April 30, 2001

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Dear Sra. Díaz:

Enclosed is our report entitled Establishing a Forest Reserve for Environmental Education. It was written at Janssen Ortho LLC during the period March 12 through April 30, 2001. Preliminary work was completed in Worcester, Massachusetts, prior to our arrival in Puerto Rico. Copies of this report are simultaneously being submitted to Professors Arthur Gerstenfeld and Susan Vernon-Gerstenfeld for evaluation. Upon faculty review, the original copy of this report will be catalogued in the Gordon Library at Worcester Polytechnic Institute. We appreciate the time that you have devoted to us.

Sincerely,

Amy Fuller	Alison Hughes	Patrick Saggal

Establishing a Forest Reserve For Environmental Education

IQP Report Submitted to:

Professor Arthur Gerstenfeld

Professor Susan Vernan-Gerstenfeld

By

Amy J. Fuller Alison Hughes Patrick Saggal

_____ _____ _____

In Cooperation With:

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April 30, 2001

This project report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed are those of the authors and do not necessarily reflect the positions or opinions of Janssen Ortho LLC or Worcester Polytechnic Institute. This report is the product of an educational program, and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be construed by the reader as a working document.

ABSTRACT

This project was commissioned by Janssen Ortho LLC in order to establish a forest reserve on the grounds of their pharmaceutical manufacturing facility in Gurabo, Puerto Rico. The project team assisted Janssen in developing a forest reserve representative of indigenous and exotic growth that can be used as an educational resource by the surrounding community. The project team evaluated the species of trees present, determined a list of potential species for integration, developed a plan detailing the contents and background of the forest, and conducted interviews with species identification experts, local educators, students, and neighboring residents. As a result, we developed a comprehensive tour guide training manual and educational material for distribution.

AUTHORSHIP PAGE

The writing of this report was a collaborative effort by all three team members. Although all sections were originally written by one individual, significant revisions were made, transferring authorship from the individual to the group.

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EXECUTIVE SUMMARY

One objective of companies today is to improve relations with the surrounding community. Johnson & Johnson has implemented a worldwide community outreach initiative in order to do this. The only requirement of this initiative is that the company must do something that benefits the environment and the community. The community may be directly or indirectly involved. Janssen Ortho LLC, a division of Janssen Pharmaceutica and subsidiary of Johnson & Johnson, has elected to directly involve the community by establishing a forest reserve to be used as an educational resource. The main objectives of the project included evaluating the current ecosystem by identifying all the trees present, developing a "Plan del Bosque", and developing educational material such as signs, handouts, and interactive material.

There are additional benefits to this project upon completion of the forest reserve. Since the three-acre area of land lies on the outskirts of the facility, the forest acts as a buffer zone between the adjacent housing development and the buildings of Janssen. The establishment of the reserve helps Janssen move towards compliance of ISO 14001, a certification based on sound environmental practices, and improves the appearance of the facility. Also, Janssen is able to preserve and protect the environment while providing the community with an educational resource.

To complete the aforementioned objectives, we identified the current species, interviewed land management experts, local educators, students, and residents of the housing development, and studied other similar reserves.

In order to identify the current species, we nondestructively marked all of the trees with numbered tags as to ensure that we did not identify a tree more than once. We took samples of the trees, which included small branches that bore leaves, fruit and/or flowers. These samples were compared to field guides and taken to a herbarium technician for proper identification. Through this process we have identified 281 of the 316 trees in the reserve. Our recommendation is that a private contractor be hired to complete the species identification process.

We obtained sample management plans to use as guides in the development of the plan tailored to Janssen's forest. The plan developed is titled a "Plan de Bosque." The Spanish phrase is used because the connotation of the word "Bosque" does not translate directly to the English "Forest." The plan includes climatic information of the Gurabo area, a list of the species present in Janssen with a written description of each, a map of the locations of all trees, maintenance guidelines for the reserve, and the benefits of the forest.

For the development of the educational material, we conducted interviews with local educators and students. Every educator stated the best way for the visitors to learn the material is through hands on activities. All the students we spoke to in the environmental clubs at the high school and middle school made suggestions as to what activities would interest them. The students are also eager to participate in the establishment and maintenance of the forest.

