantera Peninsula, also borders the CMP. See Figure 3 for image of the CMP area. An entity called Cantera Company predated the formation of ENLACE and the Special Planning District but now works in conjunction with ENLACE to accomplish similar goals within this adjacent community. A community organization called the “G8” is comprised of representation of the eight communities listed above and also serves as a partner on this project. ENLACE working in conjunction with these community organizations shepherded the massive community input process for the design of the CDP.



Figure 3: The image shows the communities adjacent the channel that comprise the special Planning District (highlighted in green). SOURCE: ENLACE and Puerto Rico Planning Board

### *The CMP Community today*

The current infrastructure of the community adjacent the CMP includes dense mixed use residential and commercial structures of mostly single or two story construction built in close proximity to the channel edge.

According to the 2010 U.S. Census and the 2010 American Community Survey, there are over 23,000 inhabitants in the eight communities comprising the CMP, of which 15-18,000 live in the District where ENLACE focuses (as seen in table below). These families comprise almost 10,000 households (ACS 2010) translating to over 22,000 inhabitants per square mile, which is the greatest population density in metropolitan San Juan. Persons 65 years of age or older accounted for 26.6% of this population. Children under 18 years of age accounted for 20-25% of this population depending on neighborhood within the community. The 2010 census reported that immigrants, mainly from the Dominican Republic, comprise 22.5% of the population, an increase from the 19.5% reported in the 2000 Census.



## Socioeconomics

Over 50% of CMP’s population reported an annual income below the US poverty level; of these, 42% reported an annual income of \$10,000 or less (US Census 2010). While official rates of unemployment are higher than other areas of metropolitan San Juan (21.7% vs. 16.1%), ENLACE’s community survey revealed that the labor participation rates are higher due to participation in the informal economic sector (Estudios Técnicos 2003). Thus, CMP is, in large part, a working poor community. See Table 1 for comparison of population size, unemployment and poverty rates, and immigrant population and median household income between the CMP district, San Juan, Puerto Rico, and the entire U.S.

Table 1. Comparison demographic data for the CMP district, San Juan municipality, Puerto Rico and the United States.

Demographics <sup>1</sup>	CMP District	San Juan	Puerto Rico	United States
	Targeted Community (by Census Tract) <sup>2</sup>	City/Town or County	Statewide (PR)	National (US)
Population US 2010 Census	15,693 [1]	378,666 [1]	3,628,402 [1]	308,745,538 [1]
Population ACS 2010	18,103 [2]	395,074 [2]	3,722,133 [2]	309,745,538 [2]
Unemployment	21.7% [2]	16.1% [2]	18.9% [2]	10.8% [2]
Poverty Rate	52.5% [2]	39.1% [2]	45.0% [2]	15.3% [2]
Foreign/Immigrant Population	22.6% [2]	14.8% [2]	4.3% [2]	12.9% [2]
Median Household Income	\$14,777 [2]	\$22,905 [2]	\$18,862 [2]	\$50,046 [2]

## Education

The American Community Survey found that 48.4% of the persons age 25 or older in the community lacked a high school diploma (2010). A network of public schools serves the inhabitants of the communities of CMP. There are 8 elementary schools, 2 middle schools, and 1 high school.

<sup>1</sup> Table from ENLACE corporation. When calculating the US Census 2010 population for the CMP District values, the populations from Census Blocks 5006, 5009, 5000, and 5010 which are outside the CMP District boundary, particularly Tract 46, were excluded. The population value used to calculate Unemployment, Poverty Rate, Median Household Income, and number of Immigrant Population (Not Puerto Rican) came from American community Survey population values for consistency.

[1] from the 2010 U.S. Census data and is available at <http://www.census.gov/>

[2] from fact finder from the 2010 American Community Survey 1-Year Estimates.

[http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS\\_12\\_1YR\\_DP03&prodType=table](http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_12_1YR_DP03&prodType=table)

<sup>2</sup> Census Tracts 36, 37, 38, 44, 45, 46. Does not include Census Blocks 5000, 5006, 5009, and 5010.

## HIA Process

A Health Impact Assessment is a systematic process that uses an array of data sources and analytic methods and considers input from stakeholders to determine the potential effects of a proposed policy, plan, program or project on the health of a population and the distribution of those effects within the population. HIAs provide recommendations on monitoring and managing those effects (National Research Council 2011). HIAs typically have six primary steps: Screening; Scoping; Assessment; Recommendations; Reporting; and Monitoring & Evaluation. See “Steps of HIA” graphic in Figure 4 for more detail.

This HIA was conducted during a 15 month period in 2013 and 2014. In June 2013, an HIA training session was conducted with approximately 40 participants from the local San Juan area and universities of Puerto Rico (Figure 5). Participants included representatives from government agencies, multiple public health academic institutions, non-profit advocacy organizations, and community members. The purpose of the training session was to simultaneously train the team conducting the HIA, CMP stakeholders, and others who will potentially use HIA methodology in Puerto Rico in the future. The training was hosted at the Environmental Protection Agency office in San Juan.

### *Engagement and Data collection methods*

Advisory committees and stakeholder meetings:  
The project leadership assembled two groups to provide regular input to this project. They are the Community Advisory Committee – consisting of local community residents - and the Steering Committee – consisting of four public and clinical health professionals familiar with CMP.



Figure 4. Steps of HIA. Source: [www.healthimpactproject.org/hia/process](http://www.healthimpactproject.org/hia/process)



Figure 5. HIA Training at EPA office in San Juan (June 2013). SOURCE: P. Sheffield

### The Community Advisory Committee (CAC)

The CAC, representing a number of different neighborhoods in the greater CMP community as well as local community organizations focused on youth and women, was charged with these responsibilities:

- Help identify and prioritize the issues to be included in the scope of the HIA.
- Assist in data collection (e.g. surveys, focus groups, interviews, other information collection tools).
- Check correctness of information regarding existing conditions and impact predictions.
- Develop and prioritize the recommendations of the HIA.
- Participate in communicating findings and recommendations to decision makers.
- Play a lead role in monitoring the HIA.

### The Steering Committee (SC)

The SC, comprised of professional representatives from academic institutions and a community clinic, was charged with the following responsibilities:

- Review and provide feedback on HIA methodologies and analyses.
- Identify and, when possible, provide information, data, activities and resources.
- Share the perspective of the organization or agency that the member represents.
- Help develop and prioritize HIA recommendations.
- Help with the HIA monitoring phase.

The Steering Committee members:

Félix I. Aponte Ortiz  
Retired Professor  
University of Puerto Rico  
Graduate School of Planning

Cruz M. Nazario Delgado, MS, PhD  
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Héctor Villanueva, MD  
Medical Director, HealthProMed  
A Federally Qualified Health Center in CMP community

The CAC and the SC provided input on scope, process, and specific products created during the HIA. The committees convened on an as needed basis from Fall 2013 – Spring 2014. Additional input was sought via email and informal conversation. Because of the dual site location of project leadership, video conferencing enabled communication while reducing travel burden between project leadership and the committees. Additionally, a health stakeholder meeting was held in fall 2013 to elicit additional input and share information regarding the efforts of different groups. See timeline in Figure 6.

#### Focus groups and survey

In addition to the committees and meetings noted above, between November 2013 and January 2014, five focus groups were conducted using the moderator's guide developed by the HIA contributors and edited by the steering and advisory committees. These focus groups were moderated and transcribed by Estudios Técnicos, Inc., a research organization familiar with the CMP community who has done extensive surveys in this area in the past. The focus groups included the following subpopulations in order to provide a broad perspective on the community: residents of northern CMP communities, mothers, school representatives, health representatives, and residents of southern CMP communities. Lastly, a flooding impact survey was conducted with school administrators. This survey consisted of semi-structured brief interviews with a representative from each of the public schools in the CMP community with questions regarding disruption to educational services that results from rainfall events and subsequent flooding.

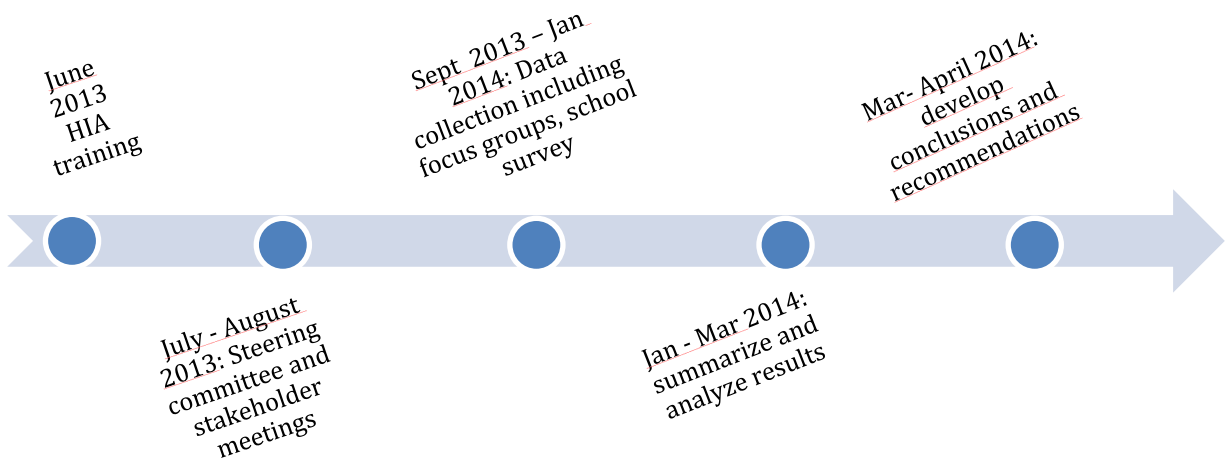


Figure 6: Timeline of HIA Process

***Goals of the collaborative HIA process between the Mount Sinai Pediatric Environmental Health Specialty Unit, ENLACE, and the G8, Inc.***

1. To promote familiarity with and capacity for conducting HIAs in Puerto Rico.
2. To optimize community partnerships in order to target environmental education and clinical services to underserved populations and low income communities at disproportionate risk of suffering from environmental exposures.
3. To make the health impacts of the funding decision regarding the implementation of the Comprehensive Development Plan for Caño Martín Peña more explicit.

