The Other 90% :
Infrastructural Components for the Masses
Port-au-Prince, Haiti

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

Port-au-Prince, Haiti, along with many dense cities in developing countries, is stifled by its rudimentary, undersized and poorly maintained waste, water and sanitation infrastructural systems. Port-au-Prince, a city already plagued by poverty and overpopulation, suffered a magnitude 7.0 earthquake in 2010 that devastated the already fragile republic. Flooded with not-for-profit and non-governmental organizations (NFPs and NGOs) and billions of dollars of aid money following the earthquake, the new challenge arose of finding ways to utilize these new, uncoordinated resources efficiently without falling victim to dependency on aid money and other fleeting, external resources.

In an impoverished economy in which the excess waste is a primary cause of illness, water pollution and space constraints, how can this waste be consistently collected at an affordable cost but also be leveraged to produce new economies and productive by-products to fund itself and also reduce reliance on costly imported products?

How can Port-au-Prince establish basic infrastructural services that are not reliant on the existing rudimentary, overburdened, dysfunctional infrastructural systems or external aid for sustenance, and are self-sustaining models?

How can this infrastructure leverage and become integrated with the architecture of the city and be a part of a network of architectural pieces that complement each other and together serve multiple purposes?

Furthermore, what is the most environmentally-sensitive and socially acceptable way to do this that is not cost-prohibitive?

The thesis proposes a series of infrastructural components for decentralized waste, water and sanitation that can address the cultural and infrastructural challenges of diverse sites within the city, as city-wide systems have proved unsuitable and have not been maintained. The proposal deals with resources and wastes on-site, in order to reduce dependence on often expensive methods of waste collection and water provision. It diverts waste and excess water from ravines; reduces waste strewn throughout the city; creates community accountability and engagement, and, in doing so, strives to improve quality of life. Waste is furthermore utilized in fueling other complementary processes, generating a micro-scale waste economy. The solution to making Port-au-Prince's infrastructural systems viable and self-sustaining is to turn them into economic drivers that produce businesses and jobs through the collection, sorting, processing and re-use of wastes and water that in turn result in safer and more sanitary living conditions, as well as helping to re-organize a city destroyed by the earthquake into productive neighbourhoods with local community nodes.

How can this proposal become systemic?

Can these proposals be applicable in other contexts besides Port-au-Prince?

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National Geospatial Intelligence Agency, “Haiti – 1:50,000” [map], 1:50,000, “Perry-Castañeda Library Map Collection,” 1962, http://www.lib.utexas.edu/maps/topo/haiti/port-au-prince-haiti-tlm50-57714.pdf.
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Map by author. Based on:
National Geospatial Intelligence Agency, “Haiti – 1:50,000” [map], 1:50,000, “Perry-Castañeda Library Map Collection,” 1962, http://www.lib.utexas.edu/maps/topo/haiti/port-au-prince-haiti-tlm50-57714.pdf;
Inter-Agency Standing Committee (IASC), “IDP Sites and Flood Threat Frequency in Metropolitan Area” [map], 1:26,000, “E-Shelter & CCCM Cluster,” February 20, 2012, http://www.eshelter-cccmhaiti.info/jl/images/pdf/drrcampsfloodsthreatsmetropolitanarea.pdf.
73 Fig. 4.9 Implementation Phasing Diagram A: Components 1, 2, 4 - 6, 8 map
Map by author. Adapted from:
National Geospatial Intelligence Agency, “Haiti – 1:50,000” [map], 1:50,000, “Perry-Castañeda Library Map Collection,” 1962, http://www.lib.utexas.edu/maps/topo/haiti/port-au-prince-haiti-tlm50-57714.pdf.
73 Fig. 4.10 Implementation Phasing Diagram B: Components 3, 7 (paired with 1) map
Map by author. Adapted from:
Inter-Agency Standing Committee (IASC), “IDP Sites and Flood Threat Frequency in Metropolitan Area” [map], 1:26,000, “E-Shelter & CCCM Cluster,” February 20, 2012, http://www.eshelter-cccmhaiti.info/jl/images/pdf/drrcampsfloodsthreatsmetropolitanarea.pdf;
National Geospatial Intelligence Agency, “Haiti – 1:50,000” [map], 1:50,000, “Perry-Castañeda Library

Map Collection," 1962, http://www.lib.utexas.edu/maps/topo/haiti/port-au-prince-haiti-tlm50-57714.pdf; National Geospatial Intelligence Agency, "Port-au-Prince Image Base Map - Sheet 1" [map], 1:12,500, "Perry-Castañeda Library Map Collection," 1994, http://www.lib.utexas.edu/maps/world_cities/txu-oclc-51277879-port_au_prince2-1994-small.jpg.

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Map by author. Adapted from:
"Port-au-Prince, Haiti," Google Earth, Google, 2012;
National Geospatial Intelligence Agency, "Haiti Image Base Map" [map], 1:12,500, "Perry-Castañeda Library Map Collection," 2009, http://www.lib.utexas.edu/maps/americas/PortAuPrince_Sheet1_Image_Base_Map-GeoEnabled.pdf; National Geospatial Intelligence Agency, "Port-au-Prince Image Base Map - Sheet 1" [map], 1:12,500, "Perry-Castañeda Library Map Collection," 1994, http://www.lib.utexas.edu/maps/world_cities/txu-oclc-51277879-port_au_prince2-1994-small.jpg.

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Map by author. Adapted from:
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National Geospatial Intelligence Agency, "Haiti Image Base Map" [map], 1:12,500, "Perry-Castañeda Library Map Collection," 2009, http://www.lib.utexas.edu/maps/americas/PortAuPrince_Sheet1_Image_Base_Map-GeoEnabled.pdf; National Geospatial Intelligence Agency, "Port-au-Prince Image Base Map - Sheet 1" [map], 1:12,500, "Perry-Castañeda Library Map Collection," 1994, http://www.lib.utexas.edu/maps/world_cities/txu-oclc-51277879-port_au_prince2-1994-small.jpg.

77 Fig. 4.13 Amenities per 5 km²: Delmas
Map by author. Adapted from:
"Port-au-Prince, Haiti," Google Earth, Google, 2012;
National Geospatial Intelligence Agency, "Haiti Image Base Map" [map], 1:12,500, "Perry-Castañeda Library Map Collection," 2009, http://www.lib.utexas.edu/maps/americas/PortAuPrince_Sheet1_Image_Base_Map-GeoEnabled.pdf; National Geospatial Intelligence Agency, "Port-au-Prince Image Base Map - Sheet 1," [map], 1:12,500, "Perry-Castañeda Library Map Collection," 1994, http://www.lib.utexas.edu/maps/world_cities/txu-oclc-51277879-port_au_prince2-1994-small.jpg.

79 Fig. 4.14 Amenities per 5 km²: Downtown
Map by author. Adapted from:
"Port-au-Prince, Haiti," Google Earth, Google, 2012;
National Geospatial Intelligence Agency, "Haiti Image Base Map" [map], 1:12,500, "Perry-Castañeda Library Map Collection," 2009, http://www.lib.utexas.edu/maps/americas/PortAuPrince_Sheet1_Image_Base_Map-GeoEnabled.pdf; National Geospatial Intelligence Agency, "Port-au-Prince Image Base Map - Sheet 1," [map], 1:12,500, "Perry-Castañeda Library Map Collection," 1994, http://www.lib.utexas.edu/maps/world_cities/txu-oclc-51277879-port_au_prince2-1994-small.jpg.

79 Fig. 4.15 Amenities per 5 km²: Pétion-Ville
Map by author. Adapted from:
"Port-au-Prince, Haiti," Google Earth, Google, 2012;

National Geospatial Intelligence Agency, “Haiti Image Base Map” [map], 1:12,500, “Perry-Castañeda Library Map Collection,” 2009, http://www.lib.utexas.edu/maps/americas/PortAuPrince_Sheet1_Image_Base_Map-GeoEnabled.pdf; National Geospatial Intelligence Agency, “Port-au-Prince Image Base Map - Sheet 1,” [map], 1:12,500, “Perry-Castañeda Library Map Collection,” 1994, http://www.lib.utexas.edu/maps/world_cities/txu-oclc-51277879-port_au_prince2-1994-small.jpg.

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95 Fig. 4.28 Recyclables Collector photograph
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Photograph source: http://4.bp.blogspot.com/-MiucEzUtbRk/TgzXPWlraLI/AAAAAAAAAD4/OqBWMN97fPo/s1600/DSC_0004-lr.jpg
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http://www.iom.int/jahia/webdav/shared/shared/mainsite/activities/countries/docs/haiti/IOM-Haiti-Two-Year-Report-2010-2011-From-Emergency-to-Sustainable-Recovery.pdf.
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Photograph by the International Organization for Migration (IOM);
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CHAPTER 5.0

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CHAPTER 7.0

159 Fig. 7.1 Tap-Taps (Public Transit), Port-au-Prince photograph
Photograph by Jan Sochor; http://www.jansochor.com/photo-essay/tap-tap.html.

1.0

INTRODUCTION

DEVELOPMENT CONDITIONS IN PORT-AU-PRINCE

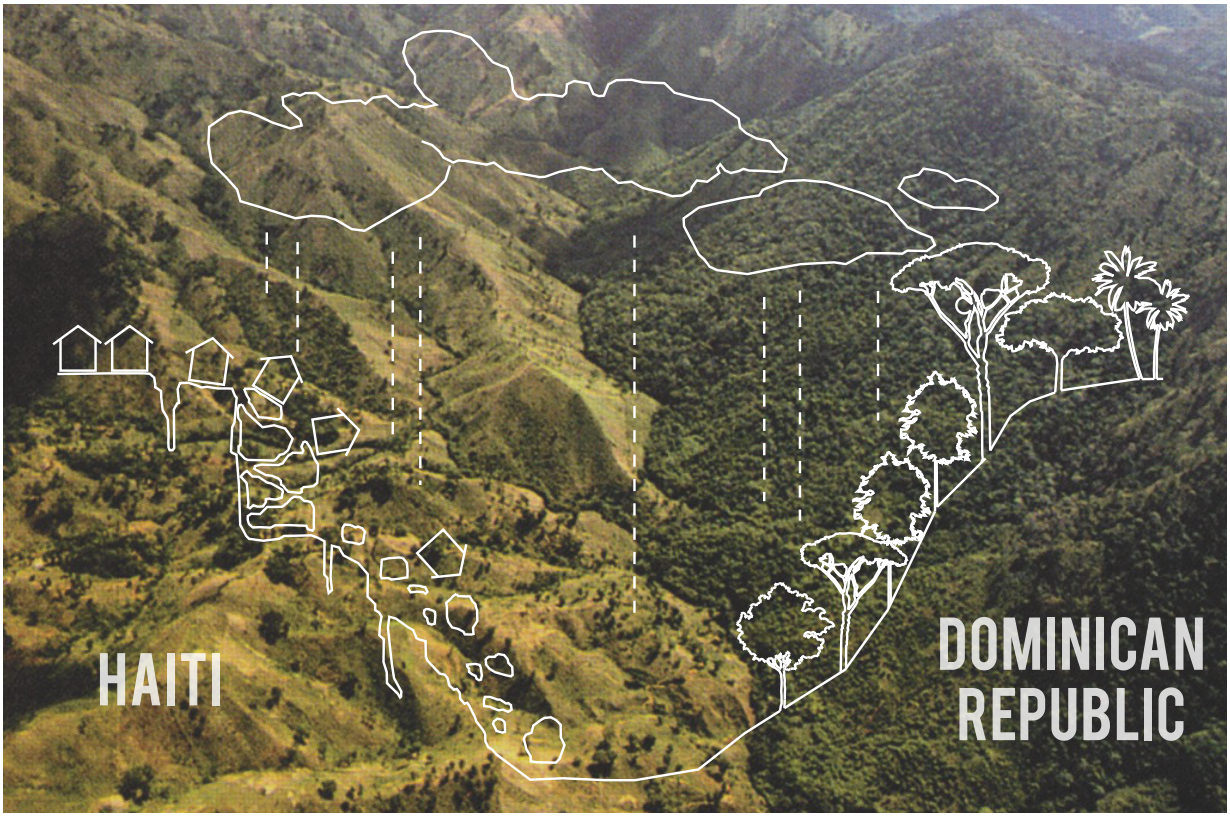


Figure 1.1 : Haiti - Dominican Republic Border, displaying the effects of Unregulated Deforestation

"Without doubt, Haiti was seriously out-of-balance before the earthquake and Port-au-Prince was a disaster waiting to happen."[1] The 2010 earthquake that cast Haiti into the spotlight overnight merely exposed the existing dysfunction and inadequate provision of the poorest country in the western hemisphere.[2] Haiti was a disaster before the disaster.

This chapter will explore the primary hindrances to Haiti's development as a means of explaining what factors are determining the chaotic state of things, what obstacles need to be maneuvered around, and why certain issues remain paralyzed, unable to move forward in order to set the stage for how to progress from here. The sheer scale of some of these issues cannot be addressed with the thesis design proposal, but design choices have been made in light of the obstacles and powers at play to provide a reasonable, suitable solution.

HINDRANCES TO DEVELOPMENT

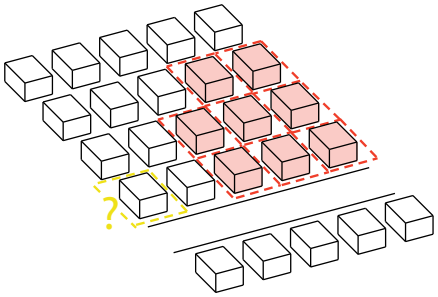
The Republic of Haiti has many forces working against it, both as a result of recent events and a past that has plagued its development. Hindrances to Haiti's development began in its past. It has a history of corruption and poverty, oppressive rulers, unenforced laws, natural disasters, exploitation of its own resources to the point of self-destruction, and dependence on imported goods. All of these, along with the new difficulties brought about by the devastating 2010 earthquake, have played their role in shaping why Haiti remains in the disordered state it is.

These issues have widespread ramifications, but their impact on Port-au-Prince's development specifically, will be explored here. "Together with limited financial resources, the lack of skilled, trained and properly organized government personnel and the lack of management systems within ministries and other government bodies are the principal constraints on the [Haitian] state's effectiveness."[3]

> DEFORESTATION

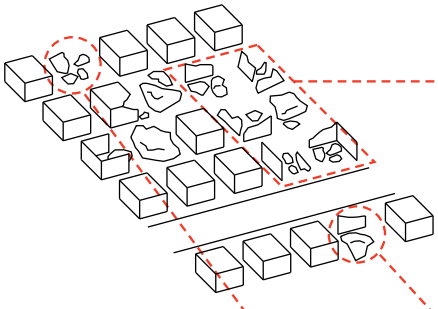
Hindrances to Haiti's development begin in its past. Haiti overthrew its oppressive French slave masters in 1804, but to keep France, its Colonial power at the time, at bay, Haitians stripped their country of its forests for decades to pay France.[4] They continue the practice today, cutting down any available trees for cooking fuel before the trees have a chance to mature and replenish the soil.[5] Only 2% of Haiti's original forests remain,[6] and there are no enforced forestry regulations in place.[7] As a result, there is no local timber available in the country for construction; all must be imported at a high cost.[8] This deforestation has also caused extensive soil erosion.[9] This is particularly problematic as much of the country is mountainous, and landslides from the extensive annual rains wash crops, people and buildings down the mountainside. Because these mountainsides are undesirable locations to build, the city of Port-au-Prince has been developing up to the edge of them. However, when rural Haitians flock to major cities in droves seeking work and education and cannot afford proper housing, the majority of them squat on the eroded mountainous land along the city's perimeter.[10] These have become bidonvilles, informal settlements (a.k.a. slums), which are crowded, unsafe, unsanitary, and unserviced by formal waste, sanitation, water and electrical services.

HINDRANCES TO RE-DEVELOPMENT IN POST-QUAKE PORT-AU-PRINCE : LAND ISSUES



ONLY 40% OF LANDOWNERS POSSESS DOCUMENTATION OF LAND TITLE OR RECEIPT OF PURCHASE TRANSACTION.

M 7.2
EARTHQUAKE



TO PURCHASE LAND FOR RE-DEVELOPMENT, THE **LAND TRANSFER PROCESS TAKES 19 YEARS.** TO PUT THAT IN PERSPECTIVE, THE AVERAGE LIFESPAN OF A HAITIAN IS 50 YEARS.

THOSE WITHOUT PROOF OF LAND TENURE (60% OF LANDOWNERS) WHOSE BUILDINGS HAVE BEEN TAGGED BY OFFICIALS FOR DEMOLITION (25% OF ALL BUILDINGS IN PORT-AU-PRINCE) **RESIST DEMOLITION BECAUSE THEIR BUILDING'S FOUNDATIONS ARE THEIR ONLY CLAIM TO THE LAND.**

THE LAYERING OF BUILDINGS CONSTRUCTED WITH NO VEHICULAR ACCESS **SLOWS RUBBLE-CLEARING AND THE PROCEEDING RECONSTRUCTION** PROCESS DUE TO INABILITY TO ACCESS THE SITE EXCEPT BY FOOT. MATERIALS ARE THEREFORE TEDIOUSLY TRANSFERRED BY HAND VIA A HUMAN CHAIN.

Figure 1.2 : Hindrances to Development in Post-quake Port-au-Prince: Land Issues

> LAND OWNERSHIP ISSUES

Haiti's dysfunctional land tenure system, which arose following the slave trade, is another impediment to development. When the French relinquished control of the country to Haitians, the land was not formally redistributed. Haiti still does not have an effective national cadastre and lacks a comprehensive, functional system for recording land ownership.[11] Furthermore, much of the records that did exist were destroyed in the earthquake."[12] "Prior to the earthquake, customary arrangements and knowledge characterized the tenure of Haiti with only 40% of landowners possessing documentation such as a legal title or transaction receipt."[13] In some cases where records do not exist, "homeowners will resist the full demolition of their homes if it erases the only tangible evidence of their claim to the land, particularly in view of the historical importance in Haiti of physical presence as a basis for asserting claims to land ownership."[14] The transfer of land ownership can also greatly hinder the prospect of development: the process of buying a parcel of land takes 19 years. [15] To put that in perspective, the average life span of a Haitian is 50 years. Additionally, the government of Haiti can declare eminent domain on a piece of land at any time, stopping a project in its tracks.[16]

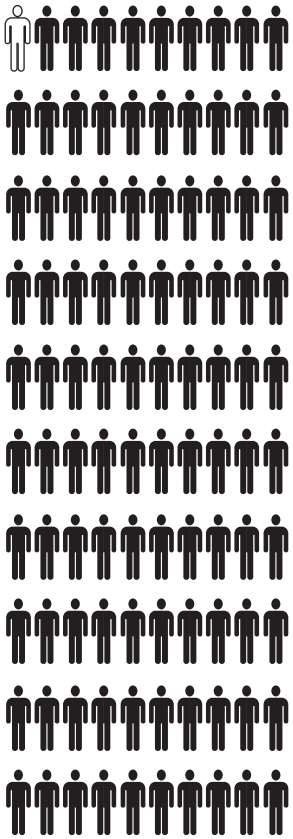
> IMPORT DEPENDENCE

Equally important as the issues land tenure brings to development and construction efforts in Haiti is its position as an island stripped of natural resources, at the mercy of imported goods. "Two centuries ago, during the colonial era, Haiti was better known as the Pearl of the Antilles, a fertile paradise that brought its French plantation owners immense wealth."[17] In Port-au-Prince, there is one major port whose port authority is highly corrupt and charges exorbitant fees to bring in goods as well as store them.[18] Unfortunately, Port-au-Prince is highly dependent on imports for everything from food to building supplies. There are no natural resources on the island for construction.[19] 97% of the country's forests have been cleared of timber,[20] the capacity of the bamboo that exists is limited, and there is no good aggregate for concrete on the island. These factors, along with a lack of education, have contributed to the faultiness of the island's primary method of construction.[21] The agricultural goods that Haiti keeps to sell within its borders satisfy less than half of the country's food needs, making Haiti highly dependent on food imports and creating a food security risk.[22]

> POVERTY

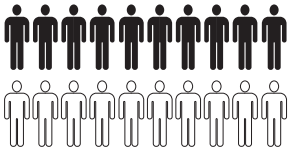
Extensive poverty is at the root of development issues in Haiti, as it is in every developing nation. In a country where nearly all educational facilities are private and where the average annual income per capita is $673 (as of 2010),[23] it is no surprise that the literacy rate (definition: age 15 and over, and can read and write[24]) is only 53%.[25] Pre-earthquake, best estimates are that approximately half of children (ages 6-18) attended school[26] due to inaccessibility either geographically or economically. Furthermore, those who can afford to do so send their children abroad to study for

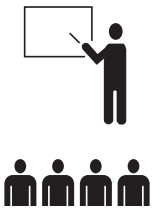
HINDRANCES TO RE-DEVELOPMENT IN POST-QUAKE PORT-AU-PRINCE



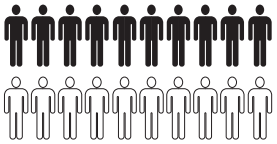
1% OF THE POPULATION CONTROLS 45% OF THE COUNTRY'S WEALTH

80% OF HAITIANS LIVE IN ABJECT POVERTY





APPROXIMATELY HALF OF HAITIAN CHILDREN ATTENDED SCHOOL PRE-EARTHQUAKE



ONLY 53% OF HAITIANS ARE LITERATE

Figure 1.3 : Hindrances to Development in Post-quake Port-au-Prince

greater educational and vocational opportunities as well as for safety, which results in “brain drain,” i.e. the educated class leaving the country.[27]

“Poverty, in particular, increases the volatility of Haitian politics, is a root cause of Haiti’s social underdevelopment and, through its fiscal effects, weakens the institutional apparatus of the Haitian state. Economic weakness also contributes to corruption, enlarges the pool of potential recruits for gang violence, and enhances the attractiveness of the drug trade.”[28]

> INADEQUATE INFRASTRUCTURE

Poverty is also one of the causes of the country’s inadequate infrastructure. Due to insufficient refuse and sewage management, which results in contaminants leeching into the water table, nearly all water sources in the country are contaminated[29], but they continue to be used as a source of drinking and washing water. Only 20% of Haitians have access to clean drinking water,[30] 52% of Port-au-Prince residents have household water supply,,[31] and less than one-third has access to electricity, even intermittently.”[32] Health standards are some of the worst in the world.

Poor health not only causes suffering for individuals and their families, but it also erodes consistency in economic markets as business employees cannot be relied upon to consistently attend work when they cannot pay for the treatment of their or their family’s maladies, and that in turn impedes their productivity and/or accountability. The country’s economic infrastructure is also a hindrance to development: “Haiti is poor in great part because of its difficult environment for business. The process of registering a business is one of the most complex and lengthy in the world and it is relatively costly… The difficulties Haitians face in engaging in economic activity have stifled economic development.”[33]

The country’s roads pose similar problems. The infrastructure of the capital, Port-au-Prince, “was designed for a population of about 700,000 and currently has a population of approximately 3 million”[34], thus its roads are clogged with traffic, turning what should be a 20-minute drive into a 3 hour trek during peak traffic hours. As only 24% of the country’s roads are paved (800 km), 70% remain in poor or very poor condition, and 80% of Haiti’s people and goods travel by road,[35] schedules are constantly being pushed back as a result of traffic, unforeseen road blocks and fuel shortages. These delays compound over the span of any development project, from the staff’s daily commute, to arranging business meetings to the transport of goods from the port to site. The city’s unreliable infrastructural backbone that a project and its players rely on hinders and delays the completion of all components of development projects.

Infrastructural maintenance, education of professionals and labourers, and enforcement of construction standards are some of the core reasons for infrastructural failure. “In many respects, the current perilous state of Haiti’s infrastructure is due more to the failure to ensure that infrastructure is well maintained and operated than to lack of money for the construction of new projects.”[36] Following the earthquake, “the massive loss of life and infrastructure was, in great

53% OF URBAN HAITIANS HAVE ACCESS TO SOURCES OF IMPROVED WATER. EVERY WATER SOURCE IN HAITI IS CONTAMINATED.

30% OF HAITIANS HAVE ACCESS TO IMPROVED SANITATION. THOSE WITHOUT ACCESS TO IMPROVED SANITATION EITHER USED SHARED LATRINES OR DEFECATE IN THE OPEN (10% OF URBAN POPULATION).

THERE IS NO SEWER NETWORK IN THE METROPOLITAN AREA; PEOPLE DISCHARGE THE WASTE WATER DIRECTLY ON THE ROADS AND INTO THE WATERWAYS.

PORT-AU-PRINCE'S WASTE COLLECTION PROVIDER, S.M.C.R.S., ESTIMATES THAT IT CAN COLLECT 20% OF THE PRODUCED WASTE (GIVEN EQUIPMENT SHORTAGES AND OTHER ISSUES).

70% OF ROADS REMAIN IN POOR OR VERY POOR CONDITION, AND AS 80% OF HAITI'S PEOPLE AND GOODS TRAVEL BY ROAD, SCHEDULES ARE CONSTANTLY BEING PUSHED BACK AS A RESULT OF TRAFFIC, UNFORESEEN ROAD BLOCKS AND FUEL SHORTAGES.

Figure 1.4 : Haitian Access to Infrastructure Statistics

Figure 1.5 : Hotel Montana, a luxury hotel in Pétion-Ville, Port-au-Prince

part, due to poor-quality construction materials and methods, enabled by a lack of oversight and accountability."[37]

> CORRUPTION AND POLITICAL INSTABILITY

Political instability and insufficient security are further detriments to Haiti's progress. Economic markets and their staff cannot operate reliably, efficiently and honestly within a corrupt, unstable context. Haiti's political history is riddled with widespread corruption, undemocratic election to power, threat and murder as a means of maintaining control, and gangs possessing the real power over people and development. "Haiti's democratic transition has been contested, and its politics remain fractious. Since 1980, Haiti has experienced a coup, two international military interventions, a democratic implosion, a period of 'technocratic' tutelage, and a return to democracy characterized by ongoing political gridlock and instability. In all but the most recent years, Haitian politics have been cacophonous and thuggish."[38] Today, political riots and kidnapping are an ever-present risk, and the military's presence does not provide sufficient peace of mind for one's security. Rather, security is provided for those who can afford it by the construction of high concrete walls, hired private guards to arm their doors, and drivers to transport them from one secured zone to the next.

"The Haitian National Police (Police Nationale d'Haïti), is the law enforcement and defense force of Haiti. It was created in 1995 to bring public security under civilian control as mandated in Haiti's constitution," and employs 10,700 police officers and 2,500 support staff as of 2012. Since 2004, approximately 8,000 peacekeepers from the UN Stabilization Mission in Haiti (MINUSTAH) have also been employed to maintain civil order in Haiti,[39] but they are generally viewed by the population as a fruitless expense. Since the exile of their president, Duvalier, in 1987, successive governments have attempted to reform Haiti "to maintain peace, enforce law and order in accordance with the rule of law, to protect its citizens and to arrest those that violate the law. However the police, being plagued by militarism, factionalism, and corruption, are mainly viewed by citizens as being repressive."[40]

Haiti's historically "…authoritarian political regime was characterized by the absolute character of the political power of the president. The methods of governing are arbitrary: physical coercion, torture, corruption. The system of one political party – and the prohibition of real political party opposition capable of articulating the interests of social classes – limits mechanisms of political participation; participation is restricted to the small group of the elite."[41]

> ECONOMIC DISPARITY

"Political leaders continued to enrich themselves illegally, to such an extent that, in 2002, the World Bank ranked Haiti the second-most corrupt country in the world."[42] Besides corruption, Haiti's wealth is also highly unequally distributed: 80% of Haitians live in abject poverty and 1% of the population controls 45% of the country's wealth.[43] This small group of elites hold the seats of economic and political power, and are effectively in control of the country's development. "It ultimately is the not the Haitian masses who are resistant to progress. Rather it is often the

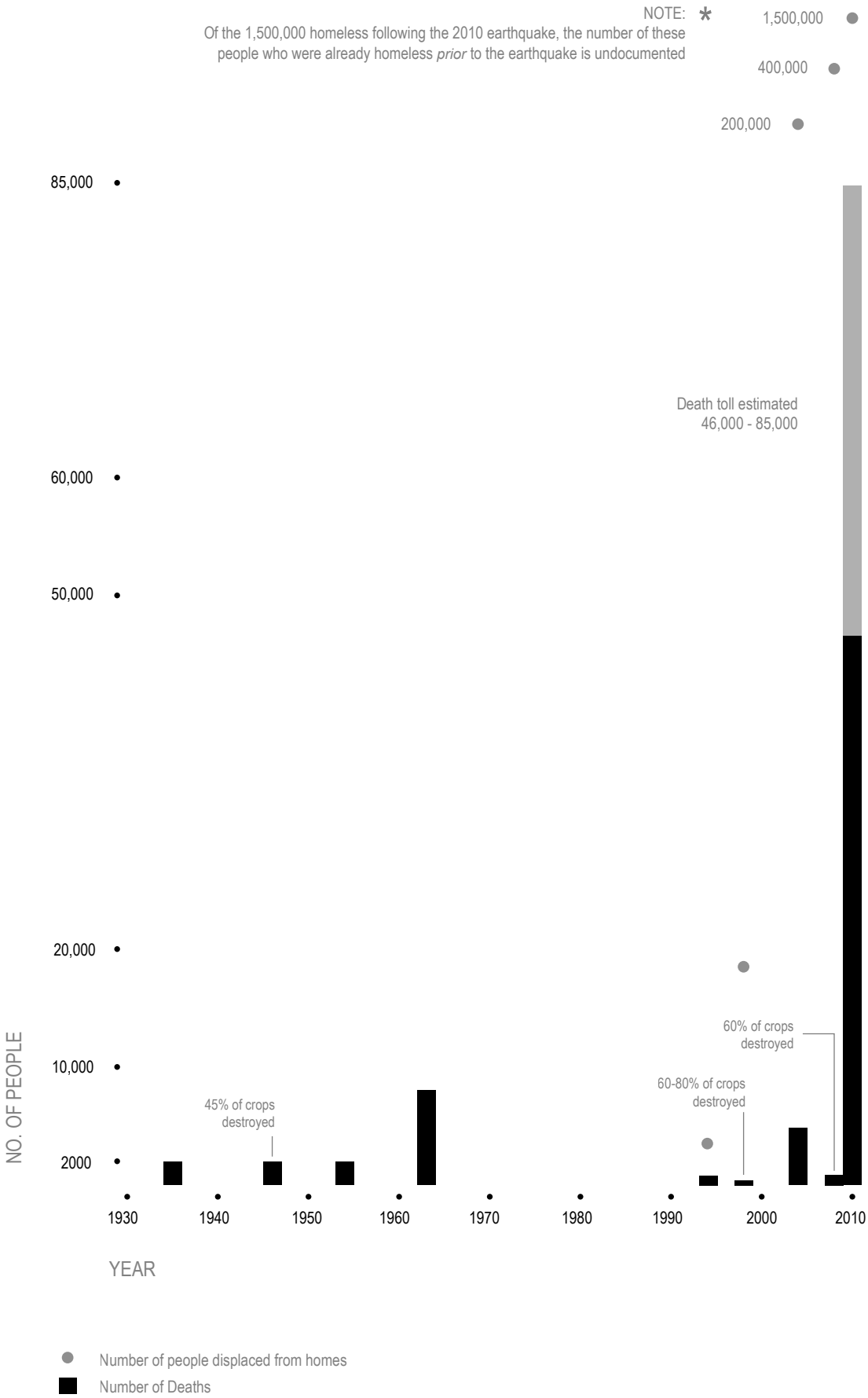


Figure 1.6 : Timeline of Natural Disasters in Haiti

Haitian ruling classes that are impervious to change… The elites formed the state that lived off the peasantry, who constituted the nation."

The largest and most developed city in the country is Port-au-Prince. Haiti's wealthy live in the upper-class neighbourhood of Pétion-Ville, which perches in the mountains above the rest of the city in stark contrast to the lower class districts. Amenities are concentrated both in Pétion-Ville, where the inhabitants can afford them, and in the downtown district that lies at the heart of all educational institutions in the country, and from where the city developed.

> NATURAL DISASTERS

Yet another force of instability in Haiti's development are naturally occurring phenomena. The country is prone to natural disasters every few years that flood, shake, and erode the earth, as well as collapse the buildings that sit upon it as construction quality is poor, building codes are not enforced, and construction practices are not monitored. Since the most recent significant natural disaster, the magnitude-7.0 earthquake in January 2010, there have been efforts to train labourers to improve construction standards, but the extent of that is limited and the quality of construction is still largely not aseismic.[44] On the subject, Darren Gill, Acting Regional Program Manager of Architecture for Humanity in Port-au-Prince said:

> "..the quality of what is currently being re-built, by and large… is also part of the problem. A lot of what we see being built around Port-au-Prince won't survive another earthquake, and in many cases, those are things that are being built by foundations and NGOs. The construction standards that they are achieving are not good enough. There will be… another disaster, [and] a lot of what still exists or is being built... is not going to be resistant."[45]

The 2010 earthquake caused between 46,000 - 85,000 deaths – primarily those living on crowded marginal land in sub-standard housing[46] – and generated 1.5 million homeless[47] in a country whose population is only 9.8 million.[48] Redevelopment has been slow and is still hindered by approximately half of the 10 million m^3 of rubble generated by the earthquake.[49]

"Although the earthquake was the cause of the disaster, Haiti's long history of poor government was largely responsible for the extent of the devastation and the society's almost complete dependence on help from abroad to deal with the consequences. The earthquake thus demonstrated not only the weaknesses of Haiti's physical infrastructure but also the more fundamental weaknesses of its institutions."[50]

BOUND TO AID

The World Bank estimates that the earthquake in January 2010 caused $11.2 billion USD in damages.[51] $4.5 billion USD has been pledged to the first two years of Haiti's reconstruction, although just 53%, $2.38 billion, has been delivered as of January 2012 (UN special envoy for Haiti).[52] A large portion of this funding arrived in the form of foreign debt forgiveness, and the deficit remains stalled in more than 60 countries and organizations that pledged assistance.[53]

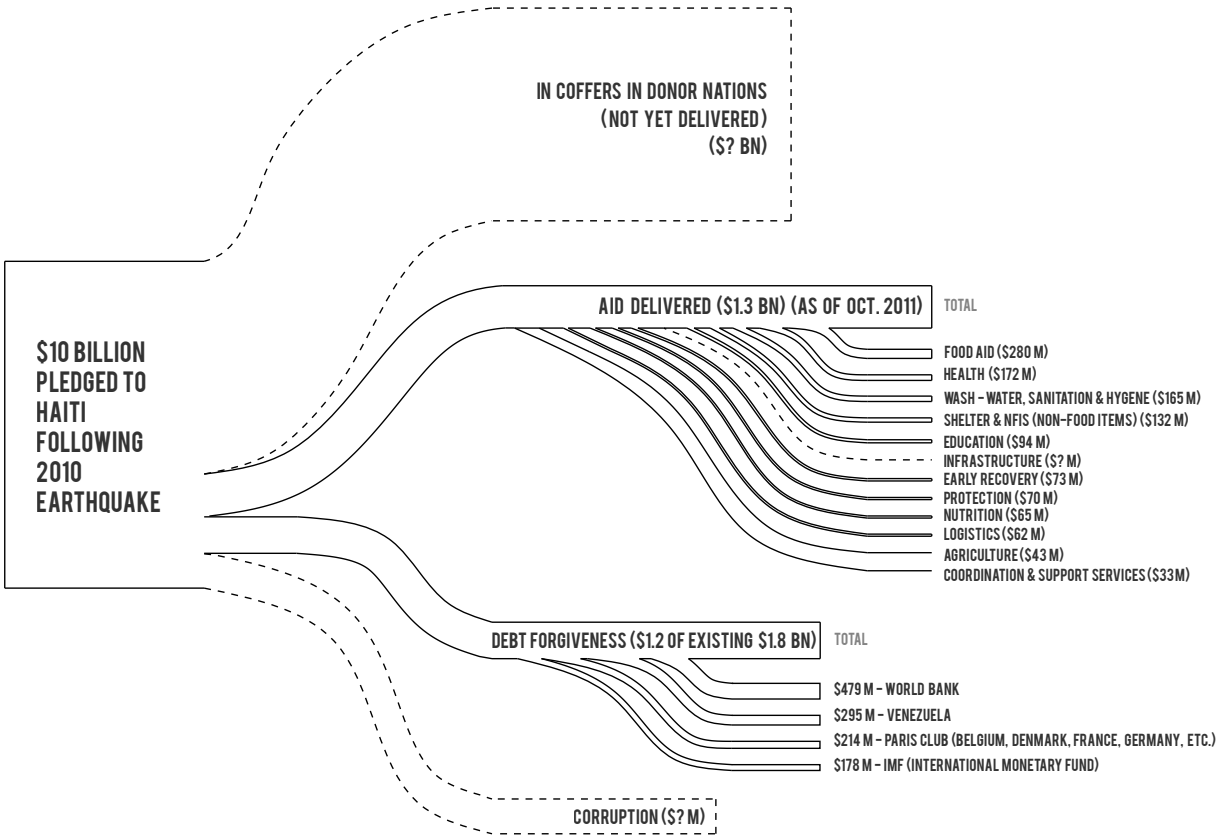


Figure 1.7 : Where Post-Earthquake Aid Money Went

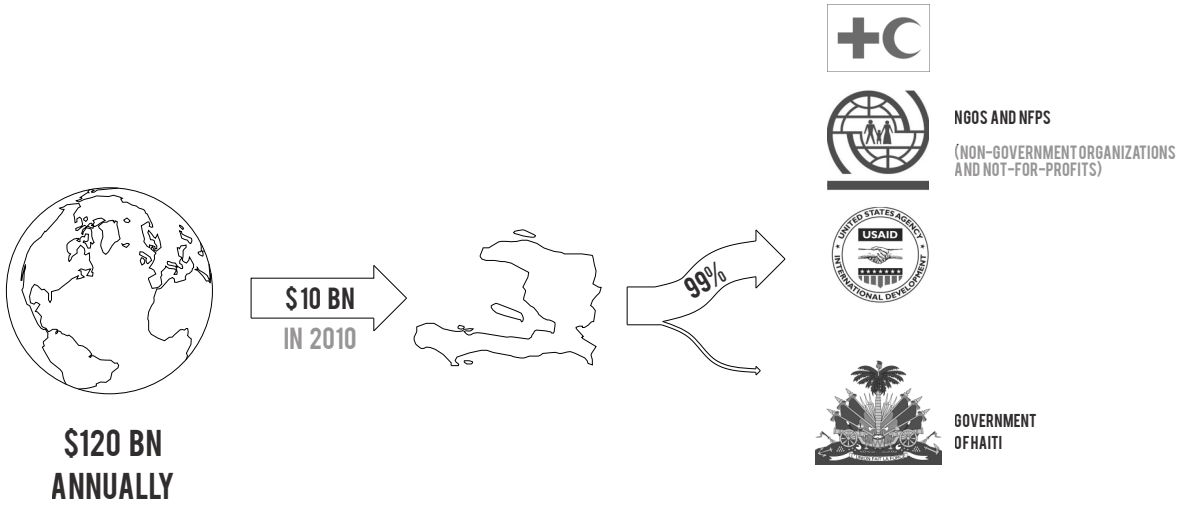


Figure 1.8 : Post-earthquake Aid Distribution to Haiti in 2010

The problem: Unless aid money is channelled through the government, government-led initiatives cannot occur, and without the government's involvement, they cannot be sustainable projects, as Haiti becomes dependant on foreign-led projects outside of its control

Following the earthquake, Haiti hosted more NGOs (non-governmental organizations, that is, the organizations administering the aid funding) per capita than any other country in the world.[54] Not surprisingly, the Republic of Haiti has been ironically coined the Republic of NGOs. As there were virtually no limitations on which or how many organizations could enter the country to facilitate aid work, hundreds of NGOs hit the ground running on Haitian soil and tried to figure out how to get their funds into the country, set up shop and establish themselves to do work for the means of 'doing good'.[55] Unfortunately, there has been no coordination of their work. As less than 1% of aid money was channelled through the government as a means of avoiding corruption and mismanagement, [56] the government did not have the opportunity to take a role in managing funding or aid agencies, which is what a country needs if redevelopment efforts are to be sustainable. In fact, there is still no management of the aid agencies; they operate independently, at times duplicating efforts and working at odds with one another to achieve their own goals. Following a natural disaster of this severity in such a dysfunctional, disorganized country as Haiti, one cannot manage NGOs, but only hope to get them meeting regularly to communicate and coordinate with one another.[57]

"For their part, international donors have often been unwilling to invest in state institutions, perpetuating their weakness. Corruption, political turmoil, and a general lack of capacity encourage international donors to channel funds through NGOs instead. As a result, the Haitian state is significantly weaker than it could be, and dependence on foreign donors is enforced."[58]

"For most of the 1990s, the Haitian government was at odds with foreign donors… Donors, including the U.S. Agency for International Development (USAID), stopped and restarted development assistance to Haiti several times, as political responses to coups and abuses of power by Haitian authorities, as well as due to differences over economic policies. In the 1996-2000 period, major donors sought to encourage the development of civil society, privatize state-owned enterprises, and decentralize the state, but the Haitian government considered all three of these initiatives threats to its power and authority, despite its recognition of the need for external funding. Donor initiatives were stymied by passive resistance by ministries and opposition in Haiti's parliament… Bilateral donors responded by increasing the use of Haitian and international NGOs to deliver services… further aggravating the responsibility deficit, as well as the Haitian government's capacity shortfalls." [59]

In 2009, foreign aid accounted for over half of Haiti's budget, 120% of the country's G.D.P. Following the widespread devastation of the 2010 earthquake, Haiti was thrown into the spotlight all around the world, and its aid budget nearly quadrupled overnight. Original estimates in 2010 showed between $4.2 - 5.3 Billion USD pledged to the country for the two years following the earthquake, making foreign aid 400% of it the country's G.D.P in 2010.[60] At the time of writing, estimates were closer to $10 billion USD.[61] Despite the immense provision, there were still 390,000 Internally Displaced Persons (I.D.P.s) in Haiti of the original 1.5 million displaced by the earthquake as of June 2012,[62] many roads remain clogged with rubble and impassible, and the majority of reconstruction follows the same sub-standard pre-quake practices.

One of the primary issues with this aid-funded development is that NGOs often operate in a way that necessitates the continuation of their role, creating an unsustainable model and generating dependency. In addition, their time working in the country is generally quite short, creating often unrealistic time schedules for projects, limited follow-up and accountability upon the completion of a project. Furthermore, the staff are primarily foreigners with relatively limited experience in the country and with the national language, Haitian Creole. Moving forward, the best use of the remaining funding would be using it to leverage and support the country's existing Haitian establishments, businesses and professionals to empower them to guide the rebuilding of their own country.

ADDRESSING DEVELOPMENT CHALLENGES

The proposal addresses the key hindrances to development in Port-au-Prince (outlined on pages 2 - 10) through design decisions that alleviate the key issues plaguing development: deforestation, land ownership issues, import dependence, poverty, inadequate infrastructure, corruption and political instability, economic disparity and dependence on aid. The proposals do this by using local materials and labour as much as is possible while still being sustainable, thereby reducing dependence on imports; utilizing aid in a bottom-up system to fund the work in a way that will not leave Haitians dependent on it; developing new locally-managed and operated businesses that spawn new economies and generate employment, thereby reducing poverty and economic disparity; and by providing more affordable infrastructure at the neighbourhood level, allowing greater numbers to afford access to it. The last hindrance to development, lack of documentation of land ownership, is the crux of many development delays. The proposals do not explicitly address land ownership, but by pairing with existing programs, they inherently have a level of permanence to them. Overall, due to the state of land ambiguity in Port-au-Prince, the generally unsophisticated level of construction and the high volume of informal economies, the city is less about individual owners and built artifacts than it is about the micro-economies themselves that have developed and inhabited the spaces available. Such is the attitude the design proposal takes. Furthermore, in response to the government's continually corrupt handling of finances, another development challenge, the proposals instead use aid money as their source of funding as it is abundant and nearly entirely independent of the Haitian government. The country has become largely dependent on problematic top-down donations; the thesis seeks to test an infrastructure that supports bottom-up micro-economies.