We interviewed residents in the adjacent housing reserve regarding their opinions or any concerns they may have on the further development of the reserve. All comments were positive all the residents interviewed liked the idea of a reserve at Janssen. It is the

general opinion of the residents that the area will serve as an effective educational resource for the community that they plan to use.

We were able to benchmark Janssen's reserve with similar reserves in Puerto Rico. The reserves studied include IPR Pharmaceutical, University of Puerto Rico Botanical Garden, and the Humacao reserve maintained by Departamento de Recursos Naturales y Ambientales (DRNA). Studying these reserves, we were able to obtain information concerning the general operation of the reserve, materials for signs and paths, as well as educational information.

We recommend that tours of the reserve be given by appointment only and by Janssen employees who volunteer their time. Employee participation in the volunteer tour guide program would need to be approved by the employee's supervisor so that the efficiency of the facility is not compromised. The tour guide should follow the training manual that we have developed. This includes verbally explaining characteristics of the area and the trees, as well as conducting selected interactive activities with the visitors for educational purposes to keep them interested. Educational information should not only be received from the tour guide verbally, but also through the distribution of pamphlets, written materials, and other activities. We developed suggested distributive materials and proposed interactive activities to meet this need.

Using the tour guides as educators is vital to the success of this reserve. One of the primary goals of the reserve is for it to serve as an educational resource. Tour guides will be an integral part of educating the visitors about the contents of the reserve and general environmental awareness. To this end, the reserve will also serve as an environmental educational resource for the Janssen employees. By volunteering as tour

guides, the employees will be increasing their own environmental awareness and can bring this knowledge and insight to spread within their departments as well.

We are confident that the reserve will be visited by many groups of school children since there was great excitement regarding the reserve when we conducted interviews at the local schools. It would be a great benefit to involve the students in any way possible with the establishment and maintenance of the reserve.

Integrating new species into the reserve should be done very sparingly because there is limited space and the current trees are only six years old and still need room to grow. If species are to be integrated, they should be endangered species so visitors become more aware of the significance of endangered species. Following the possible integration of new endangered species, an educational unit focusing on endangered species should be developed.

We have designed a path for the reserve. It should be made of brick, cement, or cobblestone to ensure handicapped accessibility. Also, the route of the path should not be straight because the reserve is fairly small. A winding path proves more beneficial because the visitors can view more trees and it lengthens their stay, providing more opportunity for learning and viewing.

Janssen has shown its commitment to the environment by creating this reserve. By using this land for the creation of a forest reserve and preventing expansion of the facility in the direction of the reserve, the reserve will serve as a permanent reminder of the importance of conservation efforts to all Janssen employees and the residents of Gurabo.

1.0 INTRODUCTION

One of the objectives of companies today is to improve relations with the communities in which they reside. Johnson & Johnson has implemented a community outreach program to meet these needs. The intent of this program is to forge a mutually beneficial relationship between corporate entities and communities. Worcester Polytechnic Institute (WPI) is working with [*]Janssen Ortho LLC, a division of Janssen Pharmaceutica and subsidiary of Johnson & Johnson, to create a background plan detailing the history and contents of the reserve and establish an educational resource for the community using the wooded area surrounding the Gurabo, Puerto Rico manufacturing plant. In addition to greatly benefiting the local community, Janssen will fulfill its obligations to the parent company and set the standards for other companies with similar interests.

Janssen Ortho LLC is sponsoring this project in order to comply with the worldwide initiative mandated by Johnson & Johnson. Johnson & Johnson has asked all of its plants and subsidiaries to put an environmental action plan in place that will benefit the communities in which they are present. Janssen saw the need to show its commitment to environmental responsibility by setting up a forest reserve which will improve the appearance of the facility, create a buffer zone between the facility and the surrounding houses, lead to compliance with ISO 14001, make a contribution to the community, and preserve and protect the environment. Janssen first sponsored a WPI project in May of 2000 that incorporated environmental aspects into all of the job

[*] This report was prepared by members of the Worcester Polytechnic Institute Puerto Rico Project Center. The relationship of the Center to Janssen Ortho LLC and the relevance of the topic to Janssen Ortho LLC are presented in Appendix A.

descriptions at Janssen Ortho LLC in order to comply with ISO 14001, the environmental management plan outline for organizations.