## ***Scope of Research***

### Health determinants

Through the training and subsequent steering committee and stakeholder meetings, stakeholders identified numerous and diverse health determinants that are relevant to the CDP and the communities of CMP. A health determinant is any one of multiple factors that affects the health of individuals and communities. Factors such as where one lives, the state of one's environment, genetics, one's income and education level, and one's relationships with friends and family all have considerable impacts on health beyond the access to and use of health care services (WHO 2014). The breadth of the CDP, described in detail in the appendix, mandated that the scope of the HIA be narrowed to focus on some key elements. The stakeholder meetings facilitated this scoping process.

Health determinants that were identified and discussed by the stakeholders and HIA team included:

- Housing
- Education
- Water Quality
- Flooding
- Land Use in CMP
- Local Economy
- Structure Demolition and Relocation
- Food Safety & Security
- Social Capital

The HIA team, Steering Committee, and Community Advisory committee then helped narrow the scope to these selected elements, based on relevance to health and overall impact:

- 1) Dredging and debris removal;
- 2) Infrastructure changes to roadways, sewer system, and storm water drainage adjacent the channel; and
- 3) Housing changes from structure demolition, resident relocation and land value changes.

Additionally, the stakeholders and HIA team considered the known health risks in the community, the likelihood that certain populations might be more exposed than others, and the possibility that certain populations would be more likely than other groups to experience negative health effects from equivalent exposures. Through this process, they identified specific vulnerable groups of interest. These included:

- Children
- Elders
- Migrants
- Populations with Special Needs

Together, these subpopulations represent over half of the community indicating that a majority of the population likely has high vulnerability to negative environmental health effects.

## ***Assessment***

This section includes the assessment of the three areas of focus of the Comprehensive Development Plan that were examined as part of this HIA: 1) dredging and debris removal, 2) infrastructure changes to roadway, sewer system, and storm water drainage, and 3) housing changes from structure demolition and resident relocation.

## **Key Findings**

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### **1. Causes of health disadvantages**

The higher rates of chronic diseases and acute illnesses in the CMP residents in relation to the rest of the population can be attributed to the deteriorated environmental conditions that limit physical activity, increase stress, and lead to elevated toxic exposures.

### **2. Reduced harmful exposures**

The implementation of the CDP will likely decrease overall chemical, bacterial, and pest exposures for the majority of the CMP residents.

### **3. Time is of the essence**

Environmental conditions are worsening, thus delaying the implementation of the CDP results in higher health risks for the CMP population.

### **4. Improved public health**

Respiratory diseases (asthma), chronic illnesses (type II diabetes, depression), and other health conditions (diarrhea) will likely be reduced when the CDP is implemented.

### **5. Community involvement**

The overall successful implementation of the CDP depends on the continued participation of the CMP communities, particularly during the relocation process and the organizing of the Community Land Trust.

## Dredging and debris removal

The proposed dredging of the channel would involve the removal of material from the bottom of the channel along 2.2 miles of the eastern CMP in order to both widen and deepen the channel. The dredged material would be sorted and transported away for disposal. This process would open up what is currently a non-navigable waterway and increase flow and water exchange rates in this ecosystem. Additionally, bulk debris currently clogging the area adjacent the channel would be removed, opening up potential waterfront recreational area and pedestrian passage. While in the short term this process would temporarily disturb the existing infill, mangroves, and animal habitat, in the long term, these changes would reduce the levels of contaminated water, standing water, and bulk debris in the community. The health outcomes are hypothesized to result from these changes. See dredging pathway graphic (Figure 7) for more details.

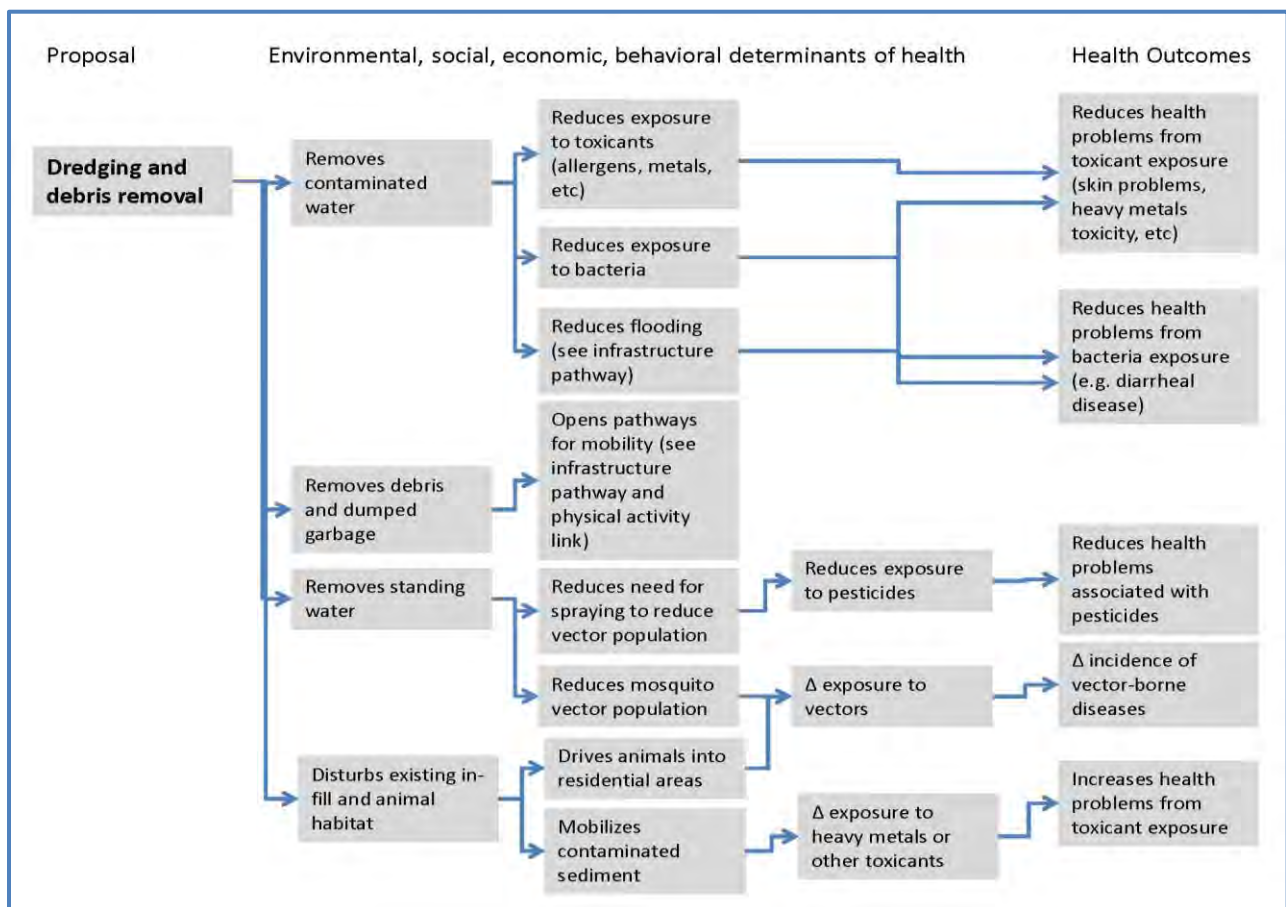


Figure 7. Pathway to Health Outcomes from Dredging and Debris Removal



- **Existing conditions related to the clogged waterway, water contamination, standing water, and accumulated debris.**

Prior to the area's development that began in the 1920's, the CMP had an average width of approximately 200 feet and a depth of around 8 feet. The channel provided tidal exchange between San Juan Bay to the west and the San José Lagoon to the east. Over the last 100 years as the housing developments multiplied, many lacked basic utilities, such as sanitary sewer systems, and adequate road infrastructure for a proper solid waste collection system. Consequently, for decades, thousands of households have discarded their refuse into the CMP. The resulting accumulation of household and construction debris, encroachment of housing and other structures, and sedimentation from urban runoff have almost completely blocked the CMP channel. The health of the ecosystem and water quality in both the CMP and adjacent San José Lagoon have been negatively affected. Furthermore, in the setting of increased development in the San Juan municipality and an increase in extreme precipitation events as climate changes, these conditions are expected to worsen if no intervention takes place.

The present day clogged waterway, inadequate sanitary sewer system, and accumulated debris in Caño Martín Peña contribute to **sediment and water contamination**. Multiple tests have demonstrated that the channel has heavy metal, other chemical, and biologic contamination. For example, elevated levels of copper, selenium, and organic contaminants and pesticides have all been documented in the sediment (Acevedo-Díaz et al 2012). Water testing showed bacterial contaminant *E. coli* with levels as high as 1,500,000 col/100 mL (Roubert et al., 2012). Furthermore, visual inspection of areas adjacent to CMP revealed stagnant water, and massive amounts of litter and larger discarded debris such as tires and old appliances. There was widespread agreement among the focus group participants that **illegal dumping** was a source of accumulated debris and a pressing issue in the community. One participant cited a clean-up that she had participated in only a couple weeks prior with a local youth group to remove accumulated trash and expressed concern that this was a recurring problem that needed attention beyond just citizen clean-ups.

The reduced flow of the waterway leads to **standing water** in and adjacent to the channel. These conditions provide breeding areas for mosquitoes and habitats conducive to many insect pests. Focus group participants reported **pesticide use** specifically due to concerns about dengue fever and spiders. Participants also expressed that the exposure to the pesticides themselves was also of concern, and the choice between these two unhealthy options, being exposed to unwanted insects or chemical pesticides was an ongoing source of **stress**.

Harmful air pollutants and noxious odors related to stagnant, sewage contaminated water are also a community concern. The anaerobic conditions of the blocked channel create **hydrogen sulfide** (H<sub>2</sub>S) gas, which can irritate eyes and mucous membranes. Chronic exposure can worsen respiratory symptoms particularly among asthmatics or people with other respiratory problems (ATSDR 2006).