2.0

ECONOMIES FROM WITHIN AND WITHOUT

FOREIGN AID VS. PRODUCTIVE ECONOMIES

Figure 2.1 : Haiti Context Map

RAND National Security Research Division composed a pointed report following Haiti's 2010 earthquake entitled "Building a More Resilient Haitian State" that outlines the priorities that Haiti should make to address the country's challenges and suggests what programs and initiatives might be refocused to achieve results. The chapter on economic policy describes the economic climate, the challenges in place for businesses, and the significant role that national foreign assistance and private remittances play in the economy:

> *Haiti's primary economic challenge is generating economic growth… Alone among the states of the Western Hemisphere, per capita GDP in Haiti has fallen over the past 40 years to roughly one-half to two-thirds the level that it was in 1965… Poverty in Haiti is partially alleviated by the influx of remittances from Haitians who have emigrated, primarily to the United States and Canada. Some 30 percent of all households and 44 percent of metropolitan households receive remittances from friends or family members working abroad. Remittances account for about 30 percent of household income. Private-sector transfers, primarily remittances, ran $1.25 billion in 2008, equivalent to 19 percent of GDP and 2.5 times exports.*[63]

> *Haiti is poor in great part because of its difficult environment for business. In 2009, Haiti ranked 151 out of 183 countries in the world in terms of doing business (this ranking was published in 2010 prior to the earthquake). The process of registering a business is one of the most difficult and lengthy in the world, taking an average of 195 days and entailing 13 separate procedures, and is relatively costly. Registering changes in title for property is even more onerous, running 405 days on average. Businesses also find a poor climate for investor protection; lengthy, burdensome procedures for obtaining construction permits; hurdles in engaging in foreign trade; difficulties in obtaining credit; and onerous procedures for closing a business. The difficulties Haitians face in engaging in economic activity have stifled economic development. Sanctions imposed following the 1992 coup and political instability have also not helped.*[64]

> *Although the earthquake was the cause of the disaster, Haiti's long history of poor government was largely responsible for the extent of the devastation and the society's almost complete dependence on help from abroad to deal with the consequences. The earthquake thus demonstrated not only the weaknesses of Haiti's physical infrastructure but also the more fundamental weaknesses of its institutions.*[65]

This chapter will address two primary economies in Port-au-Prince: foreign aid, a rich, politically and socially-charged source of funding that has recently flooded the country following the 2010 earthquake, and agriculture, an existing and environmentally fruitful economy that is promising for the country's economic growth and plays a key role in the thesis design proposal.

2.1

BOUND TO AID

THE IMPACT OF AND ISSUES WITH FOREIGN AID

Figure 2.2 : Foreign Aid's Path:
93% of aid is spent in the donor's country (products and services sent, ex. materials, professionals).

CULTURE OF AID

> *We live in a culture of aid. We live in a culture in which those who are better off subscribe …to the notion that giving alms to the poor is the right thing to do.. Deep in every liberal sensibility is a profound sense that… the rich should help the poor, and the form of this help should be aid. The pop culture of aid has bolstered these misconceptions… Media figures, film stars, rock legends eagerly embrace aid, [and] proselytize the need for it…But …across the globe the recipients of this aid are worse off; much worse off. Aid has helped make the poor poorer, and growth slower. Yet aid remains a centrepiece of today's development policy and one of the biggest ideas of our time… Aid has been, and continues to be, an unmitigated political, economic, and humanitarian disaster for most parts of the developing world… The evidence is startling as it is obvious… Countries.. which have become dependent on aid [are] trapped in a vicious cycle of corruption, market distortion and further poverty – and thus the 'need' for more aid.*[66]

The world sends aid to countries whose people are in need because we cannot stand to see so many people suffering and, on a far more pragmatic level, we do not want their issues to spread to where we are. "The origins of large-scale aid transfers date as far back as the nineteenth century – when even in 1896 the US provided overseas assistance in the form of food aid. [Furthermore], under the Colonial Development Act of 1929, the British government administered grants for infrastructure projects across poorer countries."[67]

To begin, there are three types of aid: (1) Emergency / Humanitarian Aid: mobilized and dispensed in response to catastrophes and calamities, (2) Charity Aid: distributed by charitable organizations to institutions or people on the ground, and (3) Systematic Aid: payments are made directly to governments either through a government-to-government transfer (bilateral aid), or are transferred via institutions such as the World Bank (multilateral aid: where resources of many countries are pooled together).[68] Systematic aid is aid directed toward long-term development, and makes up a far larger percent of all aid's budget than emergency aid. Charity aid can fall both under emergency aid and systematic aid.

THE PROBLEM WITH AID

There are fundamental issues around the subject of aid. Aid, particularly emergency aid, earns criticism for the following key reasons: poor implementation and management of funding;[69] high staffing and overhead costs;[70] the recipient country's corruption (donors are averse to providing resources to the government who will use it for other things;[71] aid provided through the government is easy to steal[72]); aid agencies' young workers are inexperienced with local culture and politics of place they are working; most NGO workers are employed on short, fixed-term contracts, with very little prospect of a future career;[73] and critically, aid agencies create a role for themselves that requires maintaining, promoting reliance, not self-sustenance.

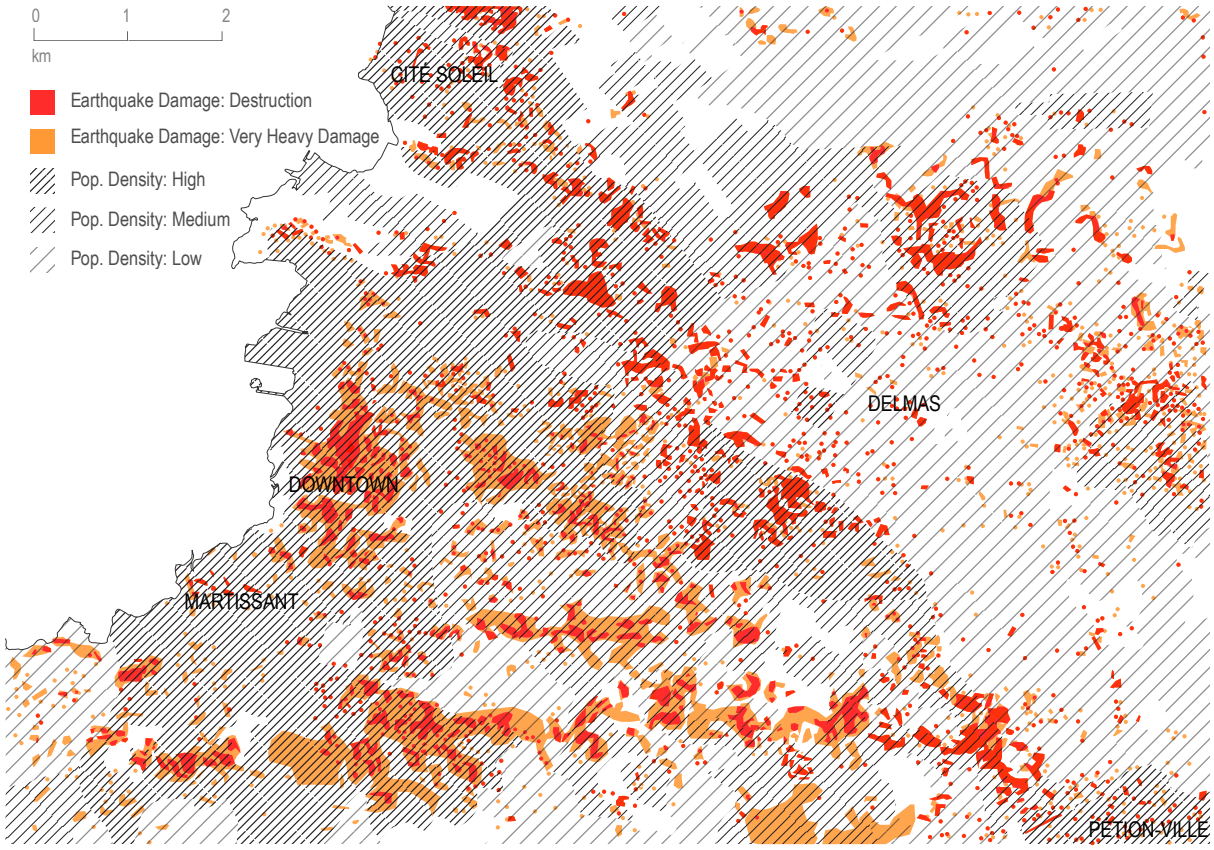


Figure 2.3 : 2010 Earthquake Damage relative to Population Density

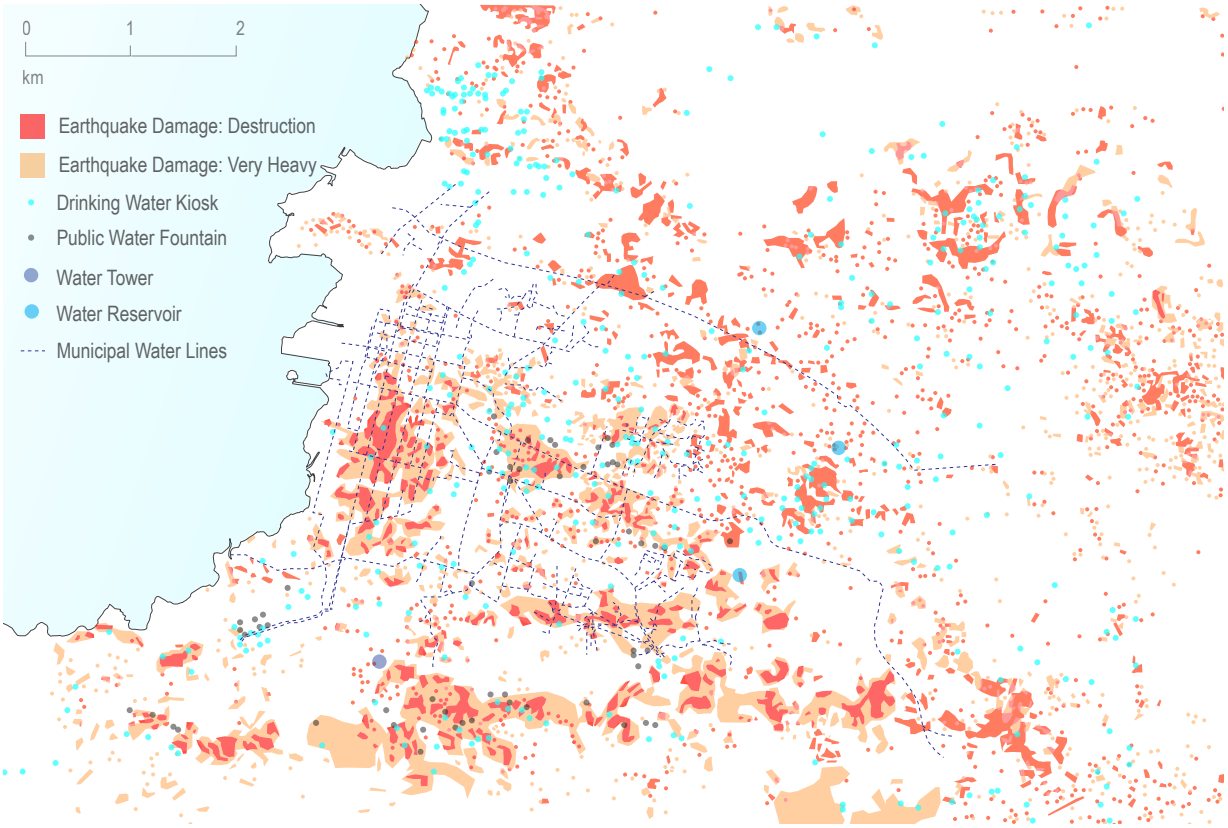


Figure 2.4 : 2010 Earthquake Damage relative to Existing Infrastructure

Figure 2.3, left, overlays earthquake damage with population density. It indicates that the damage was extensive throughout the city, but concentrated in the most populous areas. Construction quality is poor and the city fabric is very dense. In the downtown core, for example, which dense and host to most of the city's only building's over two stories, the damage was quite extensive, as buildings fell upon each other, causing further destruction.

Other dense areas fared better due to their soil conditions. Areas with a lower building density such as Delmas fared relatively well. The southern end of the city is highly damaged as it lies on the side of an eroded mountain. There are a number of slum settlements squatting on the most steep land, which are composed of poorly constructed buildings which were apt to destruction in the mudslides.

Figure 2.4 depicts the earthquake damage's impact on the city's existing infrastructure. As the downtown suffered the most widespread destruction and much of the city's infrastructure is concentrated there, it took a heavy blow. However, outside of the densely populated areas the infrastructure was largely undamaged.

The municipal water lines, which deliver non-potable water, were largely non-functional after the earthquake, and as of late 2012, only delivered water very intermittently to some areas. Much water infrastructure construction and repair has been conducted since 2010 to alleviate the provision loss.

* Note: documentation of public water fountains outside of the south-west quadrant of the city is unavailable

Figure 2.5 : Aid to Haiti Before (2009) and After (2010) the Earthquake

Calamity resulting from natural disasters is one of the major ways that countries receive aid funding. Due to the sudden onset of a disaster and the overnight need for assistance, aid organizations are called to suddenly mobilize and disburse personnel and enormous quantities of supplies with little-to-no time to prepare. Natural disasters that occur in developing countries attract far more aid money than developed countries do as the population has little ability to prepare and cope with the sudden onset of a disaster. The management of emergency aid, given its sudden onset of need, is very difficult to coordinate. Organisations administering aid after a natural disaster face immense barriers due to damage to infrastructural and communication networks; accountability to donors whose interests are not necessarily those of the beneficiaries; duplicated and/or uncoordinated efforts due to unclear leadership between governments, aid agencies and developers; and, in the case of many developing countries, pre-existing political instability.

Whether long-term investments in re-development or emergency aid, one of the primary debates surrounding aid is whether aid is best provided in a top-down or bottom-up manner. Emergency aid to a country that is essentially non-functional following a debilitating disaster will nearly always necessarily be handed out by a foreign body, as they are equipped and have the means to mobilize and provide assistance. However, the desire should always be to put the government in driver's seat as soon as and as much as possible because the foreign-managed assistance model can never be a self-sustaining one. Foreign-led initiatives tend to lead to the creation of a role that requires them to remain there unless their power or administrative responsibilities can be handed over to local organizations / professionals.

In impoverished Haiti, a wealthy development agency could well supplant a government just finding its feet economically.[74] A foreign organization working in a (generally always dysfunctional and / or corrupt) developing country carries a significant amount of power. In a place where limited policy or law is enforced and, representing a significant investment, foreign organizations have the ability to work above the law. As the government is generally not the one leading emergency response initiatives, these bodies are in many ways, the ones in charge, in lieu of the government.

Following the well-publicised magnitude-7.2 earthquake in Haiti in 2010, the country received unprecedented amounts of aid from around the globe pledged to the first two years of re-development.[75] "As for whether aid promotes economic growth, that's a bitter and unresolved argument. But even the leading critics of aid …believe in assisting Haiti after the earthquake."[76]

HAITI'S PRE-EARTHQUAKE AID

"Without doubt, Haiti was seriously out-of-balance before the earthquake and Port-au-Prince was a disaster waiting to happen."[77] At 130% of the government's annual revenue before the earthquake (in 2009),[78] aid was sustaining Haiti, whose economy was not viable on its own. Before the earthquake, Haiti received $1.12 billion USD annually ($142.1 million in relief and $977.6 million in development funding).[79]

Figure 2.6 : "Republic of NGOs" graffiti, Pétion-Ville, Port-au-Prince

Haitians "both want foreign help and are wary of its past."[80] "Following the 1986 [ousting of their president 'Baby Doc' Duvalier], who, ironically, was lorded with foreign funds that went principally to Swiss bank accounts, donors were loath to work with successor governments – including those democratically elected. Instead, they chose to funnel hundreds of millions annually through foreign-based NGOs that enacted 'projects' drawn up in Washington, New York, Ottawa, etc. and that lasted only as long as the money did. Haitians, by the early 1990s, were derisively calling their country a "Republic of NGOs" and by 2008, none other than the President of the World Bank, Robert Zoellick, lamented the cacophony of "feel good, flag-draped projects" that had proven a vastly inadequate substitute for a coherent national development strategy."[81]

Immediately prior to the earthquake, aid was coordinated by the 'Group of 11' (G11) donors included Canada, the European Union, France, the Inter-American Development Bank (IDB), the International Monetary Fund (IMF), Japan, Spain, the United Nations, the United States, the World Bank and a representative of Argentina, Brazil and Chile.[82] For aid to foster sustainable, long-term development, there is a "need to rebuild the Haitian state from the bottom up, and of work with Haitian officials – not push them aside... This is not the time to impose governance on Haiti – that is a 19th century idea unfit for the 21st century. This is an opportunity to help strengthen Haiti's public institutions, not to replace them."[83] From its inception, the Office of the Special Envoy for Haiti (OSE) of the United Nations has …stressed the importance of the Haitian government and its citizens being "in the driver's seat."[84] It "recommends the transfer of more resources and assets directly to Haitian public and private institutions. This will strengthen their systems; improve their management of resources; promote accountability between the government and its citizens; and increase the collective impact of our efforts. It will also create jobs and build skills for the Haitian people. Donors can do much to increase the proportion of funds channelled through the Haitian public and private sectors as part of recovery efforts." [85]

HAITI'S POST-EARTHQUAKE AID

In 2010, the year of Haiti's catastrophic earthquake, aid was an estimated 400% of government internal revenue. Following the earthquake, Haiti received $3.27 billion in 2010 ($1.55 billion in relief and $1.73 billion in recovery and development funding).[86] "Approximately 99% of post-earthquake relief aid was disbursed to bilateral and multilateral humanitarian agencies, the Red Cross movement and international non-state service providers, including NGOs and private contractors."[87] Nearly all aid therefore circumvents the government of Haiti, and by extension, Haitian public institutions, making the government's control of Haiti's development impossible.[88]

The Government of Haiti was severely affected by the earthquake and "in this context no Haitian-led, overarching plan or coordination mechanism for relief was established. Donors, as well as the UN, the Red Cross movement and international NGOs, conducted their own assessments, prepared their own plans, and issued their own appeals for funding."[89] Therefore, coordination mechanisms were either ad hoc (activated in the emergency phase of aid; developed by the international community), or the UN-managed cluster system (a basic coordination framework for UN agencies and major international NGOs for assessment, planning and fundraising, with

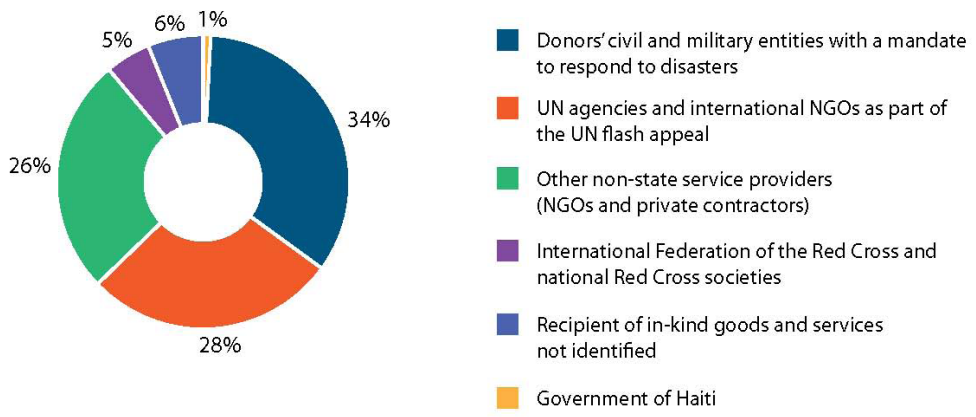


Figure 2.7 : Relief aid to Haiti by Recipient (January 2010 - March 2011)

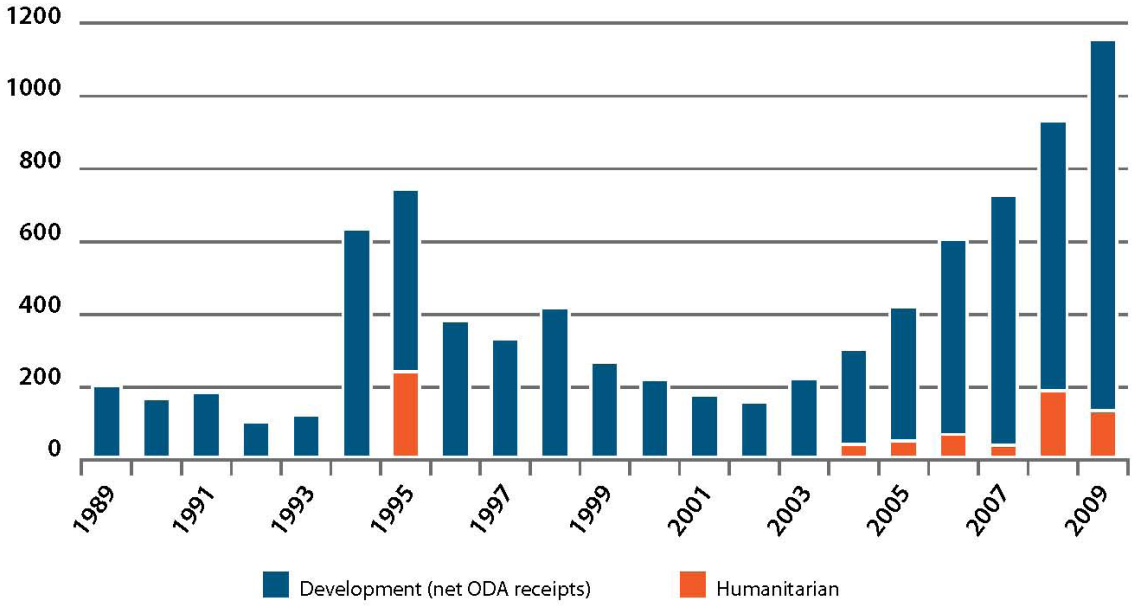


Figure 2.8 : Net Official Development Assistance (ODA) to Haiti (1989-2009) in current USD millions

individual cluster members responsible for implementation and results tracking; activated in Haiti immediately after the earthquake and continues to operate).[90] Today, as in the days following the earthquake, there is no management of aid organizations, there is only coordination.[91] The cluster system is a method of sharing information, updating the major players on each other's work, and attempting to ensure development is following the Government of Haiti's reconstruction plan.[92]

A WAY FORWARD

"In the aftermath of the storms that devastated Haiti in 2008, Haitian President Prèval asked not for charity, but for a helping hand to allow Haitians to rebuild their country. Today he is making a similar point."[93] For Haiti to move forward on its own feet, Haitians need to be in the driver's seat of development projects, regardless of the funding source. A popular development movement of grass-roots reconstruction models, following the cash-for-work model, "will inject serious liquidity into the Haitian economy and stimulate recovery from the bottom-up."[94] "As Harry Hopkins, the legendary administrator of the Works Progress Administration, pointed out: "most people would rather work than take handouts. A paycheck from work didn't feel like charity, with the shame that it conferred. It was better if the work actually built something. Then workers could retain their old skills or develop new ones, and add improvements to the public infrastructure like roads and parks and playgrounds."[95]

The thesis design proposal (chapter 4.0) is composed of projects that take advantage of this foreign assistance to 'build back better' without allowing their support to become necessary for continuation. They are designed as small components that leverage aid donations to initiate the start-up of their small local businesses. Aid money is used to fund the construction and start-up costs, but the proposals themselves generate revenue to fund their operation and therefore become self-sufficient, rather than being dependant on further aid funding to operate.

2.2

Figure 2.9 : Rows of Crops, Tap Tap Garden, Cité Soleil, Port-au-Prince

AGRICULTURAL ECONOMY

Figure 2.10 : Inverted Tire Pots, Tap Tap Garden, Cité Soleil, Port-au-Prince

OVERVIEW OF AGRICULTURAL ECONOMY

80% of Haitians live under the poverty line and 54% in abject poverty.[96] "By 2007, 78% of all Haitians – urban and rural – survived on $2.00 a day or less, while 68% of the total national income went to the wealthiest 20 percent of the population."[97] Over half of Haitians are unemployed, and therefore depend on subsistence farming for their food.[98] The agricultural sector consists mainly of small-scale subsistence farms that produce about 25% of total exports.[99] The agricultural market is arranged such that the vast majority of farms are family-owned. Merchants purchase goods from the farms, transport them to town markets and sell them either within the country or for export. The agricultural goods they produce are coffee, mangoes, sugarcane, rice, corn, sorghum, and wood.[100] Tropical fruit production presents the greatest potential for economic growth in Haiti, and is already considered one of the country's most important exports.[101]

Although the country was once a gold mine of natural resources and agricultural capacity, the agricultural sector has steadily been in decline, primarily due to ecological factors, the main challenge since the 1990s. One key factor is extreme deforestation. This began in the 1800s after Haiti declared its independence from France and began deforesting its lush mountainside to pay off France to keep them from invading again.[102] In 1925, Haiti was still lush, with 60% of its original forest, but since then an estimated 98% of its original forest cover has been cut down for use as coal for cook stoves.[103] This process has destroyed fertile farmland soils, contributing to decertification.[104] Other factors contributing to agricultural decline are soil erosion, droughts, flooding, and other natural disasters. Economic factors that contribute to additional agricultural decline are continuing fragmentation of landholdings, low levels of agricultural technology, migration out of rural areas, insecure land tenure, a lack of capital investment, high commodity taxes, the low productivity of undernourished animal and plant diseases, and inadequate infrastructure.[105]

> GROWING CONDITIONS

Port-au-Prince's hot and humid tropical climate is favourable to agriculture with year-round temperatures in the 30's, at least 1400 mm of rainfall per year, and consistent sunshine. The region is prone to hurricanes, earthquakes and floods in the rainy season that produce landslides, particularly in the mountainous region on the south end of the city. The north wind brings fog and drizzle that interrupt Haiti's dry season from November to January. From February to May however, the weather is very wet. The prevailing winds come from the west off the Bay of Port-au-Prince, and northeast trade winds bring rain during the wet season.

The city's average annual rainfall is 1400 - 2000 mm, but it is unevenly distributed, much falling in the rainy seasons in May and October. Rooftop rainwater harvesting is an immense resource that most everyone utilizes, but it has the potential to become a richer resource as a community-based network.

	J	F	M	A	M	J	J	A	S	O	N	D
Avg. High (°C)	31	31	32	32	32	33	34	34	33	32	31	31
Rainfall (mm)	33	58	86	160	231	102	74	145	175	170	86	33
Sunshine Hours	270	250	270	260	250	230	270	270	240	250	240	250

Figure 2.11 : Climate Data, Port-au-Prince

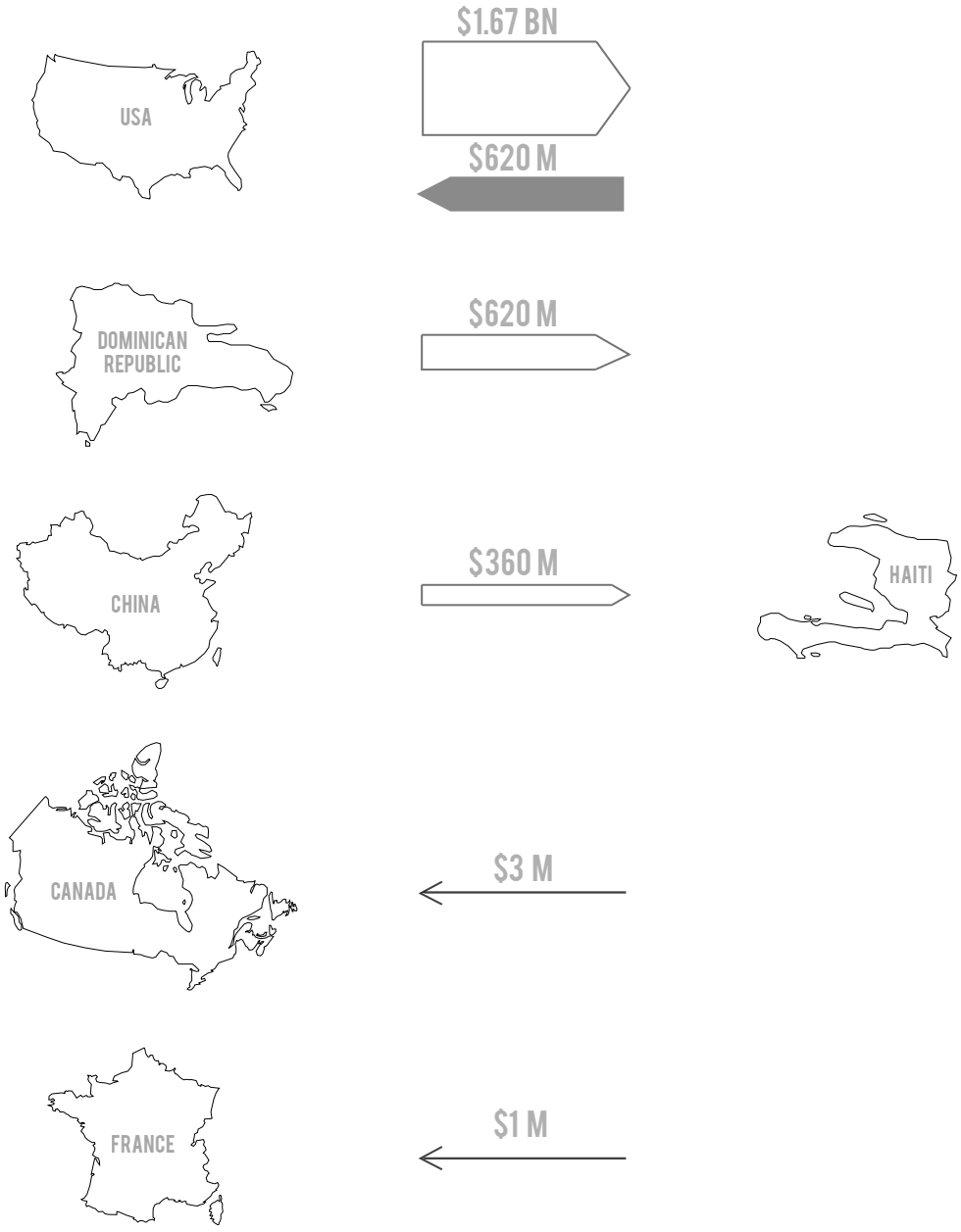


Figure 2.12 : Annual Imports and Exports to and from Haiti

> HISTORIC CONTEXT

"Two centuries ago, during the colonial era, Haiti was better known as the Pearl of the Antilles, a fertile paradise that brought its French plantation owners immense wealth produced by the sweat and suffering of enslaved Africans. In the era of French colonization, the precious woods of Saint-Domingue (acajou, campeachy, and Brazil wood) began to be exploited. This practice continued until the resources were more or less exhausted, around World War II. Tree cutting for the production of charcoal continues today. As a result, Haiti is a deforested nation with denuded mountainsides and many hungry citizens, desperate enough to take flimsy boats to try their luck elsewhere."[106]

"From 1492 to 1804, the colonial economy catered to the interests of metropolitan Spain and France. The colony produced items that could not be made in the old world, particularly coffee, sugar, cacao, and indigo. Sugar, for many centuries, remained the most profitable crop. However, sugar plantations and sugar-grinding mills were destroyed during the war of independence."[107]

"Today there are two types of economy: a market economy that is crumbling and an increasingly precarious subsistence economy that is benefiting from the downfall of the market economy. This conflict opposes market-based operations and practices of the small independent farmer, who cultivates just enough for the survival of his own family. Signs of this dual market system emerged during the colonial period…In the post-independence era, a shift occurred from plantation agriculture to small, family-based landholdings. Many farmers continue to grow both cash crops for export and subsistence crops. The multiple crop system reflected the farmer's way to minimize risk by working to ensure that at least one crop would provide a decent harvest."[108] "Although manufactured goods and imported products are bought and sold every day by small traders and shopkeepers, the majority of the trade takes place once or twice a week in a town's marketplace. Some vendors come from far away to sell their goods."[109]

> FOOD SECURITY

Although more than half of employed Haitians are farmers, the Haitian agricultural industry produces less than half of the country's food needs.[110] Haiti is therefore highly dependent on food imports. Many experts state that Haiti's agriculture is the least productive in the world due to bad agricultural policies and the absence of a comprehensive strategy.[111]

Imports to Haiti	$3.275 billion (2011 est.) Products: food, manufactured goods, machinery and transport equipment, fuels, raw materials Partners: US 51%, Dominican Republic 19%, China 11% (2010 est.)[112]
Exports from Haiti	$690.3 million (2011 est.) Products: apparel, manufactures, oils, cocoa, mangoes, coffee Partners: US 90.2%, Canada 4%, France 1.5% (2010 est.)[113]

Fig. 2.13 : Tire Planters in Kan Neptune Camp, Port-au-Prince

Fig. 2.14 : Sinaes camp's school garden, Port-au-Prince

Fig. 2.15 : Fenced-in garden, Villa Rosa, Port-au-Prince

Contributors to Haiti's GDP (2010): 59%: Services Industry (25% of labour force)
25%: Agriculture (primarily: coffee, rope fiber, sugar, cocoa) (66% labour force)
16%: Manufacturing Industry (9% labour force)[114]

INTERVENTION OPPORTUNITY

Agriculture is an exciting prospect for Port-au-Prince. The climate provides fertile growing conditions year-round, and there is an opening in the market for more affordable, locally-produced food, as imports comprise more than half of Haiti's consumed food, and the importing expense is cost-prohibitive for many.[115] Because much of the city's population originated from surrounding rural areas within the first or second generation, many know how to farm, and Port-au-Princians who have the space to create a garden generally do. As in any city, says Corinne Coe of SOIL, a prominent composting organization in Port-au-Prince, you will find those who are interested in gardening, and those who are not, but a pool of interested farmers certainly exists.[116]

The greatest challenges to urban agriculture are limited space, protection from theft (high fences and/ or adjacency to a residence required to thwart trespassers), water provision (in rural areas, ravines or ditches would be the primary irrigation source, whereas water supplied by truck would be in urban areas) and pollution, which degrades the water, soil, and air.

Because space is at a premium in the city, gardening or composting prospects are reliant on locations with enough land available. For example, the particularly dense urban areas such as downtown would lend themselves less to large agricultural plots than the less dense neighbourhoods of Tabarre and Pernier (peripheral districts of the city where agriculture is prominent), Pétion-Ville (whose inhabitants can afford both the space and funding to grow), and Delmas (a low-density working-class neighbourhood whose residents are apt to garden and where there is space available for it). These are the areas where the thesis design proposal in chapter 4.0 suggests initiating both agriculture and the sale of compost for agricultural use. Additionally, Port-au-Princians develop small, private agricultural plots throughout the city; the thesis design also encourages these. As resident, Vera Kreuwels says, people will grow plants in any space they have available.[117] Examples of these are shown, left. These small interventions not only introduce small green spaces into the concrete fabric of Port-au-Prince, but by growing produce, Port-au-Princians become less dependent on transporting goods from other parts of Haiti or other countries, and they thereby experience greater empowerment.

Composting is very important to both agriculture and waste management, the latter of which will be discussed further in the design proposal presented in chapter 4.0. Compost processing is best located away from habitation and any ground water source, but close enough to the city for ease of vehicular access for workers. These are the areas suggested in the design proposal for processing, while the sale of compost in Port-au-Prince would be best received in Tabarre due to the abundance of agricultural land, and in Pétion-Ville, due to the concentration of wealthy Port-au-Princians who have excess capital to spend on gardening.[118]

3.0

INFRASTRUCTURE IN PORT-AU-PRINCE

Figure 3.1 : Ravine in Delmas 33, Port-au-Prince

30% OF HAITIANS HAVE ACCESS TO IMPROVED SANITATION. THOSE WITHOUT ACCESS TO IMPROVED SANITATION EITHER USED SHARED LATRINES OR DEFECATE IN THE OPEN (10% OF URBAN POPULATION).

Due to the lack of sanitation infrastructure, people primarily use pit latrines to dispose of their excreta. As there are no enforced regulations on their construction, contaminants leech from the pit latrines into the water table and pollute the groundwater. Human waste is also discarded directly into the city's waterways, further polluting the water and causing the spread of illness.

THERE IS NO SEWER NETWORK IN THE METROPOLITAN AREA; PEOPLE DISCHARGE THE WASTE WATER DIRECTLY ON THE ROADS AND INTO THE WATERWAYS.

The waterways that run through Port-au-Prince are further contaminated by water polluted with detergents, petrol products, chemicals, etc.

PORT-AU-PRINCE'S WASTE COLLECTION PROVIDER, S.M.C.R.S., ESTIMATES THAT IT CAN COLLECT 20% OF THE PRODUCED WASTE (GIVEN EQUIPMENT SHORTAGES AND OTHER ISSUES).

Due to the lack of waste collection, wastes end up primarily in the waterways, further contaminating the water, or they are burned, polluting the air. Piles of waste litter the city and coat the streets, attracting vermin and breeding disease.

53% OF URBAN HAITIANS HAVE ACCESS TO SOURCES OF IMPROVED WATER. EVERY WATER SOURCE IN HAITI IS CONTAMINATED.

As drinking water is available only by the bottle or bag at a cost and half of Haitians live on < $2 / day, not everyone can afford to drink potable water. Unfortunately, because of the contamination from wastes described above, all water is polluted and causes illness.

Figure 3.2 : Haitian Infrastructure Statistics

OVERVIEW

Infrastructure in Port-au-Prince is a foundational source of the issues plaguing its inhabitants. The excess of wastes in the city create an unpleasant, unsanitary and at times dangerous environment (particularly for young children or those without footwear), and wastes filling the waterways are hazardous because their abundance often causes flooding in the rainy seasons. Wastes also create obstacles in the road, slowing progress of individuals and the economies they contribute to. The inconvenience of access to infrastructure also slows progress. For example, to simply access water, one has to physically retrieve it, pit latrines need to be arranged to be periodically emptied or else covered over, and garbage often needs to be arranged to be privately removed, or else burned.

Furthermore, the pollution and illness caused by insufficient infrastructural provision has widespread ramifications. Illness impairs one's ability to attend school, work, to run a business consistently and reliably, or raise a family. It also adds an additional financial burden and stress to a family.

PROPOSAL

It is because of the degree of importance of these unmet needs that the thesis is focused on providing basic waste, water and sanitation to the masses. The services need to be accessible to more people and more easily accessible. This means that they need to be less expensive, and access points more frequent. The means of provision should also be a more sustainable, environmentally friendly option. Currently, wastes are either dumped in waterways that flow into the Bay of Port-au-Prince, they are burned, or else are trucked for hours to a landfill north of the city on the coast and leech into the groundwater there as well. Wastes would be best off reduced through recycling and reuse and processed locally to reduce transportation fuel and emissions.

The thesis design proposal is an economic model in which household and human wastes are transformed into income-generating businesses which produce jobs in the sorting, processing and transportation of wastes, and through the collection, filtration and dissemination of rain and ravine water for potable and non-potable needs. The proposals are interventions which would serve the needs of the community, and generate new and strengthened relationships between neighbours through the shared use of the proposals. Through the provision of basic waste, water and sanitation infrastructure, which was previously inaccessible or less sanitary, the users are able to lead healthier, more productive, less worried lives with greater time to spare through the more-easily accessed systems.

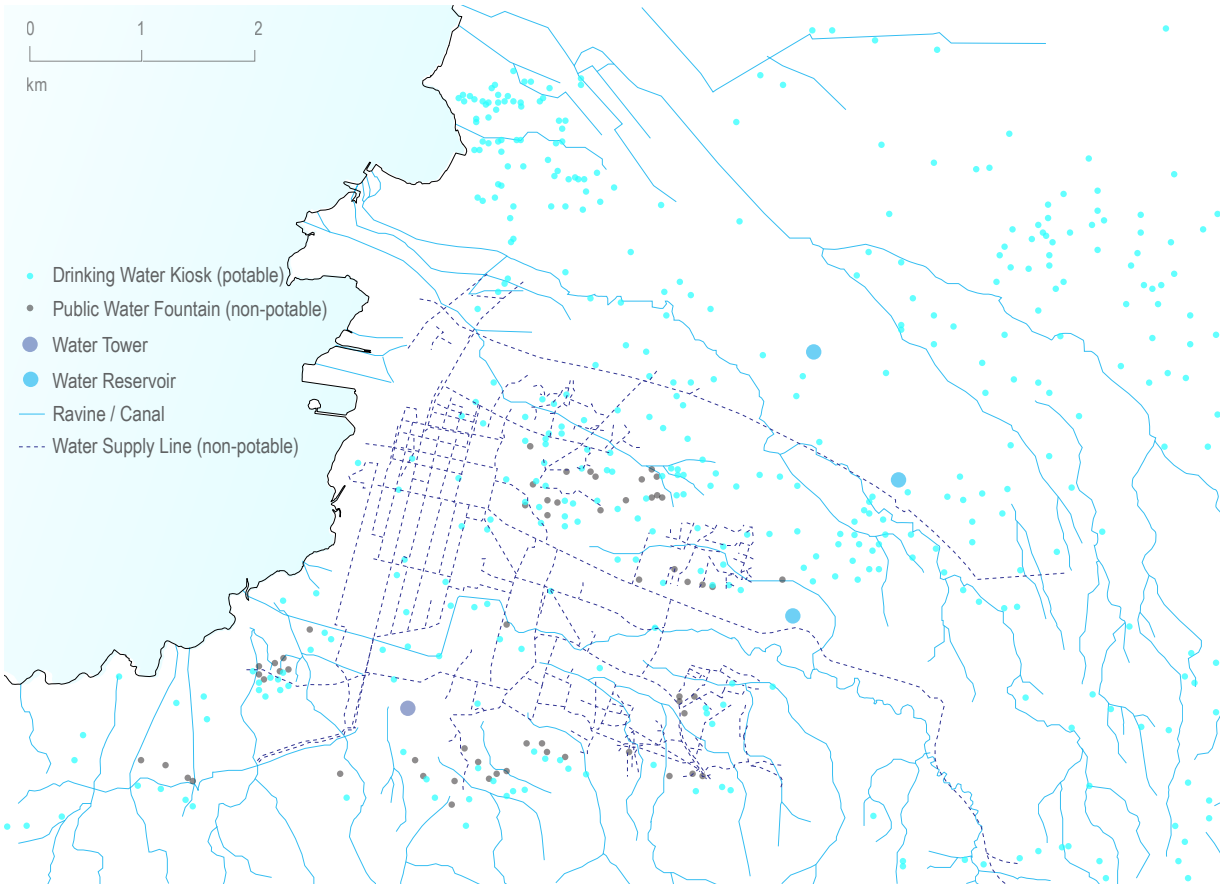


Figure 3.3 : Water Networks in Port-au-Prince

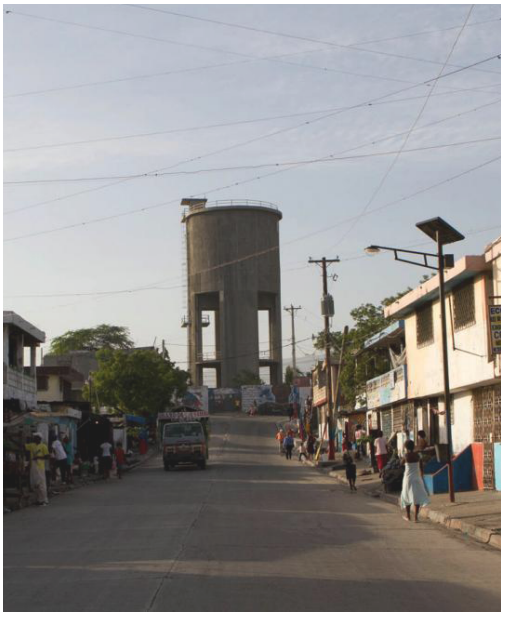


Figure 3.4 : Water Tower, Cite Soleil

Figure 3.5 : Water Reservoir, Delmas 33

This drawing, left, maps all of the water networks in Port-au-Prince. The ravines and canals carry stormwater down from the mountains, through the city, all to empty into the Bay of Port-au-Prince. The water supply lines carry non-potable water into buildings serviced by them once or twice per week, on average.