The objectives of our project were diverse and were divided into two major components. The first major component is the environmental assessment. This is of great importance to our project because it enabled us to determine what species of trees were currently in the reserve and to create the "Plan de Bosque." In order to complete this part of the project, we identified and catalogued the tree species present in the intended area for the forest reserve. Next, we consulted with experts from the University of Puerto Rico and the Departamento de Recursos Naturales y Ambientales regarding the introduction of new species of flora into the area to make it more representative of indigenous growth.

The second major objective was to design the area as a place that school children and other residents can visit to learn about indigenous and exotic growth of Puerto Rico. We established plans for a path for visitors to traverse the area. We also made recommendations based on feedback from educators and environmental experts in the area to develop a curriculum to accompany the site.

It is clear that the local community can benefit greatly from this project. Janssen has identified a need in the community for environmental education and plans to use the reserve to address this need. In addition, Janssen will fulfill its obligations to the parent company, Johnson & Johnson, by making a contribution to the community and preserving and protecting the environment. Also, other companies pursuing similar initiatives will have the opportunity to benchmark against the standards set by Janssen Ortho LLC. It is our intention that the reserve can be used for research by colleges and

secondary schools in the area as well. We hope that one of these groups or a future IQP group can conduct a follow-up study about how successful the introduction of new species to the site was based on our recommendations and how well the educational components are serving the community. Further evaluation of the site after our initial recommendations and the subsequent implementation can serve to improve the performance by Janssen, as well as serve as an educational outlet to university students.

This project for Janssen is being directed by WPI as an Interactive Qualifying Project (IQP). The IQP is a degree requirement for all WPI undergraduates and serves as a chance for students to examine the intermingling of science and technology with societal implications. WPI sponsors many project centers across the world, including sites in Europe, Asia, Australia, Latin America, and in the United States. This project meets the criteria of the IQP because it is focused on the scientific foundation of species identification and landscape planning, as well as the societal aspect of education for the benefit of the surrounding community.

2.0 LITERATURE REVIEW

As discussed in the introduction, there are three major goals of this project. The first is to assess the current environmental status of the land that Janssen Ortho LLC intends to use as a forest reserve. The next is to develop a plan for the implementation of the forest reserve based on the environmental assessment. The final goal is to use the reserve to educate the surrounding community. The educational component is the most important part of the project, but the land inventory and assessment must be completed before an educational action plan can be implemented. In addition, there are five major outcomes of the project that will naturally occur as the project is implemented. To this end, our team conducted research in several areas including the native species and environment of Puerto Rico, techniques of environmental assessment, conservation, environmental restoration, environmental management, ISO 14001 standards, accessibility standards, and education about environmental benefits of conservation and protection.

We discuss the climate and flora to allow the reader some background on the characteristics of the Gurabo area. In reviewing literature regarding ecological assessment methods, we provide background about the current state of the area and include information about specific methods for species identification. We research conservation techniques to gain a broad-based knowledge of factors that go into deciding which new species to integrate. The information that we provide about environmental restoration serves as an outline of the goals for integrating new species into the site and what needs to be done to make them representative of naturally occurring indigenous forest. Also included is a discussion of biodiversity and human interaction to show how