- **Health Links**

Diarrheal disease – Diarrheal disease is an infection caused by exposure to certain types of bacteria that results in mild to severe diarrhea with a risk of dehydration, particularly in very young children or elderly adults. Exposure to contaminated standing water and flooding events is clearly associated with increased risk of such illness (i.e. diarrheal disease, gastrointestinal disease). Estimated prevalence of diarrheal disease in Puerto Rico is 21% per year. Prevalence in the CMP community is higher than the overall rate in Puerto Rico. In a survey conducted in CMP, 31% of the participants reported experiencing GI disease in the last 3 months. Furthermore, in the same study, **rates of diarrheal disease in the last 3 months – up to 51% - were highest among people who reported that their own street or home had flooded.** Thus, there is a clear association in the CMP community between flood water exposure and increased risk of GI disease (Roubert et al. 2012).

Vector borne diseases are illnesses such as dengue fever that are transmitted by certain types of mosquitos or other insects or animals. Standing water contributes to mosquito populations, which in turn lead to a greater risk of dengue fever and potentially other diseases. Dengue fever is an on-going problem in Puerto Rico. As of March 2014, over 1000 suspected dengue cases had been reported with 25% of those confirmed with laboratory analyses (CDC 2014). Periodic outbreaks occur, with over 20,000 cases reported as recently at 2010. Furthermore, conditions in CMP increase the risk of dengue. **Clusters of dengue cases have been detected around flood areas in the northern part of the CMP area and around illegal dumpsites in the southern part of the CMP community** (personal communication Dr. Brenda Rivera, March 2014). This new finding gives additional urgency to efforts to reduce flooding and remove accumulated debris in the community.

Pesticide use – Any pesticide use represents a potential increase in pesticide exposure for the people – doing the spraying or living - nearby. Government spraying campaigns are informed by the systematic surveillance of dengue cases (as noted above) led by the Centers for Disease Control Dengue Branch located in San Juan. While specifics regarding frequency of spraying by the government were not available, in general, spraying is increased in areas where clusters are detected. Regarding use of pesticides by individual residents, focus group participants reported using pesticides to reduce mosquito populations. Specifically, they reported using a type of organophosphate pesticide called Malathion. A number of recent studies in other locations have highlighted potential negative effects of commonly used organophosphate pesticides. These health risks can occur even at low levels of pesticide exposure. In two New York City studies, children whose mothers were exposed to organophosphates during pregnancy were seen to have a decrease in neurobehavioral development starting at 12 months and a decrease in perceptual reasoning and Working Memory evaluated at 6-9 years of age (Engel et al., 2011; Rauh et al., 2011). Another study evaluating the effect of chronic exposure to low levels of organophosphates found that prenatal exposure was associated with poorer intellectual development in 7-year-old children (Bouchard et al., 2011).

○ **Predicted Impacts of Dredging and Debris Removal**

<b>Health Determinant</b>	<b>Health Indicator*</b>	<b>Direction of Impact</b>	<b>Magnitude (how many)</b>	<b>Severity (how much)</b>	<b>Comments</b>
<b>Toxicant Exposure</b>	Blood lead level, skin problems	Short Term: ↑	Low	Low	Contaminated sediment disturbed during dredging
		Long Term: ↓	High	Medium	Permanent removal of contaminated water
<b>Bacteria exposure</b>	Diarrheal disease	↓	High	Medium	
<b>Mosquito habitat</b>	Cases of dengue	↓	High	High	
<b>Pesticide use</b>	Pesticide body burden	↓	Moderate	Medium	

\*Health indicators cited here are examples, not a comprehensive list

Explanations:

- *Direction of Impact* refers to whether the proposed project will increase (↑) the burden of disease or decrease (↓) the burden of disease
- *Magnitude* reflects a qualitative judgment of the size of the anticipated change in health effect (e.g. the number of people affected) - low, moderate, or high
- *Severity* reflects the nature of the effect on function and life expectancy and/or its permanence - low, medium, or high

The goal of the dredging project is to open the channel such that there is less chronically standing water; wastewater is cleared from the community in sanitary sewers; and storm water runoff is more quickly cleared from the area. Thus, the existing sources of stagnant, contaminated water would be reduced. Consequently, population exposures to unsanitary water conditions would likely be reduced. In turn, rates of illnesses, such as diarrheal disease, associated with contaminated water exposure would be expected to decrease. These changes would also reduce mosquito breeding habitat. Reducing habitat for vectors is an evidence-based intervention for reducing rates of vector borne disease such as dengue fever. Furthermore, reducing the local source of mosquitoes would reduce the need to spray for mosquitoes – both government spraying campaigns and individual pesticide use. Most pesticide exposure that occurs in domestic settings is low level and the health effects would be expected to be subclinical – not easily detectable or quantifiable. Thus, specific quantifiable diseases might not be reduced but pesticide body burden could decrease, with some potential benefit for intellectual development in children.

The debris removal and dredging will potentially displace animals such as iguanas, rats, caimans, and other marine or wetland animals. These displaced animals would potentially enter the nearby residents' homes, causing stress, a risk of bite injuries, and potentially other bacterial exposures. Furthermore, the sediment being removed potentially has both chemical and biological toxicants. Air quality could also be affected in several ways. The anaerobic conditions of the blocked channel are already creating hydrogen sulfide gas and

levels could increase temporarily when this terrain is disturbed. Construction equipment and demolition could also produce particulates and other pollutants. Construction noise, from such equipment as the sheet pile driver, is also a concern. However, an early analysis determined that the majority of noises associated with dredging and other construction equipment will not exceed that of background traffic noise in the community.

### **Infrastructure changes to the streetscape and sewer and storm water drainage**

The proposed infrastructure changes include modifications to roadways, sewer system, and storm water drainage system. The roadway changes would create a “paseo” or a pedestrian-friendly street along the edge of the channel that would buffer the aquatic ecosystem, including the mangroves, by keeping all building development a minimum distance from the edge of the channel, providing a widened passage for vehicles – particularly emergency response vehicles, and permit safer and more inviting recreational activity through better street lighting and designated bike lanes and a sidewalk. The sewer and storm water drainage system changes would connect all buildings to the sanitary sewer system and increase the storm water drainage capacity, which would properly separate contaminated wastewater from the community and reduce flooding. The health outcomes are hypothesized to result from these changes. See infrastructure pathway graphic for more details (Figure 8).

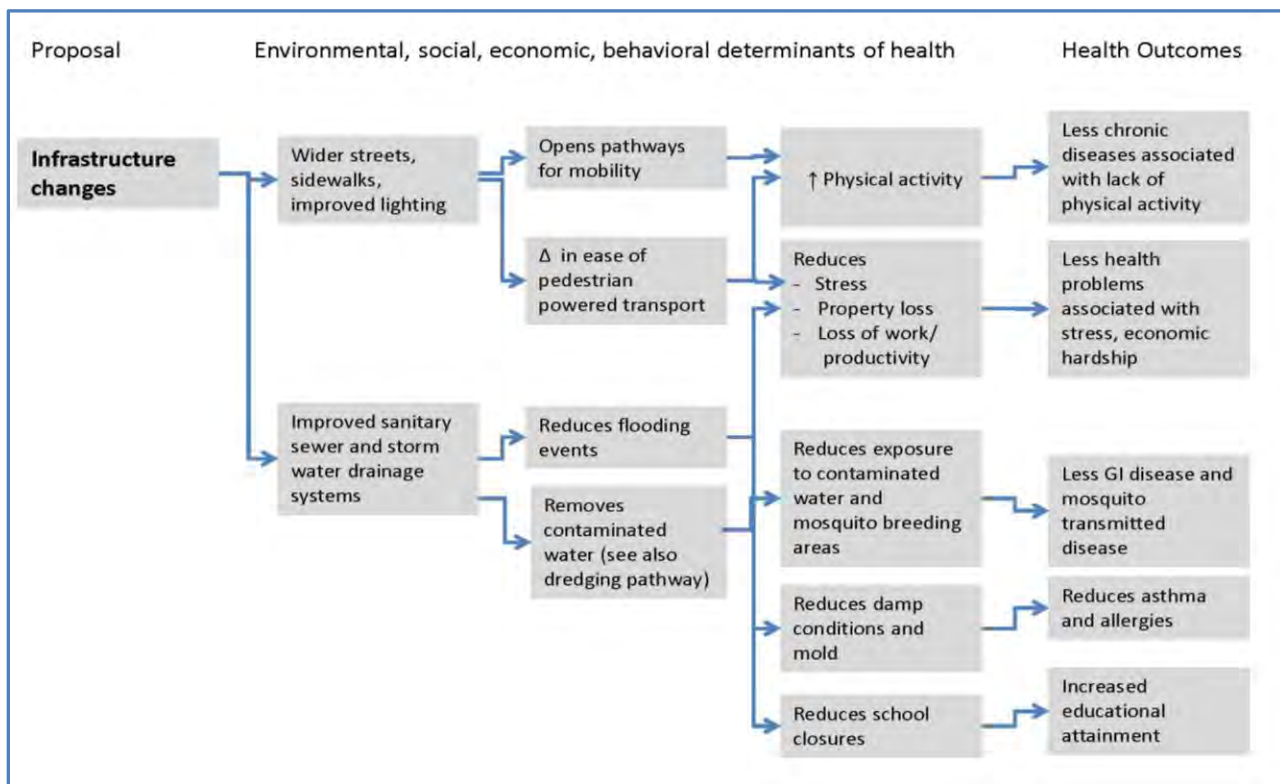


Figure 8. Pathway to Health Outcomes from Infrastructure Changes

○ **Existing conditions**

Street infrastructure – The current infrastructure of CMP includes dense mixed use residential and commercial structures in close proximity to the channel edge and in some cases even on top of the former location of the waterway. Parking occurs along the edges of already narrow streets, often leaving such a narrow space available for passage that sometimes emergency vehicles have not been able to pass. In addition, the close proximity of street to the channel edge makes them more prone to flooding during rainfall events and further harms the ecological health of the channel which in turn leads to more clogging and more flooding risk. Additionally, the congested streets compounded by the illegal dumping of trash permit virtually no waterfront recreational access and sidewalks and bike lanes are non-existent. These conditions discourage outdoor physical activity. Overall focus group participants reported not getting enough physical activity. They reported that most of their physical activity was in the form of community activities such as attending children’s events and community events. Neighborhood conditions, physical activity and chronic disease are discussed more in the health links section below.