For their drinking water needs, customers buy imported spring water by the jug, bottle, bucket or bag from Drinking Water Kiosks or grocery stores in town. Public Water Fountains supply free non-potable water for washing water needs and, unfortunately, drinking water for those who can't afford to buy potable water. In the city, there are also three large water reservoirs and one tower containing both potable and non-potable water.

Note: documentation of Public Water Fountain locations are not available outside of the city core, i.e. the northern and eastern peripheries of the map.

The way each type of water is managed and distributed is diagrammed in the following pages, along with all other major infrastructural systems.

DRINKING WATER
EXISTING INFRASTRUCTURE DIAGRAMS

A

WATER KIOSK

Location	Distributed throughout urban Port-au-Prince
Ownership	Private
Operation	Operated by worker
Water	Potable spring water purified via filtration, reverse osmosis, UV filter and/ or chemical additive
Cost	Varies by location; on average: 20L Jugs : 30 GRD 0.5L Bags (“sachet d’eau”) : 1 GRD 50 Jerry Can : 6 GRD

1 Private businessman sells water to customer. Customer typically brings their own water vessel to fill.

2 Water tanker truck delivers spring water from 1 of 18 springs south and north of Port-au-Prince. Culligan’s aquifer is in Croix-des-Bouquets

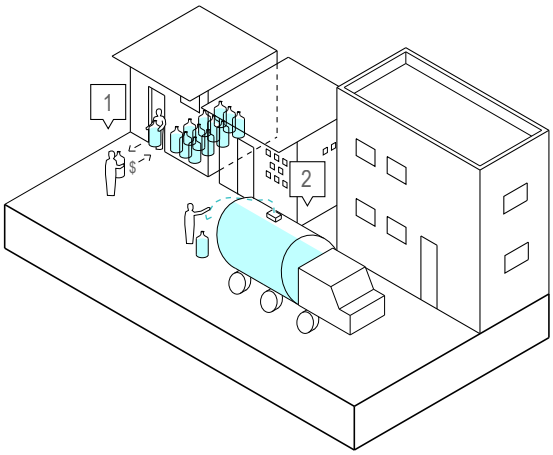
B

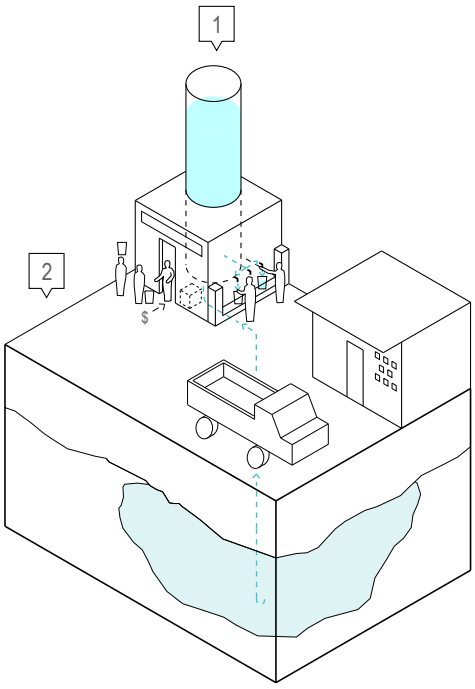
PUBLIC WATER FOUNTAIN

Location	Distributed throughout Port-au-Prince
Ownership	Gov. of Haiti (DINEPA / CAMEP); some co-funded by NGO(s)
Operation	Operated by a worker
Source	Pumped from aquifer, water tower or reservoir
Water	Non-potable, but drunk by those who can’t afford potable water From aquifer
Cost	Free

1 Water typically stored on roof to facilitate gravity-fed water not dependant on pump (i.e. electricity, which is fleeting)

2 Fountain is always accessible to the street for ease of access





Approximate Percentage of Population using System

Figure 3.6 : Existing Drinking Water Infrastructure Diagrams

C

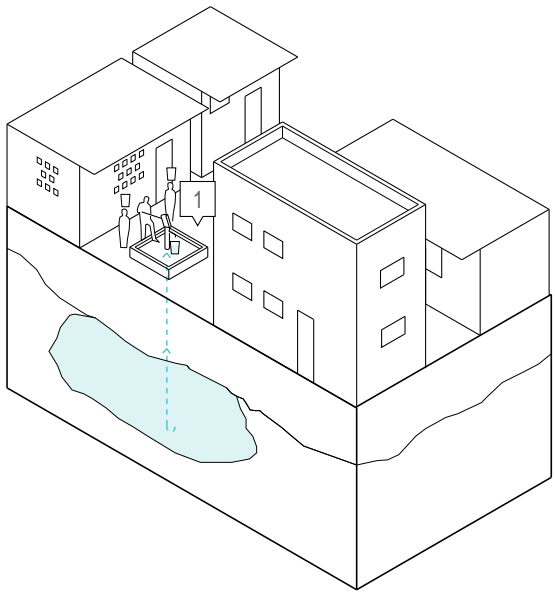
PUBLIC HAND PUMP (Aquifer)

Location	Distributed throughout sub-urban and rural Port-au-Prince
Ownership	Gov. of Haiti (DINEPA / CAMEP); some co-funded by NGO(s)
Operation	Operated by user Not staffed
Source	Aquifer, water tower or reservoir
Water	Non-potable, but drunk by those who cannot afford potable water
Cost	Free

1 Users bring their own vessels to fill with hand-pumped non-potable water

The infrastructural systems in Port-au-Prince are a complex web of private and public service provision. The following diagrams are a means of documenting the different means of providing drinking water, washing water, stormwater management, household waste management and human waste management.

Each series of diagrams is annotated with information on the service provider, means of service, frequency, cost, and location of water source or waste disposal point, as far as the information is available. The estimated percentage of the population that uses each system is shown in a pie chart next to each typology.



DRINKING WATER
TYPICAL EXAMPLES OF MEANS OF ACCESS

A WATER KIOSK

Fig. 3.7: Drinking Water Supply Truck, Pétion-Ville

Fig. 3.8 : Drinking Water Kiosk, Delmas 33

Fig. 3.9 : Sachet D'eau
Common Potable Water Source
Purchased from Grocer / Street Vendor

B PUBLIC WATER FOUNTAIN

Fig. 3.10 : Public Water Fountain, Delmas 33

Fig. 3.11 : Public Water Fountain, Delmas 32

C PUBLIC HAND PUMP (Aquifer)

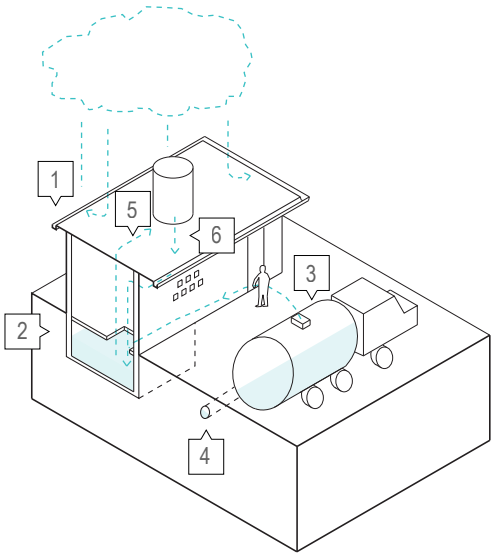
Fig. 3.12 : Public Hand Pump, Haiti

WASHING WATER
EXISTING INFRASTRUCTURE DIAGRAMS

A CISTERN

Location	Throughout Port-au-Prince
Sources	Supplied by: (1) water truck, (2) state water supply lines (DINEPA), (3) rainwater collected rom rooftop
Water	Non-Potable
Cost	DINEPA: $12 USD / mo. Water Truck: varies by distance; approx. $42 USD / 3,000 galon truckload
Notes	Water pumped to a tank on the roof to supply water fixtures via gravity-fed system. This allows system to operate when electricity is off. DINEPA line supply inconsistent (2 hr/ week; off for 6 months).

1. Rainwater collected from rooftop via gutters and channelled into private cistern
2. Cistern
3. Rainwater in cistern supplemented with water purchased from a water truck and DINEPA water lines
4. DINEPA water lines (unreliable)
5. Water pumped from cistern to rooftop barrel / tank for storage. This way, when the electricity shuts off (which occurs frequently), water can still be gravity-fed
6. Water is distributed to building's sinks, showers and toilets, as applicable



B PUBLIC WATER FOUNTAIN

Location	Distributed throughout Port-au-Prince
Ownership	Gov. of Haiti (DINEPA / CAMEP); some co-funded by NGO(s)
Operation	Operated by a worker
Source	Pumped from aquifer, water tower or reservoir
Water	Non-potable, but drunk by those who can't afford potable water From aquifer
Cost	Free

1. Water typically stored on roof to facilitate gravity-fed water not dependant on pump (i.e. electricity, which is fleeting)
2. Fountain is always accessible to the street for ease of access

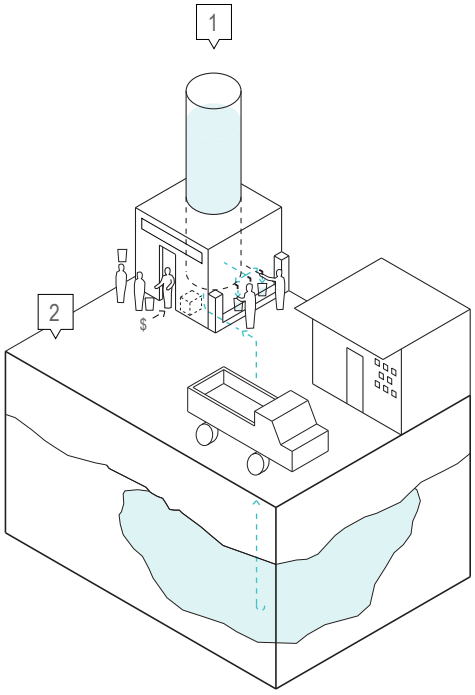


Figure 3.13 : Existing Washing Water Infrastructure Diagrams

Approximate Percentage of Population using System

C

PUBLIC HAND PUMP (Aquifer)

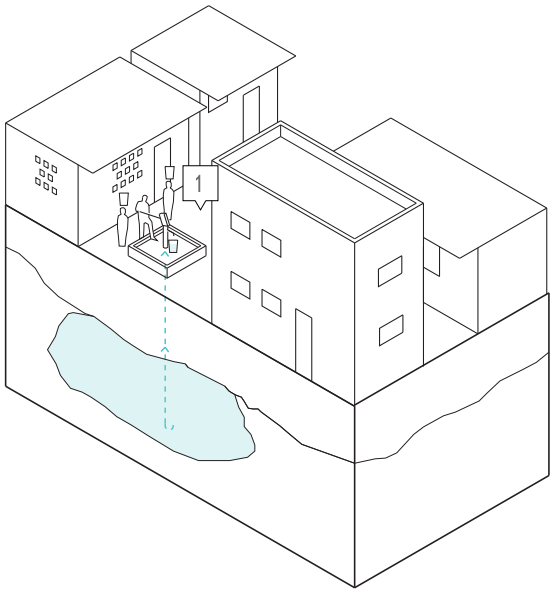
Location	Distributed throughout sub-urban and rural Port-au-Prince
Ownership	Gov. of Haiti (DINEPA / CAMEP); some co-funded by NGO(s)
Operation	Operated by user Not staffed
Source	Aquifer, water tower or reservoir
Water	Non-potable, but drunk by those who cannot afford potable water
Cost	Free

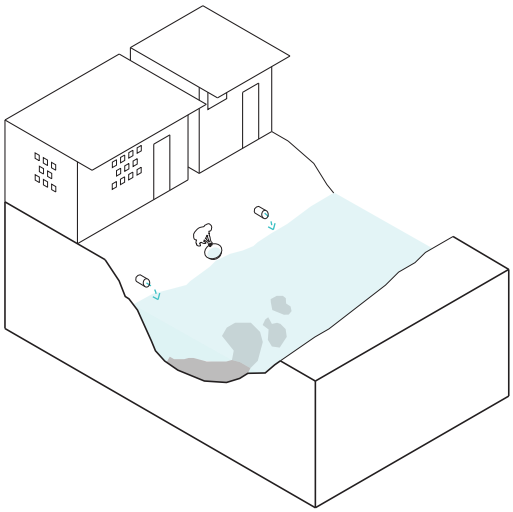
1 Users bring their own vessels to fill with hand-pumped non-potable water

D

RAVINE

Location	Throughout Port-au-Prince
Source	18 Natural springs south of city Heavily Polluted (blackwater)
Methods	Collect via bucket from ravine, or wash directly at the ravine





WASHING WATER
TYPICAL EXAMPLES OF MEANS OF ACCESS

A CISTERN

Fig. 3.14 : Accessing a Residential Cistern, Cité Soleil

Fig. 3.15 : Water Storage via rooftop Water Tank and rain barrel, Delmas 33

Fig. 3.16 : Residential Cistern under Construction, Villa Rosa

B PUBLIC WATER FOUNTAIN

Fig. 3.17 : Public Water Fountain, Villa Rosa

Fig. 3.18 : Public Water Fountain Access Pipe, Villa Rosa

C PUBLIC HAND PUMP (Aquifer)

Fig. 3.19 : Public Hand Pump, Santo, Leogane, Haiti

Fig. 3.20 : Public Hand Pump, Santo, Leogane, Haiti

D RAVINE

Fig. 3.21 : Accessing Washing Water from Ravine, Port-au-Prince

Fig. 3.22 : Accessing Washing Water from Ravine, Wharf Jeremie, Ouest

STORMWATER MANAGEMENT
EXISTING INFRASTRUCTURE DIAGRAMS

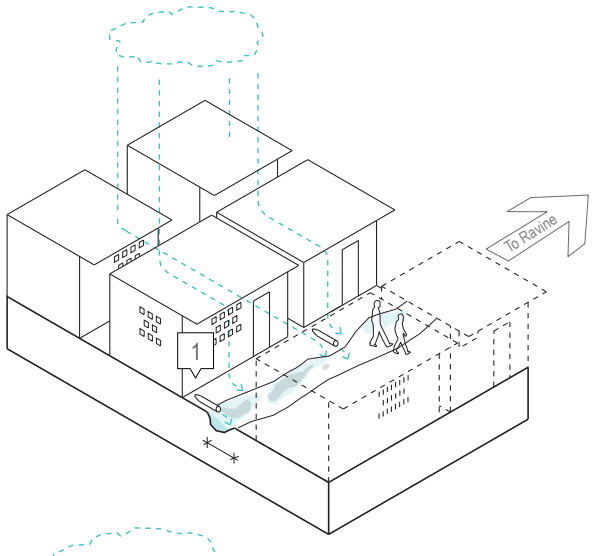
A

NO STORMWATER INFRASTRUCTURE : FEED INTO PATHWAY / STREET / RAVINE

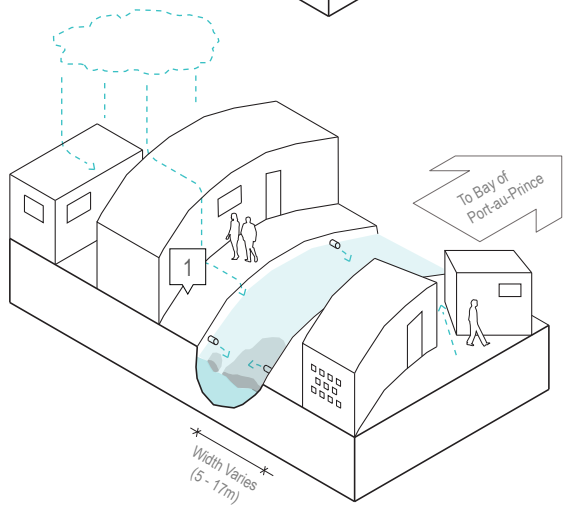
Location	Throughout Port-au-Prince Typically in less affluent areas
Exit Point	Bay of Port-au-Prince
Notes	Water travels through the street or pathway (the area of lowest elevation) Some roads and ravines are devoid of water until they experience a flash flood when it rains Pathways are typically littered with waste

1 Greywater from all buildings is discharged into the street along with stormwater via a pipe

A1



A2



Approximate Percentage of Population using System

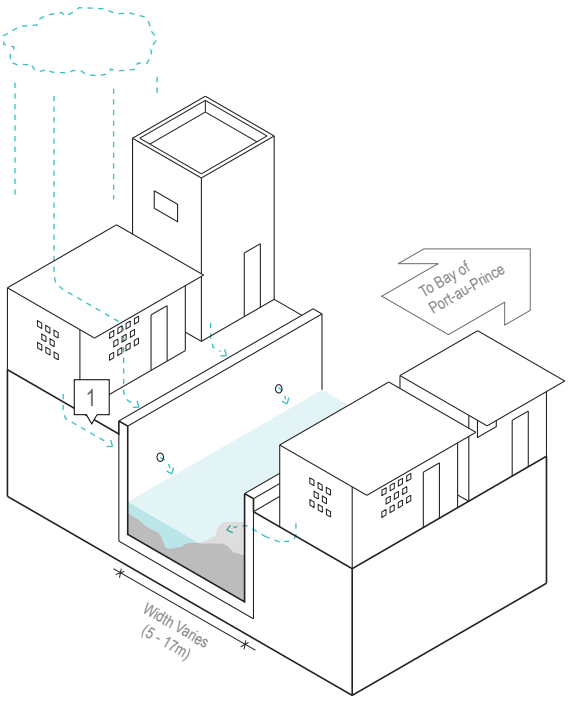
Figure 3.23 : Existing Stormwater Management Infrastructure Diagrams

B

CANAL

Location	Urban Port-au-Prince
Exit Point	Bay of Port-au-Prince
Construction	Typically concrete / stones and mortar; sometimes gravel and earth
Notes	Also filled with waste Flood in rain due to insufficient capacity and volume of waste inside

1 Greywater from all buildings is discharged into the street along with stormwater via a pipe



C

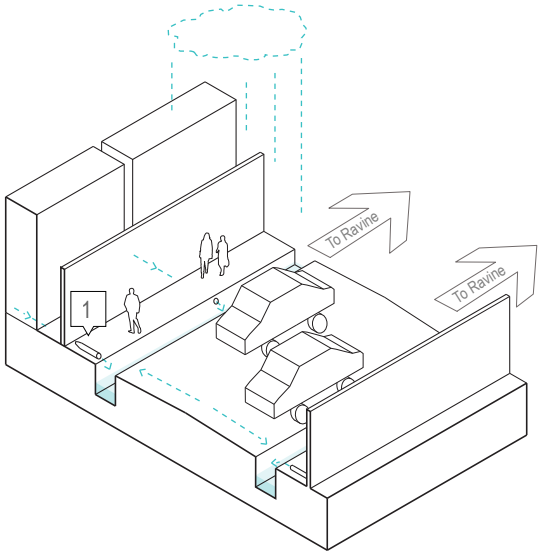
CONSTRUCTED CHANNEL ALONG STREET

Location	More affluent areas of urban Port-au-Prince C2 exists in Petionville only
Exit Point	Bay of Port-au-Prince

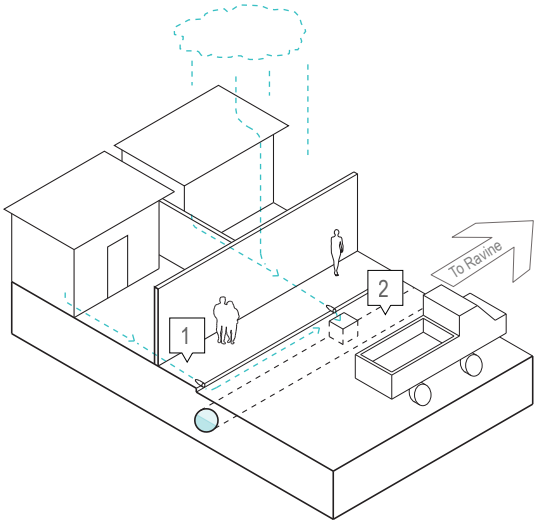
1 Greywater from all buildings is discharged into the street along with stormwater via a pipe

2 Below-grade pipe feeds into nearest ravine / canal, which leads to Bay of Port-au-Prince

C1



C2



STORMWATER MANAGEMENT
TYPICAL EXAMPLES

A NO STORMWATER INFRASTRUCTURE : FEED INTO PATHWAY / STREET / RAVINE

Fig. 3.24 : Stormwater empties into Pathway, Villa Rosa

Fig. 3.25 : Stormwater empties into Street, Delmas 33

Fig. 3.26 : Pipes from Residences empty Greywater into Canal, Delmas 33

Fig. 3.27 : Pipes from Residences empty Greywater into Canal, Delmas 33

B CANAL

Fig. 3.28 : Stormwater empties into Canal adjacent Street, Downtown

Fig. 3.29 : Stormwater empties into Canal adjacent Street, Villa Rosa

C CONSTRUCTED CHANNEL ALONG STREET

Fig. 3.30 : Stormdrain to Sewer running below Street, Pétion-Ville

Fig. 3.31 : Stormdrain to Sewer running below Street, Pétion-Ville

SOLID WASTE MANAGEMENT
EXISTING INFRASTRUCTURE DIAGRAMS

A

DISCARD IN STREET

Description Citizens discard waste in the street (first in garbage bins, where they exist, and when they overflow, pile up waste around bins). The waste is eventually picked up by SMCRS ("Service Metropolitain de Collecte des Residus Solides"), the government department in charge of solid waste and taken to the landfill.

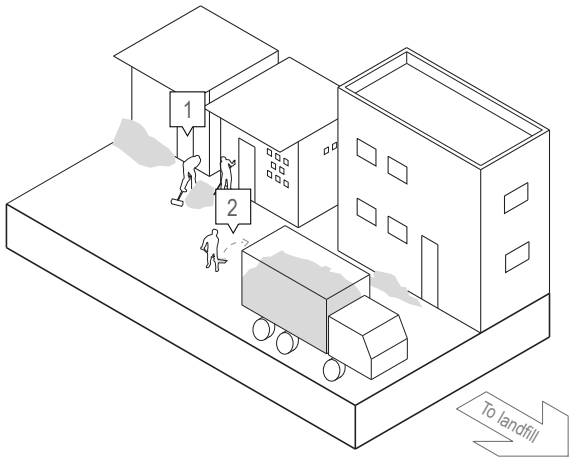
Result Disease- carrying blight (ex. Malaria-carrying mosquitoes)

1 A1 : Port-au-Prince districts are responsible for piling up waste

2 A1 : SMCRS crew collects and transports solid waste to landfill (Truitier, North of the city)
: Trucks run 2x / day, but are inconsistent
: SMCRS has 75 vehicles (rear-load packer)
: 75% of the collection vehicles are out of commission at any given time

3 A3 : Private Waste Removal
: Service is commonly arranged by resident / business owner as a result of irregular SMCRS service
: Waste is sent to 1 of 20 unofficial drop-off locations across the city which are serviced by SMCRS

A1



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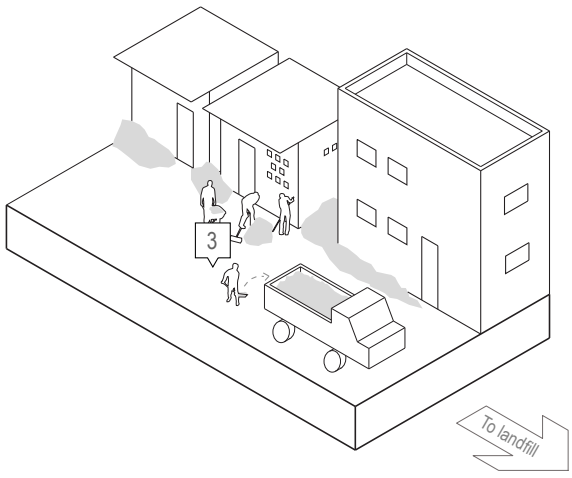


Approximate Percentage of Population using System

Figure 3.32 : Existing Sold Waste Management Infrastructure Diagrams

B DISCARD IN RAVINE

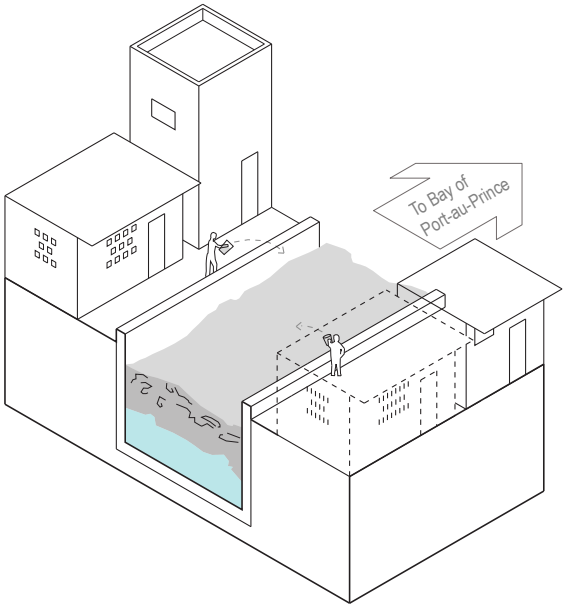
Location	Distributed throughout Port-au-Prince
Notes	Ravines also contain human waste
Discharge	Waste directly or indirectly empties into Bay of Port-au-Prince
Result	Disease- carrying blight Flooding in heavy rain

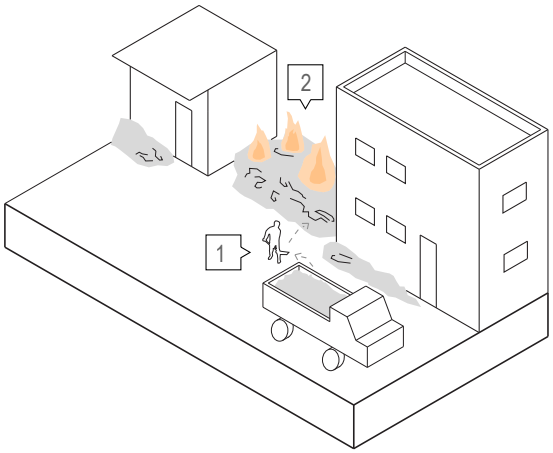
C BURN WASTE

Notes	Common for citizens to set waste piles on fire if piles / bins are unserviced, in order to prevent spread of disease, odour; reduce volume of waste

1 Private Waste Removal companies discard waste in unofficial drop-off locations (20) across Port-au-Prince

2 Residents set waste piles on fire





SOLID WASTE MANAGEMENT
TYPICAL EXAMPLES

A DISCARD IN STREET

Fig. 3.33 : Typical Waste-strewn Streets, Marché Ipolyte, Port-au-Prince

Fig. 3.34 : S.M.C.R.S. Collection Truck, Port-au-Prince

B DISCARD IN RAVINE

Fig. 3.35 : Woman Discarding Waste into Ravine, Delmas 33

Fig. 3.36 : End of Canal, where Waste Accumulates, Martissant

C BURN WASTE

Fig. 3.37 : Accumulated waste outside of Tabarre Market Burning, Tabarre

Fig. 3.38 : Accumulated Waste Burning, Port-au-Prince

HUMAN WASTE MANAGEMENT
EXISTING INFRASTRUCTURE DIAGRAMS

A

PIT LATRINE

Location Throughout Port-au-Prince
Notes Most common method of human waste management

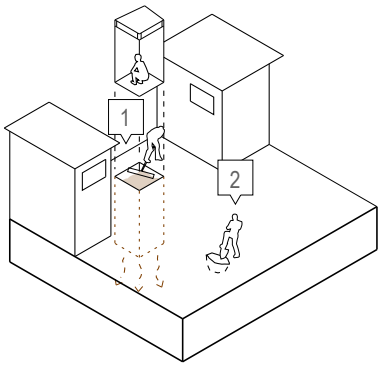
1 A1 : Step 1 : Cement over existing latrine (for the average family, a deep latrine will last 25 years). Waste leeches into the ground water (in downtown area, water table is approximately 1 m).

2 A1 : Step 2 : Dig a new latrine and repeat

3 A2.1 : Tanker Truck Desludging
: Method is used when latrine is accessible to street
: There are very few tanker trucks in Port-au-Prince
: Waste is pumped out and dumped in landfill (Truitier, Port-au-Prince's only landfill, receives 24,000 gallons of human waste / day).

4 A 2.2 : Hand Desludging
: Method used when latrine is not accessible by vehicle (ex. road too narrow or steep)
: Waste is manually removed by bucket and is far more expensive than removing by truck.

A1



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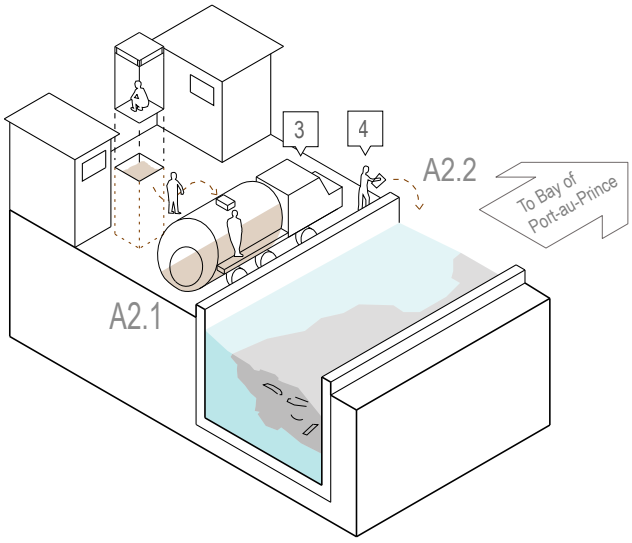


Approximate Percentage of Population using System

Figure 3.39 : Existing Human Waste Management Infrastructure Diagrams

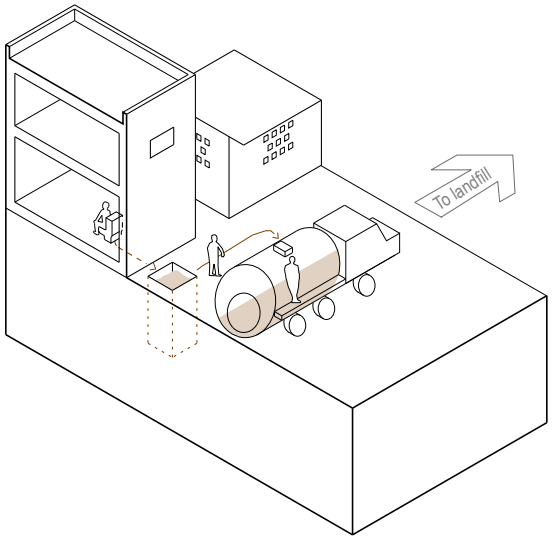
B INDOOR PLUMBING

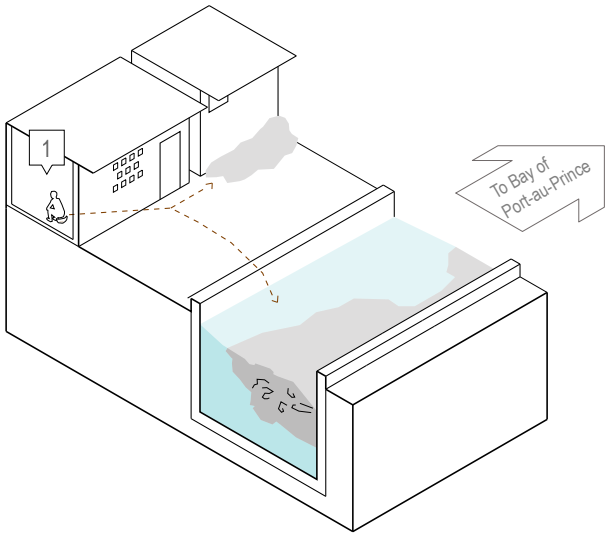
Location	Throughout Port-au-Prince
Discharge	Into septic tank, which is emptied and discharged in landfill
Notes	In wealthier homes / businesses

C OPEN DEFECATION

Location	Throughout Port-au-Prince
Discharge	Into Bay of Port-au-Prince or Landfill
Notes	Method used after dark by those who share a latrine with another household for safety reasons

1 Defecate in plastic bag in house or tent and throw into ravine / pathway / street





HUMAN WASTE MANAGEMENT
TYPICAL EXAMPLES

A PIT LATRINE

Fig. 3.40 : Pit Latrine, Cité Soleil

Fig. 3.41 : De-sludging Latrines by hand when full, Tabarre

Fig. 3.42 : De-sludging truck Empties Latrines when Full, Champs Mars

B INDOOR PLUMBING

Fig. 3.43 : Indoor flush toilet, Port-au-Prince

Fig. 3.44 : De-sluding truck empties contents into landfill, Truitier

C OPEN DEFECATION

Fig. 3.45 : Bags of Human Waste Discarded in Pathway, Kan Neptune Camp

Fig. 3.46 : Bags of Human Waste Discarded in Canal, Delmas

METHODS OF TRANSIT
EXISTING INFRASTRUCTURE DIAGRAMS

¢

"TAP TAPS" (Taxis)
Method of Transit: Shared
Ownership: Private
Cost: set by distance; varies per driver
Use: Immediate; flag driver in street
Notes: Not an organized network; any vehicle-owner can do this
Common method of transit to school, work

$

MOTORBIKE TAXIS
Method of Transit: Individual
Ownership: Private
Cost: Set by distance; varies per driver
Use: Immediate; flag driver in street
Notes: Not an organized network; any vehicle-owner can do this

$$$

TAXI COMPANY
Method of Transit: Individual
Ownership: Private Business
Cost: Set by distance; varies per driver
Use: Call for pick-up

$$$$$

PRIVATE DRIVERS
Medthod of Transit: Individual
Ownership: Private
Cost: Varies; $100-150 / day
Use: Pre-arranged

$

PUBLIC OUT-OF-CITY BUSES
Medthod of Transit: Shared
Ownership: Private Business
Cost: Varies per distance
Use: Pre-arranged stops
Notes: Travels to numerous cities outside of Port-au-Prince

0

GOVERNMENT SCHOOL BUSES
Medthod of Transit: Shared
Ownership: Government of Haiti
Cost: Free (Included in tuition)
Use: Pre-arranged stops
Notes: For school-children only
Only approximately 45 vehicles exist in all of Haiti

Figure 3.47 : Existing Methods of Transit in Port-au-Prince

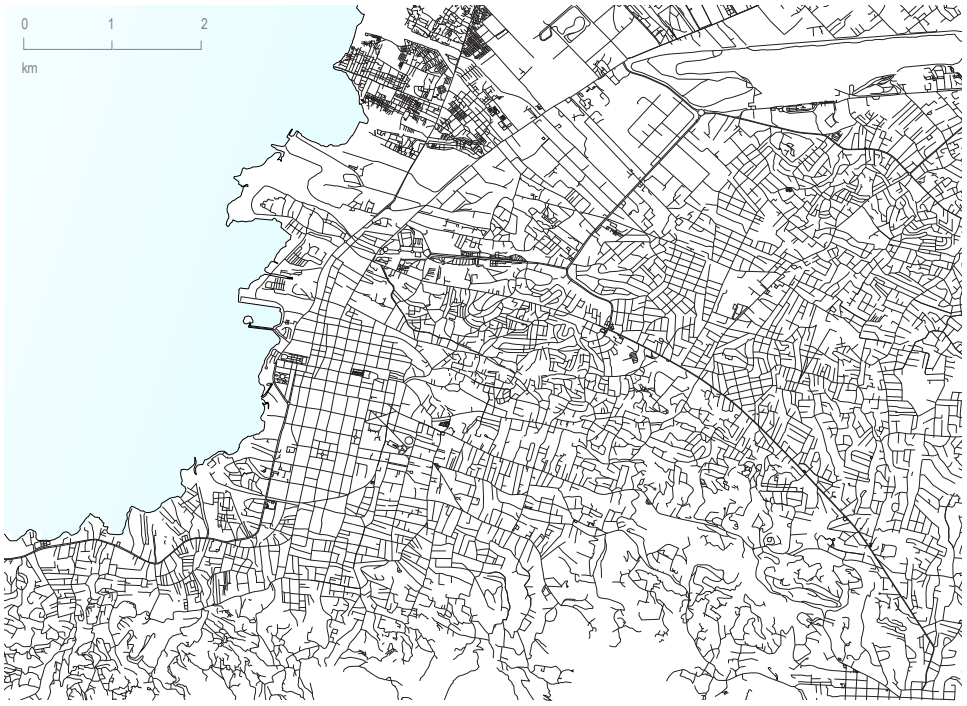


Figure 3.48 : Map of Roads in Port-au-Prince

Port-au-Prince's roads have a large influence on development in Port-au-Prince, as 80% of Haiti's people and goods travel by road,[119] 24% of Haiti's roads are paved, and more than 70% roads remain in poor or very poor condition.[120] Additionally, due to Haiti's mountainous terrain, rainy season and poor maintenance record many roads become impassible during the rainy season.[121]

As the infrastructure in Port-au-Prince, "was designed for a population of about 700,000 and currently has a population of approximately 3 million,"[122] its roads are clogged with traffic, turning what should be a twenty minute drive into a three hour trek during peak traffic hours. Schedules are constantly being pushed back as a result of traffic, unforeseen road blocks and fuel shortages, and the delays hinder any business development from one's daily commute to arranging business meetings to the transport of goods from the port to site. The city's unreliable infrastructural backbone upon which a project and its players rely hinders and delays the completion of all components of a project.

4.0

DESIGN PROPOSAL

PROPOSAL

The proposal is a kit of parts of infrastructural components that can be inserted into an area and operate independent of the city's existing infrastructural networks to provide basic waste, water and sanitation services while operating as a self-sustaining, profitable business model. The components can be inserted onto existing vacant land (which is limited), or be part of a new development opportunity on land whose buildings have been tagged red, i.e. slated for demolition, of which there are tens of thousands in Port-au-Prince. The adaptable and replicable kit of parts can operate alone, in tandem, as a group, or as an entire system in a community in the city to satisfy waste, water and sanitation requirements.

One is good.
Two is better.
Three is great.
The whole system is best as, together, the component parts create a complete, holistic system.

WHY THIS MODEL?

City-scale systems are expensive both to construct and maintain, and have proven inconsistent, unreliable, or failures. For example, the city's few sewer lines are entirely non-functional; household water service lines (non-potable) are unreliable (operation varies from twice per week to once per month), and solid waste collection is inconsistent, as 75% of the vehicles of SMCRS, the government waste collection provider, are out of service at any given time, they estimate that they can collect 20% of the city's waste,[123] and they only serve some districts. As a result of these basic needs not being met, inhabitants either live in unsanitary conditions, or, if they can afford it, rely on private companies to provide infrastructural services.

As large infrastructural systems at the scale of a city require heavy government funding to run and have proved unsuitable and unreliable, the proposal is to treat wastes and water locally as a small business. This business model will greatly increase the viability and sustainability of the infrastructural systems and their maintenance, reduce transportation costs and transit time due to its centralized location, and create jobs (in construction, maintenance, sales, and resultant secondary economies). The infrastructural systems themselves provide basic waste, water and sanitation services by means of water harvesting, treatment and dispersal; waste collection, sorting, recycling and composting; and human waste composting.

The design proposal is a series of components depicted in various configurations and combinations to serve different needs as a means of explaining how these are adaptable and replicable proposals that can become systemic for both Port-au-Prince and beyond. Although specifically designed for Port-au-Prince, these systems are universally applicable strategies of waste, water and sanitation management through community-based rainwater collection and filtration; waste collection, sorting and recycling; human and organic waste composting, and stormwater management.

This chapter presents the design components first on their own, and then introduces the programs that pair well with them. The first proposal, A, is a holistic network of all of the components combined with programs to serve the infrastructural needs of a neighbourhood in Port-au-Prince. The following series of combinations, B-G, pair the components and programs together in a series of combinations and configurations that are well-suited to work together and feed off of each other.

WASTE ECONOMY

"The food of the 21st century is waste."[124]

The design proposal is largely an economy of wastes. It uses the principal that "waste from one industry becomes fodder for another,"[125] which Landscape Architect, Bélanger, describes. The proposals take existing wastes and waters and recycle, remediate and regenerate them to engender products and businesses from them to meet basic waste, water and sanitation needs with a fraction of the resources. A waste economy of reuse and downcycling is the most logical response in an impoverished economy where resources are scarce, wastes are excessive, and workers are bountiful. Time-consuming, labour-intensive waste sorting and processing tasks are therefore desirable for job-creation as well as minimizing resource needs and fueling waste reduction, which produce more sanitary living conditions.

Bélanger goes on in Landscapes of Disassembly, to explain how "exhausted economies are being jumpstarted through combined strategies of economic regeneration and ecological reclamation, where water, land, energy and waste are becoming the bedrock of a new world economy."[126]

FUNDING AND MAINTENANCE

Either an NGO (non-governmental organization), NFP (not-for-profit), private business, or a collaboration of the above would provide the design, construction and start-up costs, and the private organization or entrepreneur would then take control of the project. The project would be designed in collaboration with the community to ensure that it will meet their needs. An owner / manager would be chosen by the funder / project management group based on their ability to operate the project in the manner it was designed, thereby guaranteeing the commitment to the community. This is the model that I.O.M. uses with its community toilets, as described on pages 133-134. In projects of this nature in Port-au-Prince, one often sees one of the funders mentioned above provide the start-up costs, and a collaboration is then made with the municipal provider of the service to continue service to the project (ex. DINEPA provides water; S.M.C.R.S. provides waste collection). This is also an option.

The proposal provides a source of revenue (ex. selling the filtered water or processed compost; charging per use of a community toilet) that funds its maintenance. As the components are paired with existing local programs that serve each other well, such as schools, sports fields, public parks

or churches, the components serve not only the surrounding neighbourhood, but also the existing programs' users, who provide further users to fund its continuation.

Interspersed with the design proposals are a number of relevant precedent projects in both Port-au-Prince and elsewhere to provide examples of how projects of this nature can work logistically, economically and socially.