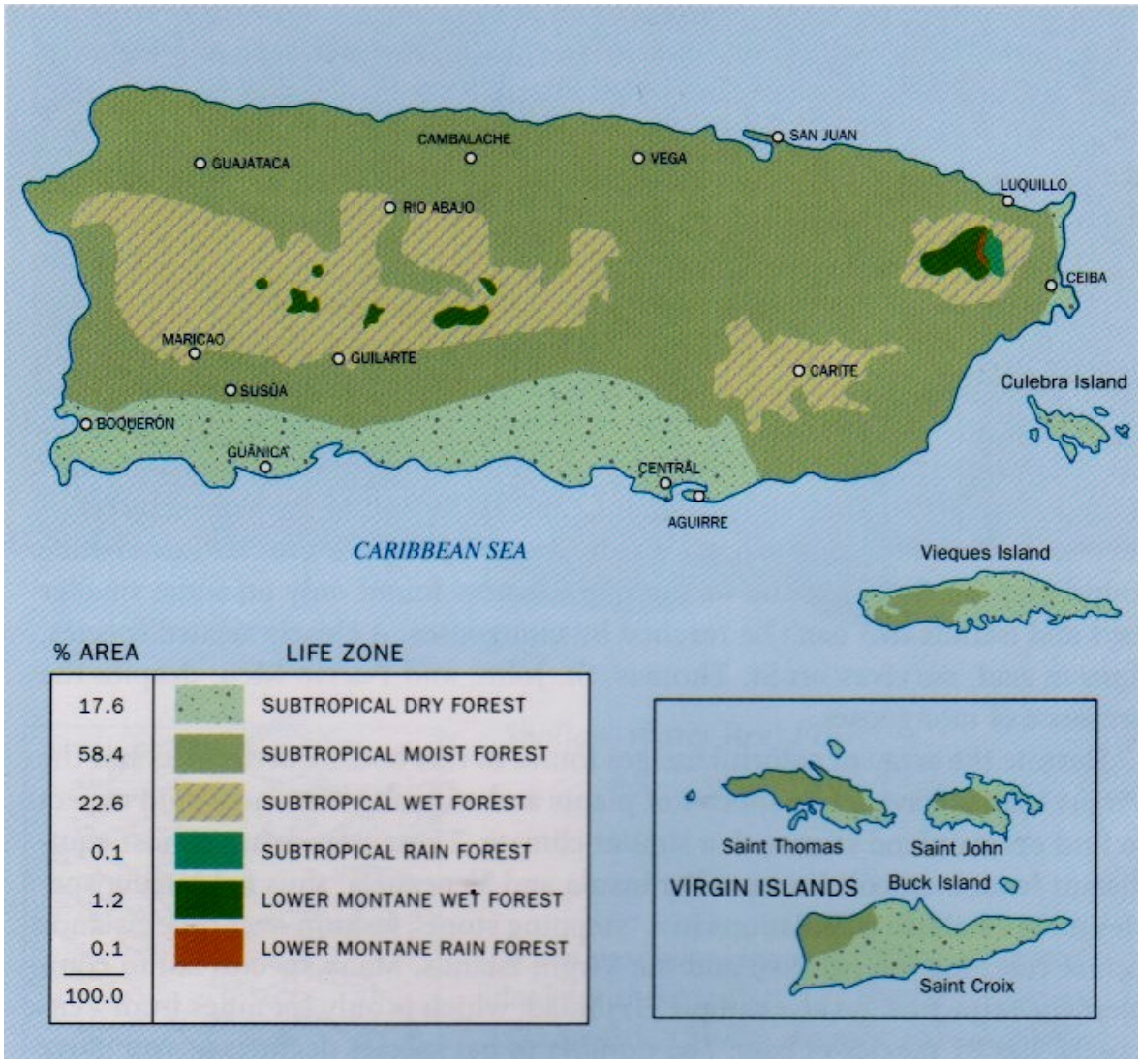
they can be factors in the approach taken to preparing the conservation area. We discuss ISO 14001 to explain how the development of the forest reserve can help Janssen achieve certification. The standards for handicapped accessibility provide a framework for making the design of the reserve compliant with applicable laws and accessible to the entire community. Environmental education evaluation provides background information on how an educational plan can be implemented to benefit the surrounding community.

2.1 Climate and Flora

The climate and flora in Gurabo, Puerto Rico, where Janssen Ortho LLC is located, are of great interest to us in determining what plants belong in the reserve area. On the island of Puerto Rico, the temperature fluctuation is quite small. However, different parts of the island tend to have different temperatures ranges. Temperatures of inland areas tend to fluctuate more than areas on the coast. This can be attributed to the coastal waters whose temperature fluctuates only from 77.9° during the coolest season to 82.5° during the warmest (Ruffner, 1985). The average temperature on the island ranges from 68° to 80° (Rivera, 2001).

Since different parts of the island have different types of weather, biologists who are experts on the flora and fauna of Puerto Rico have divided the island into six regions. These regions are the subtropical dry forest, moist forest, wet forest, rain forest, lower montane wet forest, and lower montane rain forest (Wiley, 2001). The subtropical dry forest is located on the southwestern corner of Puerto Rico and is the driest of all the regions. It has an annual rainfall of 23.6 to 43.3 inches. The subtropical lower montane rain forest is located on the slopes of the Sierra de Luquillo. This is the wettest and smallest region of all with an annual average rainfall of 180 inches (Wiley, 2001).