Inadequate sanitary sewer and storm water drainage – Currently, sewage from an estimated 3,000 of the CMP residences flows untreated into the channel. As described above, measures of bacteria in the CMP channel water do not meet the recreational water standards set by the state Environmental Quality Board (Roubert et al. 2012). Furthermore, capacity of the storm water drainage system is not adequate to handle storm water runoff during

rainfall events, which directly contributes to flooding in the community. These two problems compound each other because the flood waters distribute the raw sewage throughout the community.

Flooding prevalence – Flooding is a frequent, recurrent event in the CMP community. Some residents reported flooding events up to 20 times per year in their homes. In 2002, 39% of the CMP community surveyed reported that their home or surrounding areas were flooded during the previous year. In a survey conducted in 2011 by the Ponce School of Medicine and Health Sciences, 53.6% reported that their houses were flooded during the previous year and almost 70% reported flooding near their home indicating that the vast majority of the residents are directly impacted by these events (Roubert et al. 2012). The trend over the last decade – driven by further clogging of the channel, faster rainwater runoff from an increase in paved surfaces, and potentially increased rainfall - indicates that the frequency of flooding is increasing. The problem is expected to worsen without intervention. Overall, extreme rainfall events are expected to increase in coming decades. Climate change is driving greater variation in the hydrologic cycle leading to these effects (Jacobs et al 2013). See Figure 9 showing flood affected areas adjacent the channel.

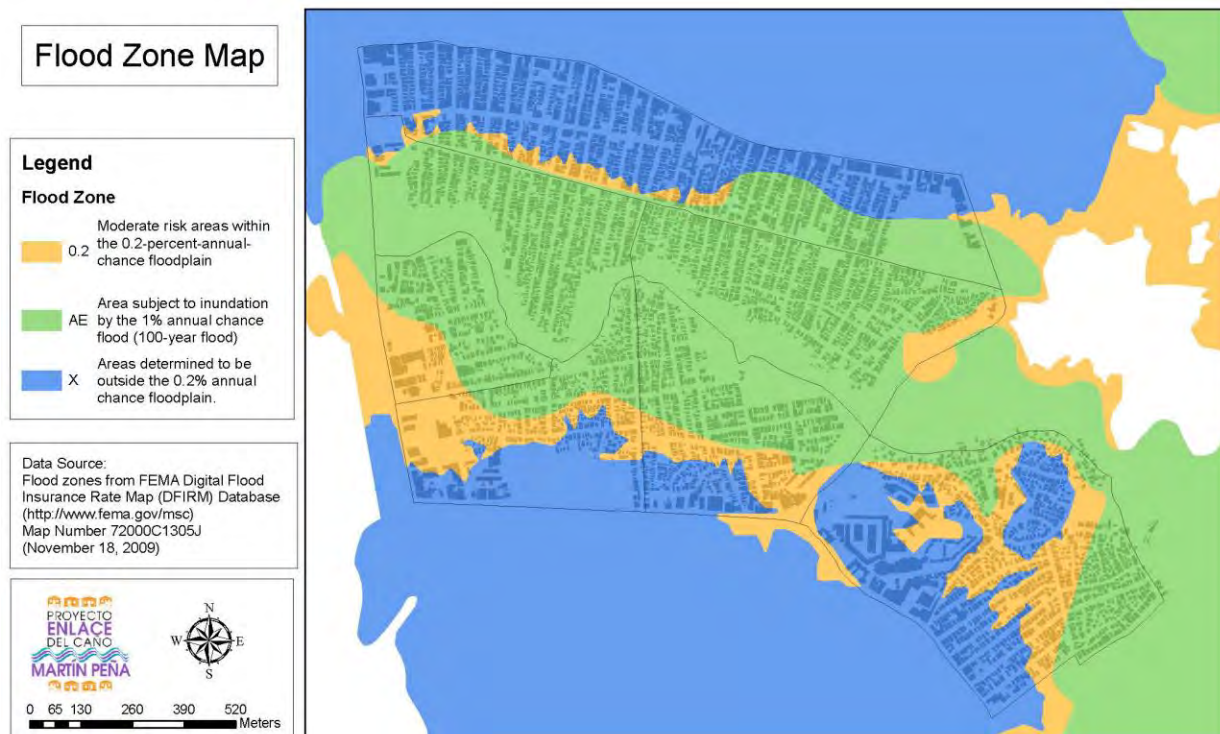


Figure 9: Top image shows streets where residents reported flooding during a July 2013 precipitation event - reportedly a 1 in 50 year event. Areas adjacent the channel without documented flooding have already been primarily relocated thus no reported flooded. Bottom image shows 100 year flood zone in green whose boundaries are similar to documented flooding in 2013. Source: ENLACE.

### Effects of flooding in CMP

Limited access to services – “I feel like a hostage in my own home,” said one community member in discussing how flooding affects the community. Community members become trapped by flood waters that can persist for days, and critical services such as ambulances and food delivery trucks for school meals have been encumbered by flooding, further isolating the community during such events. See photo of flood waters (Figure 10).

Mold – Focus group participants reported having to contend with high humidity, dampness, and mold following the frequent flooding events that affect their property and often the inside of their homes. One participant said, “After moving to the area, I suffered more from asthma.” Another participant said her daughter had new onset asthma when moving to a community adjacent the CMP from the Dominican Republic.

Property damage – The expense, time burden, and sense of personal loss were all cited by focus group participants as problems resulting from flooding-related property damage.

Educational effects – School administrators reported disruption to the education of youth in the community due to the inability of students to get to the schools when flooding occurs due primarily to obstructed routes of transport to and from the school. School directors reported as high as 50% absenteeism during flooding events which can occur up to dozens of times a year and last multiple days at a time. One mother who participated in a focus group said that none of her 7 children can get to school two streets away when it floods. Another parent reported that she immediately runs to get her children out of school as soon as it starts raining because she knows that the route from home to school will quickly be impassable. Additionally, students often lose educational materials due to flooding including books and computers. Another parent reported volunteering in the school to help clean up after a flooding event. She described ceiling panels caving in with mice and mice droppings falling on students and teachers.



Figure 10: Community residents conversing during a flooding event. EL VOCERO / Dennis A. Jones from <http://www.vocero.com/san-juan-abre-centro-de-acopio-en-el-roberto-clemente/>



○ **Health Links**

Injury and mortality - In many places with poor infrastructure and limited economic resources, flooding has led to higher rates of mortality. People are at increased risk of injury both during a flood and when they return to their homes or businesses and begin the clean-up process. Flooding has been shown to increase fecal-oral transmissions of disease, particularly in locations with poor sanitation systems or where there is limited access to clean water. Direct contact with sewage-contaminated waters may lead to gastrointestinal illness, which can be caused by bacterial, viral, and protozoan pathogens (Ahern et al 2005; Leclerc et al 2002).

Chronic diseases – such as diabetes, heart disease, asthma, obesity, and depression - are linked to environmental conditions associated with high stress and low physical activity as created by the frequent flooding (Ahern et al 2005). Chronic diseases are becoming an increasing problem in the United States, and Puerto Rico has rates that are comparable or higher for some of these disease categories and/or risk factors for these diseases (Table 2).

Chronic disease and risk factor prevalence

A.

	Diabetes	↑ BP	↑Chol	CHD	Asthma	Depression	Arthritis
PR	12.9	35.4	35.2	9.1	7.6	15	18.1
U.S.	11.3	29.6	38.1	5.9	8.8	9.1	25.9

B.

	Overweight	Obesity	No leisure time physical activity
PR	37.7	28.4	35.4
U.S.	36.2	28	24.2

Table 2. Percent of population with specific A. chronic disease or B. risk factors for chronic disease. PR – Puerto Rico, ↑ BP– high blood pressure, ↑Chol – elevated cholesterol, CHD – coronary heart disease. All statistics are for adults > 18 years except obesity and hypertension are for adults > 20 years of age. Percentages for U.S. data are state medians except depression (state mean) and diabetes (national estimate). Source: BRFSS 2006, 2008, and 2009 data (Li et al 2011; CDC 2010).

While current rates of all of these subcategories of chronic disease and risk factors are not available for the entire CMP community, a 2013 study of adult women in the CMP community reported higher prevalence than the island-wide statistics for a number of these subcategories: hypertension 40%; arthritis 36%; diabetes 23%; depression 22%; and asthma 20%. Older studies that included both men and women in the CMP community further support this idea that CMP residents have higher rates of chronic disease than elsewhere in Puerto Rico (Alvaréz-Rohena et al 2001; Balbás, 1995).

For children, the statistics are also of concern for Puerto Rico in terms of high chronic disease prevalence. Specifically, the increasing prevalence of pediatric obesity and diseases related to physical inactivity —such as diabetes, high blood pressure and heart disease— have been the focus of attention island wide (Associated Press 2007; Otero- González et al 2008; Stettler et al 2005; and Venegas et al 2003). Again, while current comparable statistics specific to the CMP community are not available, low income communities such as CMP suffer a disproportionate burden of these diseases and even very young children are

affected. For example, in 2011, Puerto Rico had an estimated obesity prevalence for low income, preschoolers of 17.9%, higher than the prevalence in all U.S. states (CDC 2013). Early childhood health is a major determinant of adult health and these statistics portend a worsening epidemic of chronic disease if the trajectory is not altered.

A major health determinant in chronic disease prevalence is physical activity. Physical activity is linked to decreased rates of diabetes and heart disease. The infrastructure of a neighborhood influences walkability and the likelihood that members will engage in physical activity (Mair et al 2010). Access to and use of pedestrian-powered transport – walking and biking - is linked to numerous positive health outcomes such as lower rates of obesity, cardiovascular disease, diabetes, and some types of cancer (CDC 2011). Factors of neighborhood infrastructure that can improve walkability and physical activity are the presence of sidewalks, streetlights, parks, green spaces, and waterfront access.