CRITERIA FOR DEVELOPMENT

In designing development proposals in Port-au-Prince, the following criteria need to be kept in mind to achieve:

> Produce local labour
> Reduce use of imported materials / utilize locally available materials and products
> Reduce carbon emissions (reduce transportation of materials, move materials on site by hand, reduce amount of imports, etc.)
> Produce local, independent businesses / economies

ECONOMIC AND SOCIAL DRIVERS

The proposals generate valuable products that generate micro-economies in themselves as well as by attracting other supplementary micro-economies. The economic values that the proposals generate are:

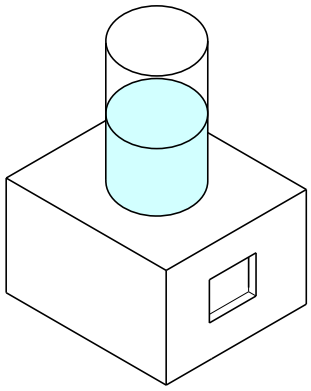
Products

- > Filtered and potable water (for drinking and washing needs)
- > Sorted recyclables that have a re-sale value
- > Subsequent products generated from sorted wastes such as compost, artwork and other wrought metal products
- > Produce from agricultural plots
- > Public toilets and showers

Outcomes

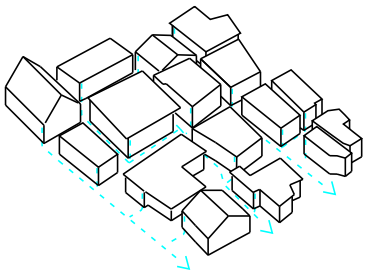
- > Local jobs generated in the construction of proposals
- > Local jobs generated in the collection, packing, processing and transporting of wastes (ex. collecting human waste barrels from toilets and processing it into compost)
- > Local jobs generated in the management and maintenance of the proposals
- > Improved quality of waterways that in turn improve health quality
- > Local jobs generated in the re-use of recycled materials (ex. metal smiths)
- > Improved sanitation (toilets, showers)
- > Reduced waste in roads and ravines (waste is diverted from ravines through the collection of solid wastes and provision of toilets)
- > Vegetated / natural habitat (marshes, parks, gardens) created within the dense urban city, creating a desirable place of respite, a new ecosystem, as well as a softscape within the concrete city to absorb stormwater

COMPONENTS
A KIT OF PARTS



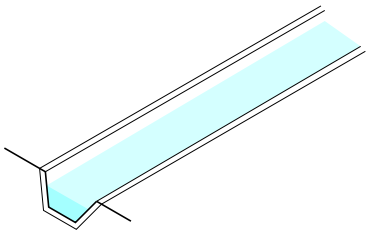
1

Water Tower and Filtration



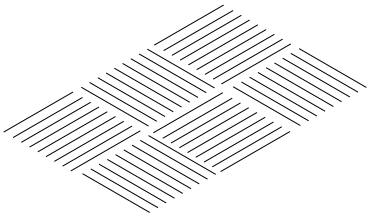
2

Rooftop Rainwater Harvesting Network



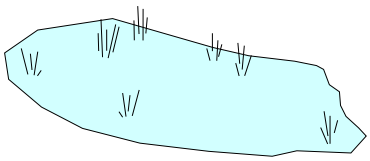
3

Canal



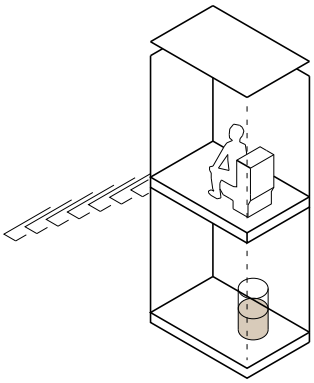
6

Agricultural Plots



7

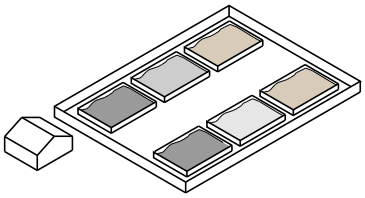
Reed Bed



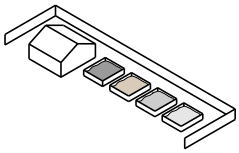
8

Dry Composting Toilet (a.k.a. UDT: Urine Diverting Toilet)

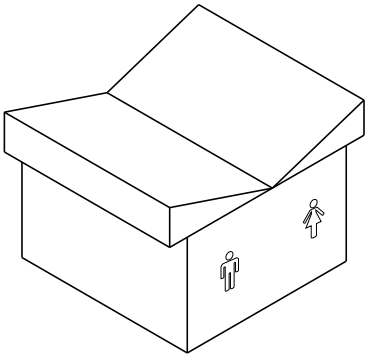
Figure 4.1 : Kit of Component Parts



4
Waste Processing Facility



5
Waste Drop-off Location



9
Community Washrooms

The proposal is a kit of parts. Together they compose a catalogue of low-tech components of basic infrastructure. The group of components offer rainwater collection and filtration; waste sorting, collection and processing; toilets, showers and agriculture.

Each component can be used on its own, in a pair, group, or as an entire network. The following pages show a network of these components designed for a Port-au-Prince neighbourhood, Combination A, followed by six pairs or groupings of components, Combinations B through G.

Fig. 4.2 : Organic Waste processed into compost, Truitier, P-au-P

Fig. 4.3 : Human Waste composting toilets, Santo, Leogane, Haiti

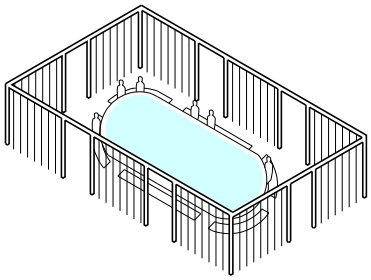
Fig. 4.4 : Filtration of Drinking Water from Reservoir, Rajasthan, India

Fig. 4.5 : Stormwater Water Rooftop Network, Villa Rosa, P-au-P

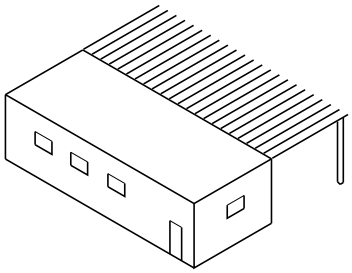
HOW PROPOSALS ADDRESS EACH INFRASTRUCTURAL NEED

	SYSTEM	REQUIREMENTS	OUTCOME
SOLID WASTE	Organic Waste Composting (75% of waste produced in PAP)	Waste Composting Areas	Waste Composting Areas
		Waste collection areas	Waste collection areas
		Staff for waste composting area, collection area, maintenance, pick-up	Staff for waste composting area, collection area, maintenance, pick-up
		Waste Processing Supplies	Waste Processing Supplies
		Education of public how system works; why it is a good, sustainable answer; how to sort and dispose of waste	Education of public how system works; why it is a good, sustainable answer; how to sort and dispose of waste
	Collection System (remaining 25%)	Staff and trucks to collect waste (utilize SMCRS)	Waste Collection providers, SMCRS, less burdened (currently estimate they can collect 20% of PAP's waste)
			Job creation
			Landfill receives less waste; fills more slowly
			Compost product to sell (in bags)
			Revenue: Compost sales
HUMAN WASTE	Urine-Diverting Toilets (UDT) and composting sites	Waste Composting Areas (can be paired with organic waste composting sites)	Job creation
		Waste collection areas	Divert human waste from landfill, ravines, bodies of water, streets, etc.
		Staff for waste composting area, collection area, maintenance, pick-up	Diverts human waste from latrines and discarding into streets / waterways, preventing faecal matter from leeching into and contaminating water table
		Waste Processing Supplies	
		Education of public (users) how system works; why it is a good, sustainable answer to PAP's waste issues; how to use and maintain toilets; how to sort and dispose of waste	Cleaner waterways, streets; results in healthier environments
			Compost product to sell (in bags)
			Revenue: Compost sales
DRINKING AND WASHING WATER	Rooftop Rainwater Harvesting and Filtration network	Rooftop gutter systems, subterranean pipe network connecting houses to filtration centres, filtration tanks, pumps, and filtration centres, from which treated water is disseminated	Reduced need for water supply from external sources (ex. private water trucks, public water fountains, aquifers, private drinking water suppliers, water towers, etc.)
		Cooperation of households to participate in rainwater collection network	Reduced energy (and time) required to supply households with drinking and washing water
		Staff for water filtration sites; maintenance crew	
		Phytoremediating reed beds along water path	Job creation
			Minimizes Stormwater runoff (which causes erosion; overwhelms the ravines and canals, which causes flooding)
STORMWATER MANAGEMENT	Rooftop Rainwater Harvesting network (minimizes runoff)	See "Drinking and Washing Water" notes	See "Drinking and Washing Water" notes
	Reed beds along water path (creates water overflow areas, reducing flood risk)		

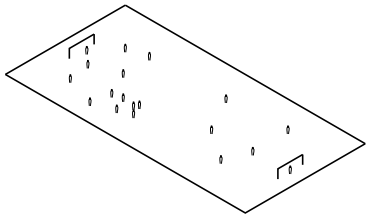
CONNECTING PROGRAMS
TO PAIR WITH COMPONENTS



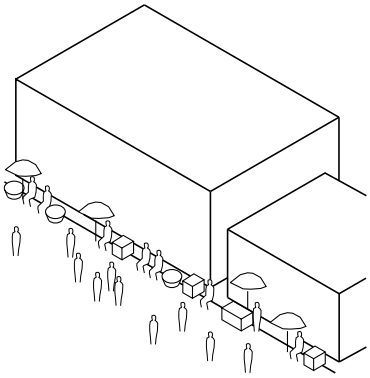
A
Washhouse



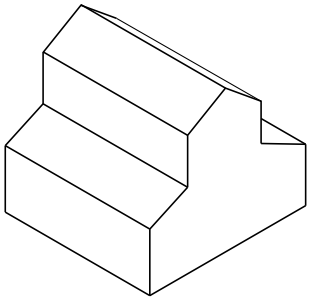
B
School



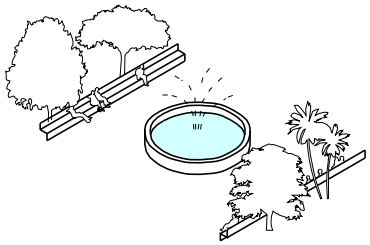
C
Sports Field



D
Street Market



E
Church



F
Public Park

Figure 4.6 : Connecting Programs for Components

The components (shown on pages 65-66) are paired with suitable programs to both benefit and take advantage of the programs (left). Generally, the owner of the connecting program (ex. a school or soccer field) is in charge of running and maintaining the infrastructural component(s), and the components serve the programs' users and improve the program, thereby benefitting the owner.

The projects would need an initial funder, such as an NGO (non-government organization), NFP (not-for-profit), DINEPA (the government body in charge of water provision, Direction Nationale de l'Eau Potable et de l'Assainissement), or a combination of these, but they are chosen to be able to generate an income in order to become self-sustaining after a period of time.

For example, by pairing a soccer pitch with public toilets, or combining a park with public toilets and showers, the owner can charge a small admission for use of the toilet or shower to cover his operational costs. The general business model is described in each of the proposals.

The proposal is designed as a kit of parts so that they can become systemic and replicated across Port-au-Prince and beyond. The pieces themselves are quite basic and rudimentary, and would lend themselves to a variety of developing countries based on their construction methods and materials, and the climate they are designed for.

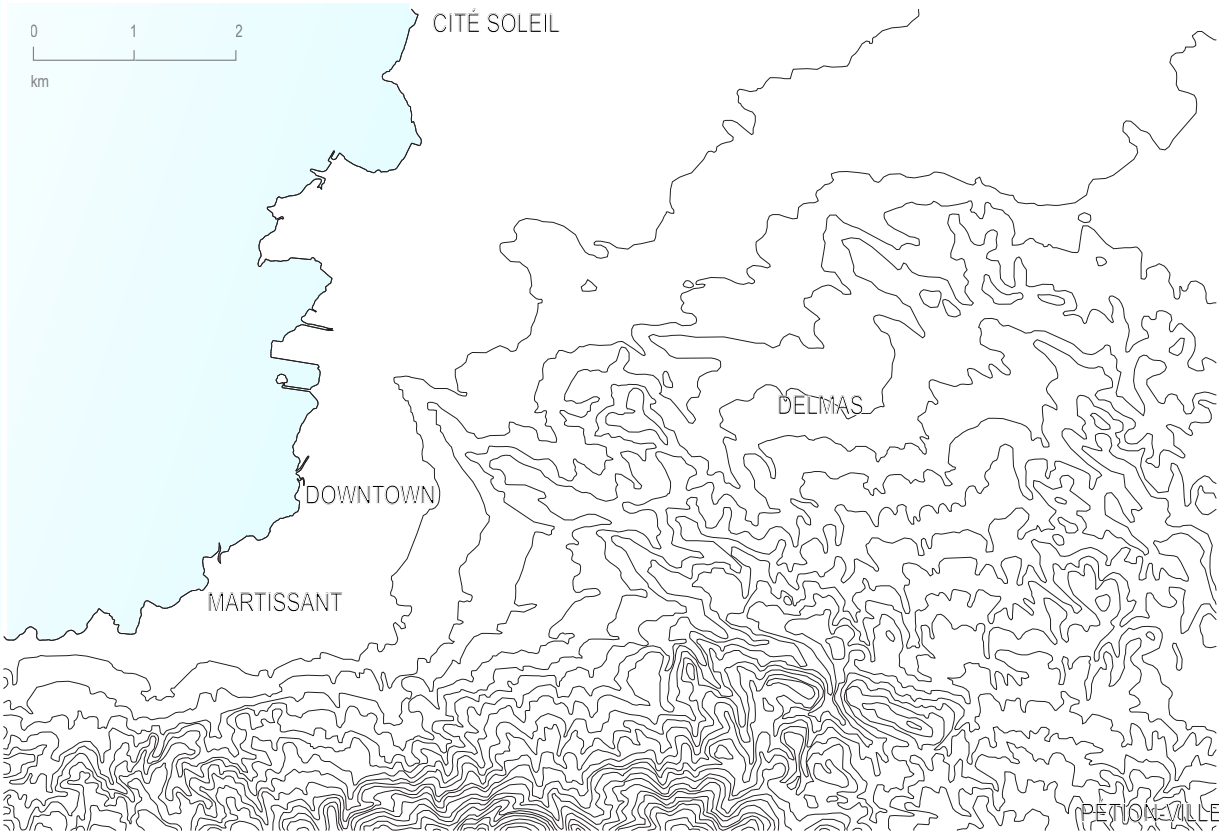


Figure 4.7 : Topography of Port-au-Prince

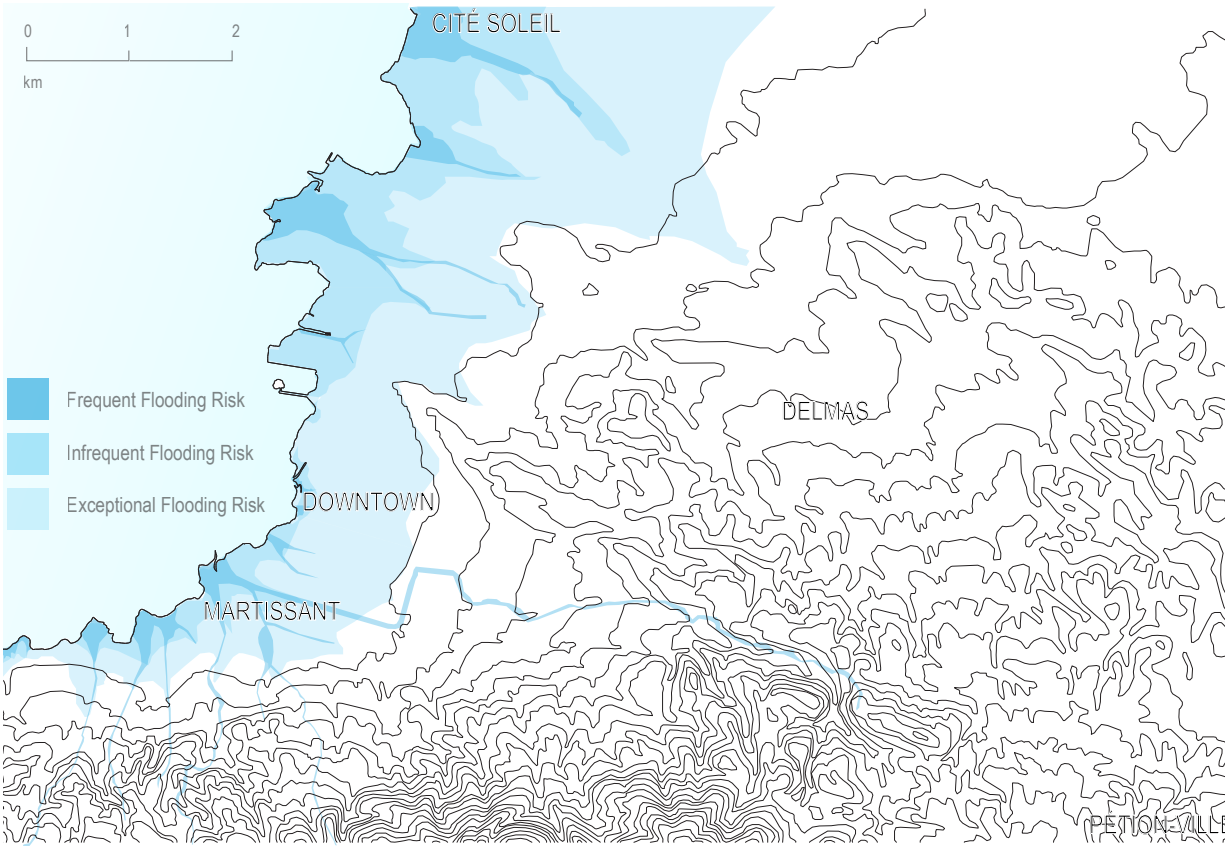


Figure 4.8 : Flood Risk in Port-au-Prince

TOPOGRAPHY

Port-au-Prince is a mountainous city, building up from the waterfront to 300m-high mountains along the city's southern edge. Topography plays a pivotal role in the functioning of the city. Topography determines the way the city floods, the way stormwater water moves through it, and, because wastes end up primarily in the ravines and canals, the direction the waste flows and where wastes concentrate (i.e. where they are delivered: at the waterfront). Due to the accumulation of wastes and the risk of flooding along the waterfront, a number of slums are located there (ex. Cité Soleil, Martissant) as it is unstable and undesirable land. Topography furthermore affects demographics as the wealthiest remove themselves from the flood-risk waterfront and polluted waterways and reside in the south-east in Pétion-Ville, while squatters illegally inhabit the eroded hillsides just west of them.

The mountains south of the city dissipate as they work their way northwest towards downtown and the Bay of Port-au-Prince, carrying stormwater runoff and soil, which is eroded due to the deforested terrain. Only 2% of Haiti's original forest remains today.[127]

FLOOD RISK

Haiti lies in the middle of the hurricane belt and is subject to severe storms from June to October; occasional flooding and earthquakes, and periodic droughts.[128]

Flooding risks are mostly confined to the coastal regions, although during the rainy seasons (May and October), stormwater cascading down the mountainside can cause severe landslides, flooding, and make roads impassable.[129] Additionally, as ravines and canals are clogged with refuse, they are subject to flooding the peripheral area.[130]

Flooding is significant in the design proposal in a number of ways. In the proposals, ravines and canals are channelized into closed stormwater pipes both to alleviate flooding risks and for sanitary reasons. By closing access to the waterways, wastes cannot be discarded within, and thus there are no longer flooding issues around the waterways due to being clogged with waste. Furthermore, the proposed water filtration towers collect water from ravines (in addition to rooftops) for filtration that both diverts stormwater in ravines to both reduce overflow risk and improve water quality.

In addition, the location of the proposed interventions is affected by topography and flooding risk. These are described in detail in the following spread. Essentially, proposals that deal with ravine channelization and remediation are proposed in the southernmost areas first, as, if ravine and canal waters downstream are remediated but polluted waters flow into them from upstream, those efforts are wasted.

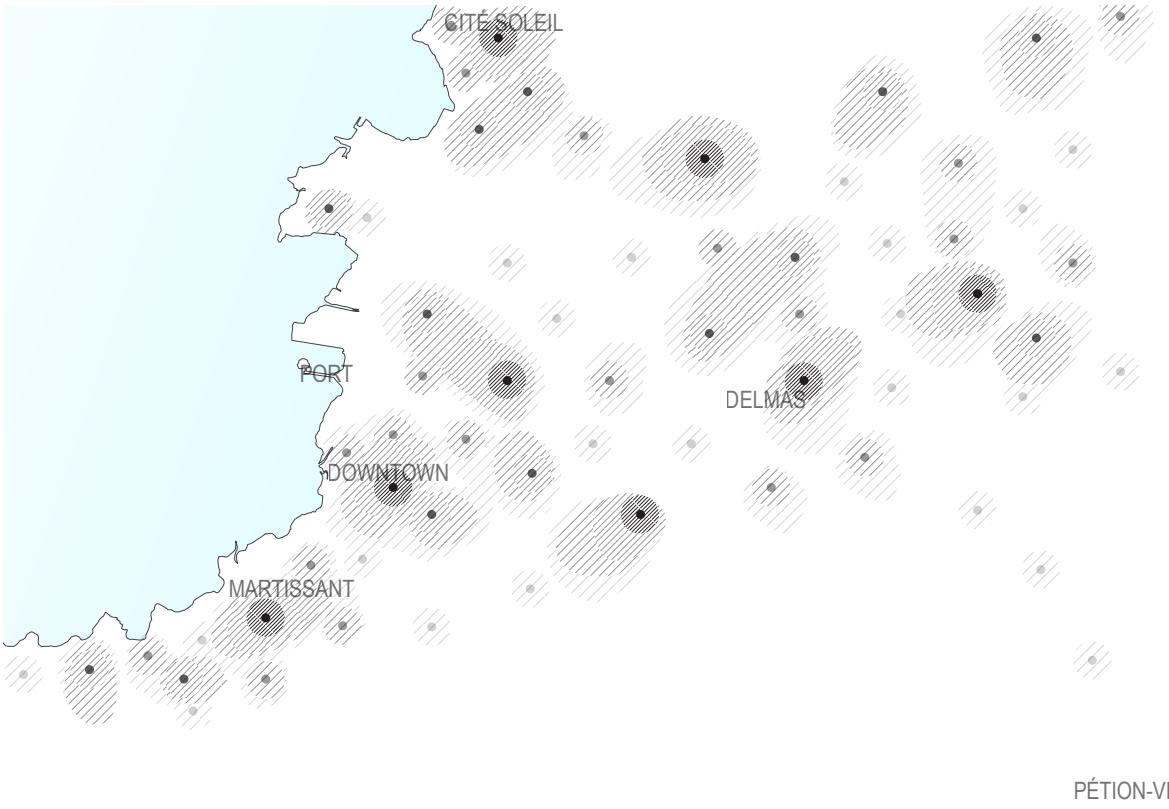


Figure 4.9 : Implementation Phasing Diagram A: Components 1, 2, 4 - 6, 8

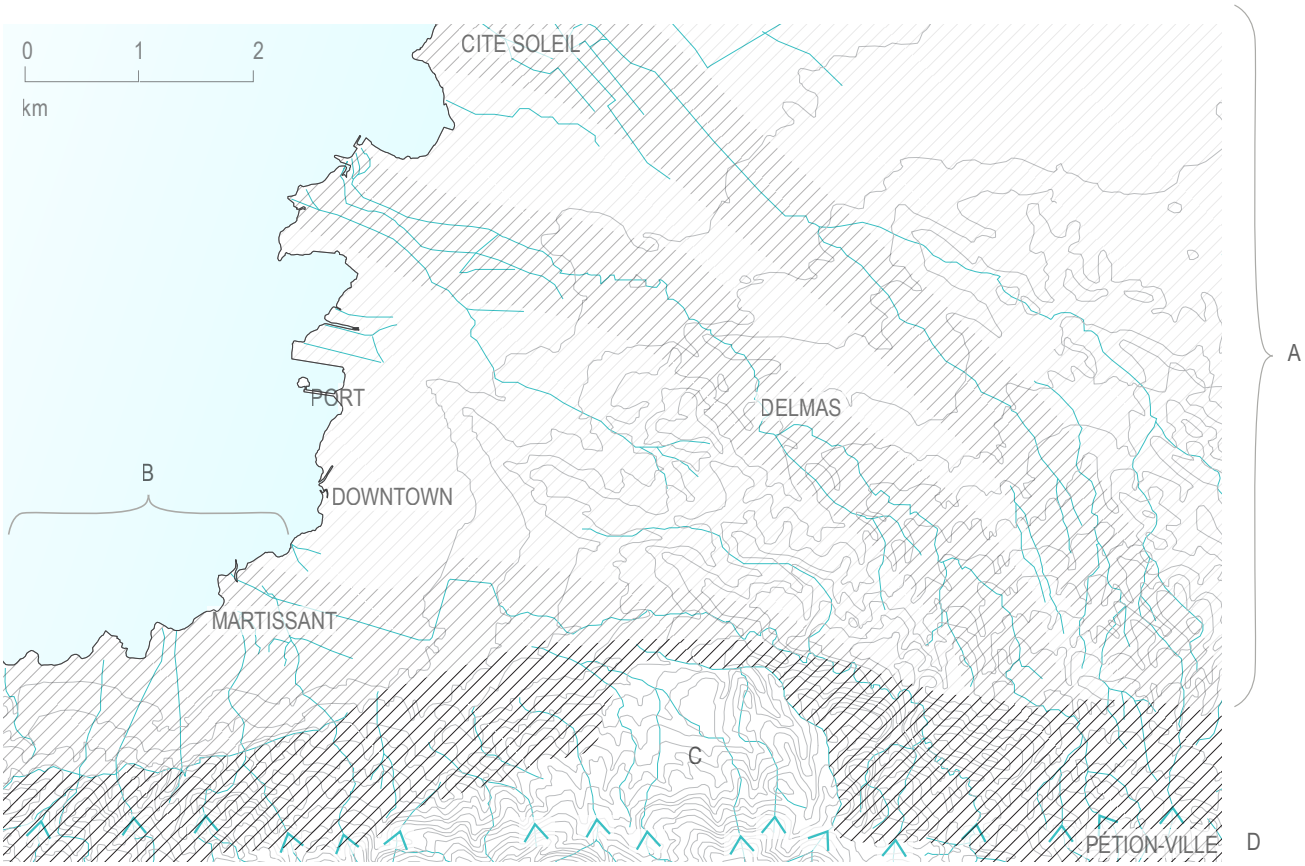


Figure 4.10 : Implementation Phasing Diagram B: Components 3, 7 (paired with 1)

INFRASTRUCTURAL SYSTEMS A

: Composting of Human and Organic Waste (Comp. 4, 8)
: Rainwater Collection (Components 1, 2)
: Agriculture (Component 6)
: Waste Collection and Processing (Components 4, 5)

DESCRIPTION OF PHASING

The infrastructural interventions would begin as individual nodes serving their adjacent districts, respectively. Over time, as education and knowledge of them spreads, influence and catchment areas grow, and new initiatives begin popping up. As this occurs, the influence and exposure of the interventions grow at an increasing rate, and, fully realized, the decentralized web of infrastructure would become a dense, comprehensive fabric of infrastructural provision across the city.

The diagram, left, shows the phasing of the proposal intervention. The precise location of the nodes shown here is not important; the purpose of the map is to indicate that the proposals are concentrated in the most populous and underserved districts first: Delmas, Downtown, Cite Soleil, and Martissant. As the nodes germinate over time and their catchment areas expand, more proposals are constructed to serve further users.

LEGEND

- Intervention Phase 1 Location
- Intervention Phase 2 Location
- Intervention Phase 3 Location
- Intervention Phase 4 Location
- Area Served by Phase 1 Interventions
- Area Served by Phase 2 Interventions
- Area Served by Phase 3 Interventions
- Area Served by Phase 4 Interventions

INFRASTRUCTURAL SYSTEMS B

: Stormwater Filtration (of ravine water, or returning filtered rainwater back into the ravine) (Component 7 paired with 1)
: Ravine / Canal cleaning and remediating (Component 3 paired with 1)

DESCRIPTION OF PHASING

The first phase of proposals involving these components is best done in the upstream inhabited areas. Water flows north-west down from the mountains south of the city through Port-au-Prince and into the Bay. Any infrastructural interventions targeting remediating ravines / canals or filtering water and returning it to the ravines is therefore best done upstream first (phase 1) because if you improve conditions in one area but continue to have contaminants and waste flowing in from upstream, your efforts are wasted. The second phase targets the areas with the most influential ravines, i.e. the major ones which cut through the city and deliver the waste they accumulate directly into the bay, and creates a corridor of intervention along the hydrological paths. The third and final phase incorporates the remainder of the city.

PHASING OF IMPLEMENTATION

- Phase 1 : Ravines upstream in the mountains which feed into the rest of the city
- Phase 2 : Main ravines / canals running through town (largest influences and collectors of waste) and south-western ravines closest to the waterfront
- Phase 3 : Remaining areas of Port-au-Prince

LEGEND

- A All of these districts (Downtown, Delmas, Cité Soleil and Martissant, particularly the latter two, slums) are in need of ravine / canal cleaning; waste discarded in them steadily accumulates as it approcahes the bay, culminating in heaps of waste and recyclables at the waterfront.
- B Martissant's waterfront region is particularly clogged with refuse as the city's canals converge here, laden with waste.
- C White zone is an eroded mountainous area that is largely uninhabited. Therefore ravine remediating efforts are unnecessary here.
- D Petion-Ville is the wealthiest district of Port-au-Prince; relatively well-serviced and clean.

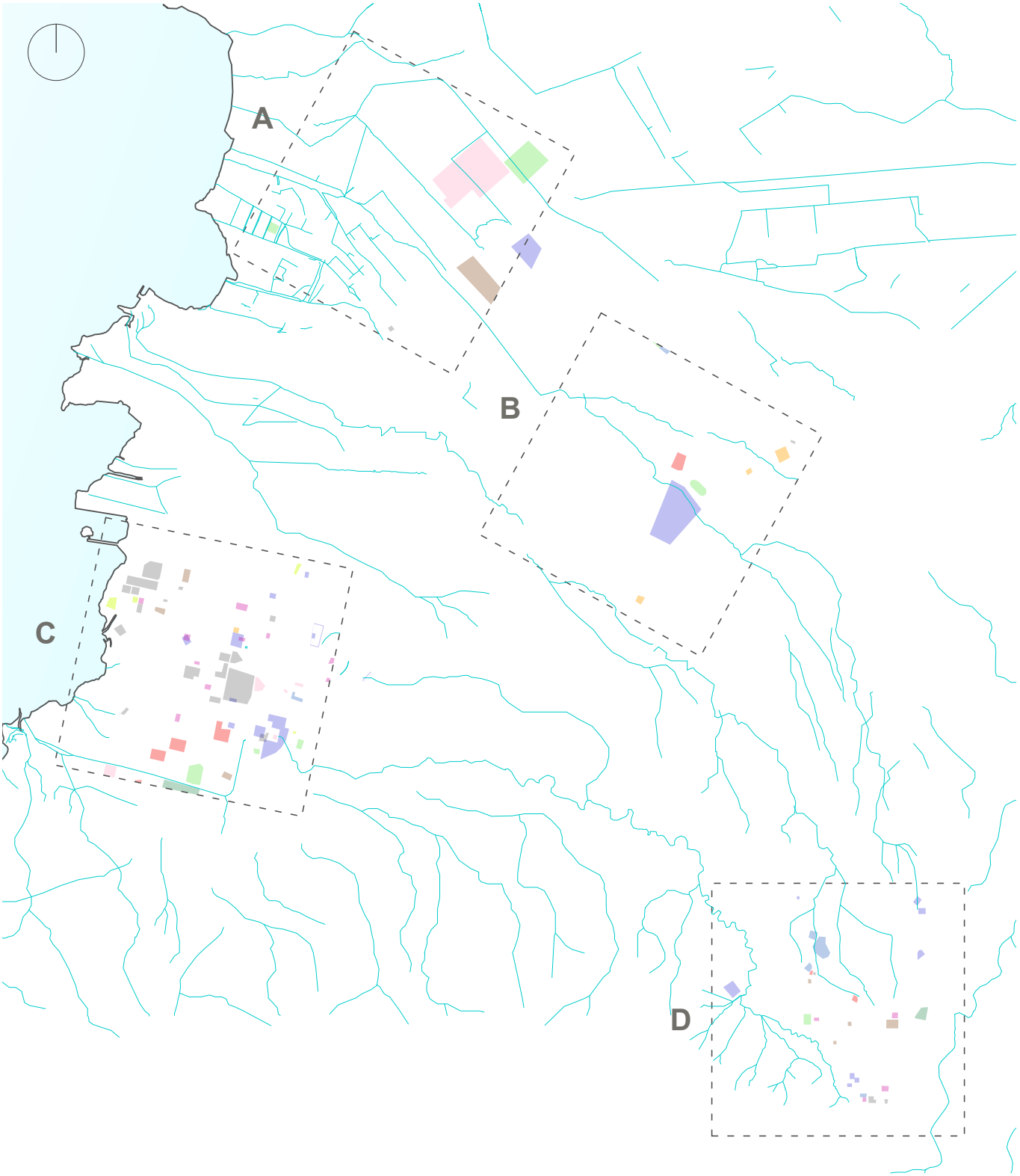


Figure 4.11 : Context Map: Amenities per 5 km²
Port-au-Prince
1 : 50,000

MAPPING AMENITIES IN PORT-AU-PRINCE

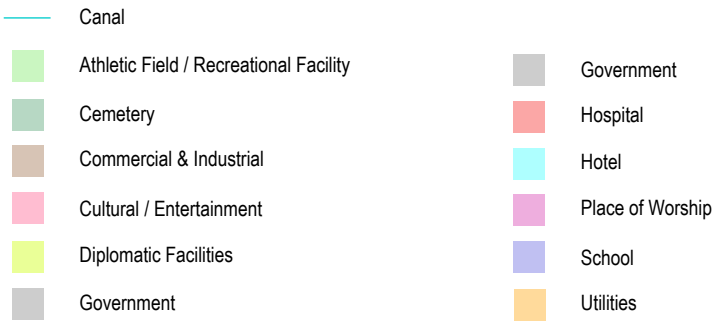
The map on the left and in the following spreads are a study of four diverse and characteristic districts of Port-au-Prince drawn to depict the city in greater depth and note the amenities available within a 5 km^2 radius of each, showing the variety of living conditions in the city. The maps include infrastructure such as water service lines and access points, rivers, significant facilities such as schools and hospitals, and amenities such as hotels and recreational facilities (coloured blocks).

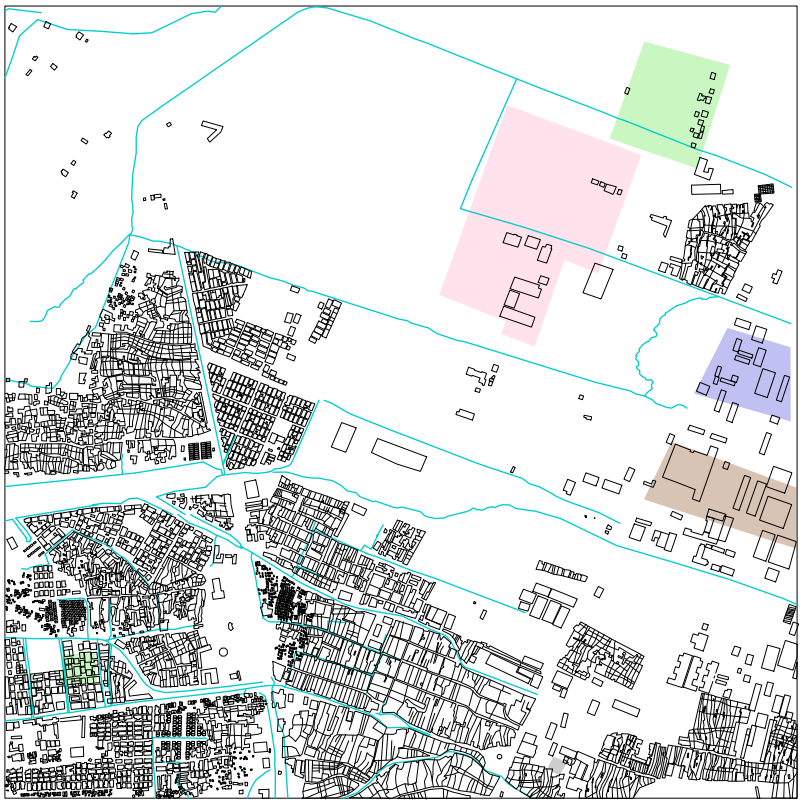
The districts are as follows:
A : Cité Soleil
: Informal Settlement (i.e. slum)
B : Downtown
: Waterfront; adjacent to Port
C : Delmas
: Peripheral low-income neighbourhood
D : Pétion-Ville
: Port-au-Prince's wealthiest district (business and residential)

Amenities and services, as listed in the map legend, are documented to depict the nature of the city's neighbourhoods and to show which programs and services are in place to pair with the proposal's interventions. For example, a component could be paired with an existing school or recreational facility, or an existing public water fountain could be retro-fitted to provide greater capacity and services to its neighbourhood (ex. Combination C, p.107-112, and Combination D, p.115-120, respectively).

The mappings show that the amenities are concentrated in both zone D, Pétion-Ville, where the inhabitants can afford them, and in Zone C, the downtown district that lies at the heart of all educational institutions in the country, and from where the city developed.

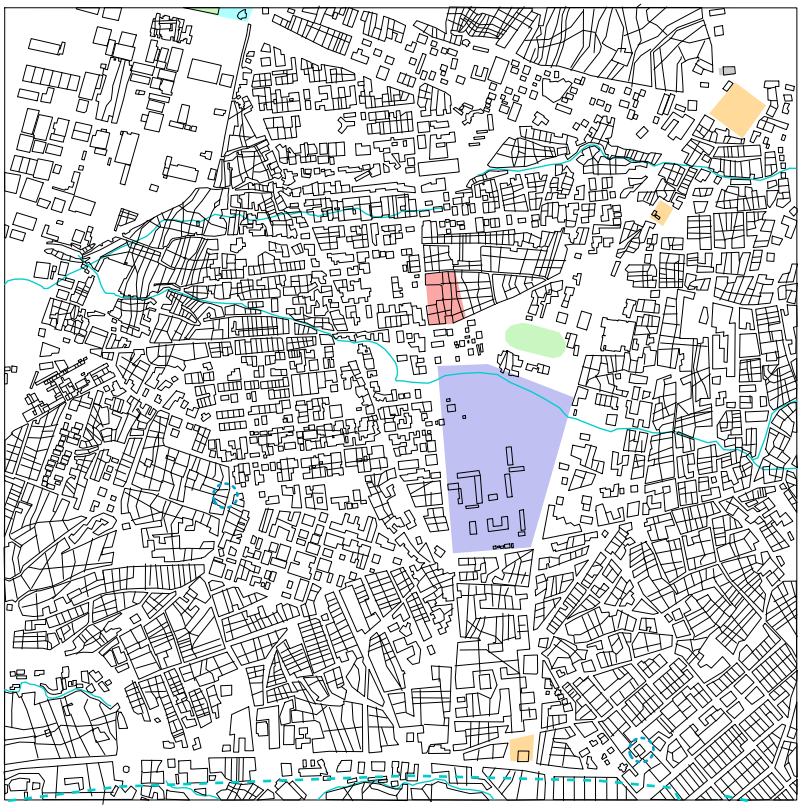
More underserviced districts, such as Cité Soleil and Delmas, would be the first targets of intervention due to their greater need, and the infrastructure and services that are existing would determine what is proposed and how it could be designed to work in conjunction with the existing conditions. Different neighbourhoods prioritize different infrastructures given what is already in place to meet the inhabitants' needs. Furthermore, the extent to which the existing fabric is developed, dense or difficult to penetrate would determine what type of system is proposed.





A

Figure 4.12 : Amenities per 5 km²: Cité Soleil Informal Settlement
1 : 20,000



B

Figure 4.13 : Amenities per 5 km²: Delmas Working-class Neighbourhood
1 : 20,000

- Public Water Fountain
- Water Reservoir
- Canal
- Water Service Line
- Athletic Field / Recreational Facility
- Cemetery
- Commercial & Industrial
- Cultural / Entertainment
- Diplomatic Facilities
- Government
- Hospital
- Hotel
- Place of Worship
- School
- Utilities

CITE SOLEIL

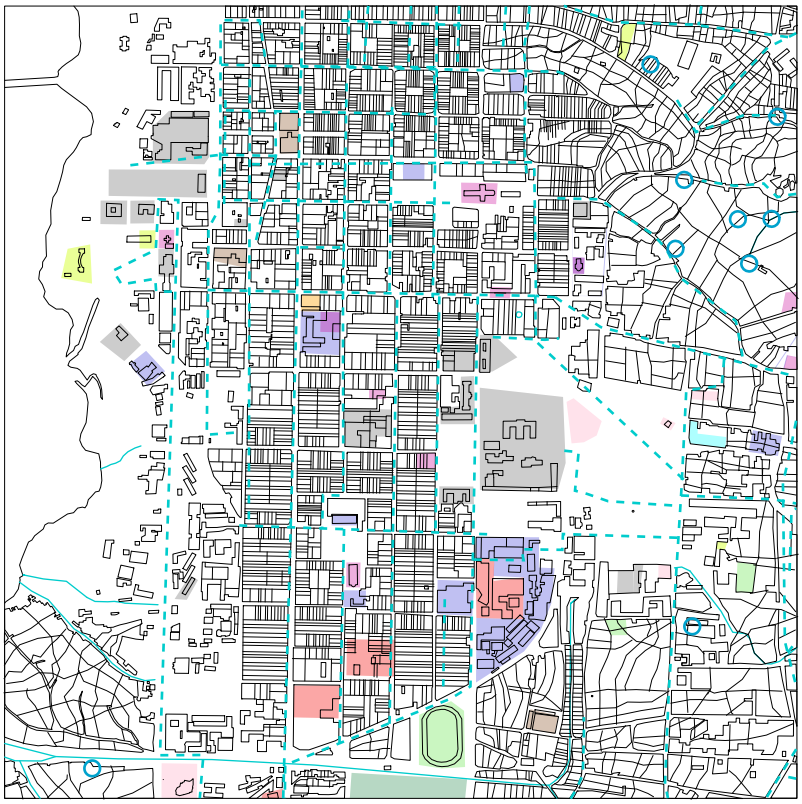
Cité Soleil, deemed the most deprived and largest slum in the Western Hemisphere[131] and one of its most dangerous areas,[132] is a district of Haiti's capital that is notoriously riddled with issues. The area began as a housing district for an adjacent industrial complex, and has grown to house approximately 300,000 inhabitants, most of whom live in extreme poverty.[133] The district is located on the Bay of Port-au-Prince's coastline and is thus prone to frequent flooding. Additionally, as the city's ravines and canals all travel downhill (north-west) to empty into the bay, the waste and excrement discarded in the ravines accumulates increasingly as it reaches the bay, and thus piles up at the end of their path in Cité Soleil. Limited formal infrastructure exists, as is the case in all of Port-au-Prince, which has no stormwater or sewage network, but relies on the open canal system to serve these purposes.

There are few amenities in the district, as shown in the mapping, namely an industrial park, private car race track and athletic club. Few formal businesses, but many independent commercial activities exist,[134] and electricity is intermittent and free, tapped from an outside source. Since the earthquake, violence escalated in the area, which is already run by gangs, when Port-au-Prince's main prison broke open and 4,000 prisoners escaped, many of whom returned home to Cité Soleil.[135] The presence of the Haitian Police or the United National Stabilization Mission (MUNISTAH) in Cité Soleil has been very limited due to the difficulty of controlling armed gangs, who do not allow authorities to enter the area.[136]

DELMAS

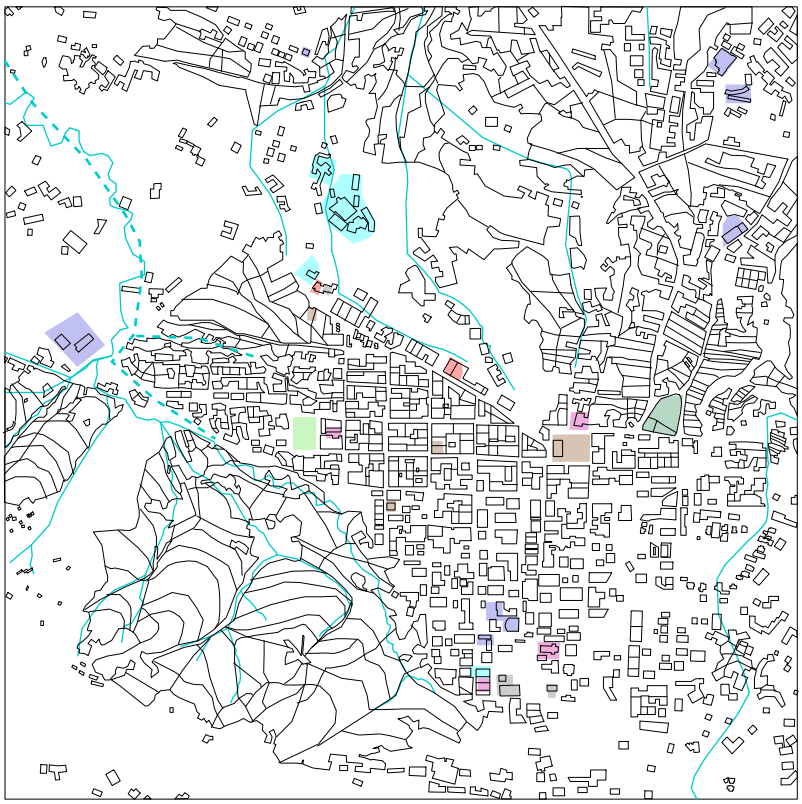
Delmas is an expansive working-class Port-au-Prince neighbourhood that developed north of the original city, and is now the location of much of the area's commercial and industrial enterprise.[137] Delmas is home to a wide economic range of residences and businesses, and many of its inhabitants commute to other parts of the city to earn a living.

The area is not located in an area particularly affected by flooding, but it does experience flooding issues along with the rest of the city where a road serves as the path where stormwater runs, in lieu of a ravine or canal. In the 5 km^2 swatch of Delmas mapped here, there are two schools, a paediatric hospital, two utilities substations, and a police office.



C

Figure 4.14 : Amenities per 5 km² : Downtown Waterfront
1 : 20,000



D

Figure 4.15 : Amenities per 5 km² : Pétion-Ville Upper-Class Business & Residential Area
1 : 20,000

- Public Water Fountain
- Water Reservoir
- Canal
- Water Service Line
- Athletic Field / Recreational Facility
- Cemetery
- Commercial & Industrial
- Cultural / Entertainment
- Diplomatic Facilities
- Government
- Hospital
- Hotel
- Place of Worship
- School
- Utilities

DOWNTOWN

The downtown district of Port-au-Prince is the educational, political, and healthcare hub of the city, home to the majority of the schools, hospitals and government buildings in Port-au-Prince. It also contains the city's only museums and uncharacteristically manicured, grandiose parks ornamented with sculptures that surround the presidential palace.

The downtown district was one of the most damaged areas of Port-au-Prince. It is also the only part of the city in which multi-storey buildings are commonplace. As education facilities are clustered in and around downtown, particularly the post-secondary programs, more than 80% of Port-au-Prince's school buildings were destroyed in the 2010 earthquake, and the system of higher education was virtually obliterated (87% of higher education buildings were damaged or destroyed).[138]

Due to its waterfront location, the area is at risk of periodic flooding from the bay as well as isolated flooding from canals or ravines overwhelmed with refuse. The waterfront along the downtown's western edge is largely inaccessible to the public. The port, located here, fuels the city, bringing in a large portion of Haiti's annual $3.28 BN of imports and earning a living off of taxing goods.

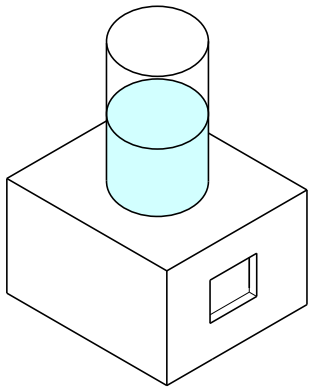
PETION-VILLE

Pétion-Ville is the most refined and developed district of the city. Quite a number of schools, as well as high-class entertainment facilities exist here, such as hotels (that offer entertainment, event and recreational spaces frequented by locals), bars and restaurants that cater to the elite. The residents are typically wealthy business people, professionals, politicians, and, particularly of late, foreign NGO workers.

Pétion-Ville lies in the mountains away from the bay and therefore isn't plagued by flooding issues, and it boasts the most sophisticated infrastructural systems for their buildings, although these are private and piecemeal, merely paid for by individuals who can afford them.

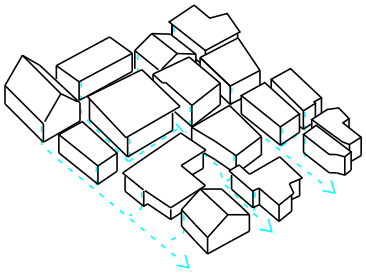
The district has fared well following the earthquake because it is less dense than other areas, which provided space for debris removal and repair. More importantly, the demographic brought owners who built better-constructed structures in the first place, and who could provide financial backing to get re-development moving.

A VILLA ROSA
NETWORK OF COMPONENTS



1 Water Tower and Filtration

+



2 Rooftop Rainwater Harvesting Network

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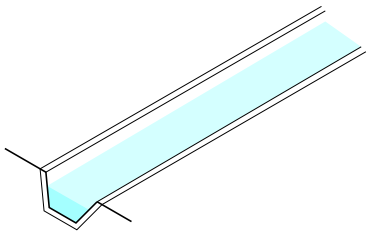
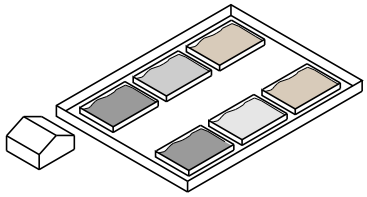


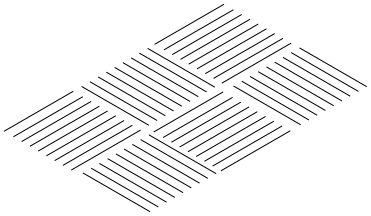
3 Canal

+



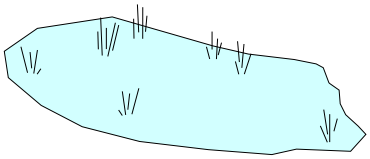
4 Waste Processing Facility

Figure 4.16 : Components and Programs paired in Combination A



6 Agricultural Plots

+



7 Reed Bed

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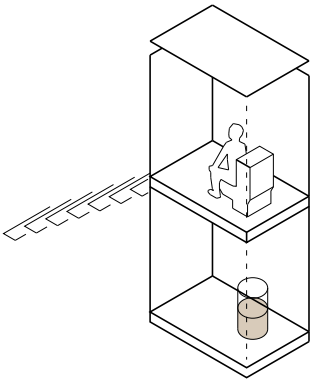

8 Dry Composting Toilet (a.k.a.
UDT: Urine Diverting Toilet)

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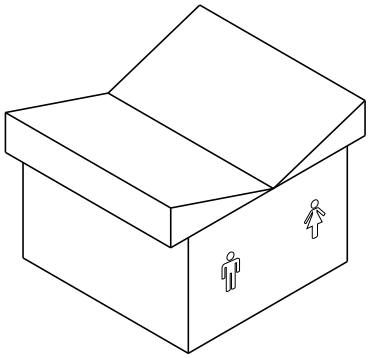
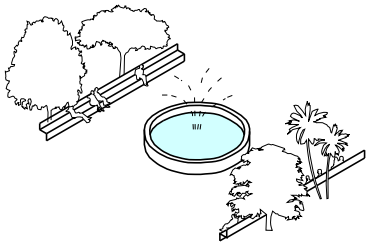


9 Community Washrooms

+



F Public Park

A VILLA ROSA
NETWORK OF COMPONENTS

Fig. 4.17 : Villa Rosa Hillside of Residences

Fig. 4.18 : Villa Rosa Context within Port-au-Prince

PROPOSED WASTE ECONOMY

The first combination is a network of components designed to serve the infrastructural needs of a neighbourhood in Port-au-Prince. In the developed world, infrastructure is treated as large-scale, independent systems that require heavy maintenance and capital to keep working. That is simply not an affordable, suitable option for Port-au-Prince, as evidenced by their attempts at these kinds of systems (ex. the municipal household water lines that connect to a portion of the city provide water unreliably and insufficiently). In contrast, the infrastructural systems that do function in Port-au-Prince are composed of a variety of piecemeal components scattered across the city that form a network of provision. The issue with these is that they are often unsanitary (ex. waterways), are not necessarily reliable (ex. municipal water lines; electricity), and not all can afford them (ex. potable water).

Canadian Landscape Architect, Bélanger, writes, “in a dramatic reversal of the 20th century Fordist dogma, typically linear, specialized, standardized nodes of production are being overturned by emerging infrastructures that are networked, flexible and recursive.” The proposal is a piecemeal assemblage of infrastructural components that operate in tandem and use each other’s waste for fodder, creating an infrastructural ecosystem founded in a waste economy. The recycling of wastes, paired with the fact that each component is an independent productive business is what makes the self-sustainability of the proposal viable.

The proposal, when realized as a network, becomes an inter-dependant ecology. Rainwater is collected, filtered and recycled along with ravine water; wastes are collected, processed and used to produce new goods (metal goods, compost) or sold for reuse (plastics) at a profit. Working in tandem, the components become a comprehensive infrastructural network. The kit of parts is not composed of self-contained, automated pieces, but they become key elements in the city fabric; they are places of business, work, exchange, processing, socialization and production. Each component generates a new micro-economy and radius of influence.

CONTEXT

The network of components is designed for Villa Rosa, an underserviced, informal settlement located in the mountains on the southern edge of Port-au-Prince. The site was chosen as a slum pilot project as it contains high numbers of inhabitants who would benefit from additional service provision. It is also a prime candidate as it is located on the pinnacle of the mountainside, and therefore has no water flowing in from an upstream district, which would carry with it wastes and pollutants. This means that it is an ideal location for waterway remediation, as no upstream wastes would flow into the canals and contaminate remediation work already done. The settlement is a well-connected community of approximately 8,200 people, with an average household size of 5.5 members, each of which are primarily male-dominated (68%).

Villa Rosa is a dense, impoverished neighbourhood composed primarily of concrete masonry houses with corrugated metal roofs that follow the natural contours of the hill with narrow vertical

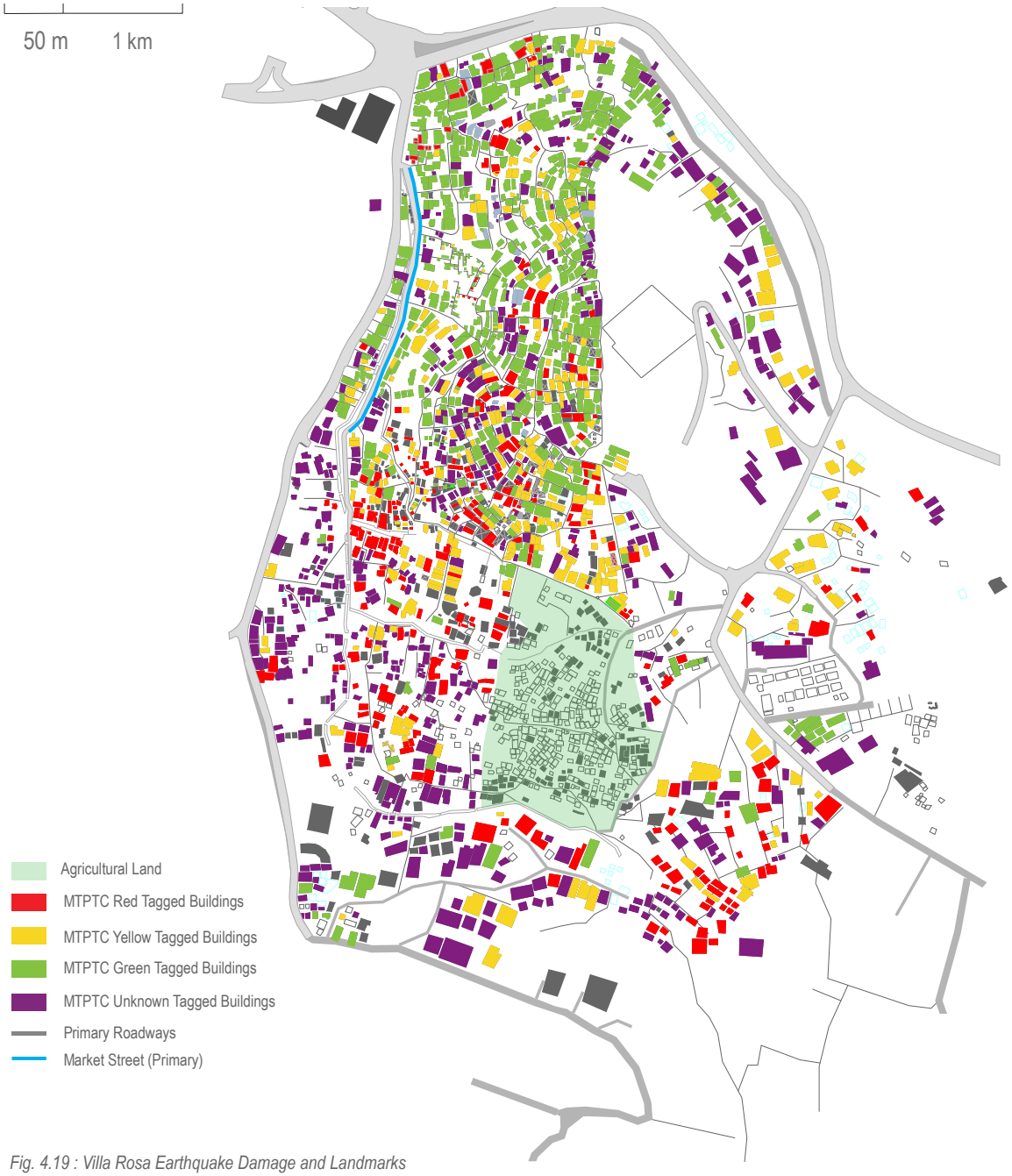


Fig. 4.19 : Villa Rosa Earthquake Damage and Landmarks

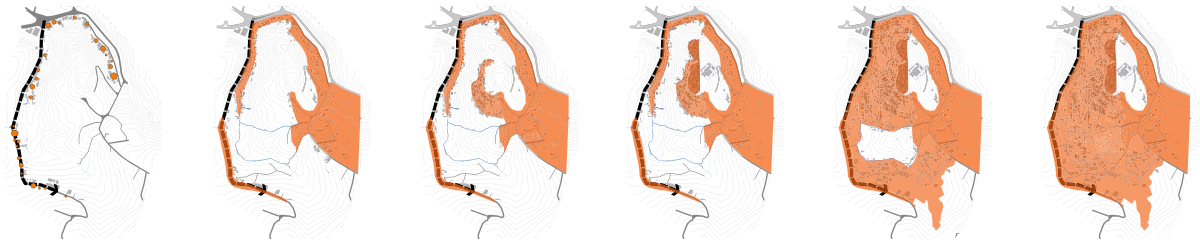


Fig. 4.20 : Villa Rosa Neighbourhood's Growth

stairways cutting up the hill and horizontal pathways providing access along the ridges. These paths and stairwells become rivers during storms, creating flooding and erosion issues, contributing to the marginality and instability of the community. The pathways determine the proposal's location of access points and manner of transport, as most of the site is inaccessible by vehicle.

President "Baby Doc" Duvalier's regime had been supressing the pressure of urban migration to Port-au-Prince, but with his fall in 1986, in the following period of political instability, the city's population exploded without any government oversight. Informal settlements appeared in the space of a few years throughout the city, including Villa Rosa. The three original families that lived in the Villa Rosa area began to sell their plots without issuing of title deeds (90% people living at villa-Rosa do not have legal land title papers), and the area has developed over the past 30 years with no or very limited planning. This, paired with the widespread destruction caused by the 2010 earthquake, creates opportunity for planned, large-scale re-development, which the design proposal takes advantage of. The extensive lack of land tenure makes securing land ownership a primary issue to address before development.

"The community possesses many resources within its borders, such as dispensaries, schools, churches, cybercafés, and markets. In addition, the active network of community organizations is itself a powerful asset for the development of the area." Villa Rosa's community organizations are vital to investigate and connect with for the management of these proposals. Existing community groups and businesses would be the ones chosen to receive, own and operate the proposals, which are donated.

Villa Rosa's venues for cultural activities include a cock fighting ring, a small movie theatre, protestant churches, a small public space for gatherings, a basketball court used for basketball and soccer, and, dominos and cards, the most common recreational pastimes, are played throughout the district. Some of the venues for these activities have suffered earthquake damage. These are the types of recreational programs that would best be incorporated into development proposals to pair with infrastructural components. Furthermore, there are three primary schools in the neighbourhood, but as all have been damaged or destroyed, their redevelopment can be leveraged in proposals. Education has become much more widespread in the neighbourhood over the past 20 years in a country where 46% of urban Haitians attend school. These programs are of interest to develop in the community. In addition to collaborating with the neighbourhood's important existing programs, the proposals should cater to the inhabitants' careers to best utilize their skills; the most common occupations are in commerce (48%), masonry (12%), driving (6%), plumbing (3%), electrical work (2%), carpentry (1%) and art (1%). Commerce involves the exchange and sale of goods, primarily located in the bustling informal markets of the main market street.

"Villa Rosa's location offers great economic opportunities and provides links with other regional economic centers. Looking at the rich assortment of community assets within a short radius of Villa Rosa, it becomes clear that the barriers to access to healthcare and education are economic, not geographical." As a result, a critical part of the proposal design is job and income generation and reduced costs of service provision.

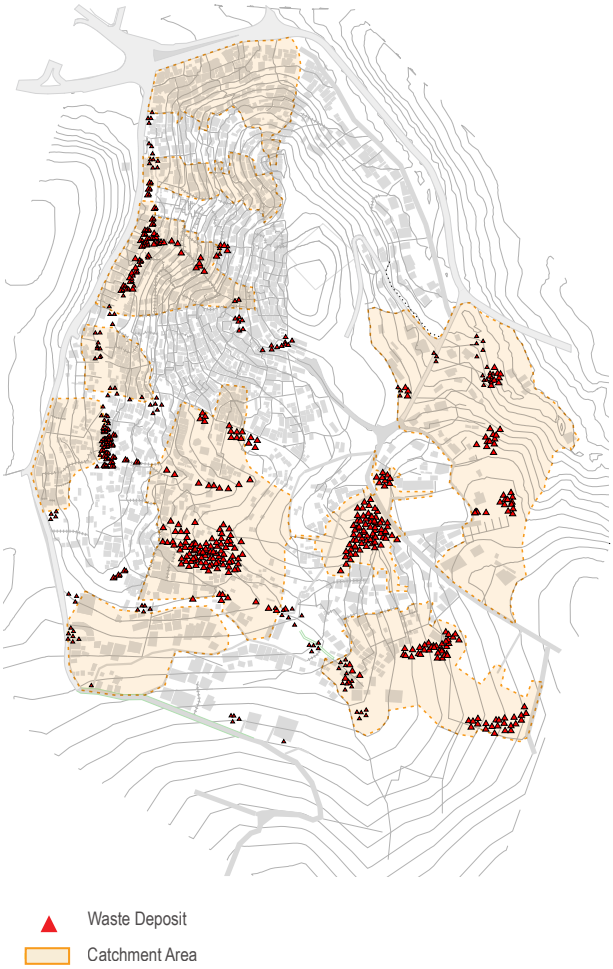


Fig. 4.21 : Map of Waste Accumulation Locations

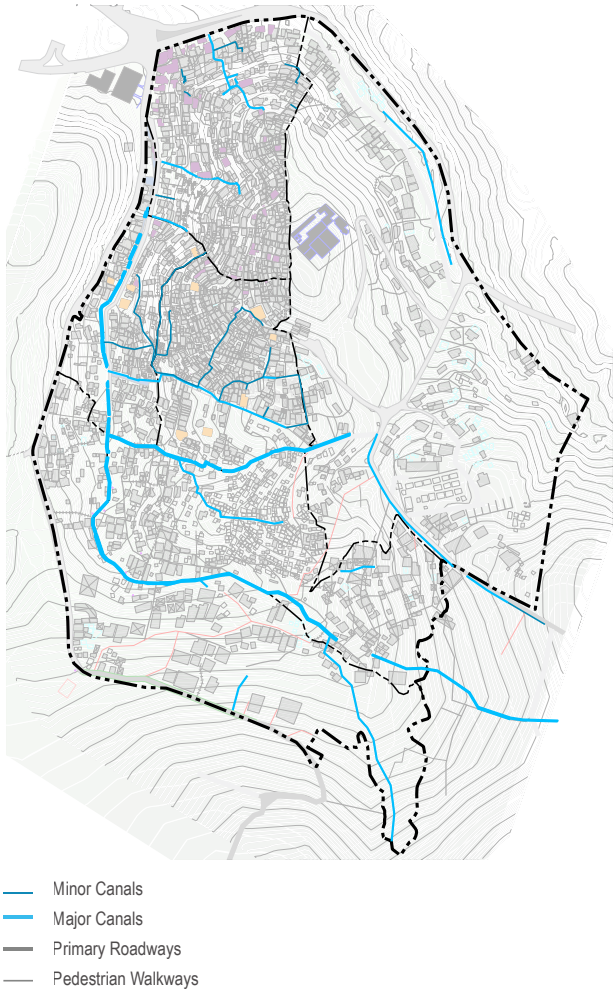


Fig. 4.22 : Map of Waterways and Pathways

EXISTING INFRASTRUCTURE

Waste collection and water supply in Villa Rosa are, as ever, sparse and unreliable, and follow the city's typical means of provision, as documented in chapter three. A number of NGOs have worked in the district since 1998 to improve infrastructure and housing, which has improved the community's quality of living and made them familiar with non-profit development work. Lisa McFadin, founder of a prominent recycling program in Port-au-Prince, HEAR Haiti, has been in discussion with numerous neighbourhoods in the city, including Villa Rosa, about proposing waste initiatives. McFadin says that Villa Rosa is the most progressive neighbourhood she has seen in terms of accepting new, unfamiliar means of waste collection and sorting. The neighbourhood's understanding of non-profits, and their openness to change and participation makes them an ideal group to work with.

Some stormwater management, latrine, public tap and pathway improvements were provided in 1998 by the French NGO, GRET, together with the Haitian NGO, COGEVIR. Later, in 2010, a piped water supply system was constructed by GRET, who assisted in the formation of water committees. This system was damaged by the earthquake but is now functioning again; the cost is one gourdes per bucket ($0.02 USD). From 2010 to 2012, the Dutch NGO, Cordaid, together with the NGO, Build Change, has committed to retrofit all damaged residences and rebuild all destroyed homes within the project boundary. From 2011 to 2012, American NGO, Architecture for Humanity, also constructed several improved pathways and provided street lighting.

There is no solid waste collection and disposal system as the area cannot be accessed by truck. Waste is instead primarily thrown in or near waterways, and some is collected in waste containers located at the Canepé Vert market. The majority of families have a pit latrine in or next to their homes, but health standards are poor, and those without access to a latrine defecate in bags indoors. Providing improved sanitation would be desirable, especially within or near public facilities.

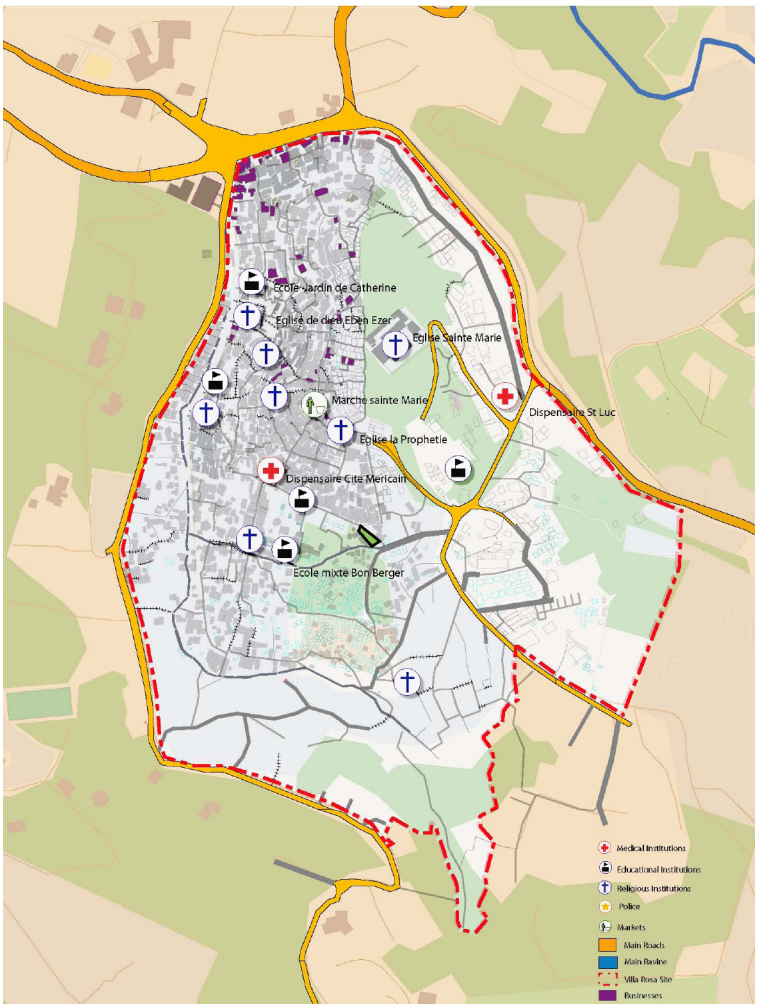


Fig. 4.23 : Amenities and Facilities within Villa Rosa

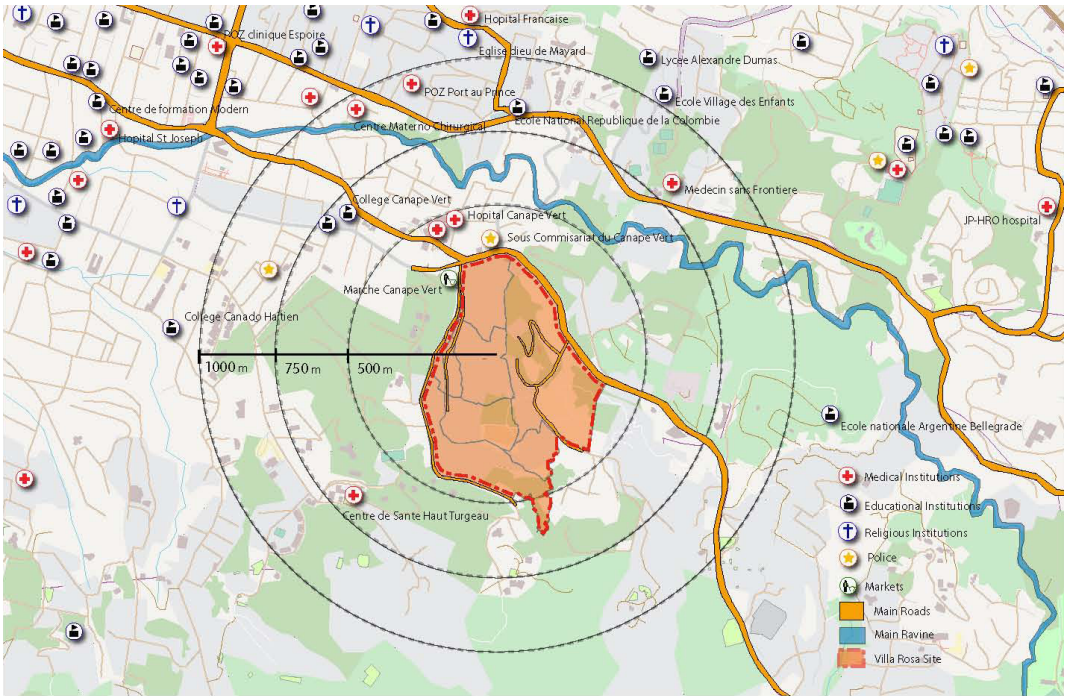


Fig. 4.24 : Amenities and Facilities adjacent to Villa Rosa

PROPOSAL

The proposal for Villa Rosa is a network of infrastructural components that are strategically inserted into the neighbourhood and paired with complimentary programs. As with all of the proposals, the components are tied to another program that serves as the owner and manager, and provides a body of customers to fuel the component. For example, the community toilets and showers are connected to a public park and waste drop-off centre, and the water filtration towers are tied to a neighbourhood network of rooftop rainwater collection, filtration and re-sale.

Villa Rosa contains a cluster of open spaces that were rented out for agricultural use prior to the earthquake, but have since been taken over by the tents of residents whose homes were damaged or destroyed. The proposal returns the land to its former agricultural use (which is the owner's intention) to produce food that can be sold in local markets. The diagrams on the following pages describe the function and interrelation of the proposals.

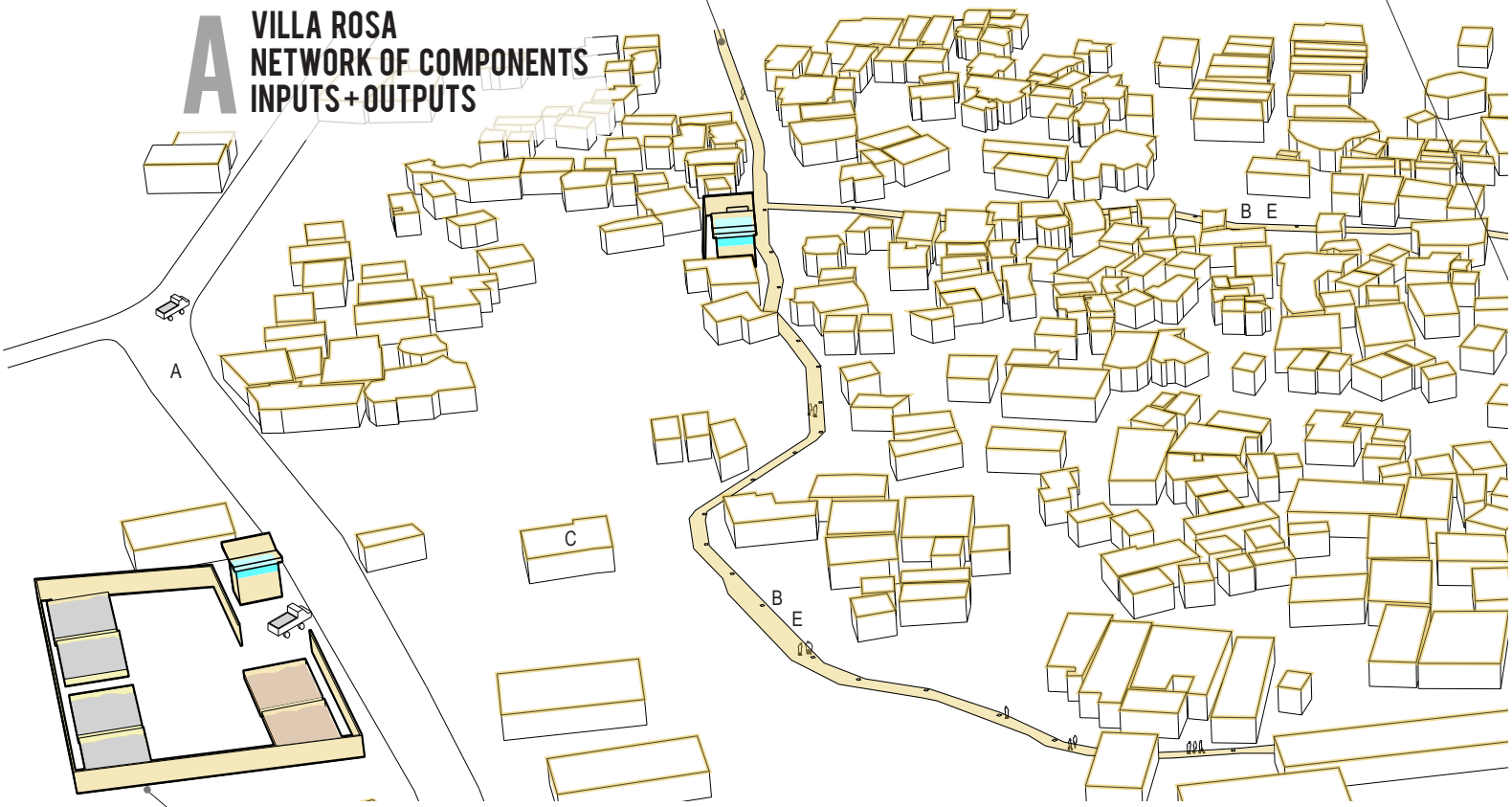
RAVINE ENCLOSURE + FILTRATION

The open ravines have been enclosed for sanitation purposes, as solid, organic and human waste are either directly or indirectly discarded into them and are a source of disease and water pollution. The channelized ravine feeds into the water filtration system, described below, and empties into periodic marshes along the path for phytoremediation purposes.

WATER FILTRATION TOWERS

The neighbourhood's rooftops have been retrofitted with gutters which feed into the water filtration tower system. Half of the rooftop rainwater is kept for individual household use, while the other half enters the system, along with the ravine water to be filtered and returned to homes for potable and non-potable water needs, respectively. Villa Rosa is a prime candidate for this system due to their mountain peak location as no polluted water is flowing into the area from upstream.

A VILLA ROSA NETWORK OF COMPONENTS INPUTS+OUTPUTS



WASTE PROCESSING FACILITY

A waste processing facility is established outside of the city (for sanitation, audio and olfactory reasons) for the processing of human waste (into compost), and the storage of recyclables and solid waste. The district's waste collection locations deposit their waste here until enough accumulates to be transported to a dumping ground (solid waste) or processing facility (recyclables). The site is currently vacant and lies just outside the boundary of the Villa Rosa neighbourhood.

A Main vehicular road

B Secondary pathway

C Retrofit: install gutters on existing buildings and pool the community's rainwater resources into the water filtration towers located throughout the neighbourhood. The system is gravity-fed as much as possible and a pump moves the water into the tower after filtration for storage. Residents keep half of the rainwater collected (avg. yield = 60,000 L / year = 66% of household needs) and the remainder enters the system.

D Public Park

E Ravine was previously open and had a narrow pathway on either side. It is now enclosed to prevent water contamination, the spread of disease and attraction of vermin. The water is released from the channel into periodic marches for phytoremediation as well as enters the network of water filtration towers for further filtration and use in sinks, showers, washhouses, and for irrigation.

F Bamboo treadle (foot) pumps are used by gardeners to pump water to the surface for irrigation.

G Water cistern holds water for daily irrigation of the gardens and bi-weekly park irrigation. The water is supplied by aquifers, where possible and water filtration towers, or else purchased from a water truck and manually pumped to the surface for use.

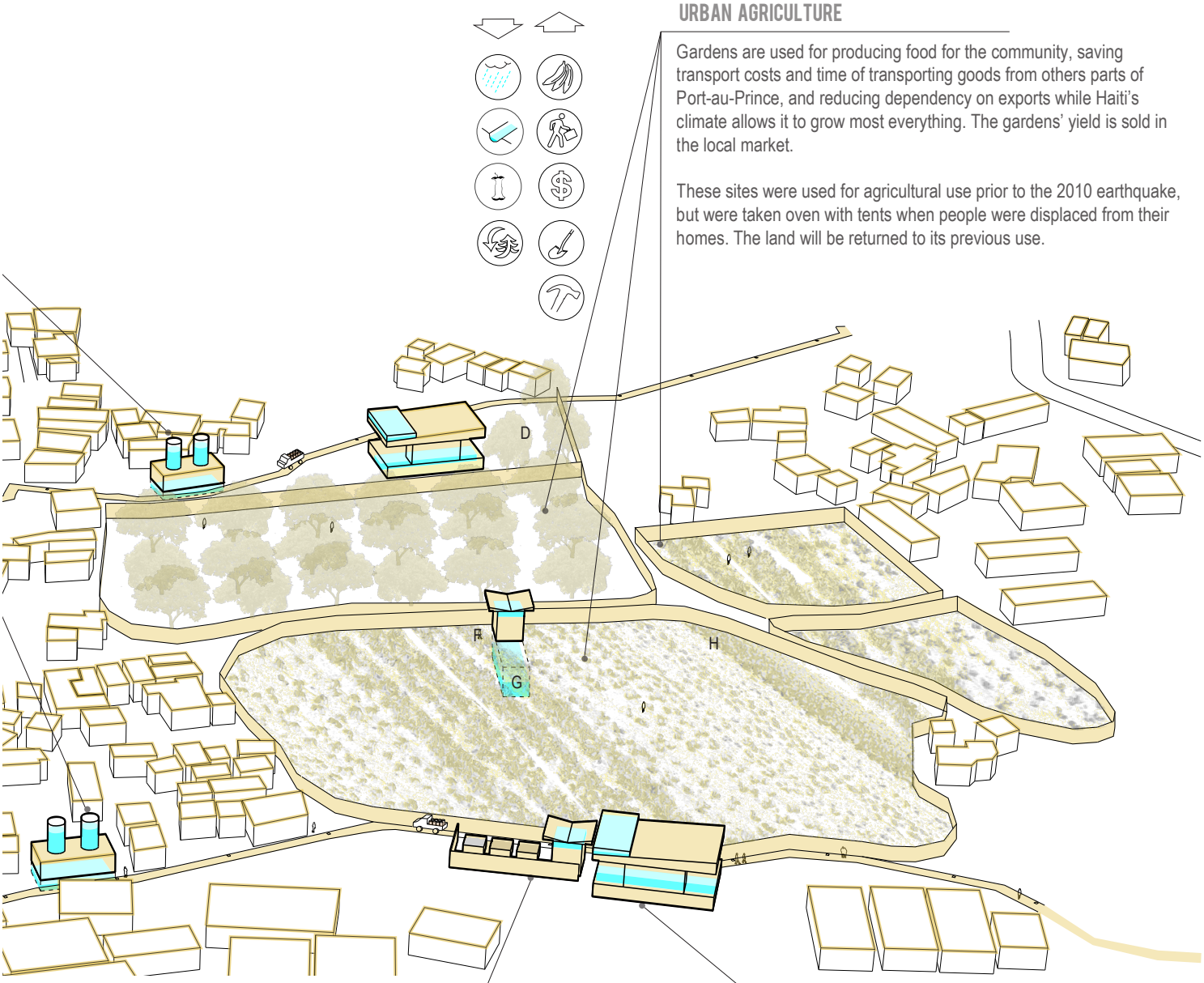
H Gardens are fenced off for the security of the crops. Only garden workers have access.

Fig. 4.25 : Inputs and Outputs in Villa Rosa Neighbourhood Proposal

URBAN AGRICULTURE

Gardens are used for producing food for the community, saving transport costs and time of transporting goods from others parts of Port-au-Prince, and reducing dependency on exports while Haiti's climate allows it to grow most everything. The gardens' yield is sold in the local market.

These sites were used for agricultural use prior to the 2010 earthquake, but were taken oven with tents when people were displaced from their homes. The land will be returned to its previous use.



URBAN WASTE COLLECTION FACILITY

(1) Individuals and businesses deliver sorted household waste and recyclables to bins that are conveniently located along pathways and receive vouchers for local businesses in return.
(2) Waste kiosk worker weighs and records weight of recyclables received and pays customer accordingly.
(3) Staff transport wastes to waste-processing facility outside of town.

COMMUNITY TOILETS + SHOWERS

Community washrooms are provided for the neighbourhood's use, as many homes do not have bathing facilities nor a toilet, but share them with others. This facility provides a safe, sanitary option that improves health and reduces human waste discarded in ravines and rubbish piles through the introduction of a composting toilet system. The human waste barrels are collected and trucked to the waste processing facility to be turned into compost for agricultural use.

The facility is owned and managed by it's adjacent program (a waste collection kiosk and public park, respectively). A minimal fee is charged per use to cover the building's maintenance and security.