Physical activity also has a positive influence on stress levels and mental health; one study has shown that neighborhood walkability is associated with lower rates of depression in men (Mair et al 2010). In contrast, the presence of deteriorating structures, abandoned buildings, litter, and graffiti indicate the absence of social control and can cause concerns about safety, which in turn instills a fear of crime and causes an increase in stress levels. Deteriorating structures may also increase exposure to dangerous materials, such as lead paint, compounding toxic stress exposures with toxic chemical exposures (Kruger et al 2007). In addition, quality of housing, availability of transportation, and the proximity of necessary services such as banking, transportation, and healthcare all play a role in determining the level of environmental stress a person living in that area experiences (Taylor et al 1997; Kruger et al 2007).

Mental illness has also been found to increase after flooding events. Several studies have found an increase in posttraumatic stress disorder and psychiatric symptoms, such as anxiety, depression, irritability, and insomnia, in adults who have been exposed to flooding (Ahern et al 2005).

Asthma, eczema and other allergic disease are associated with damp and moldy buildings that result from flood events (Fisk et al 2010; Wu and Takaro 2007; Mendell et al 2011; Jenerowicz et al 2012). Dampness and mold within homes has been associated with dyspnea, wheezing, cough, allergic rhinitis, bronchitis, and upper respiratory tract infections (Fisk et al., 2010; Mendell et al., 2011). Exposure to mold-laden air is thought to contribute not just to worsening asthma and other respiratory symptoms but also to causing asthma in children (Landrigan 1999; Mendell et al 2011; Wu and Takaro 2007). Dampness also promotes other asthma and allergy triggers such as dust mites and bacteria (Mudarri and Fisk, 2007).

Both anecdotal and epidemiological data suggest that the burden of allergic disease in the CMP communities is high. Focus group participants, community advisors, and stakeholders reported eczema-like skin problems particularly after contact with flood waters. Acevedo-Díaz et al 2012 found that the prevalence of allergies was higher in residents of CMP communities adjacent to the channel (65.3% versus 60.4% compared to communities farther from the channel. The prevalence of asthma for children 5-9 (21.9%) was similar to that reported for Puerto Rico (21.5%) (Maymi et al 2007), but significantly higher among children younger than 5 (44.5%) (Acevedo-Díaz et al 2012).

There is a high cost associated with those who suffer from asthma; the symptoms of asthma require frequent medical intervention and lead to a reduction in work productivity

or missed days of work or school. A child's illness due to asthma may lead to both the child missing school and the child's parent missing workdays (Wu and Takaro, 2007). Asthma cases linked to chronic exposure to dampness and molds lead to an annual national cost of 3.5 billion dollars (Mudarri and Fisk 2007; Mendell et al 2011).

Flooding can increase the risk of vector-borne diseases, particularly those transmitted by mosquitos; flooding may cause the pooling of stagnant waters, thereby increasing the number of mosquito breeding sites (Ahern et al., 2005).

Flooding contributes to missed school days – interrupting education. School attendance is important for academic success, and frequent absences during a child's early years in school may have substantial impacts on educational success (Chang et al 2008). School absence in the early years of education is shown to particularly hinder the acquisition of reading skills. One study found that only 17 percent of children with chronic absence from both kindergarten and first grade were proficient readers by the end of third grade; 64 percent of students with regular attendance were proficient readers by the end of third grade (Bruner et al., 2011). The negative impact of school absence on educational success is especially pronounced for children living in families of lower socioeconomic status. Families of lower socioeconomic status are less likely to have the resources to provide children with the help needed to make up for school absences. Chronic absence in kindergarten children living in poor families has lasting effects and has been linked to low levels of academic achievement even as far out as fifth grade (Chang et al., 2008; Bruner et al., 2011). Furthermore, higher educational attainment is linked to multiple health indices – higher overall life expectancy, better self-perceived health status, and lower infant mortality (RWJF 2011).

Flooding can also affect unemployment by prohibiting regular work attendance which has considerable economic and health effects. Stable jobs with fair pay lead to better health. Stable employment is associated with a lower risk of developing a stress-related conditions like heart disease (RWJF 2013).

○ **Predicted impacts of infrastructure changes**

<b>Health Determinant</b>	<b>Health Indicator*</b>	<b>Direction of Impact</b>	<b>Magnitude (how many)</b>	<b>Severity (how much)</b>	<b>Comments</b>
<b>Lack of physical activity</b>	Obesity, heart disease, diabetes	↓	High	High	Wider streets and sidewalks increase pedestrian powered transport
<b>Property damage and mobility impairment from flood</b>	Stress, anxiety and depression	↓	High	Medium	
<b>Allergen exposure</b>	Rates of asthma and allergies	↓	High	Medium	Reduced damp conditions and mold
<b>Mosquito habitat</b>	Cases of dengue	↓	High	High	
<b>Impaired educational Attainment</b>	Number of missed school days, graduation rates	↓	High	Medium	Greater continuity of education, leading to improved educational outcomes

\*Health indicators cited here are examples, not a comprehensive list

Explanations:

- *Direction of Impact* refers to whether the proposed project will increase (↑) the burden of disease or decrease (↓) the burden of disease
- *Magnitude* reflects a qualitative judgment of the size of the anticipated change in health effect (e.g. the number of people affected) - low, moderate, or high
- *Severity* reflects the nature of the effect on function and life expectancy and/or its permanence - low, medium, or high

Infrastructure changes to the streetscape and drainage as included in this HIA are expected to result in improvements that could influence physical activity opportunities and reduce levels of contamination in water and the amount of standing water as discussed in the dredging section above. The infrastructure changes are expected to result in improved neighborhood physical characteristics. Many of these planned changes are associated with positive mental health and higher rates of physical activity. These include the presence of well-lit green spaces, parks, walkable area, and bike paths (O'Campo et al., 2009).

The additional storm water drainage and sewer infrastructure, buffer zone between residential properties and the channel, and improved drainage from the peripheral streets would all be expected to reduce the amount of flood water that accumulates. Fewer disturbances to the school schedule due to flooding would allow for greater continuity of education, which is associated with improved educational outcomes. Improved

educational outcomes, such as graduation rates and school success - are associated with multiple improvements in public health from cardiovascular disease to mental health to greater life expectancy. Additionally, less flooding would also be expected to result in fewer missed work days and greater productivity. Consistent gainful employment is associated with better health. Lastly, fewer flooding events would mean less moisture damage to homes and personal property. Less moisture damage and less overall damp conditions would reduce the viable surfaces on which mold can grow. Mold is a known respiratory irritant and allergy trigger. Thus, fewer flooding events would be expected to result in fewer conditions that promote allergy and other respiratory problems.

**SPECIAL FOCUS:  
Asthma among children in Caño Martín Peña**

Puerto Rico has higher rates of asthma among children than most areas of the United States. In many communities, more than 1 in 5 children have asthma. Thus, asthma is a concern island-wide. CMP communities are no exception. In a survey conducted in 2012, researchers from the University of Puerto Rico Medical Sciences Campus found asthma rate of over 23% among children under 18 years of age living within the communities bordering the CMP. They also found that the rate of asthma for children under five was 44.5%, more than double the 21.5 % reported for that age group in Puerto Rico.

Environmental conditions that trigger asthma attacks and potentially cause asthma are abundant in CMP. The elevated moisture levels from the frequent flooding and damp conditions promote mold growth and foster dust mites and asthma-inducing pests such as cockroaches. These conditions also lead to additional use of chemicals for cleaning and pest control that can cause asthma attacks. To make matters worse, heavy rainfall events are expected to increase in Puerto Rico under climate change, increasing these problems related to excess water and moisture under the current conditions (IOM 2011, Jacobs et al 2013, ALA 2014).

The proposed dredging, sanitary sewer additions, and storm water drainage improvements will decrease these environmental asthma triggers. These changes would help to reduce standing water, reduce the frequency of flooding, and consequently reduce conditions that contribute to high levels of mold, dust mites, cockroaches, and use of chemicals that can all contribute to asthma.

**Housing changes from demolition, resident relocation, and changes in land value**

In order for the dredging and the infrastructure modifications described above to occur, almost 400 additional residential structures will need to be demolished. The households currently residing in those structures need to be relocated. This significant community change will impact both those being relocated who will experience a change in housing structure and location and also the greater community who subsequent to these changes will likely experience a significant increase in property value and potential loss of social network. The health outcomes are hypothesized to result from these changes. See housing pathway graphic (Figure 11) for more details.