A VILLA ROSA
NETWORK OF COMPONENTS
COMPONENT RELATIONSHIPS TO EACH OTHER AND NEIGHBOURHOOD

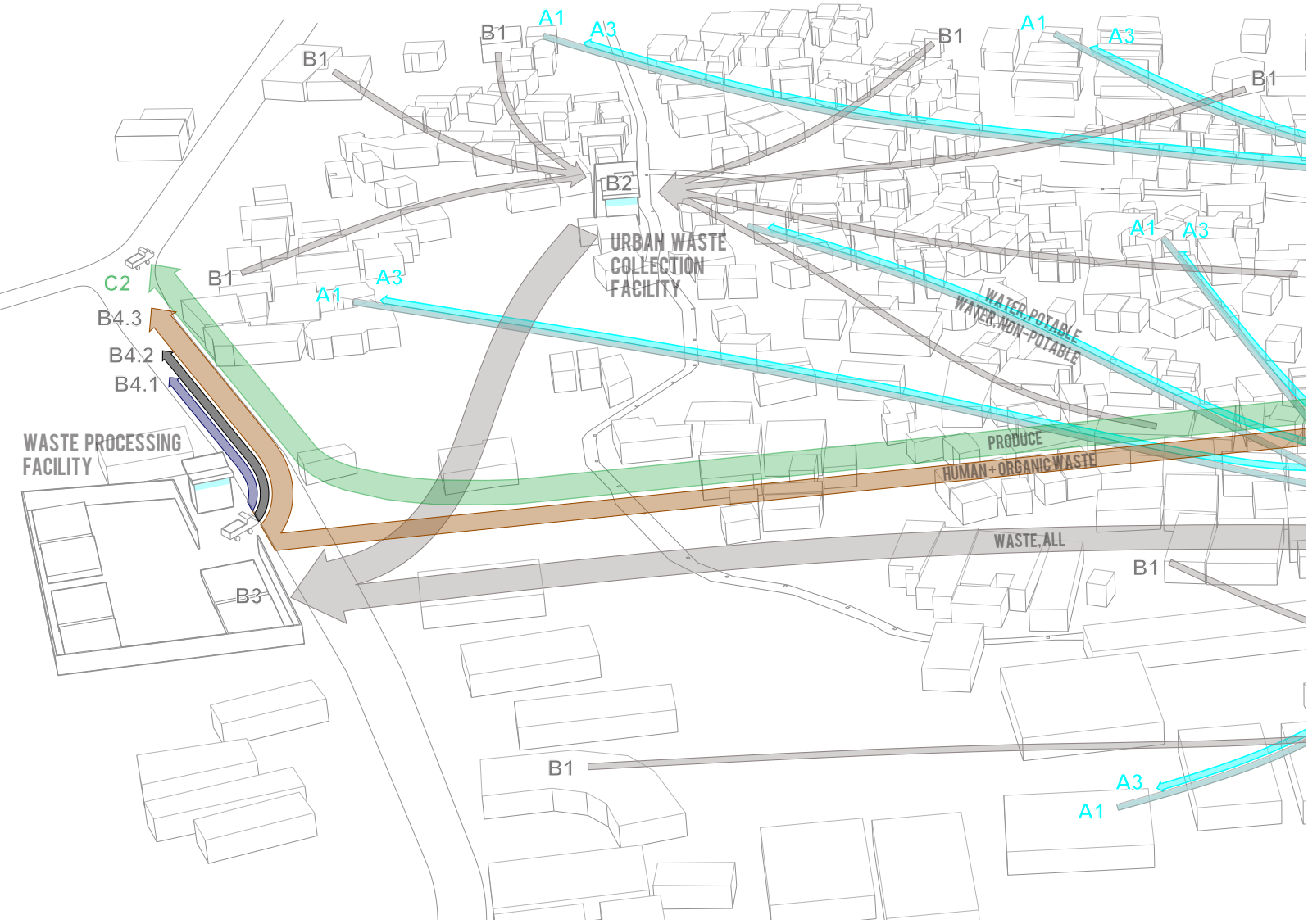
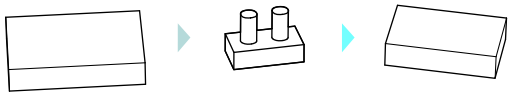


Fig. 4.26 : Network of Relationships between proposals for Villa Rosa Neighbourhood

PROCESS

WATER



A1

Water collected from rooftop (non-potable) and sent to water filtration tower

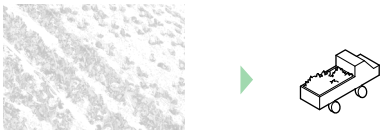
A2

Rooftop and Ravine water filtered

A3

Filtered, potable water sent back to homes for drinking use

PRODUCE

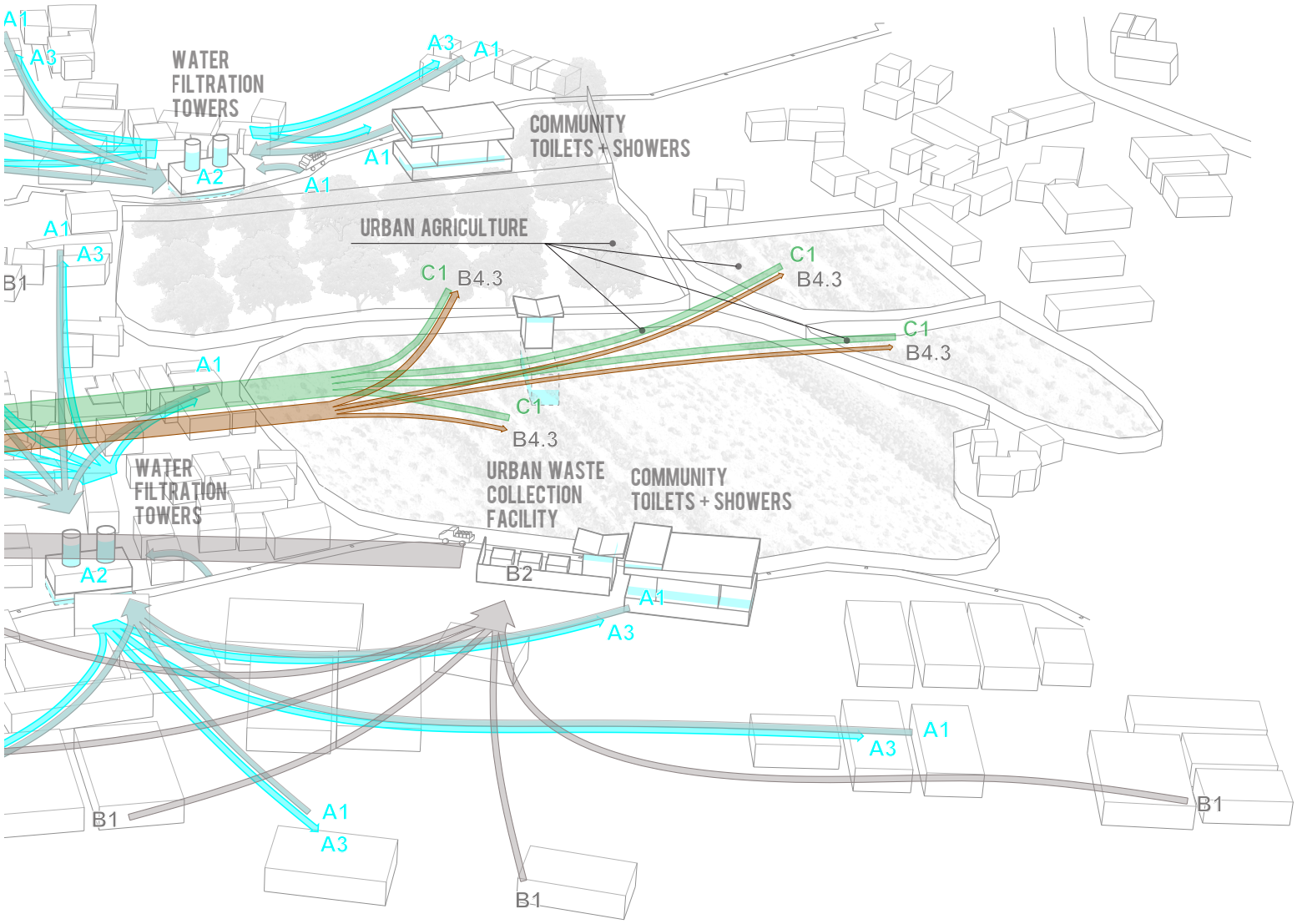


C1

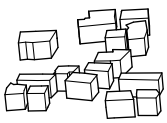
Produce collected from gardens

C2

Produce sold in local markets

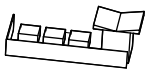


WASTE



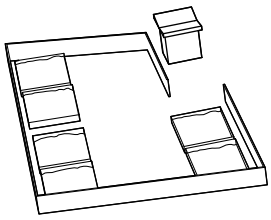
B1

Sorted household wastes delivered to Waste Collection Facility



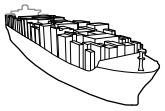
B2

Wastes stored for pick-up



B3

Waste Management staff deliver sorted wastes for processing



B4.1 Recyclables shipped for processing

B4.2 Solid waste to landfill

B4.3 Compost produced from human and organic waste bagged and sold in markets; used in agriculture

PRECEDENT : RECYCLING PROGRAM

H.E.A.R. HAITI (HAITIAN ENVIRONMENTAL ASSOCIATION OF RECYCLERS) THROUGHOUT PORT-AU-PRINCE

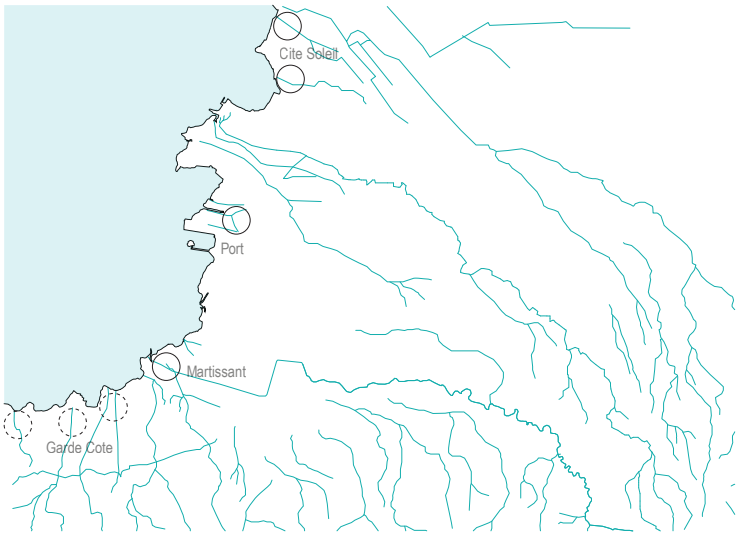


Figure 4.27 : Plastic Collection Locations

Figure 4.17

Figure 4.18

Figure 4.19

Figure 4.20

Figure 4.28 : Recyclables Collector

Figure 4.29 : Collector Transporting Plastics and cans to Pick-up Location

Figure 4.30 : Collected Material outside Plastic and cans Collection Kiosk. The collector earns $0.12 / lb of plastic, and $0.15 / lb of metal.

Figure 4.31 : Collected Materials are Compacted for Transport

Figure 4.32 : Once enough Recycled Material is Collected, it is Compacted and Trucked to the Port to be Shipped to China or the U.S.A. for Processing.

Figure 4.21

The recycling component of the proposed system of waste collection and processing presented in the following pages (Combination B, p. 97-104) is already occurring in Port-au-Prince at a smaller, piecemeal scale. There has been a flurry of interest in recycling since late 2011, and as of May 2012, there were about five different recycling groups operating in Haiti.[139] Ideally, says Lisa McFadin, head of a prominent recycling organization in Port-au-Prince, H.E.A.R. Haiti (Haitian Environmental Association of Recyclers), these groups would combine their efforts to pool resources and knowledge.[140] This is precisely the thesis design proposal.

In July 2012, the largest recycling project in Port-au-Prince to date was inaugurated by H.E.A.R. Haiti, in which eight groups in Martissant, a waterfront slum located at the convergence of the city's main canals (marked on the map on the opposite page) collect recyclables from their respective districts. The project, funded by USAID, is a pilot being undertaken with the hopes that it will be replicated across the country. Lisa McFadin is trying to integrate the recycling collection with Port-au-Prince's solid waste collector, S.M.C.R.S., to initiate a public-private partnership, which she says would be great for the field and for Haiti.[141] McFadin has already initiated the program for Martissant in Oakland, California, a rough district east of San Francisco, considered one of the most dangerous large cities in the U.S.[142]

The photographs, left, document the current system's collection and processing of recyclables. The collectors, who are individuals undertaking the job independently, earn 5 GRD / lb ($0.12 USD) for plastic, and 6.5 GRD / lb ($0.15 USD) of metal from the collection kiosk manager, upon delivery. The materials are compacted, and when enough for a load accumulates, they are trucked to the city's port to be shipped to China or the U.S.A. for processing.

The next step, says McFadin, is to bring recycling full circle by processing material within Haiti. Currently there is no public plastic refinement facility in the country, but only a couple very small private companies, and although facilities exist in the Dominican Republic, the trade relationship between the two countries is poor. McFadin says it would cost $1.5 million to develop a plastic refinement facility in Haiti.

At the time of writing, 200 lbs of plastic is collected in Port-au-Prince daily, and kiosk owners earn six times the minimum wage,[143] making this an exciting economic prospect. Lisa McFadin pointed out the importance of creating small pilot projects, as is the case in Martissant, and in another project she was working on the design of in Villa Rosa, another slum in Port-au-Prince, in order to prove the system can work. Once the authorities see that this can work at a smaller scale, they can be convinced to get behind a scaled-up version. This is the model that the thesis proposal follows; it is composed of community-scale collection and processing facilities, which can be replicated across the city and become a larger network over time.

HEAR Haiti's model is a financially viable business once it becomes operational. This is of the utmost importance in a context where sustainability is such an issue with aid-funded projects. Projects of any nature need to be able to sustain themselves once the start-up funding is spent, because, as has been seen in countless projects in the country, they fall apart unless (a) funding has been set aside for the project's continual operation and maintenance or (b) the project generates enough income to sustain itself. The latter is, of course, preferable, and what the thesis design proposes.

B WASTE PROCESSING FACILITY

Fig. 4.33 : Example of 5 - Typical Waste Disposal in the street, Tabarre, Port-au-Prince

Fig. 4.34 : Example of 4 - Bottle Collection pile for pick-up, Delmas, Port-au-Prince

Fig. 4.35 : Example of D - Typical Street Market, Pétion-Ville, Port-au-Prince

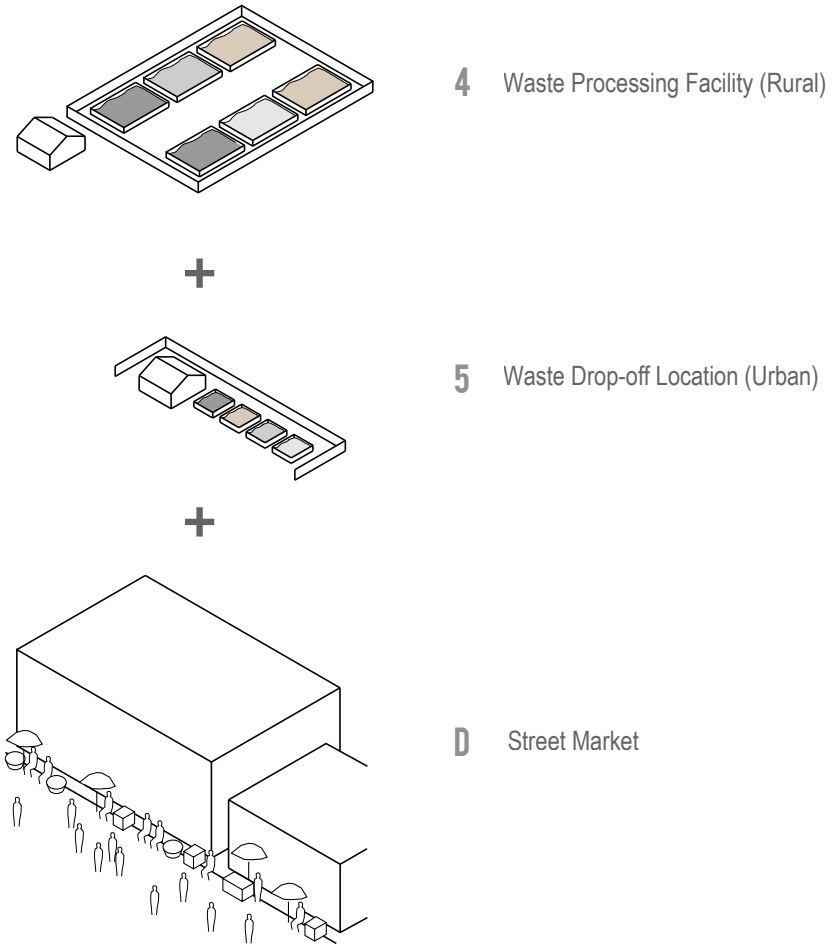


Figure 4.36 : Components and Programs paired in Combination B

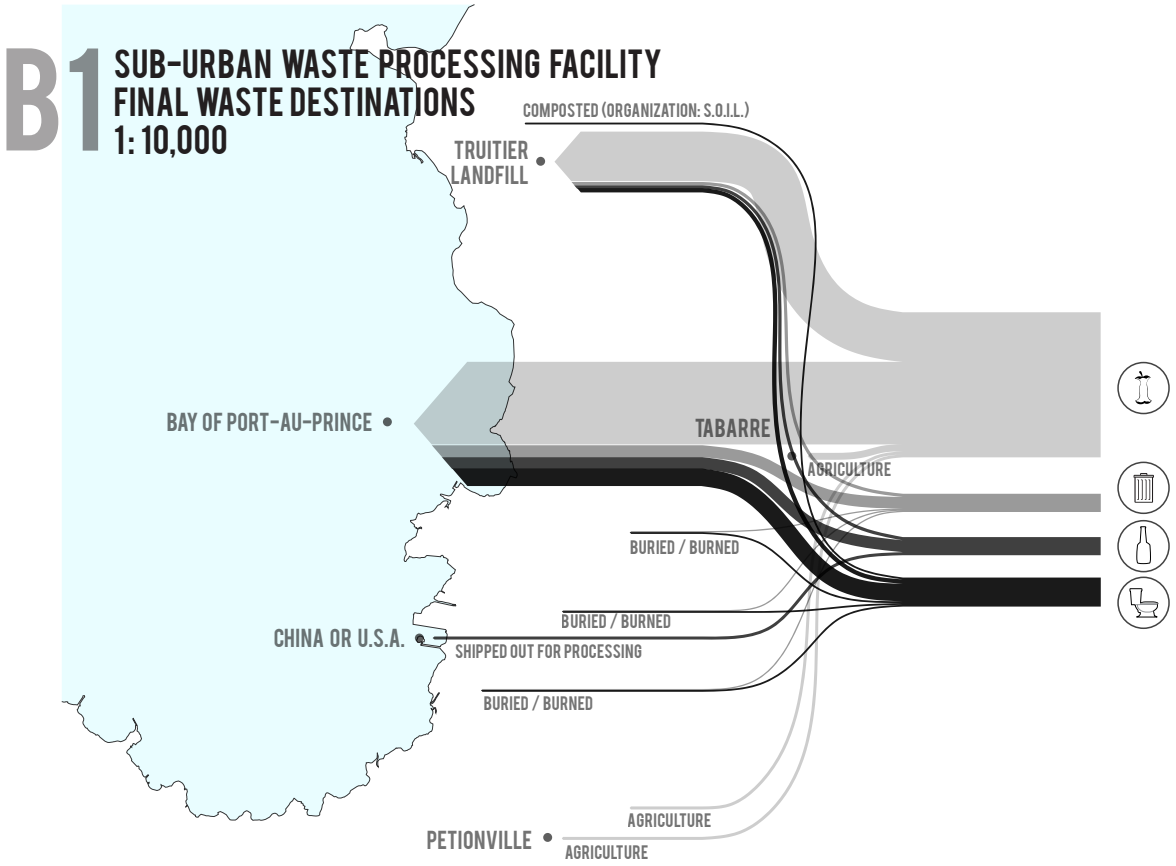


Figure 4.37 : Final Waste Destinations: Map of Existing Conditions

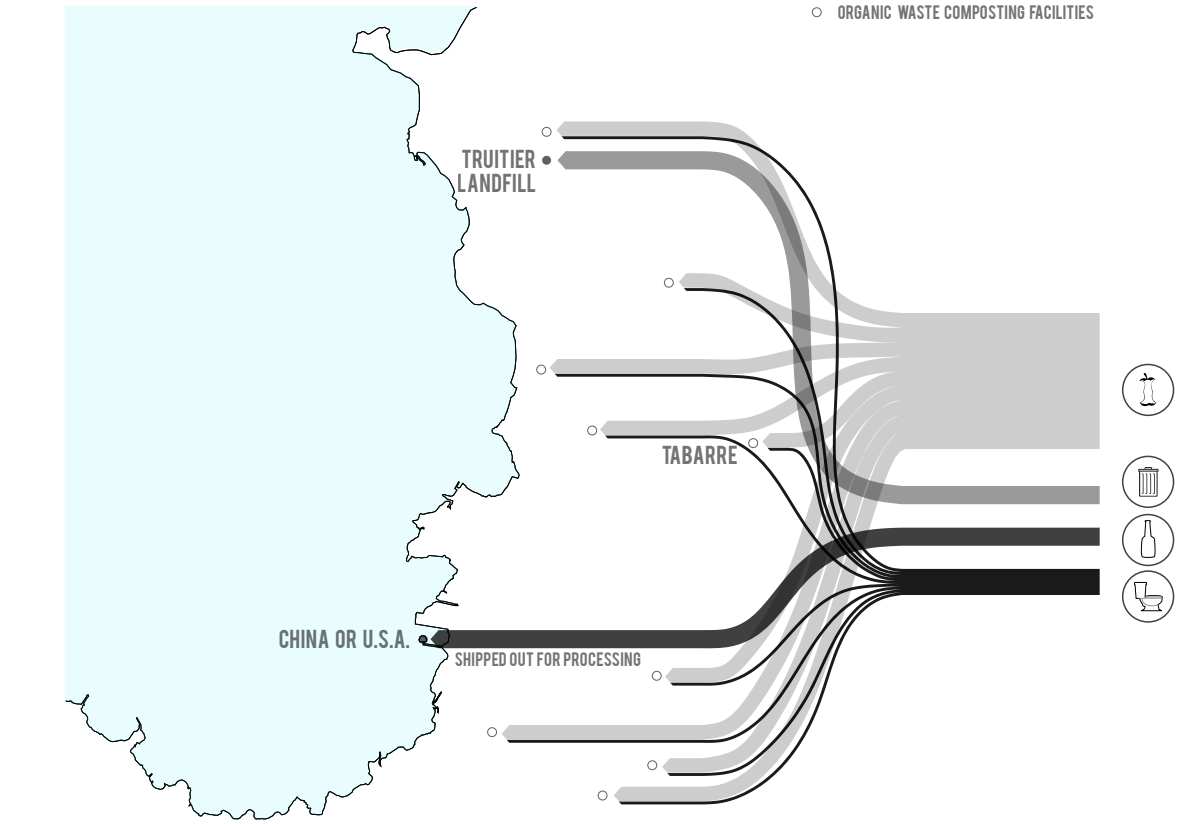


Figure 4.38 : Combination B1
Final Waste Destinations: Map of Proposed Network

The diagrams opposite depict the current destination of all wastes (organic, solid, recyclable and human) in Port-au-Prince (top), and the destinations resulting from Proposal B (bottom). Currently, the majority of wastes are cast into the street, ravines or canals, and ultimately end up in the Bay of Port-au-Prince, while the 20% of solid waste that the S.M.C.R.S. has the capacity to collect is deposited in Truitier landfill.[144] See documentation of solid waste disposal methods on pages 51-54.

PROJECT DESCRIPTION

The proposal is a series of decentralized waste facilities that are collection and processing centres for recyclables, organic and human waste, resulting in their diversion from the landfills and waterways.

* Note : Volumes of waste depicted in the diagrams on the opposite page are approximate. Accurate waste figures on recyclables, human waste and organic waste are not available.[145] However, it is documented that Port-au-Prince produces 4000 m^3 (1400-1600 tonnes) of solid waste per day,[146] S.M.C.R.S. and a small number of private collection companies pick up 300 m^3 of this 4000 m^3 of waste and deliver it to Truitier landfill,[147] and that approximately 75% of all waste produced is organic matter (food castoffs).[148] This last figure is very important; if the organic waste can be composted, three-quarters of the solid waste can be diverted from landfills and ravines.

HUMAN WASTE COMPOSTING CONTEXT

One of the first hurdles to processing human waste into compost is that it is not readily accepted by the general population as an acceptable means of disposing of waste, so they are averse to both the toilet and maintenance process, as well as the idea of using the compost for agricultural purposes.[149] When surveyed for their toilet preferences, Port-au-Princian "people will choose a pit latrine nine times out of ten,"[150] despite it being an unideal and problematic system (ex. contaminants leech in the water table; not sanitary, etc.) because they are familiar with it and know it works. Education is extremely important when initiating a new human waste management system[151] to facilitate the instruction of users on other, better, safer, and healthier options. Composting as a means of disposing of human waste is an effective solution to Port-au-Prince's waste problem. It diverts waste from waterways and landfills, produces a valuable product that generates a micro-economy, creates many jobs in its labour-intensivity, and because it operates as a composting collective, it follows a model Port-au-Princians are familiar with and effective at operating.[152]

Another challenge with composting human waste is that composting centres in urban areas present certain logistical issues. They take up a lot of space, require large setbacks, and attract vermin.[153] This is why the proposed waste processing facility is located outside of the city, and only small, frequently-serviced drop-off locations are proposed scattered throughout the city to provide more easily accessible disposal sites.

For any waste infrastructural project to happen on a large scale (i.e. more than 500 users), it must be accepted by DINEPA,[154] the regulatory government body of drinking water and sanitation (Direction Nationale de l'Eau Potable et de l'Assainissement). DINEPA is upset with and not open to composting in the city because many projects have failed, says Lisa Smyth, Sanitation Consultant working in Port-au-Prince.[155] "DINEPA recognizes that composting is a good answer;"[156] to the human waste issue and it is a logical and sustainable solution to the problem for Port-au-Prince. For this reason, Smyth says, DINEPA is slowly moving toward acknowledging human waste composting and working with composting organizations (ex. SOIL, GiveLove), and "they will slowly come on board."[157]

B1 SUB-URBAN WASTE PROCESSING FACILITY
OVERALL SCHEME
1:300

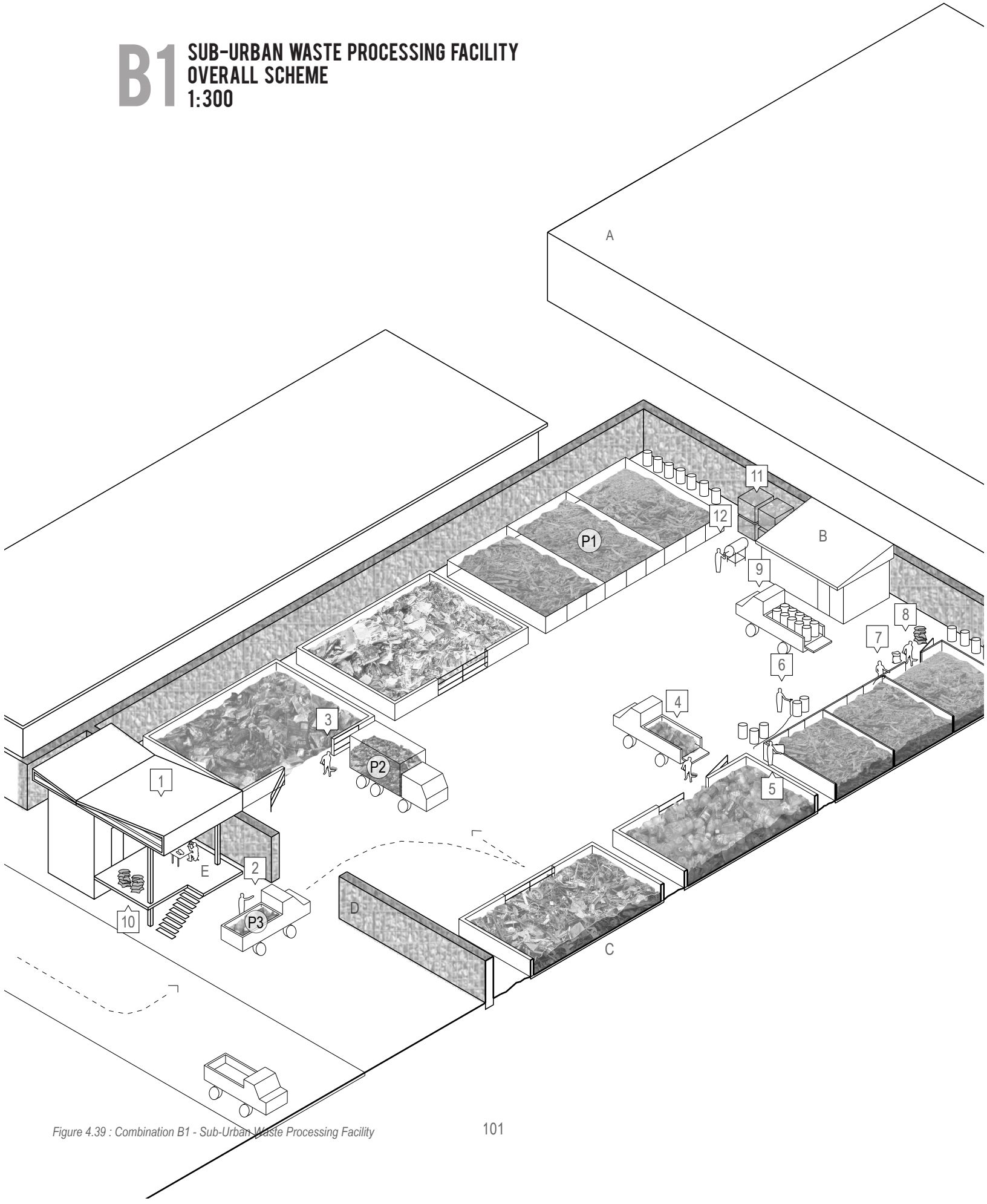


Figure 4.39 : Combination B1 - Sub-Urban Waste Processing Facility

PROJECT DESCRIPTION

This facility is a one-stop drop-off location for sorted waste in sub-urban or rural locations. Customers receive vouchers for local businesses in exchange for the delivery of their sorted recyclables (metals, plastics), household (garbage) and organic waste (food scraps and human waste). The wastes are processed and / or sorted until they are ready to be picked up by another company to be delivered to their final destination.

Currently, approximately 20% of waste is collected by the municipality, SMCRS, the remainder that is picked up is done by private companies, and the rest is discarded in a street or waterway. By providing incentive to properly dispose of waste and recyclables, this unhealthy pattern of waste and lack of responsibility can be broken.

This proposal is a busy hub in which vehicles from the city dropping off and picking up waste constantly flow in and out of. Piles of wastes around the city would begin to diminish as collectors sort through them for their valuable recyclables, and homeowners and businesses begin sorting wastes themselves and delivering them to the facility for processing and disposal. It generates new economies, jobs and business relationships.

PROCESS STAGE

1 Waste Kiosk (contains office and washroom).

2 Drop-off: Private truck delivers sorted waste. Waste kiosk manager assesses load, pays customer, and directs them inside, where staff empty vehicle's contents into bin.

3 Pick-up: garbage is picked up by S.M.C.R.S. (The Department of Metropolitan Solid Waste Collection) truck and delivered to Port-au-Prince's landfill, Truitier.

4 Recyclable material deposited in appropriate bin. When enough recyclable material accumulates it is picked up via truck for shipment to the U.S.A. or China for processing.

5 Staff empty compostable material (human and organic waste) into the first of the 3-stage compost bins.

6 Staff wash the emptied barrels with rainwater harvested from the waste kiosk and storage shed's roofs, supplemented with water pumped from an adjacent aquifer.

7 As the organic material breaks down, the more broken down matter is moved to the next stage in the 3-bin system.

8 After about 6 months of decomposing, the rich compost produced is removed and bagged on site to sell for gardening / agricultural use. The bags are sold directly from the waste facility, as well as in markets in Tabarre and Petionville.

9 Full barrels are collected from local composting toilets and replaced with clean barrels.

10 Processed compost bagged and sold at facility entrance as well as at its sister urban drop-off facility, B2.

11 Recyclables compacted for transport and stored on site until pick-up.

12 Compacted recyclable material (plastic and waste) stored until pick-up.

POTENTIAL PARTNER

P1 SOIL or GiveLove (Human Waste Composting Organizations) (Private Company)

P2 S.M.C.R.S. (Government Department)

P3 Private Drivers (Private Company / Individual)

LABELS

A Sub-urban industrial context provides the necessary space for this facility, as well as distance from residences for sanitary and comfort reasons.

B Tool shed for recycling and compost processing tools (compactor, shovels, thermometers, coveralls, boots) and bagas (a compost cover material fundamental to the composting process).

C Sealed concrete slab prevents leeching into groundwater.

D Re-claimed gabion basket walls (claimed from the 10 million m_3 of rubble produced by the 2010 earthquake).

E Covered metal-working space for recycling of collected metals.

B2 URBAN WASTE DROP-OFF FACILITY OVERALL SCHEME 1:200

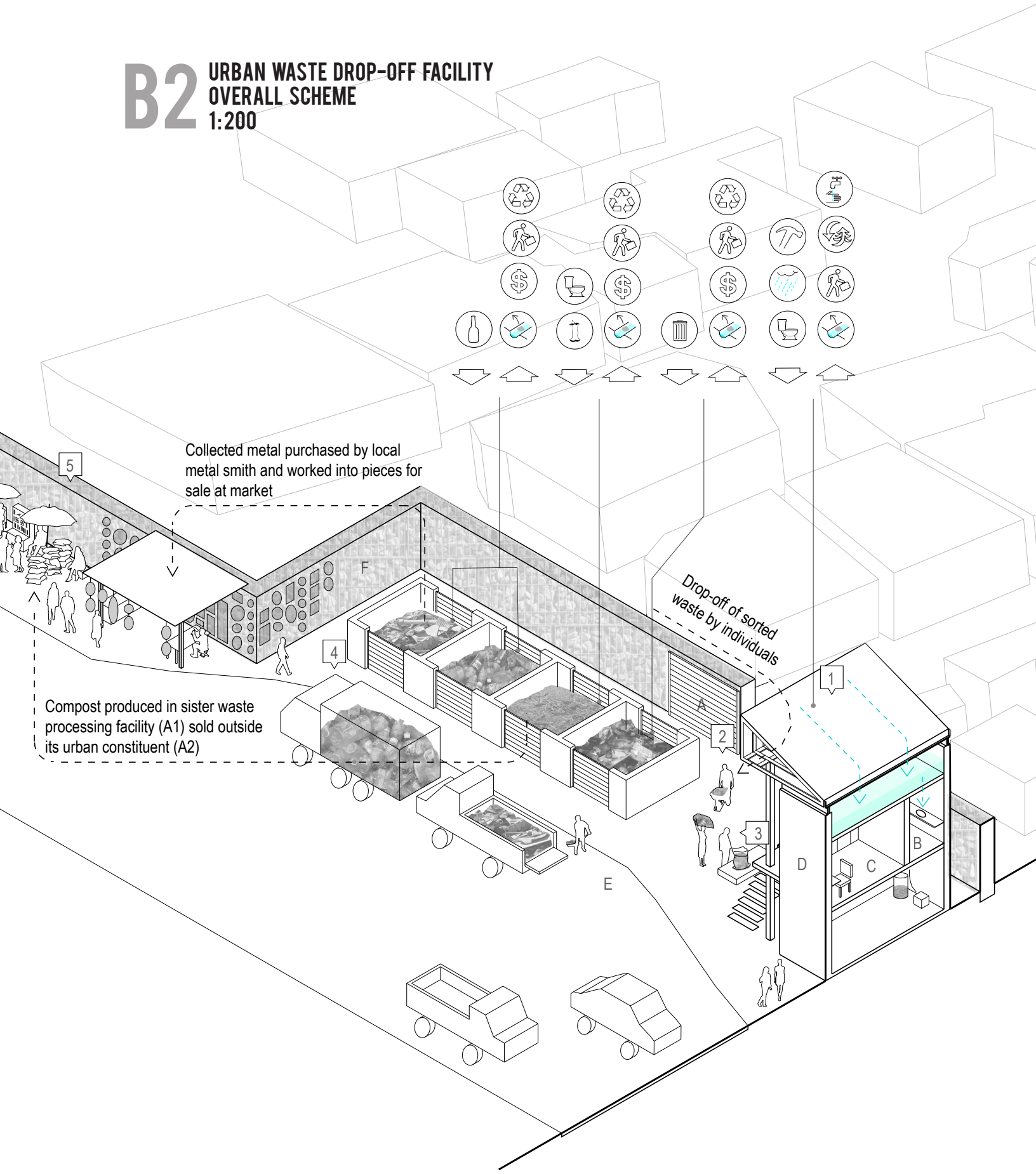


Figure 4.40 : Combination B2 - Urban Waste Drop-Off Facility

PROJECT DESCRIPTION

Version B2 of the waste facility proposal is designed for urban locations, where, due to space constraints and the desire to minimize waste storage within the city for safety and olfactory reasons, the facility is a smaller drop-off location only. Waste processing happens outside of town at the A1 facility. Local inhabitants deliver sorted wastes by foot or vehicle for monetary incentives ($0.12 USD / lb of plastic, $0.15 / lb of metal, and vouchers for local businesses for organic, human and solid waste).

Given its urban context, this combination would be a bustling area where customers drop off sorted wastes on foot and by car throughout the day. A supplementary economy would naturally develop out of the recyclables and compost materials available through the processing, working, and sale of them, connecting this economy and its workers with local markets.

PROCESS STAGE

1. Rainwater harvested from corrugated metal rooftop and used for washing purposes (washroom sink and exterior hose for waste processing).
2. Community collects and sorts their wastes and delivers it to their local waste collection facility.
3. Staff weighs the sorted waste, pays customer the price set for each respective recyclable and gives them vouchers for local businesses in exchange for garbage, human and organic waste.
4. When enough waste is collected, a truck is scheduled to pick up a load. Solid waste is picked up by the S.M.C.R.S (Department of Metropolitan Solid Waste Collection) to go to the landfill, recyclables are re-used locally where possible, and otherwise shipped to the U.S.A. or China for processing.
5. Sellers of related products naturally congregate to the facility's recycled materials market, such as those selling seeds and plants.

LABELS

A Pedestrian access provided to neighbourhood; closed at night to protect goods from theft.

B Staff Washroom. Toilet is a dry composting toilet. Urine container and waste barrel collect excreta in the lower room, which is accessible from an exterior door for emptying and replacing vessels.

C Office of attendant.

D Recycled glass coke bottles (abundant in Port-au-Prince) set in concrete for structure.

E Layby for vehicular waste drop-off and pick-up.

F Rubble-filled gabion basket walls (filled with some of the 10 million m_3 of rubble created by the earthquake).

LEGEND

- - - - > Waste path

- - - - - > Rainwater Path

Outcomes

Inputs

Stormwater

Non-potable Water

Waste Diverted from Ravines

Construction

Job Creation

Composting

Income

Human Waste

Organic Waste

Recycling

Recyclable Material

Solid Waste

PRECEDENT : COMMUNITY RAINWATER RESERVOIR NETWORK

AAKASH GANGA

RAJASTHAN, INDIA

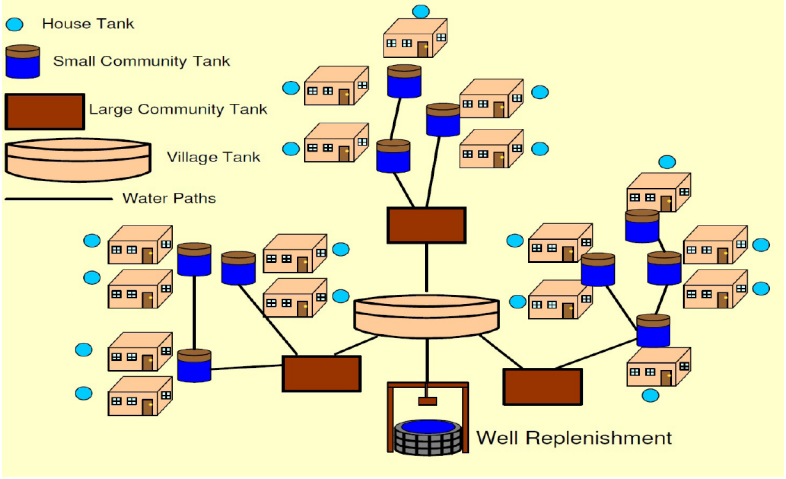


Fig. 4.41 : Diagram of Aakash Ganga Network

Fig. 4.42 : Residential (personal) Reservoir

Fig. 4.43 : Shared Reservoir adjacent Plantation

“Aakash Ganga,” i.e. “River from Sky” is an innovative economic model of domestic rainwater harvesting that is being employed in several villages in rural Rajisthan, a dry area of northwestern India. The project is a shared water network for rural villages in which rainwater is harvested from household rooftops, channeled through a network of pipes to a series of subterranean reservoirs for storage, and filtered for drinking as it is pumped out of the reservoir.[158] It was designed as “a domestic rainwater harvesting system that alleviates the perennial scarcity of drinking water in the rural villages.”[159]

“Aakash Ganga’s strategy is to form public-private-community partnership or social enterprise to provide drinking water to the people. It rents roofs from home owners or acquires the rights to harvest their rooftop rainwater.”[160] “Half of the water is stored in a reservoir adjacent to the home, and the remainder is sent into the shared community reservoir to pool the community’s water resources. If residents have only thatch roofs or cannot afford their own reservoir, they take water from the shared reservoir.[161] “Aakash Ganga’s social enterprise model couples [the] ‘social business’ of Noble Laureate Muhammad Yunus and [the] cultural sustainability of Gandhi. It evolved over several years through incubation and pilot in six villages.”[162]

“The project has developed a 2-tier social enterprise model for full cost recovery and sustainability.”[163] Villagers cover as much as 50% of the infrastructural costs while maintenance costs are recovered through revenue generation.[164] The Rajasthan Association of North America (RANA) provided the initial capital to begin Aakash Ganga in 2003, and has received several awards and grants to fuel its exposure and a study to determine how the model can be replicated and increased in scale. [165] Aakash Ganga provides sufficient capacity to meet annual drinking water needs for a village, and has been implemented in six villages, now, providing drinking water for 10,000 people.[166]

Combination C of the thesis design proposal (p.107-112) learns from this model of collective ownership, and develops it into a more sophisticated model to include water filtration and dissemination back to households via pipeline. As with all of the thesis design proposals, the rooftop water collection network is designed to become an income generator which produces the revenue be self-sustainable.

C ROOFTOP RAINWATER HARVESTING + FILTRATION NETWORK

Fig. 4.44 : Example of 1 - Public Water Fountain, Tabarre, Port-au-Prince

Fig. 4.45 : Example of 2 - Washing Water supply lines (white pipes), Villa Rosa

Fig. 4.46 : Example of 3 - Canal littered with Refuse, Downtown Waterfront

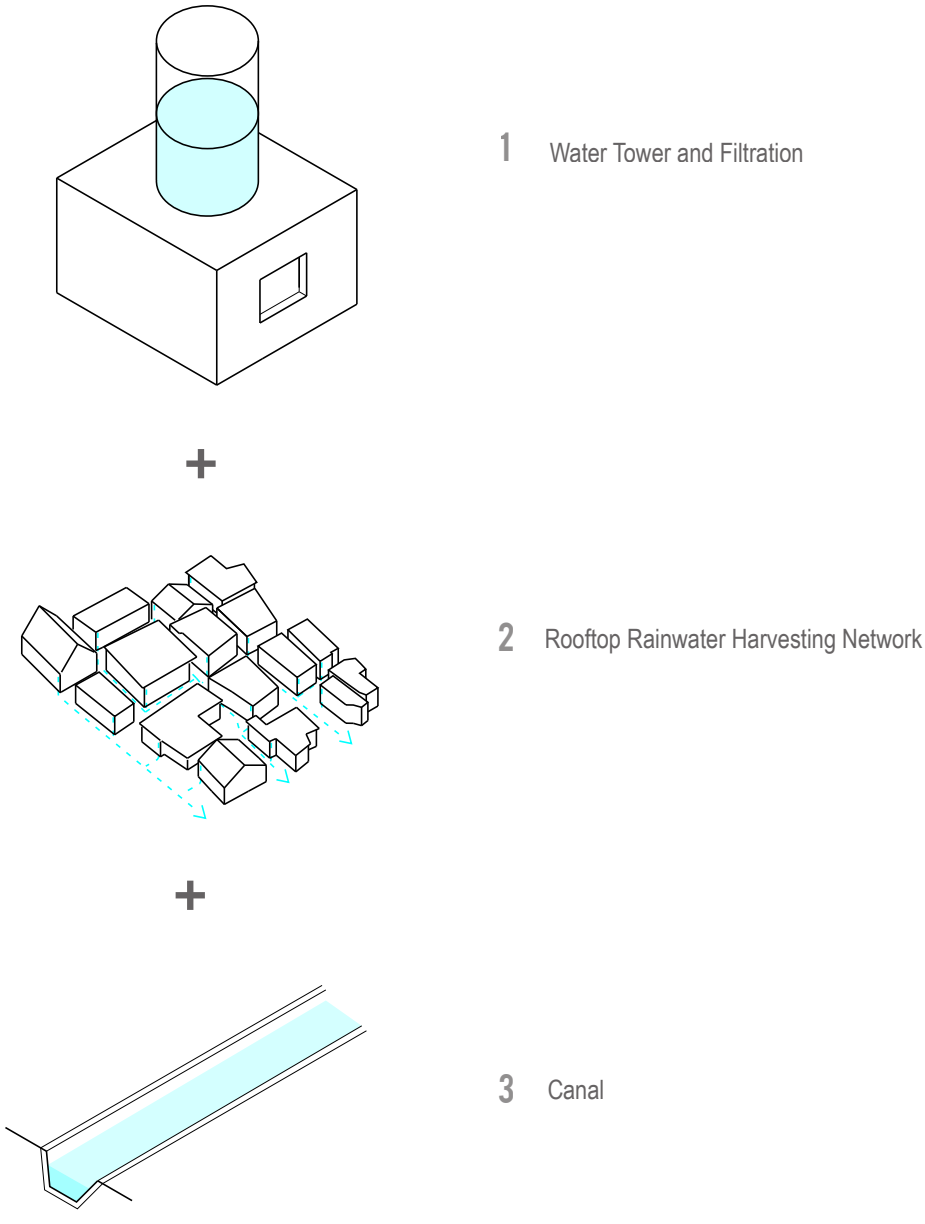


Figure 4.47 : Components paired in Combination C

C ROOFTOP RAINWATER HARVESTING + FILTRATION NETWORK OVERALL SCHEME

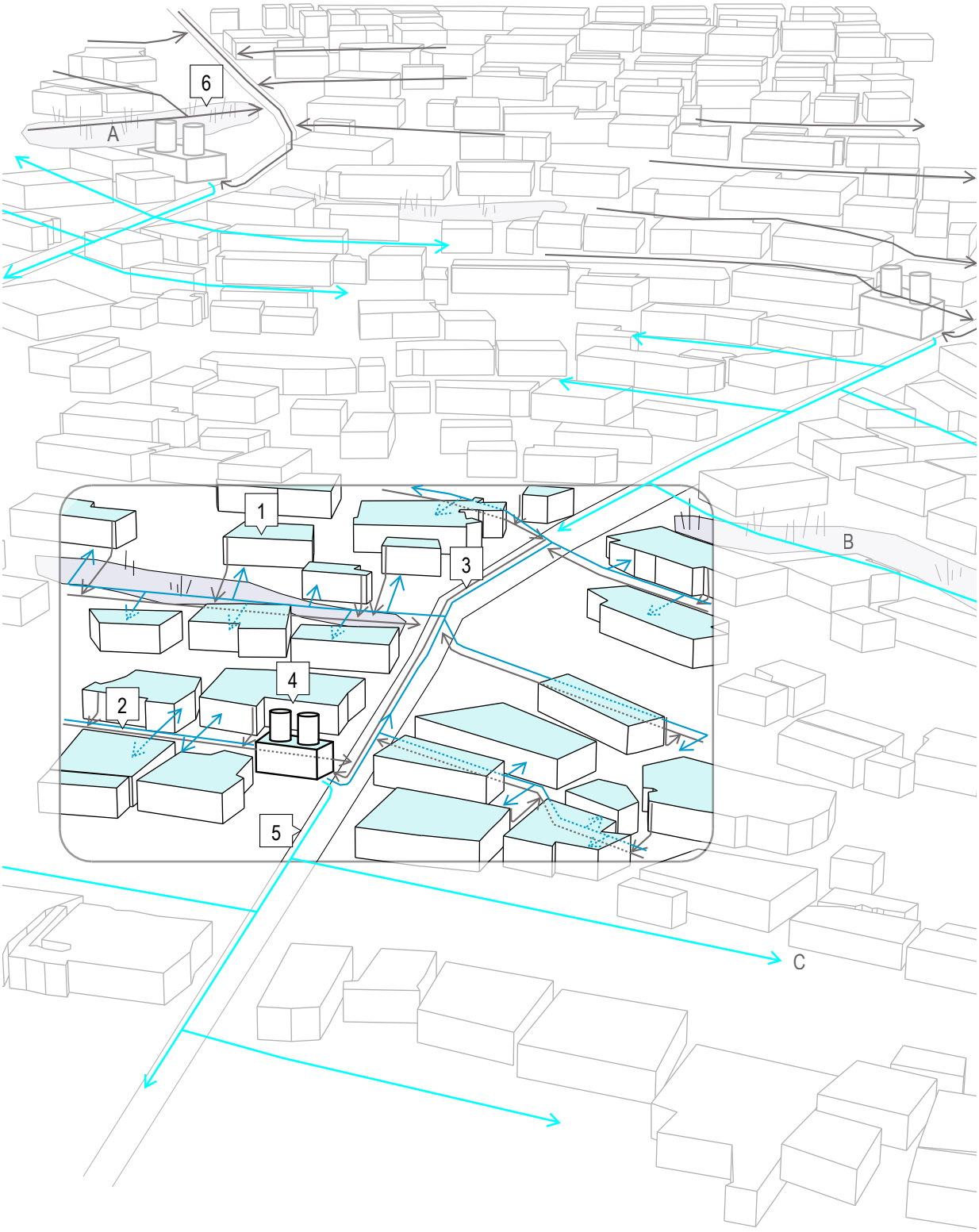


Figure 4.48 : Combination C - Rooftop Rainwater Harvesting and Filtration Network`s Overall Scheme

PROJECT DESCRIPTION

This proposal is a water network: a community-scaled cycle of water harvesting, filtration and dissemination. Rainwater from rooftops and ravine water are collected and filtered within retrofitted public water fountain buildings for drinking and washing water, respectively, and piped to the neighbourhood. This neighbourhood connectivity of inhabitants and their water source would create collaboration through a collective goal achieved through the combination of personal resources.