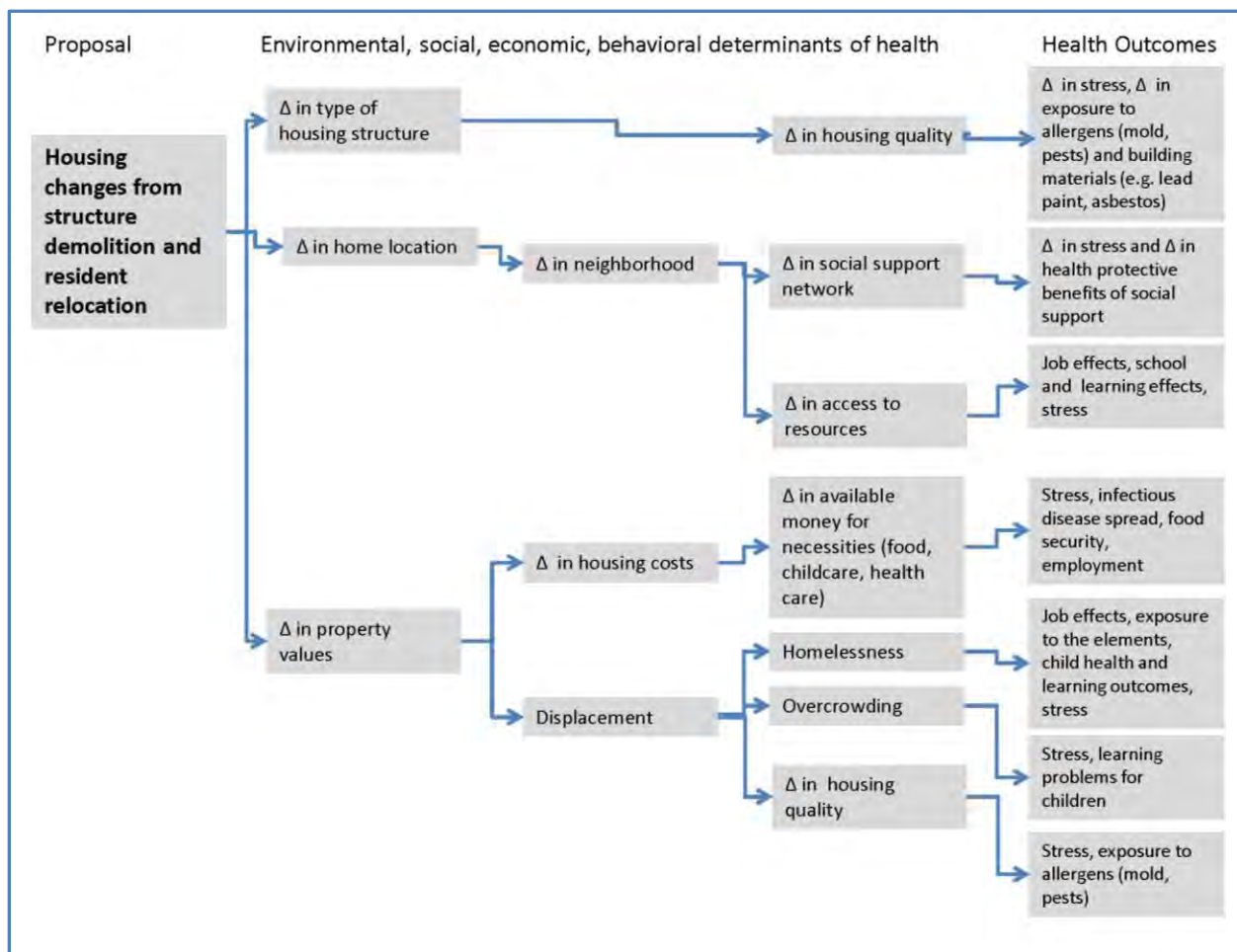


Figure 11. Pathway to Health Outcomes from Housing Changes Due to Structure Demolition and Resident Relocation.

○ **Existing conditions for housing**

As stated above, the CMP area has over 22,000 inhabitants per square mile which is the highest density in metropolitan San Juan. The current housing structures consist primarily (over 60%) of cement block structures (Estudios Técnicos 2003) of which the majority were constructed in the 1970's. The residents of CMP live in a mixture of single family and multifamily, multigenerational housing throughout the 8 neighborhoods adjacent to the channel. The housing conditions vary greatly from suitable, safe, and sanitary to unsuitable. Overall, many people report that their homes are a source of environmental stress, citing mold, insect or rodent infestation, or general deterioration often exacerbated by flooding. Almost half of the existing housing is renter (48%) versus owner occupied (52%), falling short of ownership levels in San Juan (57.2%) and Puerto Rico overall (73.3%). Half of the owner-occupied homes in the target communities are valued below \$50,000 compared to San Juan (17.5%). In several communities, as much as 17 percent of homes are valued below \$20,000.

Focus groups reported a variety of social networks – formal and informal around the community – but a number of participants also reported being isolated in their homes with few neighbors in immediate proximity. Some of the social connections cited by participants included neighbors in geographic proximity, family within the community, specific significant elders who play a leadership role, churches, and schools. ENLACE reports that an estimated 375 households, of them 120 renters, will need to be relocated as a consequence of the project. Relocations are regulated by the Uniform Relocation Assistance and Real Estate Acquisition Act (URA), U.S. Public Law 91-646, as amended, implemented through 49 C.F.R. Part 24, and the Acquisition and Relocation Bylaws for the Caño Martín Peña Special Planning District (ENLACE Bylaws). To date, approximately a third of the families that will be affected have been successfully relocated. The success of relocating residents has been mainly the results of community participation under the guidance of ENLACE. Nevertheless, relocation still causes great distress.

- **Health Links**

Housing conditions have both direct and indirect health effects. Firstly, deteriorating structures, due to instability, increase the risk of injury and may also increase exposure to dangerous materials, such as lead paint. Furthermore, the presence of deteriorating structures, abandoned buildings, litter, and graffiti can cause concerns about safety, instill a fear of crime, and cause an increase in stress levels (Kruger et al 2007). As stated above, the CMP area has the highest population density of metropolitan San Juan. The spacing of people within a neighborhood also impacts both physical and mental health. Overcrowding is associated with a greater risk of infection, increased respiratory disorders, and higher mortality rates due to cancer, stroke, heart disease, and homicide (Taylor et al 1997) and has been found to impact interpersonal behaviors, mental health, motivation, and cognitive development (Kopko 2007).

Studies have found that children 10-12 years old are more likely to exhibit withdrawn behavior in overcrowded situations; withdrawal may be a coping mechanism to handle an over stimulating environment. Elementary school-aged children who live in overcrowded homes have been found to have higher rates of psychological distress and behavioral issues. Children living in overcrowded homes were found to score lower on standardized reading exams (Kopko 2007).

Chronic stress that many residents report experiencing in connection with the threat of flooding and deteriorating housing negatively impacts health. The body physically reacts to stress in ways that over time can cause harm (Taylor et al 1997). Furthermore, a person may handle chronic stress by turning to unhealthy coping mechanisms such as drug and alcohol abuse or smoking (Echeverría et al 2008). High stress is one factor that leads to higher levels of mental health disorders, such as depression, anxiety, and substance abuse (Stockdale et al 2007). Studies have shown that mental illness can be as disabling as other leading chronic diseases (O’Campo et al 2009). Furthermore, mental health issues have also been linked to other chronic diseases, such as coronary heart disease (Taylor et al 1997).

The social community also influences health. Neighborhoods with a weak social community are also linked to lower numbers of pedestrians who walk for exercise, pleasure, or transport due to an increased fear of being robbed or attacked; thus, a weak social community is linked to decreased outdoor physical activity (Echeverría et al 2008). The absence of social capital, known as “social impoverishment,” has been linked to negative influences on health, such as high rates of child abuse, adolescent aggression and delinquency, high levels of adult crime, and teen pregnancy (Taylor et al 1997; Stockdale et al 2007).

Conversely, living in a neighborhood with strong social ties has been linked to several positive health behaviors. People living in a strong social community have been found to pursue more preventive health measures such as screening for cancer, eating less dietary fat, exercising, and not smoking or drinking. Additionally, women living in neighborhoods with strong social ties have been found to seek higher levels of prenatal care (Taylor et al 1997). The presence of strong social ties, known as social capital, has been linked to lower levels of stress and depressive disorders. Social capital also acts to reduce crime rates; the trust among community members that goes along with social capital leads to lower rates of crime, homicide, assault, robbery, and burglary (Kruger et al 2007). Strong social ties have been found to increase perceptions of safety, which reduces stress and depressive symptoms (Mair et al 2010). Connections with one’s neighbors and the feeling of mutual respect also contribute to positive mental health (Echeverría et al 2008).

Land value changes can increase the cost of living and either force relocation of families or create additional economic stress on families. Through this mechanism, land value changes could result in negative health impacts for community members, particularly children. Studies have found associations between high housing costs and the inability of families to afford basic needs, which may lead to inadequate childhood nutrition (Meyers et al 1993).



○ Predicted impacts from housing changes

Health Determinant	Health Indicator*	Direction of Impact	Magnitude (how many)	Severity (how much)	Comments
Toxicant exposure	Blood lead level	↓	High	Medium	Lead paint, asbestos, etc found in older homes
Allergen exposure	rates of asthma and allergies	↓	High	Medium	Residents removed from homes with mold and pests
Resident relocation	Stress, anxiety and depression	Short Term: ↑	High	Medium	Stress associated with lifestyle change and changes in the social support system.
		Long Term: ↓	High	High	Relocated residents would be placed in higher quality homes
Economic insecurity due to higher land values; higher housing costs	Stress	↑	Low	High	Increased land values may lead to homelessness or overcrowding for some residents

\*Health indicators cited here are examples, not a comprehensive list

Explanations:

- *Direction of Impact* refers to whether the proposed project will increase (↑) the burden of disease or decrease (↓) the burden of disease
- *Magnitude* reflects a qualitative judgment of the size of the anticipated change in health effect (e.g. the number of people affected) - low, moderate, or high
- *Severity* reflects the nature of the effect on function and life expectancy and/or its permanence - low, medium, or high

Community housing quality is expected to improve as a result of the housing changes that will occur. Reductions in flooding will help existing households maintain and improve the quality of housing when not faced with frequent water damage. Current housing conditions for the community members who will be relocated vary from adequate to dilapidated. The ENLACE bylaws (see below) call for provision of Decent, Safe, and Sanitary housing for any community resident relocated by the dredging and associated development projects. Thus, if these bylaws are respected, those currently in deteriorating housing will move to higher quality housing.

The relocation can lead to negative health effects by increased stress and disruption of social community and access to resources.

Land values are expected to increase following the dredging and community revitalization of the channel, especially considering the close proximity of CMP to the 'Golden Mile' financial district. The Community Land Trust (see below) exists to manage this change while preserving the opportunity for current community members to continue to live affordably in their community.