Currently, drinking water in Port-au-Prince is accessed exclusively by purchasing bottles, jugs or bags of it, and washing water is provided via water truck and rooftop rainwater collection. This proposal provides both of these in the convenience of one's home and pools water resources to use as a community.

MANAGEMENT

The project's construction, start-up and first several years of maintenance would best be funded by NFP(s) and/ or NGO(s) (Not-For Profits and/or Non-Government Organizations) under coordination with DINEPA (the government body in charge of water provision, Direction Nationale de l'Eau Potable et de l'Assainissement), and, once settled, the network could become a self-sustaining or nearly self-sustaining entity, with monetary support from DINEPA as necessary. Of importance to note is that service providers in North America, for example, would not be self-sufficient at the cost they charge consumers for their services (electricity, hydro, solid waste collection, human waste management, etc.) without government subsidies, so it is not unreasonable to expect that of this system as well, especially within the first several years.

PROCESS STAGE

1 Rainwater is collected from all rooftops and travels through a gutter to a subterranean pipe network.

2 Rainwater travels through a pipe network beneath a main pathway to a water filtration tower. The network takes advantage of the mountainous terrain (particularly common in informal settlements which typically squat on undesirable eroded land along the city's edge) to create a gravity-fed system. Each water tower collects water from the neighbourhood above it, and distributes filtered water to the neighbourhood below it.

3 Along with rainwater, ravine water (channeled below pathway) is pumped to water tower to be filtered and subsequently disseminated for washing purposes.

4 Water filtration tower:

Existing public water fountains retrofitted with filtration tanks and the addition of a second water tower.

One water tower stores water filtered to the level of potability; the other stores lesser-filtered water used for washing purposes (feeds sinks, toilets, showers, ext. taps).

5 Water disseminates from water towers in two lines to supply residences and businesses: one washing water line (non-potable) and one drinking water line (potable).

6 Once water is used by residence or business and becomes greywayter, it is filtered once more and then discharged from the filtration cycle into the nearest water line. It then passes through one of the periodic reed beds located upstream of the next water filtration tower to undergo phytoremediation, after which, it enters the system again. The site that the system is show in here as a bidonville (hillside slum).

OUTCOMES

A Reed beds set back from path to reduce amount of waste discarded within via pedestrians and drivers.

B Neighbourhoods have new natural area within them as a result of addition of a marsh which brings with it new flora and fauna in an otherwise compacted earth landscape.

C System reduces dependency on the necessity to purchase water privately.

LEGEND

Rainwater Pipe Path

Potable Water Pipe Path

Non-Potable Water Pipe Path

Rooftop Rainwater collection

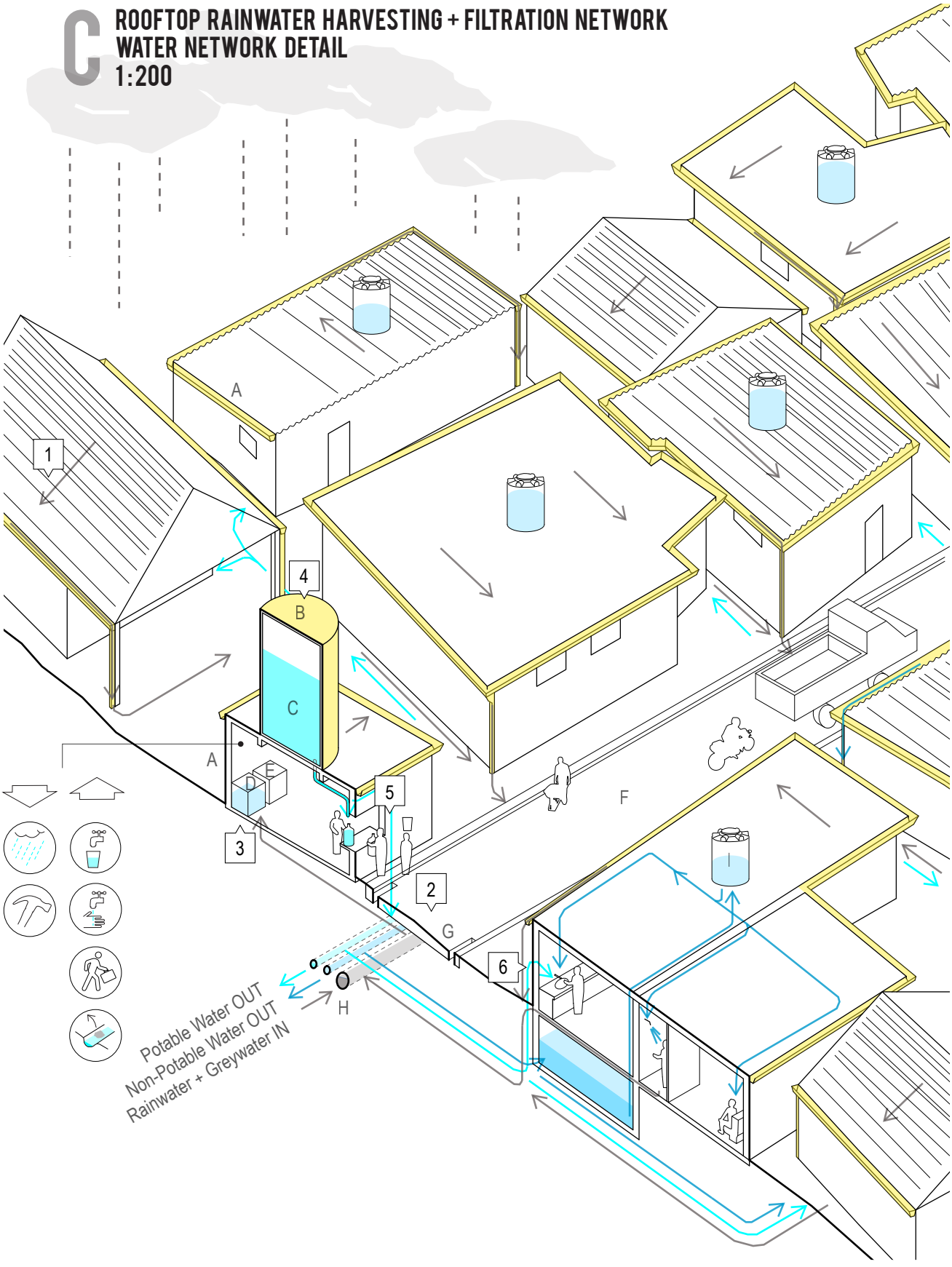


Figure 4.49 : Combination C - Rooftop Rainwater Harvesting and Filtration Network Detail

PROCESS STAGE

1 Rainwater is collected from rooftops and channelled through eavestroughs to a below-grade pipe network, which leads to filtration tanks and water tower. Greywater from houses and water pumped from adjacent canals / ravines is also sent to the water filtration tower.

2 Neighbourhood pipes feed into a pipe below new sidewalk that leads to water filtration tanks.

3 Water is filtered through a series of gravel and sand filters (easily accessible from inside for maintenance) to, in this example, the level of potability. Some towers produce potable water for drinking, while others create non-potable filtered water for washing purposes.

4 Potable water storage tower.

5 Potable water is pumped to the building's tower for storage so that even when the area's electricity shuts off (which is often), water can be gravity-fed to deliver to customers in bottles or jugs.

6 Filtered water is pumped back to those in the neighbourhood who pay for its in-house delivery.

LABELS

A Designed as a low-cost retrofit to existing buildings (adding gutter system to roofs and retrofitting existing public water fountains) as opposed to requiring the new construction of facilities.

B Eavestroughs and water tower are colour-coded yellow to make the system more legible and increase awareness.

C Potable water reservoirs provide greater water security for the neighbourhood.

D Water filter

E Water pump

F Paved path provides an erosion-free, solid surface; allows easier transport of goods, and no longer being the ravine's path, is more sanitary.

G Pathway (crowned) directs stormwater into stormwater line via grated storm drains.

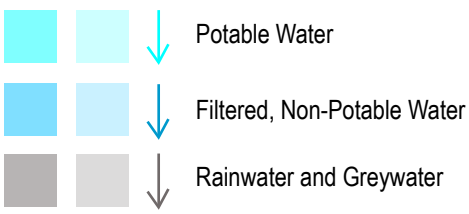
H Ravine is channelized to prevent refuse from being discarded into the water network and thereby preventing the spread of disease.

I Rooftop rainwater barrel, a house-hold staple. Stores non-potable water and gravity-feeds water fixtures, therefore functions whether or not electricity is available.

WATER CALCULATIONS

Haitian's Average Water Needs: 60 L / cd (cd = capita per day)
Average Household: 5 people; therefore avg. household needs = 300 L
Assume: potable water needs = 10 L/ cd
: non-potable water needs = 50 L/ cd, therefore 250 L/ household/ day
= 91,250 L / household / yr
Design Precipitation = (2/3)(Annual Precip.)
= 960 mm
Avg. Port-au-Prince Roof Area = 75 m² / household
Roof Yield, given 960 mm design precip. = 60,000 L / yr
= 66% of annual non-potable water needs

LEGEND



PRECEDENT : URBAN HUMAN WASTE COMPOSTING

SOIL: SUSTAINABLE ORGANIC INTEGRATED LIVELIHOODS

PORT-AU-PRINCE: CITE SOLEIL, TABARRE AND PERNIER; CAP-HAITIEN

Fig. 4.50 : A member of of Pax Christi explaining Composting

Fig. 4.51 : Compost Bins at Pernier Waste Processing Site

Fig. 4.52 : Supplies Shelf (human waste bins and urine containers)

Fig. 4.53 : Drum Washing Station, Limonade, outside Cap-Haitien

Fig. 4.54: Urine-diverting Toilet seat and Bagas (cover material)

Fig. 4.55 : Moving Material from a Closed Bin to a Windrow

Fig. 4.56 : Urine Diversion Toilet (not SOIL's)

Fig. 4.57 : Planting Trees at SOIL's Pernier Garden using Compost

"In nature soil transforms organic matter, sustaining ecological systems by converting one organism's wastes into another's resources. It is from the soil that [Sustainable Organic Integrated Livelihoods, SOIL, has] borrowed both [their] name and philosophy." [167] "[SOIL] believes that the path to sustainability is through transformation, of both marginalized people and discarded materials, turning disempowerment and pollution into participatory production."[168] SOIL, funded in 2006, is a "non-profit organization dedicated to protecting soil resources, empowering communities and transforming wastes into resources in Haiti,"[169] and is currently the largest waste treatment operation in the country.[170]

As less than 25% of urban Haitians have access to adequate sanitation facilities,[171] people dispose of their wastes in the ocean, waterways, plastic bags, or streets. "At the same time, agricultural output is low due to poor soil fertility, soil erosion and lack of fertilizers."[172] "Ecological sanitation, EcoSan, is a low-cost approach to sanitation where human wastes are collected, composted and recycled for use in agriculture and reforestation. It simultaneously addresses many of Haiti's most pressing issues: improving public health, increasing agricultural productivity, mitigating environmental degradation, and providing low-cost sanitation."[173]

"SOIL is currently transforming over 5,000 gallons of human excreta per week into rich compost critical for agriculture and reforestation"[174] using a thermophilic composting process. SOIL's EcoSan toilets serve over 50,000 people in communities throughout northern Haiti and in Cap-Haitien.[175] SOIL built Haiti's first waste composting site in their first large-scale project in Cap-Haitien in 2009.[176] SOIL also designed and built 200 temporary toilets for displaced persons camps following the 2010 earthquake, which served 50,000 people. This small organization also worked on a household toilet pilot project of 25 people in a neighbourhood in Tabarre, where toilets are provided and users pay for the toilets' maintenance.[177] Similarly, in 2012, SOIL began another pilot project in a neighbourhood in Cap-Haitien where they intend to implement a new model in which users transport their own drums to a central depot point within the small neighbourhood, from which they would be transported to a processing facility.[178]

SOIL's role in a project entails:

> Providing users with eco-san toilets fitted with removable waste drums to catch the faeces and diverted urine, respectively Providing a drum team to pick up and replace drums when full
> Educating toilet owners and users about EcoSan, toilet use and maintenance
> Arranging toilet manager to contract staff to clean toilet
> Processing waste into compost
> Using the processed compost: (a) bagging compost for sale, and (b) using compost in gardens[179]

Currently, the compost SOIL produces is bagged and sold in bulk.[180] SOIL sells their compost to the Pax Christi garden in Cite Soleil and uses it in SOIL's office garden, in their experimental garden in Pernier, and at their composting site in Truitier.[181]

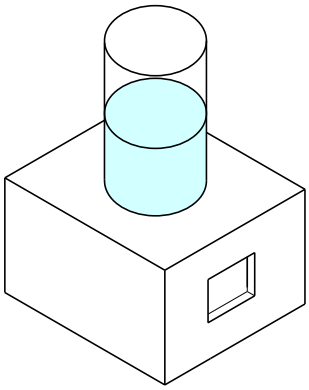
This model of collecting and processing human waste is imbedded in the thesis design proposal's strategy for human waste, as displayed in the toilets in Combination D (p.115-120) and the waste processing system in Combination B (p.97-104). It also reflects the thesis design proposal's general attitude towards wastes, which is to use them as initiators of recycling economies. As SOIL and other human composting organizations in Haiti have learned, community engagement and education become key factors in the introduction and implementation of these types of systems to convince the users to adapt the system and educate users of their importance. Greater education and awareness of waste-cycles, health, micro-economies and agriculture are important for the flourishing this precedent, and for all of the thesis design proposals. Therefore, a model of community engagement and education would be a critical step in this and all categories of proposal.

D SCHOOL AND COMMUNITY WASHROOM

Fig. 4.58 : Example of 8 - Urine Diverting Toilet

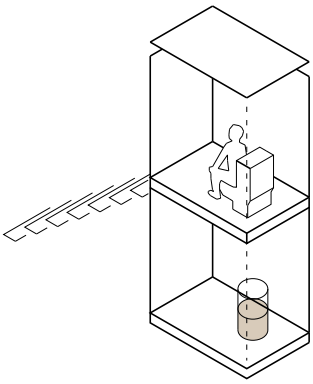
Fig. 4.59 : Example of 9 - Community Toilets by I.O.M.

Fig. 4.60 : Example of B - École Argentine in Bel Air, Port-au-Prince



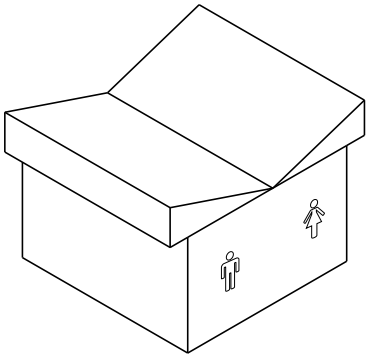
1 Water Tower and Filtration

+



8 Dry Composting Toilet (a.k.a. UDT: Urine Diverting Toilet)

+



9 Community Washrooms

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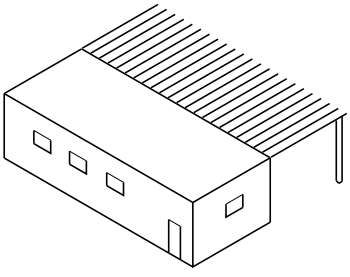


B School

Figure 4.61 : Components and Programs paired in Combination D

D SCHOOL AND COMMUNITY WASHROOM OVERALL SCHEME 1:400

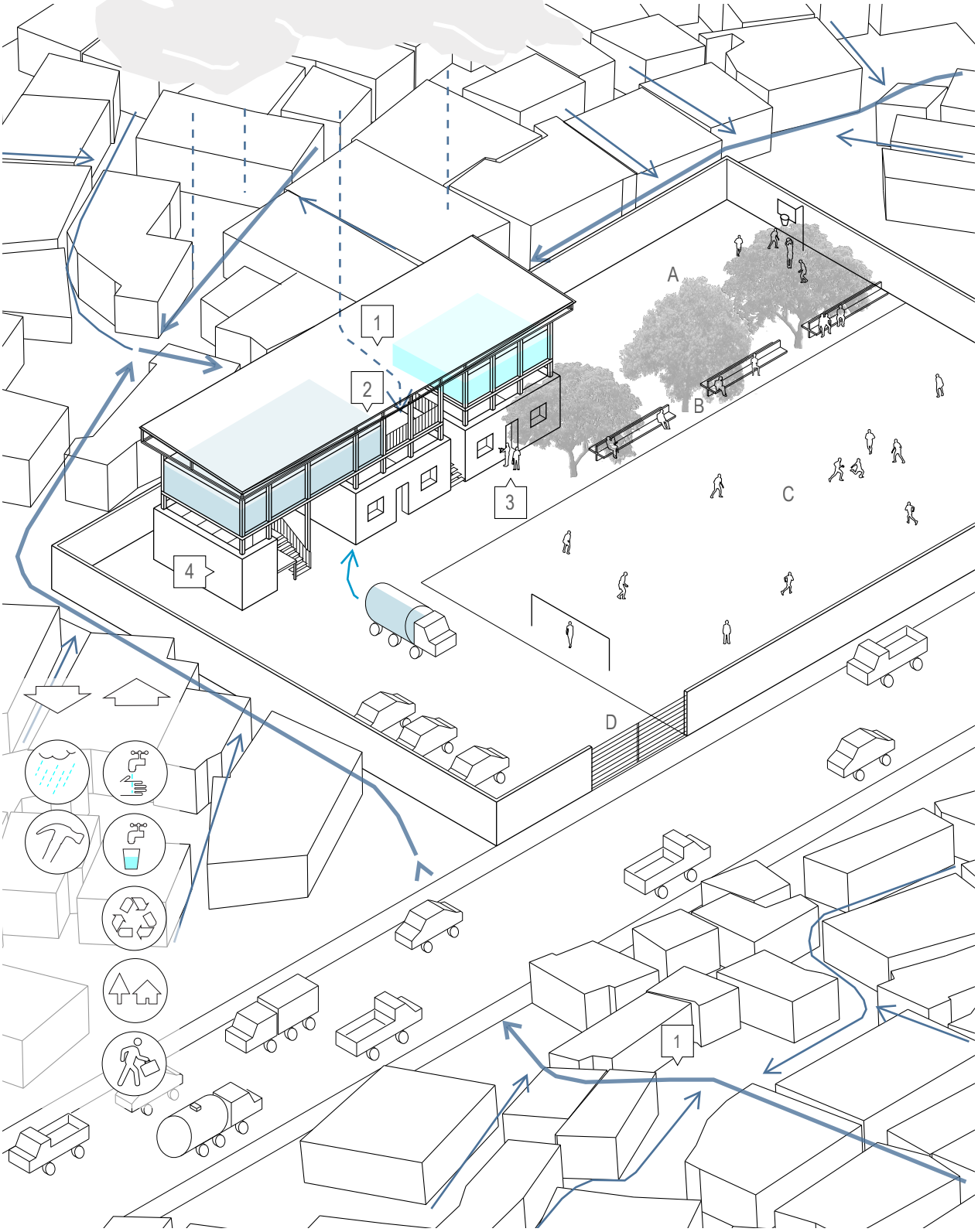


Figure 4.62 : Combination D - School and Community Washroom Overall Scheme

PROJECT DESCRIPTION

For their washroom needs, the majority of Port-au-Princians use pit latrines which often leech contaminants into the groundwater, and many do not have a toilet of their own, but share with neighbours. Although all schools in the city are private, most have limited resources and many can only offer one or two pit latrines which all children and staff share. This proposal is a washroom paired with a grade school that serves the school during the school day and the community in the evenings and on the weekends. A small fee is charged to the community per use to fund security guards and maintenance. This proposal is most suitable in a more under-serviced neighbourhood such as a slum, as shown here, which would have a much greater need for it.

The school grounds' soccer field and basketball court provide recreational venues for students during school hours and the community after hours and on the weekends. Amenities like these in the city are scarce and thus act as great attractors to children, athletes and socializing spectators. Opening these to the public would connect neighbours more and make this site an immense social condenser, as all public parks in the city are.

The water and toilet provision would likewise attract an abundance of users, both those visiting to use the athletic grounds and those in the vicinity without improved sanitation facilities. Is also simply serves as the area's public water fountain (see washing water sources, p.43, B) and would be a central location for water retrieval and subsequent socializing.

Water for the facility is provided by water collected from the neighbourhood rooftops and is supplemented by water provided by truck, as necessary, which is typical practice.

PROCESS STAGE

1. Rainwater is collected from the neighbourhood rooftops and pumped to the building for filtration.
2. Water is filtered for potable and non-potable water needs: drinking and washing, respectively.
3. Potable water feeds drinking fountain for students, staff and community.
4. Non-potable water feeds washroom sinks and exterior tap.

LABELS

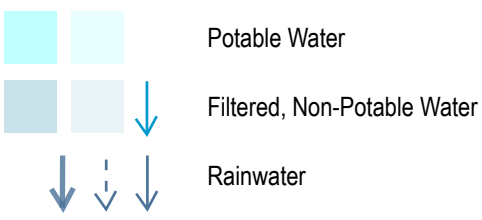
A Basketball Court. Court and Soccer Field, C, serve students during school days and the community on evenings and weekends.

B Spectator seating

C Soccer Field

D Guard hired to protect property at all times to prevent theft and damage, which is standard practice in Port-au-Prince. Gate is locked during school hours and open to the public on evenings and weekends.

LEGEND



D SCHOOL AND COMMUNITY WASHROOM PROCESSING DETAIL 1: 200

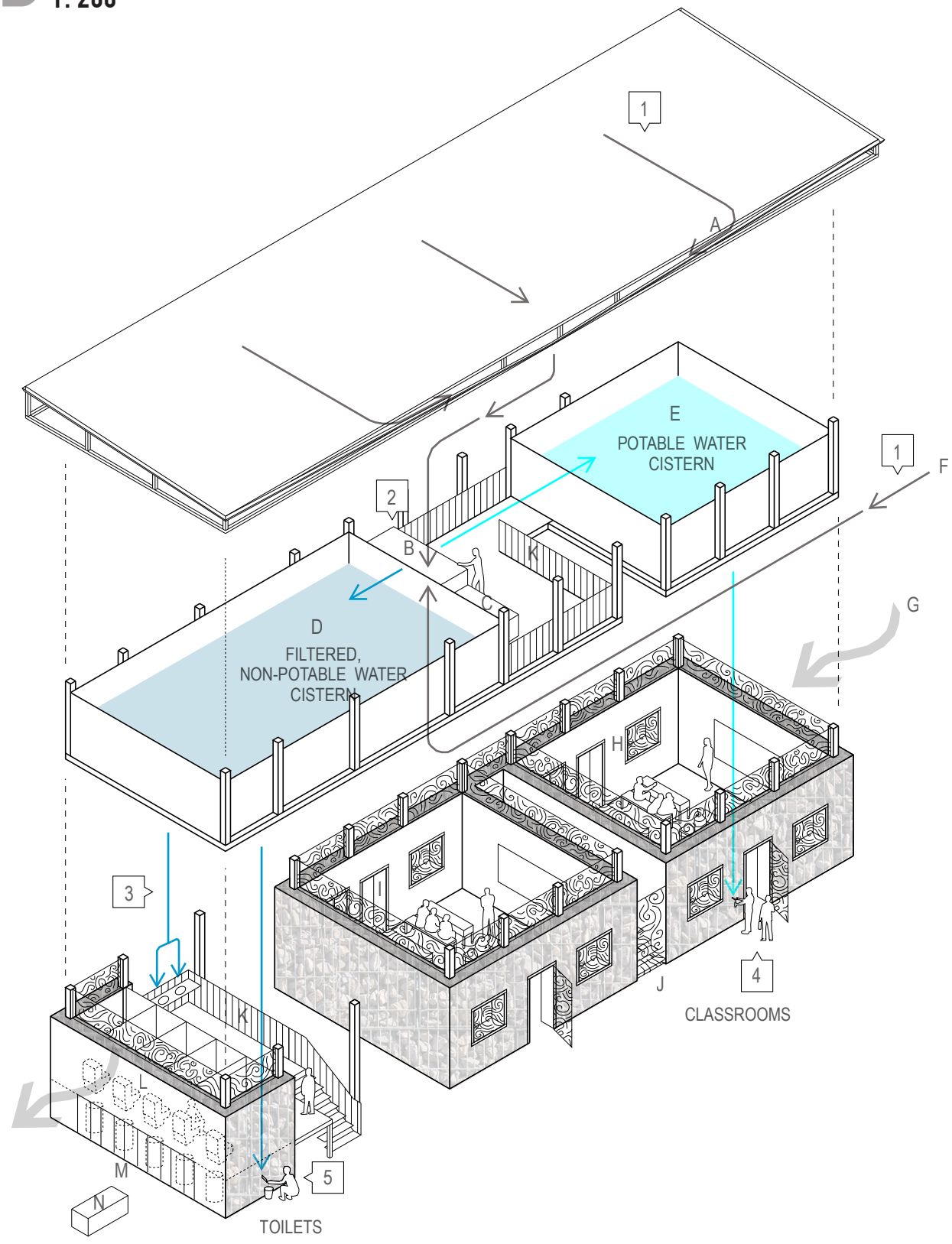


Figure 4.63 : Combination D - School and Community Washroom Processing Detail

PROCESS STAGE

1. Rainwater is collected from school rooftop and neighbourhood rooftops and pumped to school's water filtration tank (B).
2. Water filtered: a larger portion of the water is filtered and stored for washing uses (D) and the remainder is filtered and treated to provide drinking water (E).
3. Non-potable water is gravity-fed to washroom sinks.
4. School students and staff have on site access to potable drinking water during the school day, and the community pays to have access to the water after school hours.
5. Filtered water is available for outdoor needs.

LABELS

- A Corrugated metal sheathing roof and rolled metal eavestrough provide non-contaminating materials for collecting rainwater from.
- B Water filter (sand and gravel) provides both filtered, non-potable water for hand washing (D) and potable water for drinking (E).
- C Water pump
- D Non-potable water cistern for washing needs; metal construction (light-weight sterile). Cisterns are located above to facilitate gravity-fed systems not dependant on electricity.
- E Potable water cistern; metal construction (light-weight, sterile). System serves as the water filtration tower for the community's potable water provision (as in Combination C).
- F Rain water collected from neighbourhood is sent here for filtration, use, and dissemination back to the community.
- G Natural ventilation through clerestory space.
- H Wrought metalwork (prominent in Port-au-Prince) over building openings provides artful security while still allowing daylight and air to pass through.
- I Second means of egress provided for comfort of personal safety (cultural norm).
- J Stair access to second-storey water filtration equipment and tanks for equipment maintenance and water treatment. Potable water requires chemical additives.
- K Locally-grown bamboo railings
- L Composting toilets
- M Access doors to human waste barrels and urine jugs. Containers are collected and replaced by waste provider who processes waste into compost for agricultural use.
- N Diesel generator (a typical household possession) used if electricity is required when power is out (for ex., to power pump). Located away from classrooms for audio and olfactory reasons.

WATER NEEDS CALCULATIONS

NON-POTABLE WATER NEEDS

SCHOOL HOURS
No. of users = 56 students + 3 staff + 1 guard = 60
No. sink uses / day = (60 ppl)(2 uses/ day) = 120 uses / day
Water use = (fixture flow rate)(0.3 min/ use)(no. users)
= (3.8 L/min)(0.3 min/use)(120 ppl)
= 136.8 L / wk = 4104 L / mo
AFTER HOURS (EVENINGS & WEEKENDS)
Water use = (fixture flow rate)(0.3 min/ use)(no. users)
= (3.8 L / min)(0.3 min / use)(80/ wk)
= 91.2 L / wk = 364.8 L / mo
Total non-potable water needs = 4469 L / mo = 53,628 L / yr

POTABLE WATER NEEDS

SCHOOL HOURS
Water use = (1.5 L/ day)(No. of users)
= (1.5 L/ day)(60 users/ day)
= 90 L/ day = 2700 L / mo
AFTER HOURS (EVENINGS & WEEKENDS)
Water use = (20L)(50 users / wk)
= 1000 / wk = 4000 L / mo
Total potable water needs = 2700 L/ mo + 4000 L/ mo
= 6700 L / mo = 80,400 L / yr

CISTERN SIZING

Non-potable cistern size req't = (1/4)(annual water needs)
= 13,407 L
Non-potable cistern capacity = (6 m)(11 m)(2 m)
= 132 m_3 = 132,000 L > req'd
Potable cistern size req't = (1/4)(annual water needs)
= 20,100 L
Potable cistern capacity = (6 m)(6.5 m)(2 m)
= 78 m_3 = 78,000 L > req't

Therefore there is ample water storage capacity for the school and community visitors. The capacity is excessive to provide the opportunity for expanding services to provide water filtration and dissemination to the community as the water filtration towers do via pipeline in combination B (p. 91 - 96).

PRECEDENT : COMMUNITY GARDEN

TAP TAP GARDEN

PARTNERS : BOCHIKA, SAKALA - PAX CHRISTI, SOIL

CITÉ SOLEIL, PORT-AU-PRINCE

Fig. 4.64 : Panorama, Tap Tap Garden

Fig. 4.65 : Tire Planters, Tap Tap Garden

Fig. 4.66 : Planted Garden bed, Tap Tap Garden

The “Jaden Tap Tap” (Tap Tap Garden) is a one-acre urban community garden on former landfill site in the informal settlement, Cite Soleil,[182] deemed the worst slum in the western hemisphere.[183] It is a community-driven initiative that began after the earthquake in 2010 involving Pax Christi, a Christian organization with deep roots in the neighbourhood. It began quite small, having no external funding, but greatly increased in scale in December 2011 through funding from the American not-for-profit organization, Bochika.

“The Tap Tap Garden is Haiti’s largest urban garden containing more than 500 brightly painted tire gardens, a flower garden, and a nursery of 1,000 trees.”[184] The garden is now a symbol of “hope, empowerment, education, and opportunity for Cite Soleil, one of Haiti’s most impoverished neighborhoods. As part of Pax Christi Ayiti’s SAKALA youth empowerment program, the garden is also a living classroom, providing 250 at-risk youth with a safe, positive environment in which to learn the basics of agroecology, agroforestry, nutrition, and to develop leadership and entrepreneurial skills. Food grown in the Tap Tap Garden feeds more than 250 neighborhood youth and residents of the nearby elderly and disabled persons displacement camp, Mitchiko, and [its produce] will be sold to ensure the long-term sustainability of the garden.” [185] Produce sale at a local market had already been initiated by a handful of gardeners as of May 2012, kick-starting the garden’s move toward self-sustainability. The plants grown in the garden are primarily edible; popular choices are peppers, tomatoes, leeks, basil, onions, pwa cango (Congo bean) and chard.[186]

The garden is maintained by community members who do so in their free time.[187] Within the Pax Christi grounds, SOIL, Sustainable Organic Integrated Livelihoods, a non-profit ecological sanitation organization, has a composting toilet, and they sell their compost to Pax Christi.[188] SOIL gives educational tours of the site to exhibit the cycle of human waste from the toilet to becoming compost that can in turn fuel a garden.[189]

When speaking with Corinne Coe, Director of Communication and Administration at SOIL, about the larger applicability of a community-run garden like this in other areas of Port-au-Prince, she said that this sort of thing could happen everywhere. Coe pointed out that, as in any city, there are urbanites interested in gardening and others that are not, and that “a lot of people in Port-au-Prince are from outside” (i.e. rural areas where household farming is commonplace), and would therefore be likely to have the skills, knowledge and interest to garden.[190] Anna Konotchick and Vera Kreuwels, NFP workers in Port-au-Prince agree with Coe that urban agriculture makes sense for the city and that there is an abundance of it, and further noted that everyone with space available for a garden will make one.[191]

This project is an encouraging example of large-scale gardening located just outside of a dense urban environment in Port-au-Prince, not unlike that of the thesis design proposal (ex. Combination E, p. 123-126; Combination F, p. 127-132). Although it is among few large gardens within the city, it displays the agricultural potential for urban Port-au-Prince. Tap Tap Garden, along with the other precedents in this chapter, was born out of the economic model of the thesis proposal, utilizing aid for its inception and start-up, and then aiming to find itself through the sale of the produced product.

E AGRICULTURE AND WATER COLLECTION NETWORK

Fig. 4.67 : Example of 3 - Canal feeding into Street, Delmas

Fig. 4.68 : Example of 6 - Private Produce Garden, Villa Rosa, Port-au-Prince

Fig. 4.69 : Example of D - Tabarre Market, Tabarre

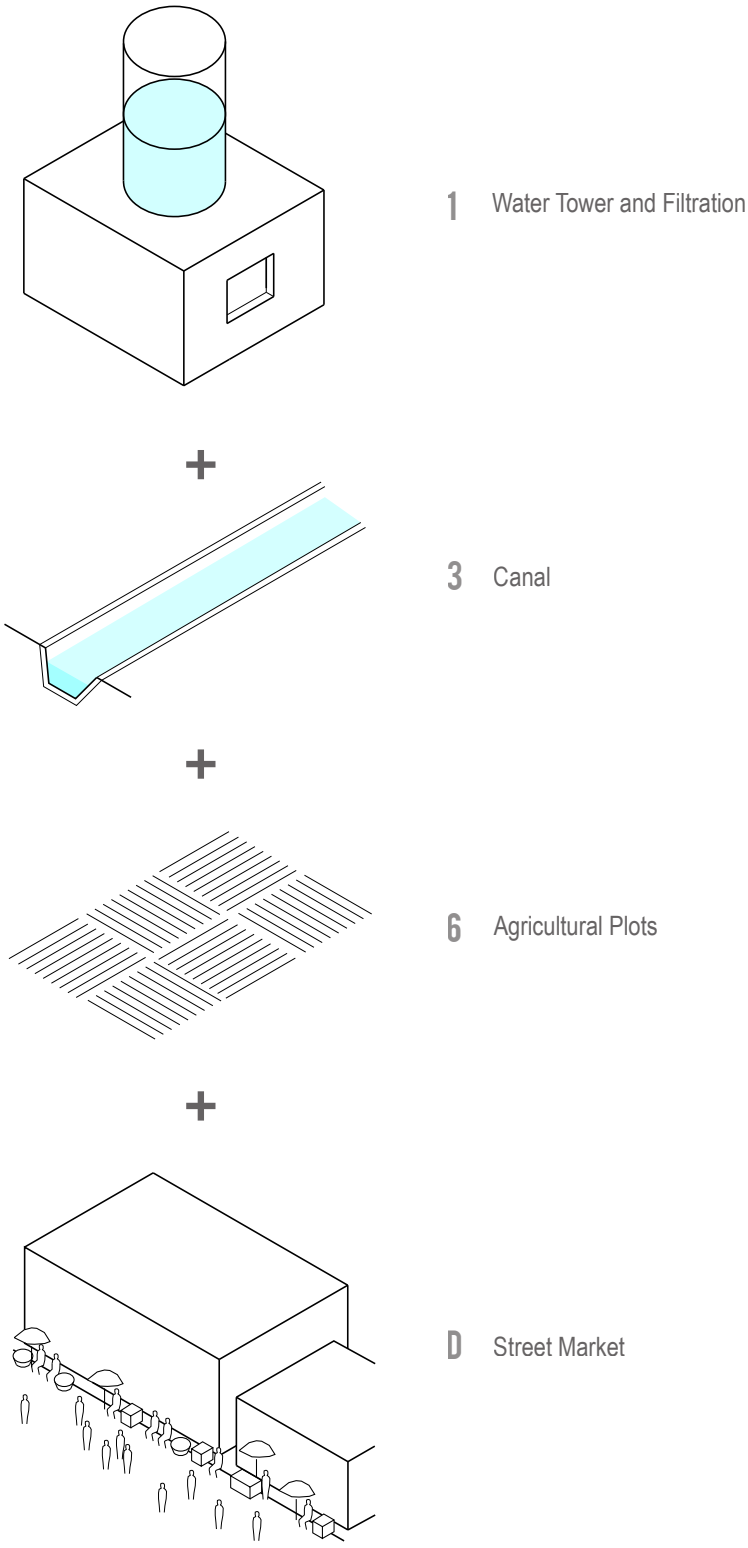


Figure 4.79 : Components and Programs paired in Combination E

E AGRICULTURE AND RAVINE FILTRATION OVERALL SCHEME 1:250

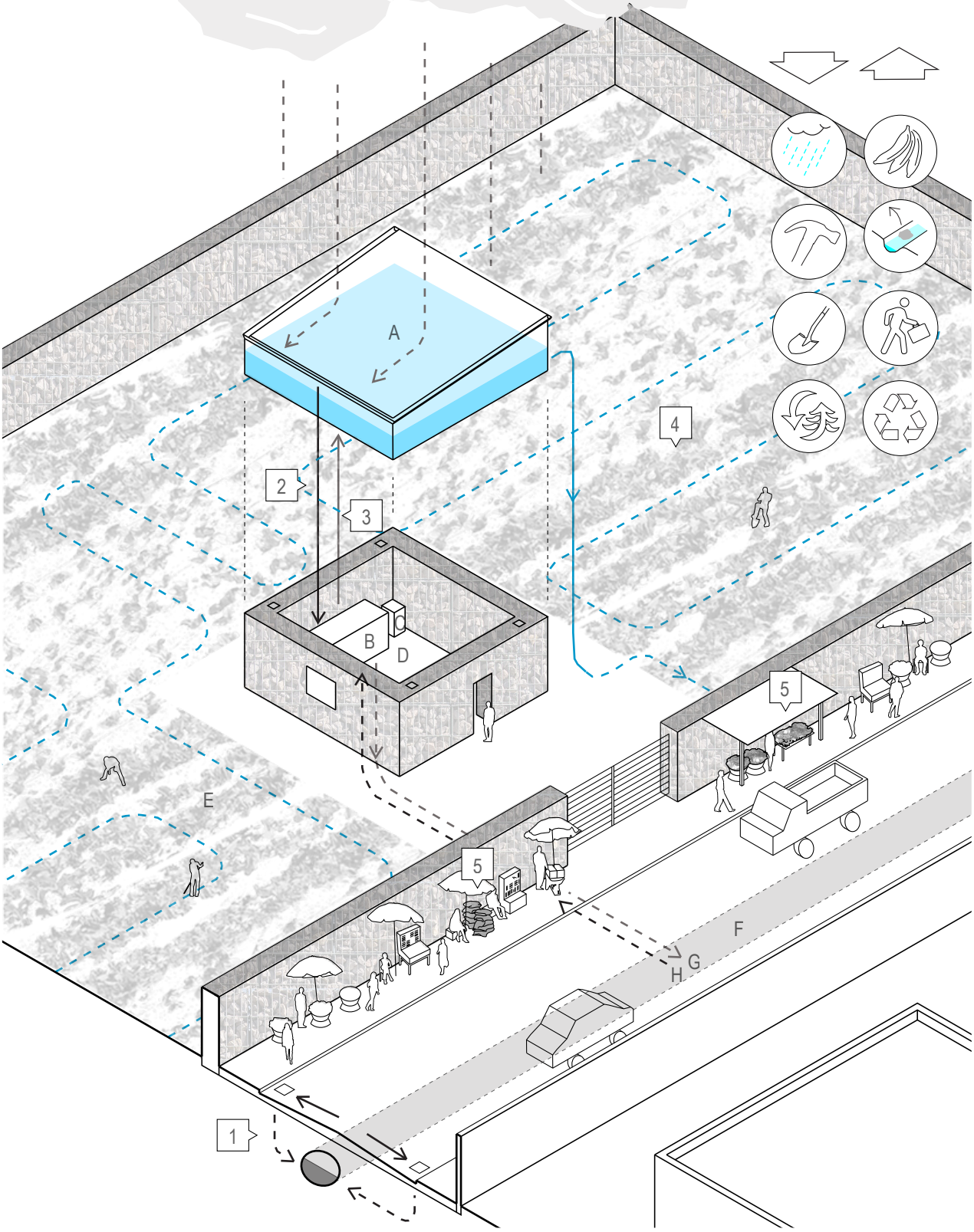


Figure 4.71 : Combination E - Agriculture and Ravine Filtration Overall Scheme

PROJECT DESCRIPTION

"Haiti is blessed with a year round growing season and plentiful rain that many countries can only envy. Urban and rural areas alike could be green, providing more food, more wood, more shade, cleaner air, stabilizing hillsides, securing watersheds. Significant water needs could be met by managing rainwater."[192]

This proposal is centred around agriculture, an addition to urban Port-au-Prince with wide-spread positive effects. The design proposal filters neighbouring ravine or canal water for agricultural irrigation, producing improved water sources, and the garden produces food for sale in local markets, generating a local micro-economy. The by-products for sale would naturally attract related economies such as the sale of food-preparation tools, compost, gardening supplies and tools, and other food. This feeds into and expands the existing, widespread market culture, generating more locally-produced goods as well as connections for collaboration between entrepreneurs (ex. those selling food, compost, cooking or gardening products; gardeners; restaurant-owners). This also creates greater connection to, and awareness of, one's food source, as currently, produce is either transported to Port-au-Prince from other parts of the country or it is imported.

Currently, water for urban agricultural use is typically purchased from a water truck and stored in a private cistern. If adjacent to a ravine, that water can be used for irrigation, but in the city, it must be considered blackwater and would best be filtered. In more rural agricultural areas, naturally flowing above-grade water (ravine, ditch or stream) would be used and supplemented by trucked in water as necessary. Rainfall and that collected from the garden shed's rooftop is insufficient as gardens need to be watered daily. Another potential water source, rainwater collected from the neighbourhood roofs, is best saved for household water needs, as per Combination C (p. 107-112), and as agriculture can use lower-grade water, ravine water is a better option for the large quantities required. This design proposes the use other means of water provision that reduce dependence on purchasing and transporting water via truck from springs outside of the city. The proposal's adjacent ravine is channeled as part of the thesis design's overall strategy to reduce water pollution, and it filters that water along with collected rainwater for agricultural use. In the dry periods when the natural waterways shrink in size, the cistern will need to be supplemented with trucked-in water, but those needs are significantly reduced by the use of ravine water. Drawing from ravines and filtering their water not only improves water and resulting health quality, but it also reduces the risk of flooding, which is significant in open waterways near the waterfront (see flood risk map, p. 71).