## **Mitigating elements**

### *Relocation plan*

Through the efforts of ENLACE with Cantera Company and other community organizations, approximately 500 families have already been relocated. However, nearly 400 additional homes will need to be demolished and the residents relocated in order for the dredging to proceed. Financing is still being sought for these additional relocation activities. This financing need is a key piece for the CDP implementation. ENLACE is helping to guide this process. While relocation assistance for the project is governed by the Uniform Relocation Assistance and Real Estate Acquisition Act (URA), U.S. Public Law 91-646, as amended, implemented through 49 C.F.R. Part 24, ENLACE has created separate bylaws, known formally as the Acquisition and Relocation Bylaws for the Caño Martín Peña Special Planning District (ENLACE bylaws), that create additional structures and protections for those within relocation areas. The eligibility criteria for those who need to be relocated are established in Puerto Rico Law No. 489-2004 and implemented through these ENLACE Bylaws. Under the laws/bylaws, ENLACE is charged with provision of Decent, Safe, and Sanitary (DSS) housing for those deemed eligible. Community members being relocated are given a choice of leaving or staying within the community. Those with strong ties to the community are more likely to choose to stay in the community, thereby preserving existing social cohesion. While change of any kind can increase stress levels, a systematic, understandable approach can help alleviate anxiety because community members know what to expect. Anecdotally, participants in the focus groups already felt this positive impact because of the careful and extensive outreach work carried out by ENLACE.

### *Community Land Trust*

Communities immediately adjacent the CMP such as those in the financial district of Hato Rey, the western section of the channel that was dredged previously, and the now highly developed tourist area of Condado also in the municipality of San Juan are all examples where longtime residents have been displaced as an unfortunate consequence of development without consideration of the existing communities. Because of this history, the G8 community and ENLACE together took action to prevent predatory real estate activity, to preserve affordable housing, and, ultimately, to protect community members from being priced out of their own community.

To that end, the Community Land Trust (CLT, El Fideicomiso de la Tierra del Caño Martín Peña) was also created in 2004 to protect the interests of the community residents and avoid involuntary displacement that has plagued other historical land grabs in Puerto Rico. Unlike ENLACE, which, by its charter, is a temporary entity existing for a time-limited

mission, the CLT is created in perpetuity. It is a private, non-profit organization, created to manage and safeguard the land transferred under Law No. 489 - 2004 for the benefit of the residents of CMP Special Planning District. The CLT is a mechanism of collective land ownership to solve the problem of a lack of land titles, avoid involuntary displacement of communities that make up the District, ensure the long-term survival of these communities, ensure District residents access to affordable housing, increase the value of land and capital in the community, streamline and help finance the implementation of the CDP for the District, and diversify sources of income of the residents. The CLT is directed by community members.

Through community land trusts, affordable housing is permanently maintained for low-income families. Members of the CLT include residents and businesses of the community, which ensures that the community land trust serves the interests of the community and its inhabitants. The CLT ensures that the land and homes will not be sold at a higher cost to developers who are interested in creating a higher-income neighborhood. A provision in the CLT mandates that houses may only be re-sold to another low or moderate-income owner. This system ensures that affordability is built into the lease and will perpetuate for all housing turnovers (What are Community Land Trusts? 2013). Community land trusts are established to help maintain affordable homeownership but are weaker at helping to maintain affordable rents (Ciardullo 2012; Davis and Demetrowitz 2003). With prioritization within a specific community land trust, affordable rents can also be a focus. However, the success of the CLT in its mission is dependent on on-going community engagement and support.

## **Recommendations**

The HIA leadership in conjunction with the Community Advisory Committee from CMP has developed the following recommendations for promotion of human health based on the evidence brought forth through this HIA process.

### *Key Recommendation*

**The Puerto Rican Commonwealth, with federal support, should finance the implementation of the Comprehensive Development Plan in its entirety, including dredging - with careful safeguards to minimize harmful exposures to residents and workers; infrastructure improvements to roadways, sewer and storm water drainage systems; and the demolition of structures and relocation of households according to the ENLACE bylaws.**

The elements included in the CDP are interconnected, and the success of any single element is dependent on all or some of the other elements. For example, structure demolition and resident relocation is a prerequisite for much of the needed infrastructure improvements whose success in turn depends on the dredging to increase flow of the channel. Underpinning each of these aspects is community support. To that end the activities and projects being implemented by ENLACE are vital to the success of the CDP. A robust public outreach campaign for such a project is necessary to inform and educate the public of the

importance of a healthy ecosystem in the area, discouraging future secondary effects that could occur.

*Additional recommendations*

**Regarding dredging and debris removal**

1. The CDP should include provisions to prevent dredging-related negative health effects (minimize trespassing into the dredging area, especially for children; remove debris and professionally prune mangroves prior to beginning dredging to minimize the scattering of animals and insects that currently reside there; non-toxically reduce migration of pests from the area being cleared; and construct sound barriers, especially in critical areas, to minimize construction noise) and to minimize worker and public exposure to dredged sediment which will likely contain elevated levels of toxic materials. This includes measures for safe transport and also disposal in areas where neither immediate nor delayed exposures will occur such as through groundwater contamination. - *These precautions will help to safeguard human health during this potentially disruptive work.*
2. The Municipality of San Juan and State Departments of Health should plan for targeted fumigation when key vector habitat is being disturbed to reduce vector-borne disease risk to the community. - *While priority should be given to non-chemical means of pest control first, for short periods during the peak of disruptive activities, the risk to the community of pesticide application will potentially be outweighed by the risk of pest infestation.*
3. The Community Health Committee of CMP should develop specific environmental health training of community health workers so those workers can best educate residents about reducing exposures and identifying early signs of health effects from elevated exposures. - *Such an effort would build on the existing health capacity of the community health worker program with targeted training to address the unique needs of the community before and during the construction process.*
4. ENLACE should partner with local clinics and/or the community health worker program to implement health surveillance – such as asthma and/or injury rates before, during, and following CDP implementation both to address problems if they arise and to contribute health data to future projects. - *This type of health surveillance could be performed in consultation with the Department of Health of the San Juan municipality to produce the most useful and comparable data.*
5. Conduct outreach about the CDP to the larger community of San Juan, particularly those to the east in Laguna San Jose, to raise awareness about the potential health benefits of increased access to recreational water space that will extend to other communities. - *This recommendation came from multiple stakeholders and community advisors who felt that the larger community would be stronger advocates for the CDP if educated regarding the widespread benefits.*
6. Enforce anti-dumping policies to keep the area around the CMP free of debris in the future. - *This recommendation is critical for the sustained benefits of the CDP.*

## Regarding infrastructure

1. Storm water drainage improvements should be considered urgent particularly in light of extreme rainfall predictions for the coming decades associated with climate change to adequately prevent flooding events. – *Inclusion of the most current climate change projections will contribute to long term sustained health benefits of the CDP.*
2. Infrastructure changes should create a pedestrian and bike friendly streetscape, additional green and open space, and public waterfront access to maximize safety, social interaction, and physical activity. – *While the ‘paseo’ is already integrated into the CDP, this recommendation emphasizes the health benefits of keeping the planning emphasis on walkers and bikers and access to recreational spaces.*

## Regarding housing

1. Preserve an equitable, sensitive, and well-organized approach to relocation by maintaining ENLACE as the lead in the relocation process. ENLACE is well integrated, works in close collaboration, and has a long-standing trusting relationship with the communities of the CMP. Even if ENLACE were not the lead agency for the relocation process, ENLACE’s bylaws as drafted with the community should be implemented by the agency leading the relocation process. – *Community trust emerged as one of the most important elements for both successful implementation and minimization of the negative stress effects.*
2. Assign a social worker to assist the families being relocated and provide support groups to help all families cope with the stress of the transition, including those who may be losing their neighbors to relocation. – *This recommendation came from the Community Advisory Committee who emphasized that the relocation process has impacts on both those being moved and those staying because of community disruption.*
3. Promote the role of the Community Land Trust by conducting outreach to the community to educate residents about its role in serving the needs of the community, preventing displacement, homelessness, overcrowding, and poor conditions and maintaining affordability. – *The successful continuation of the CLT is dependent on residents understanding and supporting its underlying mission.*

## Monitoring

Monitoring following this HIA will determine:

- What progress has been made on the overall implementation of the plan?
- Which specific recommendations have been enacted?
- What evidence is there for changes in individual, family, and community health as a result of HIA recommended actions?

Also important will be monitoring to determine if the key expected impacts – reduction of flooding and exposure of residents to contaminated flood waters – have occurred. ENLACE will play an instrumental role in this type of monitoring.

The following table (Table 3) summarizes the suggested actors and indicators for each recommendation. For the majority of these recommendations, ENLACE is already implementing or is best positioned to facilitate their enactment. In their position as a ‘quasi-public’ organization – basically a type of government agency that is created to work within a community for that community’s benefit for a time-limited period, ENLACE functions more like a non-profit organization with strong community ties and trust but has liaisons with public agencies that create a unique capacity for effective change.

	<b>Recommendation</b>	<b>Enacting entity</b>	<b>Monitoring indicators</b>	<b>Monitoring agency</b>	<b>Timing</b>
<b>Dredging and debris removal</b>	Prep dredging work site: secure borders, prune mangroves, remove debris, control pest migration, and add sound barriers	ENLACE	Site is secure and sound mitigation in place when dredging is set to begin	G8	Prior to dredging
	Targeted fumigation where key vector habitat is being disturbed	DOH - State and municipal San Juan	Public report of insect nuisance, Dengue CDC* branch surveillance data	ENLACE CDC Dengue Branch	Prior to and during dredging
	Local environmental health worker training	Local health organizations	Local environmental health workers ability to identify health effects from elevated exposures	ENLACE or other EH worker supervising group	Prior to dredging
	Partner with local clinics to implement health surveillance	Local health organizations	Asthma and diarrheal disease visits	Local clinics with DOH	During and after dredging
	Outreach to other communities in San Juan about CDP health benefits	ENLACE and G8	Awareness of project throughout San Juan		After dredging
	Enforce anti-dumping policies in the area around the CMP	Community and local law enforcement	Cleanliness of area	Community and local law enforcement	After dredging
<b>Road and sewer changes</b>	Factor in extreme rainfall predictions	ENLACE	Measurements of storm drains and sanitary sewers	Water and Sewer Authority (PRASA)	During drain design
	Create pedestrian and bike friendly street, additional green space, and waterfront access	ENLACE	Residents present outdoors, access to open space	Sports and Recreation Department (DRD)	During design and as follow up
<b>Housing changes</b>	ENLACE leads the relocation process or other agency following guidance	ENLACE	Stress and anxiety levels in population	G8 and other community groups	During and after relocation
	Provide support groups and a social worker for relocated families and remaining families	ENLACE	Stress, anxiety, and depression levels in population	Local social workers	During and after relocation
	Conduct outreach to community to educate residents about the Community Land Trust	ENLACE	Stress levels, no. of homeless and overcrowded residents, residents that chose relocation into the CLT	Local social workers	After relocation

Table 3. Enactment and monitoring of recommendations, \* CDC Centers for Disease Control and Prevention

## Conclusions

This Health Impact Assessment has revealed that the CMP community is characterized by residents with strong desires to see their community have improved mobility within and access to outdoor spaces for all residents and with an understanding that the poor health of the channel ecosystem is linked to many of the human health problems that they are experiencing. The community has chronic disease rates as high as or higher than other Puerto Rican communities, and the health studies that have been conducted previously in the community identify the degraded environmental conditions as a key factor in many of these diseases. The HIA has further identified that there is a strong base of literature about similar communities that demonstrate that the existing conditions in CMP – deteriorating housing, frequent community flooding, an inadequate sewage system, frequent school and work disruptions due to the flooding, repeated exposures to sewage contaminated flood waters – are linked to infectious, allergic, chronic disease and mental health problems as well as negative economic and school performance effects.