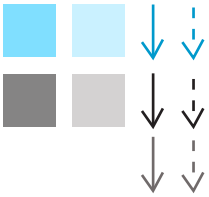
PROCESS STAGE

1. Ravine channelized to prevent pollution. Rain channeled via crowned road into stormwater line below street.
2. Garden shed pumps water from stormwater line and collects rainwater from rooftop to send through filtration system to remove large particles and contaminants.
3. Once filtered, water is pumped to rooftop cistern for storage.
4. Filtered water is gravity-fed from rooftop cistern to drip-line for agricultural irrigation; water is absorbed into the earth.
5. Produce and compost from garden is sold at local market.

LABELS

- A Filtered water cistern; stored for agricultural irrigation
- B Water Filter
- C Water Pump
- D Garden Shed (houses tool storage, water filtration; constructed of concrete structure and recycled rubble-filled gabion walls).
- E Food garden
- F Stormwater line (contains stormwater and channelized ravine)
- G Overflow pipe back to stormwater line
- H Intake Pipe from stormwater line (to be filtered before use)

LEGEND



F WASHHOUSE AND FOUNTAIN PARK

Fig. 4.72 : Example of A - Communal Laundry Washing and Drying, Port-au-Prince

Fig. 4.73 : Example of F - Parc D'Italy, Downtown Waterfront

Fig. 4.74 : Example of F - Parc de Marché Ipolyte, Downtown Waterfront

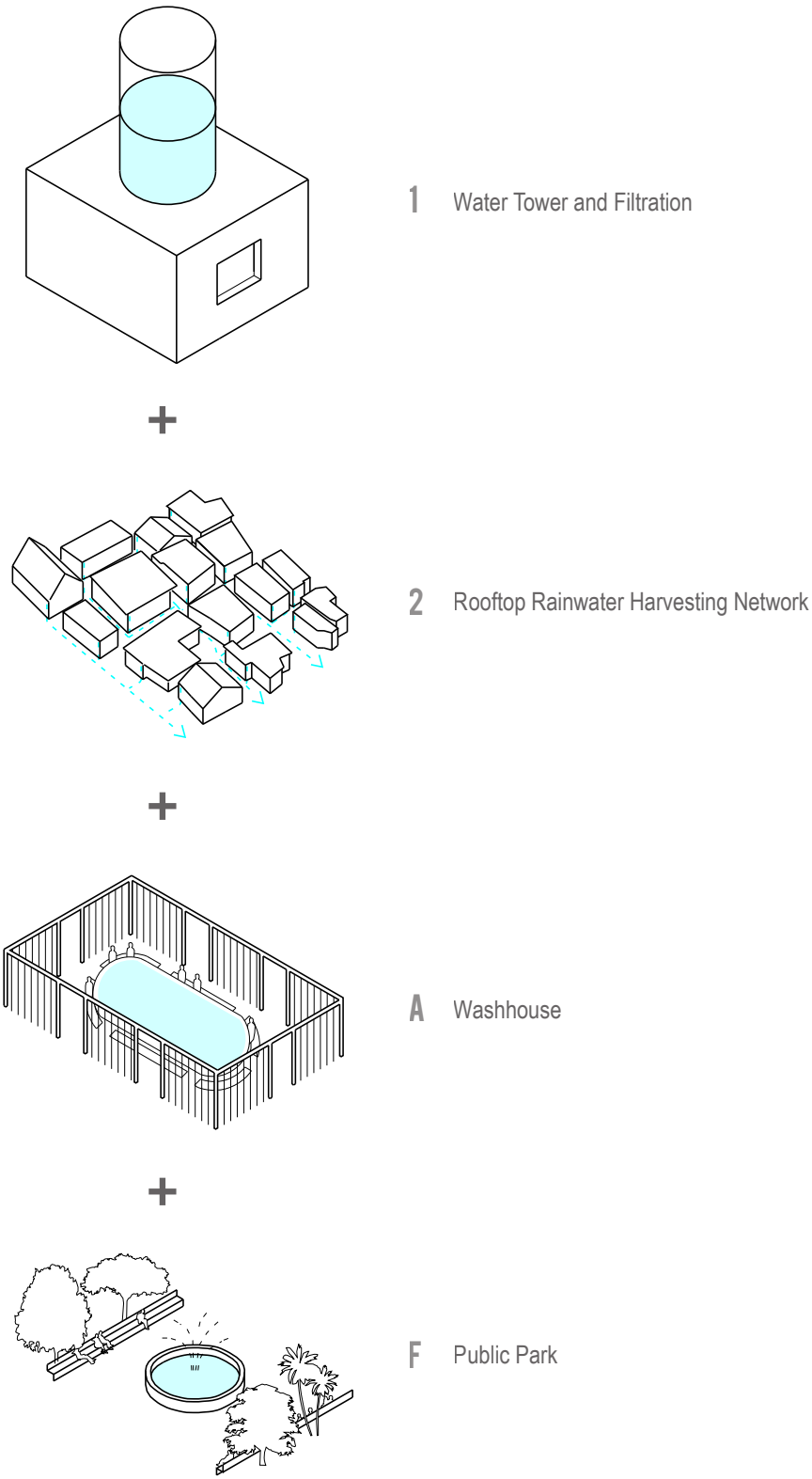


Figure 4.75 : Components and Programs paired in Combination F

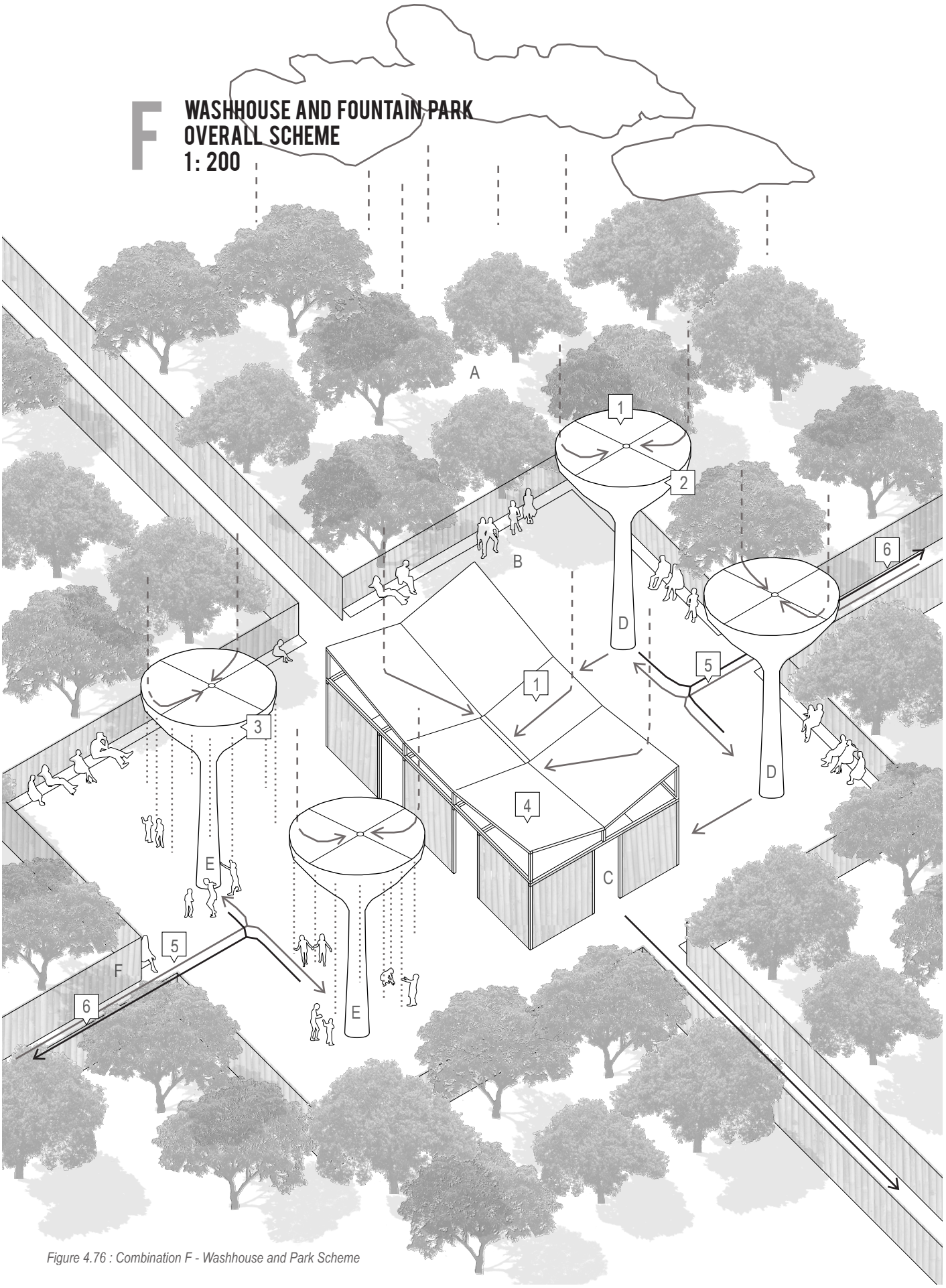


Figure 4.76 : Combination F - Washhouse and Park Scheme

PROJECT DESCRIPTION

A park is created from the combination of a productive orchard, a washhouse, and water towers that acts both as water storage for the community and a fountain. Fountains and a washhouse are combined to create a playground for children and workspace for their mothers.

Water is collected from the park's and community's rooftops (see combination C, p. 107-112), and manual pumps on site to serve the park's water needs. After use, greywater from the washhouse and fountain is sent to a water filtration centre.

The orchard's mango trees, coupled with the towers, provide a cool, shaded area for all ages to both play and relax. This proposal would be an extremely popular recreational venue and refuge from the heat for all ages, given the extremely limited public parks. Locating a park within a garden provides the public privileged access to a beautiful setting and creates an oasis, removed from the busy city.

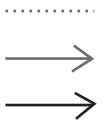
PROCESS STAGE

1. Rainwater is collected from all catchment surfaces.
2. Rainwater stored for either (a) agricultural irrigation,
3. (b) supplying the youth fountain, or
4. (c) used for laundering clothes.
5. Park rainwater supplemented by neighbouring rooftop water collection and purchased non-potable water supplied by truck.
6. Greywater from the washhouse and fountains is collected and pumped to the nearest water filtration centre for filtration and re-distribution.

LABELS

- A Orchard
- B Public Park. A shaded area of refuge from the intense Haitian heat is provided by the tree canopy and the tower shadows.
- C Washhouse
- D Water storage tower
- E Water fountain and storage tower
- F Locally-grown bamboo benches and fence keep public out of garden, which is managed by the park operators.

LEGEND



Fountain Water

Rainwater and Greywater path

Blackwater path (i.e. soapy water)

F WASHHOUSE AND FOUNTAIN PARK
WASHHOUSE DETAIL
1: 100

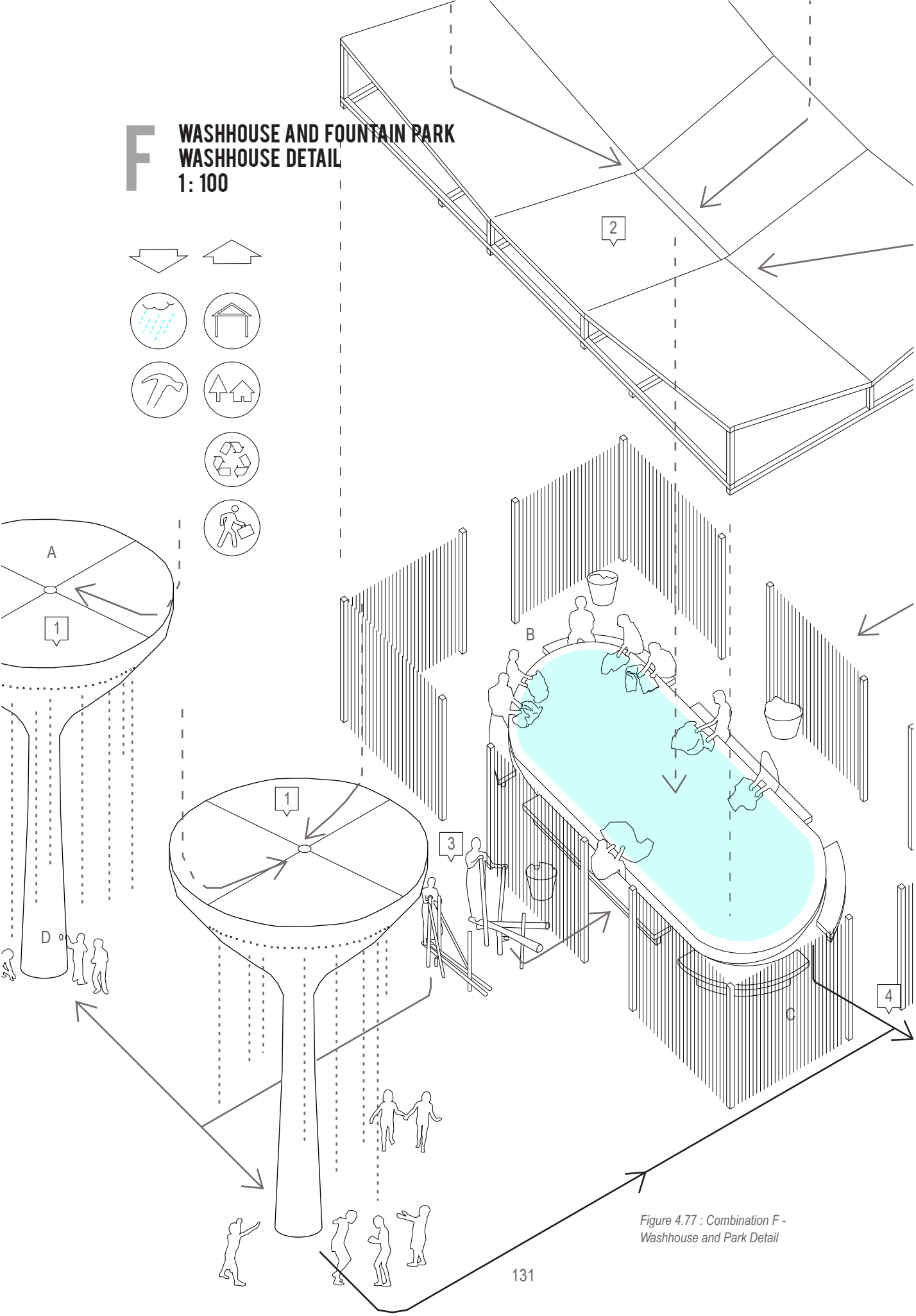


Figure 4.77 : Combination F - Washhouse and Park Detail

PROJECT DESCRIPTION

Currently, washing is typically done individually with water collected from rooftops (in barrels or cisterns), aquifers (accessed by hand pumps), a community water fountain (accessed by bucket), or directly from a ravine. This proposal is far more convenient, efficient, sanitary and comfortable.

This would be a social hub in the city. Public parks in Port-au-Prince are very hard to come by, and children would flock to this water playscape, particularly given the extreme heat. The treadle foot pumps make a game of pumping water, and youth can use them to power both their own fountains as well as to assist their mothers and neighbours doing clothes washing work as they keep an eye on their children.

PROCESS STAGE

1 Rainwater is collected on the towers' wide tops and channelled into the tower for storage for use for the washhouse and fountain. Water supply is supplemented by water pumped from an aquifer.

2 Rainwater channeled through central slot into the wash basin for washing use.

3 If the towers run out of stored rainwater, a bamboo treadle pump is provided for the children and women, respectively, to use to supply both the washhouse and fountains with water from an aquifer.

4 When the washing water is dirtied from laundering, a valve is manually released to empty the greywater from the basin to travel to a water filtration centre.

OUTCOMES

A The water towers provide : A large surface area for capturing rain water
: Rainwater storage for washhouse and fountain supply
: Shade from the sun (Port-au-Prince's mean daily high is 32 ºC)
: A safe place for children to place while their mothers work nearby

B Washhouse

LABELS

C Bamboo screen is a locally-grown cladding that provides shade and privacy while allowing natural ventilation to pass through.

D Users push button to activate fountain for 1 minute.

LEGEND

Fountain Water

Rain and Aquifer Water path

Greywater path

Inputs

Outcomes

Stormwater

Construction

Shelter

Recreational Area

Recycling

Job Creation

PRECEDENT : PERMANENT COMMUNITY WASHROOMS
I.O.M. : INTERNATIONAL ORGANIZATION FOR MIGRATION
THROUGHOUT PORT-AU-PRINCE

Fig. 4.78 : Permanent Sanitation Facilities funded and constructed by IOM, Cité Soleil

Fig. 4.79 : Permanent Sanitation Facilities funded and constructed by IOM, Cité Soleil

Fig. 4.80 : Permanent Sanitation Facilities funded and constructed by IOM, Croix des Bouquets

Prior to the influx of aid-funded projects following the earthquake in 2010, Port-au-Prince has had virtually no public washrooms, and in general has always had a very low calibre of sanitation provision. Among the many projects that the International Organization for Migration, IOM, has developed in Port-au-Prince are 175 permanent community toilets that they funded and constructed. IOM has also built an abundance of temporary toilets, sinks and showers in IDP (Internally Displaced Persons) camps that arose following the earthquake, but those are decommissioned as the camps are emptied.[193]

In 2011, 175 permanent community toilets were constructed by IOM in densely populated areas where space limitations do not permit the construction of individual family toilets.[194] IOM's toilets are elevated, lined pit latrines which, by their design, prevent surface and groundwater contamination, which is typical of latrines. The latrines are of concrete block construction and need to be de-sludged, i.e. emptied of their contents, every 5-10 years. In locating the toilets, Port-au-Prince Water Sanitation and Hygiene (WASH) manager, Nicole Klaesener Metzner, says that less dense residential areas are less receptive to community toilets as inhabitants wish to have one of their own, whereas a dense area such as a slum is an ideal site as it is nearly impossible to find space to build a toilet.[195] Appropriately, the design thesis community toilet proposals (Component 9, p. 66) are proposed first in the most underserved, dense neighbourhoods, namely slums, as shown in the phasing diagram, figure 4.9 on page 73.

Management of a shared toilet is key; if no one is designated in charge of it, it will not be maintained.[196] IOM ran community organizations through a rigorous selection process to decide whom to give the toilets to, and upon completion of construction, immediately handed them over to the organizations to manage. The idea is to find a program that can utilize the toilet, such as a market or school, provide the toilet to them, and let the surrounding community, as well as the program, benefit from its use. IOM also worked with the organizations to train them in managing the latrines (ex. to contract someone for cleaning and periodic de-sludging) and turning them into a small business (ex. charge a small fee per use). IOM's model is a key strategy utilized in the thesis design proposal for both toilet proposals and all proposals: pair complementary programs together that serve one another and create a productive business out of the intervention to generate the funding necessary to maintain itself. Furthermore, as is the case with the thesis design proposals, the project is initiated with aid funding, and once running, generates its own revenue to operate independently.

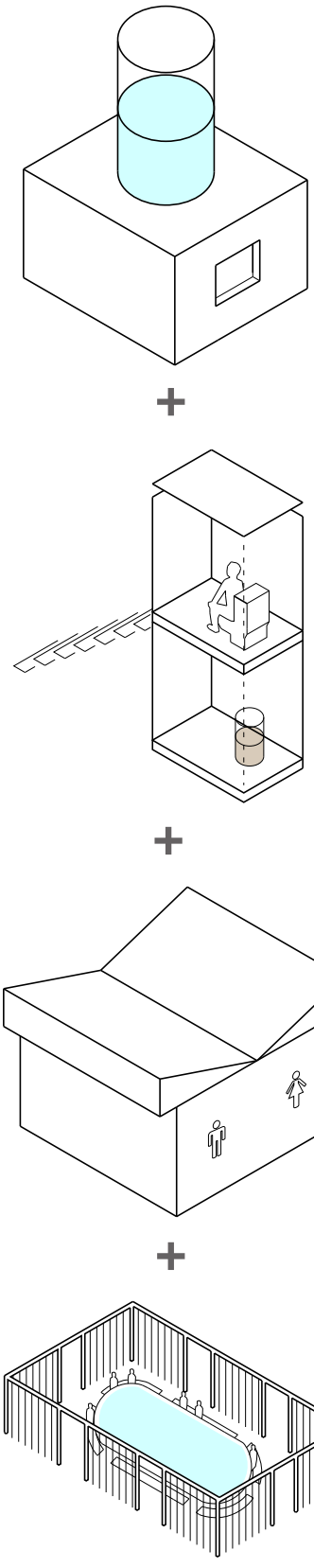
When asked her opinion on the idea of proposing community composting toilets in Port-au-Prince, Nicole Klaesener Metzner echoed the thoughts of Corinne Coe of SOIL (p. 113-114) and Lisa Smyth, Sanitation Consultant (p. 100), who work in the industry in Port-au-Prince. Klaesener Metzner agreed to the brilliance of composting toilets if one has a use for the compost, which is why the thesis design proposal components are designed in tandem with composting and agricultural programs (ex. Combination A, p. 81-94; Combination E, p. 123-126). Klaesener Metzner also noted that composting toilet projects are typically driven by outsiders rather than it being the users who are interested in initiating them. Port-au-Princians are generally turned off by composting toilets as they are unfamiliar, they expect them to smell, and the idea of using compost made from human waste in agriculture is unappealing. As Coe said, this is why education in composting toilets is extremely important; the toilets work well, their waste becomes productive and is diverted from waterways and landfills, the waste actually does not smell, and it can yield productive, nutrient-rich compost.[197]

G COMMUNITY WASHROOM

Fig. 4.81 : Example of 1 - Public Water Fountain, Delmas 33

Fig. 4.82 : Example of 8 + 9 - Composting Toilet for Community Org. + Soccer Field, Cité Soleil

Fig. 4.83 : Example of A - Communal Clothes Laundering, Port-au-Prince



1 Water Tower and Filtration

8 Dry Composting Toilet (a.k.a. UDT: Urine Diverting Toilet)

9 Community Washrooms

A Washhouse

Figure 4.84 : Components and Programs paired in Combination G

G COMMUNITY WASHROOM OVERALL SCHEME 1:500

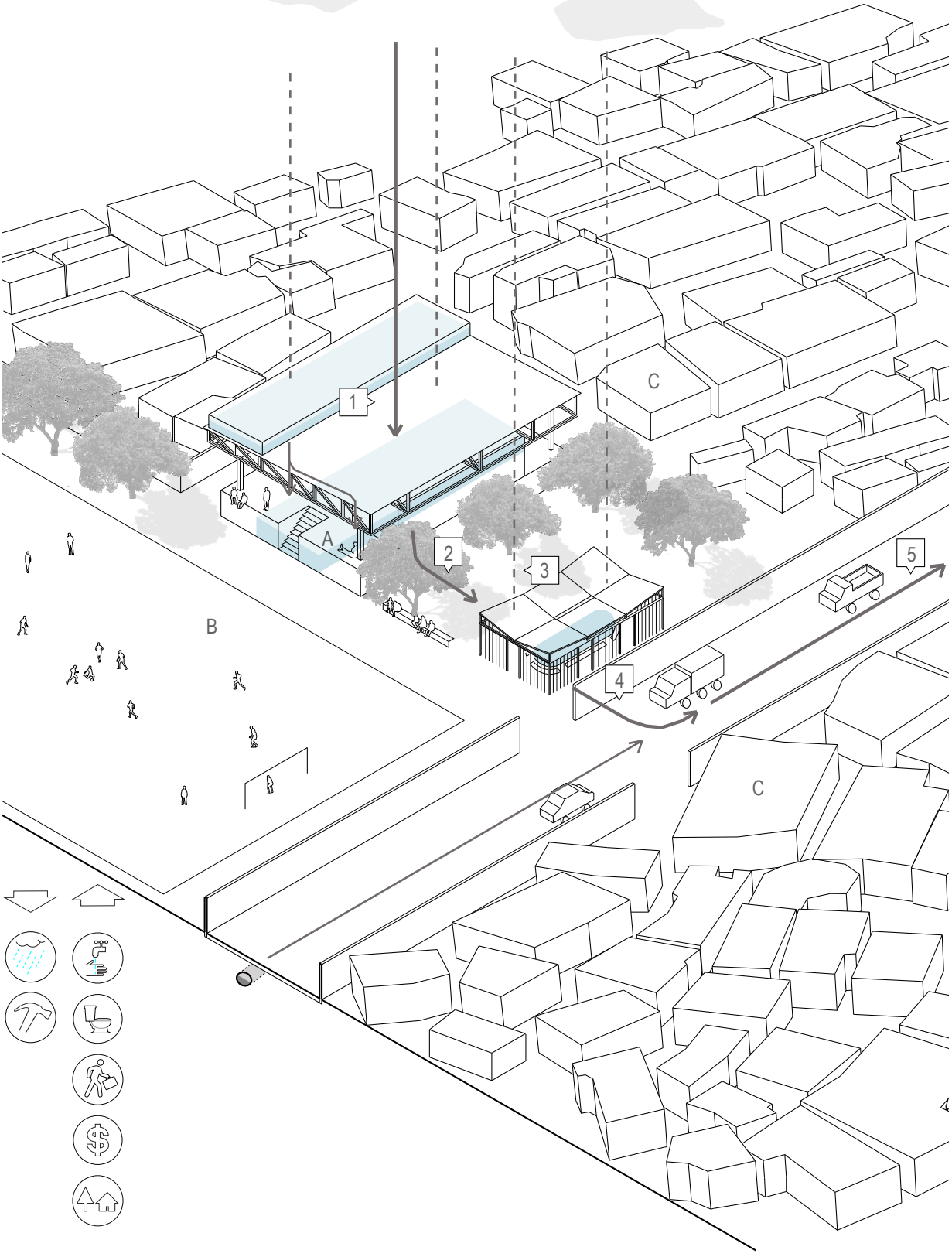


Figure 4.85 : Combination G - Community Toilets and Showers Overall Scheme

PROJECT DESCRIPTION

This proposal is the pairing of water filtration and storage, community toilets, showers, and a washhouse. The four form a water network whereby the water is collected from the community washroom's roof, filtered, fed into the building's sinks and showers, and after use, sent to the washhouse to be used for laundering clothes. Both collecting rainwater and re-using it for lower-needs purposes reduces operation costs and dependence on the supply of non-potable water as well as provides stormwater management (which reduces erosion and flood risk).

Providing community toilets is a viable proposal, i.e. people would use them, if they are given an affordable, safe opportunity to. Former Sanitation Consultant at Architecture for Humanity in Port-au-Prince, Lisa Smyth, says, "People don't perceive community toilets as 'improved sanitation,' but if it's safe and serviced, people will use it."[198] Currently, even in Port-au-Prince's informal settlements, most people do have access to toilets to use (most commonly pit latrines), and those who do not have their own toilet share them with their family, friends, or neighbours.[199] However, under the cover of dark, leaving one's home to use the toilet isn't necessarily safe, so a bag or vessel inside the home is the method used in lieu. Providing a well-lit, guarded washroom safely accessible to one's home provides a more dignified option. Furthermore, in a public setting, there are virtually no public washrooms in Port-au-Prince, and in outdoor public spaces in particular, they would be highly desirable (ex. adjacent to a park, market, sports field, etc.).

MANAGEMENT

Providing these paired amenities would generate a new place of recreation, socialization and interaction between neighbours working, playing, relaxing, and using the facilities. The site would become a productive social condenser.

An important part of this proposal is the ownership of the toilets, showers and washhouse, as, in the case with any publicly used program, unless someone is in charge of it, it will not be maintained.[200] By charging a minimal fee per use, maintenance and security provision can be covered. As with all of the proposals, the program needs to be owned and managed to function properly and consistently. The strategy here, as in all of the proposals, is to provide infrastructure within a program that can function as a business and at times in addition to serving an existing program (ex. a sports field or church), providing incentive for the owner to maintain it.

PROCESS STAGE

1. Rainwater is collected from the community washroom roof, filtered, and used in sinks and showers.
2. After these uses, the (now greywater) travels to the adjacent washhouse for a task with lower water-quality requirements: washing clothing. The water fills the washhouse basin for laundering, and the basin is emptied when the water is saturated.
3. Washhouse roof collects rainwater to supply laundering needs.
4. After use laundering, the washhouse users pump the used water out of the basin in the to greywater line and refill the basin with a new supply.
5. Greywater is pumped to the nearest filtration facility and subsequent reed beds for phytoremediation.

OUTCOME

A. Sheltered, shaded entrance space on either end of the community washroom become a public rest and socialization area.

B. Programs are paired with the community washroom and washhouse (ex. soccer field, shown here) to attract another population to the area who can also serve as users of the washroom and washhouse. For example, the athletes will be in need of washrooms and showers, and the children of the women using the washhouse can use the sports field while their mothers work.

C. The community adjacent to the proposal is the primary source of business for the community washroom and washhouse, targeting those who cannot afford a private toilet / shower / washing facility, or who simply want to enjoy the comfort of the improved facilities offered and their social context. The revenue made from the minimal admission fees charged fund the facilities' ongoing maintenance and security.

LEGEND

Greywater and Blackwater

Filtered, Non-Potable Water

G COMMUNITY WASHROOM WATER AND WASTE CYCLES 1:200

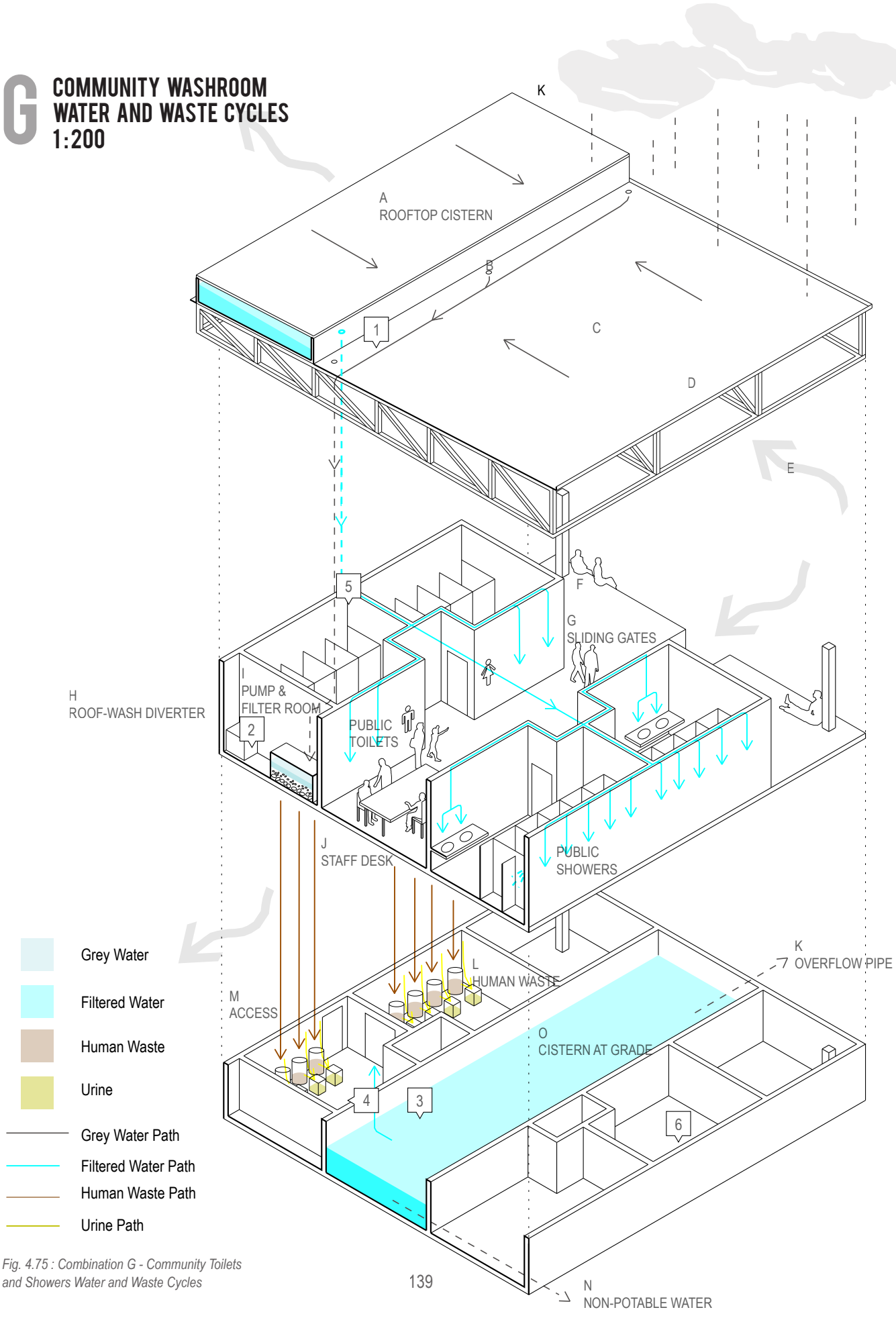


Fig. 4.75 : Combination G - Community Toilets and Showers Water and Waste Cycles

PROCESS STAGE

1 Rainwater travels down sloped roof into openings which channel the water via pipe to the filter and pump room. The entire water processing system from the roof to the cistern at grade is gravity-fed, and can therefore work independent of electricity.

2 Rainwater is gravity-fed into the (gravel and sand) water filter.

3 Once filtered, the water is stored in the cistern at grade. This cistern provides additional storage (a) when the rooftop cistern is full and (b) when the electricity is out (which is a common occurrence) and therefore water cannot be pumped to the roof.

4 When electricity is available, water is pumped to the roof cistern. This is done so that even when the electricity is down, the cistern can gravity-feed the building's water fixtures.

5 Rooftop cistern feeds water fixtures (sinks, showers).

6 Greywater (water discharged from showers, sinks) is sent to adjacent washhouse for use in laundering before returning to the water network for filtration and re-use.

LABELS

A Rooftop Cistern Capacity = 83,000 L (83 m3)
The cistern's black lid naturally heats water via the sun (Port-au-Prince has 3050 annual sunshine hours, compared to Toronto's 2045 hours / year).

B Gutter guard installed at pipe entrances to prevent large debris from entering the system.

C Smooth metal roof collects and directs rainwater. Suggested materials: untreated stainless steel or factory-enameled galvanized steel.

D Metal lip around roof perimeter contains rainwater. Sloped roof directs water toward drain that feeds water into filtration and pump room below.

E Natural Ventilation provided through open-air circulation space and 1.0 m clerestory above showers and toilets.

F A sheltered, shaded and naturally-ventilated outdoor public space is created on both ends of the building.

G Sliding gates at each end of the building entirely seals off the community washroom when it is closed.

H Gutter contains manually-opened Roof Wash Diverter. To use, flap is manually closed after the first rain following a long dry spell, and open during dry spell to minimize pollutants collected on roof during dry spell from entering the system.

I Water pump and filter room.

J Desk for staff (2): custodian and fee collector; security guard. The building is open and manned 24h / day.

K Cistern's overflow pipe feeds into adjacent ravine / canal.

L Compost barrels and urine jugs replaced with clean, empty vessels when full by waste management staff (external organization commissioned by community washroom operators). Storage room accessed from exterior doors at grade.

M Ground-level access doors to 2.0 m high storage room allow for removal and replacement of human waste barrels and urine vessels.

N Access line to non-potable water supply, as necessary (ex. in dry season / drought).

O Cistern at Grade
Capacity = 200,000 L (200 m3). Combined with the rooftop cistern (83,000 L), the two can store 283,000 L, which exceeds the required storage capacity of 253,000 L (equivalent to 1/4 of the estimated annual water needs).

WATER CALCULATIONS

Design Precipitation = (2/3)(Average annual precipitation)
= (2/3)(1440 mm) = 960 mm
Roof Catchment Area = 336 m². Yield, given design precipitation of 960 mm/ yr (a dry year) = 235,000 L/ yr
Annual rainwater yield = 25% of projects annual water needs. Remainder could be supplied by water tanker truck, and / or harvested rooftop rainwater if in used in conjunction with neighbourhood rooftop water collection.

WASHROOM SINK
WATER CONSUMPTION
Users (400 uses / wk) + Staff (56 uses / wk) = 456 uses / wk
Tap Flow Rate (low-flow faucet): 3.8 L / min
Tap Water Use = 4495 L / wk
= 233,740 L / yr

SHOWER WATER CONSUMPTION
Users: 310 uses / wk
Shower head Flow Rate (low-flow): 7.6 L / min
Shower Water Use = 15,389 L / wk
= 800, 260 L / yr

CISTERN SIZING
Total Water Use (sink + shower) = 1,034,000 L/yr
Cistern Size = 1/4 annual water needs
= (0.25)(1,034,000 L)
= 258,000 L

5.0

CONCLUSION

Fig. 5.1 : Tabarre Market
Architecture loses its importance as Haitians will appropriate the space available to suit their needs.

DESIGN APPROACH

It is the author's belief that the design proposal presented in the previous chapter hovers between theoretical and pragmatic design. It is rooted enough in the reality of Port-au-Prince to be appropriate, context-sensitive and a viable business model, but it questions standard business practices and pushes the expectations of infrastructural services and amenities to perform at a higher level in terms of economic sustainability and environmental sustainability, to be accessible to more people and to fuel the development of local businesses. The thesis is generally not focused on the specifics of the design itself, but on using the design as a tool to express a new way of implementing and managing projects that are designed to become self-sustained businesses and develop local micro-economies to fuel the Haitian economy.

WORKING WITH AID

The designs operate in a context that remains rich in foreign aid funding and NGO workers, and are intended to be funded in the way that projects of this nature in Port-au-Prince are typically funded: by aid. An abundance of funding was spent after the 2010 earthquake in the relief phase of aid, providing supplies and professionals for things such as medical assistance, food, water, sanitation, and temporary shelter. Unfortunately, aid was spent on relief purposes for months and even years after the earthquake, when these needs should be met within the first few months of a natural disaster. Continuing to use aid in this way meant that no lasting improvements were achieved, and the process generated a role that needed to continually be filled. While there were and still are tens of thousands of Haitians who cannot meet their own basic needs, to continue to hand out supplies is not solving the larger issues; it merely provides a temporary crutch. Likewise, aid does not solve larger issues of poverty; it merely provides short-term alleviation.

Ideally, one would initially have aid relief serving immediate needs following a natural disaster for a short period of time while working on the fundamental issues that are causing the instability in the meantime. These are broader issues such as improving medical and sanitation provision and quality, improving the educational system to produce better-trained professionals, developing a more robust legal system and the bodies in place to enforce it, increasing transparency in government, and instilling environmental reforms. What has been created by flooding the market with unprecedented foreign aid and NGO workers is a dependency on resources that will soon leave. Unfortunately, in Port-au-Prince there was a massive population who could not meet their own basic human needs even before the earthquake and they, along with those that are newly homeless and jobless as a result of the earthquake, will provide an ample audience to continue to accept free hand-outs.

Although hand-outs need to desist, this bottom-up strategy is the model that is desirable to continue in order to deliver assistance into the right hands, as Haiti boasts the world's second most corrupt country,[201] and earthquake aid has been taking years to reach Haiti, let alone the end recipients. Less than half of the $10 billion USD pledged to Haiti has arrived, but it will make it to Haiti eventually,[202] and therefore despite the destitution of the government, there will be funding available for projects. This money would be best spent on projects that empower Haitians to improve their conditions themselves.

INFRASTRUCTURAL INTERVENTION

The area of development that is imperative for Port-au-Prince to address, and that is the focus of this thesis, is infrastructure, and the subsequent development of micro-economies. The proposal follows the desirable method of operation described in the introduction to the proposal (p.62-64): project funding is provided by a private or government funder to construct and start-up the project and, once completed, the project would begin receiving and processing wastes and/ or water, serving its users and funding itself either with the revenue charged for the use of the facility or from the revenue generated from the sale of the processed, wastes. Because the design proposals all produce revenue, they are able to contribute to funding their own maintenance and thus empower themselves, as local businesses, to be self-sustaining.

> PROPOSAL MANAGEMENT

The project funders, NGOs and NFPs, whose funding comes from private and government sources, would determine a district to work in and then arrange a community meeting through the community's established groups and organizations. Each NGO has a unique focus and thus will enter the project with its own idea of what to propose, but the meeting's purpose is to present these ideas and establish whether the community is interested in such a proposal, and to get their input on what the community's needs are. This, and subsequent meetings, would provide opportunity for the community representatives to voice their suggestions for design proposals, and how best to implement and integrate them. The community would be the best source of insight into what would be beneficial for them, and how it could be implemented within a challenging context (ex. how to prevent a proposal from falling under gang control, how to protect it from theft and damage, how to ensure the users' safety, etc.). The community would also be a valuable source of suggestions for what programs and organizations would best pair with the desired infrastructural proposal. For example, a waste drop-off kiosk might best be located next to a collection of private artisan workspaces that they are familiar with, and a cell phone charging station may be a great addition to the building. Or perhaps they could suggest what school and surrounding neighbourhood would best benefit from toilets and a water filtration program, given the recent changes in municipal provision, or school operation. From there, the NGO can seek out local organizations and businesses to be the project recipients, or organizations can apply to be selected. The latter is typically the case for well-established NGOs and projects. The types of groups selected to receive

the projects would be schools, churches, land owners of recreational grounds and gardens, waste processing companies, and market building owners.

Once an owner is selected, the project is designed with input from the owners and the community who will use it. It is then built, and the NGO details the manner in which the project should be operated, maintained, and run like a business. Afterwards, the project is handed over to the group, and the NGO's role is complete.

Jobs produced in the operation and maintenance of the facility would be stipulated in the project contract to be contracted locally, whenever possible. As Port-au-Prince's economy is generally informal, these positions would likely be advertised and filled through personal and organizational connections, and word-of-mouth. The owner would compose groups of maintenance and operation staff personally, or they would hire a manager to do so.

Upon completion, the projects would be open to those that the project was designed for: the facility users and the surrounding neighbourhood. In the case of a school, users would be the students and staff during school hours, and the neighbourhood in the evenings and weekends. In the case of a waste processing facility, the grounds would be used by staff, and customers from the district would arrive to deliver and purchase sorted wastes for re-use, respectively.

Once operational, a challenge arises in ensuring that the project remains operated, maintained and used in the way that it was designed. This is most likely to be achieved when it is desirable to the owner to continue using it in its intended manner because it is profitable (ex. a sports facility's athletes would benefit from a toilet and water filtration centre), and when an owner with a proven reliable history is selected.

> LOGISTICS

It is important to note that water, sanitation, and electrical infrastructure is typically subsidized by the government to cover operation costs; the income for use from customers alone is insufficient to cover operational and management costs.[203] Therefore it is reasonable if the proposals need financial assistance to operate, particularly when they are initially establishing themselves. Ideally the projects would operate without subsidies, but the goal is not solely to operate independently, but to reduce dependency on less-sustainable outside sources or water and waste management, to offer more environmentally friendly and sustainable infrastructural options, to provide infrastructural services to those who could not normally afford it, and to produce more local micro-economies, which work well in Haiti.

This is an architectural proposal as opposed to a business plan and therefore the design is not detailed to the level of calculating operational costs and revenue, but many projects of this nature have been done by non-profit organizations and are currently operating successfully in Port-au-Prince. For example, SOIL (p. 113-114) has several toilet projects in which they collect and process human waste into compost and sell it for agricultural use; IOM (p. 133-134) has funded

the construction of numerous community toilets that have been paired with local organizations who own and operate them; Tap Tap Garden (p. 121-122) in Cité Soleil is run by volunteers for the non-profit, Pax Christi, and the garden's produce feeds local children.

Although this series of systems is proposed for Port-au-Prince, Haiti, they are fundamental infrastructural components and networks that would be appropriate to replicate in a wide range of contexts. The intention is that this adaptable kit of parts would act as catalyst for a systemic model of infrastructural intervention.

ENDNOTES

Fig. 6.1 : Tap-Taps (Public Transit), Port-au-Prince

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