The dredging infrastructure changes including improved storm water drainage, a buffer zone between residential property and the channel, and improved drainage from the peripheral streets, and the necessary housing demolition and resident relocation required by the project could have significant short and long term health impacts on the residents. By and large, the physical changes to the community would be expected to result in improved health. An improved streetscape, for example, that is more conducive to walking and bicycling will foster greater physical activity. Increased physical activity can lower rates of chronic diseases such as diabetes in adults and result in improved school performance in children. Reduced flooding events in residents' homes will mean less mold and other allergens in indoor air. This improved air quality can lower rates or severity of respiratory diseases such as asthma.

In the short term, there are additional precautions that should be taken to ensure the community does not experience untoward exposures – physical injury, air quality changes, or excessive noise -- related to the dredging and construction. Additionally and perhaps most importantly, the relocation of community members living in structures that will be demolished is a crucial and delicate part of this entire process. Specific resources should be devoted to facilitating this process – with assistance from such community-integrated agencies like ENLACE and potentially one or more social workers to facilitate the transition, in particular the use of the CLT as a tool for stress reduction and living conditions improvements.

With careful adherence to the planned implementation and additional incorporation of the recommendations from this HIA, multiple important health benefits could come from the dredging, infrastructure changes, and housing changes leading to overall improved well being in the community. As one community member stated, “a healthy community is a happy community.”



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## Appendix

### *CMP Comprehensive Development Plan (CDP)*

While still a “program/project” under direction of the Puerto Rico Highways and Transportation Authority and the Puerto Rico Department of Transportation and Public Works, ENLACE served as the primary facilitator for the development of the CDP. Between 2002 and 2004, as part of the planning process, ENLACE convened over 700 community participation activities. These activities included round table discussions, public assemblies, workshops, presentations, and educational activities at local schools. The CDP focuses its vision, goals, and policies on four principal areas: (1) environment; (2) socioeconomic development; (3) institutional capacities; and (4) mobility, transportation, and tourism development. In addition to the dredging, sewage, storm water, and roadway infrastructure, and housing demolition and family relocation aspects addressed in this HIA, the CDP also integrates the design and implementation of a number of other environmental, infrastructure, housing development, urban revitalization, land tenure, and socioeconomic development strategies before, during, and after the channel’s dredging and restoration phase.

Figure A1 shows how the CDP will widen the existing channel and create an ecologic buffer that will also serve in part as a green recreation space for the community.

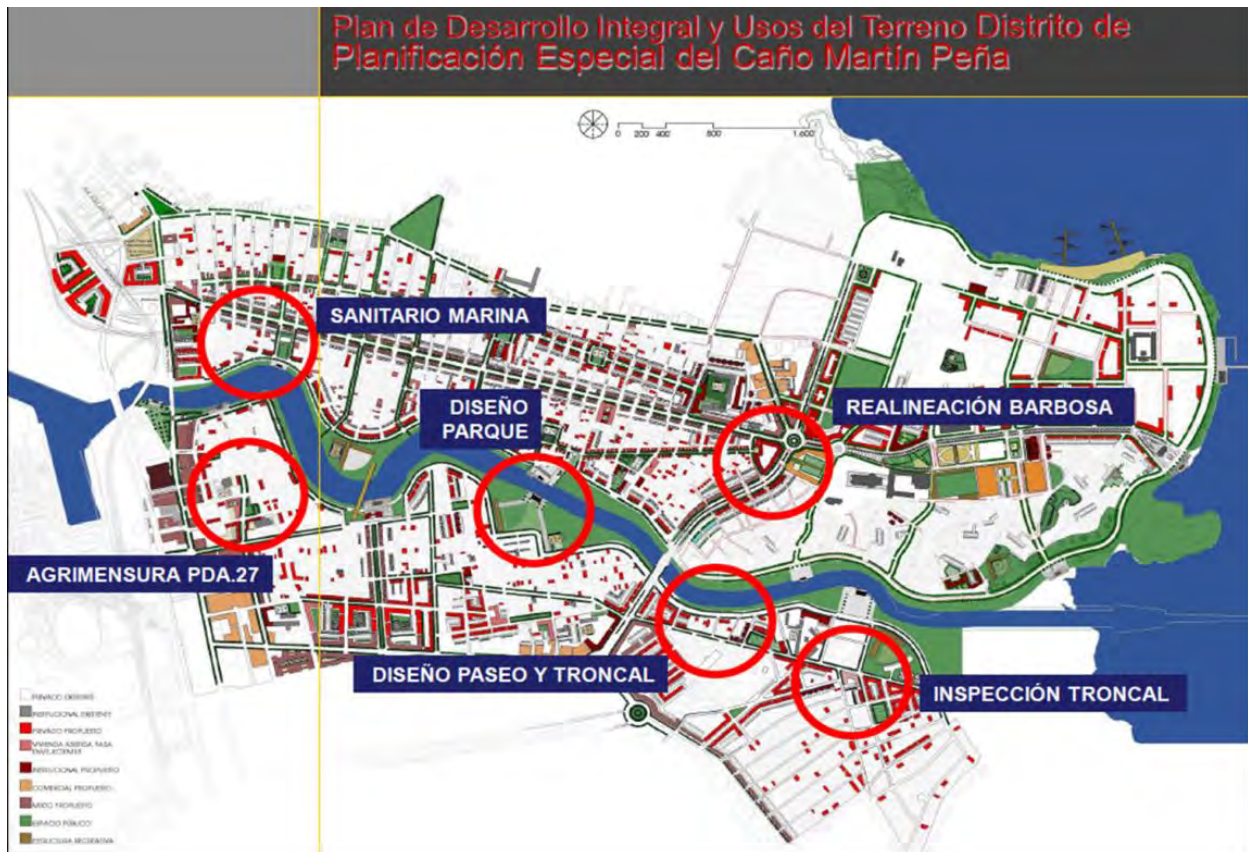


Figure A1.

The CDP includes the following critical components:

- A widened channel configuration to 100 feet and a depth of 10 feet following the existing channel alignment.
- A mangrove conservation area.
- Recreational access areas located within the conservation area.
- The “Paseo del Caño” as a widened street along the CMP as a public space that separates the eight communities from the CMP and its mangroves and prevents future encroachment. It also provides a bicycle lane and pedestrian amenities, as well as access to the recreational access areas.
- A relocation plan as required under the Uniform Relocation Act of Assistance and Real Property Acquisition Policies Act as amended, P.L.91-646; 42 U.S.C 4601 et seq. (URA).
- Construction of new housing units and rehabilitation of existing ones, primarily to provide relocation alternatives within the District.
- Construction of critical infrastructure and relocation of several infrastructure facilities, including 66-inch-diameter San José and Rexach sewer trunks, the 36-inch-diameter Borinquen water distribution line, and the 115-kV power transmission line.
- New streets to provide for public space that can be used to locate critical infrastructure, as needed to address the lack of sewer systems.

ENLACE is implementing the following related initiatives:

- Acquisition of 150 structures to date within the CMP, which includes the relocation of 122 eligible occupants, and demolition of structures. All acquisition and relocation efforts have been made in compliance with the URA, as required under PR Law PR 2004-489. Together with the efforts of the Cantera Company, the Israel-Bitumul CHDO, and the PRHTA, approximately 500 households have been relocated from the CMP and adjacent areas and another 375 structures located within the CMP still remain to be acquired.
- Real estate acquisition in other areas of the District, and housing rehabilitation to serve as relocation opportunities within the District.
- One-on-one orientation to families living within the CMP in the District.
- Design of improvements to the San José Trunk in the segment within the Israel-Bitumul communities. The project will be built by the Puerto Rico Aqueduct and Sewer Authority (PRASA).
- Environmental awareness activities targeting mainly school children.
- A microbusiness incubator that provides support to recycling and ecotourism community owned businesses.

The following relevant initiatives are or have been implemented by other Commonwealth of Puerto Rico government agencies, most under the coordination of ENLACE.

- Relocation of the Barbosa Bridge over the CMP, elevating it to allow access for the barges, as part of the future CMP dredging (PRHTA).

- Two surface debris clean-up activities in areas adjacent to the CMP, which resulted in the removal of over 885 tons of debris and the recuperation of over 1,500 pounds of recyclable material.
- Construction of the Barrio Obrero Marina vacuum sewer system, north of the CMP.
- Evaluation of alternatives for the relocation of the San José and Rexach 66-inch diameter sewer trunks and the Borinquen 36-inch-diameter potable water distribution line (PRASA).
- Conceptual design for a sewer system in northern Israel-Bitumul (PRASA).
- Delineation of the public domain lands associated with the CMP within the District.