Janssen Ortho LLC is located in North East Puerto Rico within the subtropical moist forest region, in the city of Gurabo. It has an annual rainfall of 63.5 inches. There, the temperature ranges from 65.9° to 86.7° (National Weather Service, 2000) with an average temperature of 78°.



(Silva Lee, 1998)

Figure 2.1: Climatic Zone Map

The trees that are endemic to the subtropical moist forest region of Gurabo are the ausubo, box-briar, common guava, cupey, false mastic, guaba, guama, gumbo limbo,

matchwood, mountain immortelle, palma de lluvia, palo de pollo, Puerto Rico acrocomia, Puerto Rican royal palm, roble blanco, shortleaf fig, Spanish cedar, trumpet tree, tulipán africano, uvilla, West Indian locust, and white prickle (Wiley, 2001). Currently, the reserve contains the roble blanco, the shortleaf fig, the Spanish cedar, and the tulipan africano.

This project requires the planting of plants other than those found exclusively in the subtropical moist forest region. Therefore, we have provided a listing of other native plants and groundcovers that may be found on the island of Puerto Rico. Wildflower Nirvana is a mail-order micronursery located in southern Florida. Their website lists the following native Puerto Rican plants by scientific name: Calycogonium krugii; Hamelia patens; Pentalinon luteum; Piriqueta costoides; Rhabdadenia biflora; Siphonoglossa sessilis; Suriana maritime; Trema lamarckianum; and Turnera diffusa. We recommend in Chapter 5.0, Conclusions and Recommendations, small shrubs and plants to add that will complement the trees present at the reserve.

Many trees, both exotic and native in nature, are found in the Gurabo region. Additionally, planted areas such as the one we are dealing with often include exotic species that would otherwise not grow there naturally, although these trees may thrive in the area following their introduction. We researched trees specific to the reserve established at Janssen following the identification of the trees present. Complete descriptions of the trees at the Janssen site can be found in the "Plan del Bosque" included in Appendix H.

2.1.1 Identifying Potential Species for Integration

Based on their 1998 study, Booth and Jones argue that the use of climatic mapping programs is helpful in identifying species for integration into geographical areas and predicting the likelihood that particular species will flourish in a given area. They conducted extensive research on mean annual precipitation, seasonality of rainfall, length of dry season, average maximum temperature of the hottest month, average minimum temperature of the coldest month, and average annual temperature. As a result of their study, they designed a computer program to identify potential species for certain geographic areas based on the above factors. The software is called LATIN and provides information for Central and South America only. Booth and Jones (1998) assert that climatic mapping programs use technology to streamline the species identification process. The two researchers are careful to caution the reader that the use of this software alone is not a reliable way to identify the best species, but it is a good way to target species to research and to confirm whether species suggested by publications will thrive. See Chapter 3.0, Methodology, for the relevance of this material to our project.

2.2 Ecological Assessment

Myers and Shelton (1980) separate environmental assessment into four main areas. The areas are physical land characteristics, energy and weather, vegetation, and human attitudes. Physical land characteristics include topography, soils, and geology. These properties, Myers and Shelton say, constrain human activities and the development of biological communities, making physical characteristics a natural starting point for analysis. Energy and weather, they continue, encompass radiant energy, air, water, and weather patterns. According to the same authors, these constitute the necessities essential

to any ecosystem and the person doing the ecological assessment should consider them next (Myers & Shelton, 1980). Vegetation is assessed third, after physical features and environmental factors according to their model. Finally, techniques for investigating human attitudes, preferences, perceptions, and activity patterns are necessary for the successful implementation of ecological assessments in accordance with societies' interaction with nature (Myers & Shelton, 1980).

Ecosystems can also be quantified in terms of structure and function. According to Bradshaw (1987), the four main parameters for assessing altered ecosystems in these terms are physical structure, nutrition, plants and animals, as well as toxicity (1987). Bradshaw asserts that soil is the starting point for this process because of its powerful implications in the ecosystem. A soil analysis will not be completed as a part of this project, but it is a topic for recommendation for future ecological assessments to be done by Janssen.

2.3 Types of Conservation

According to one model, plant conservation has two major subcategories, species-by-species protection and habitat conservation (Falk, Millar & Olwell, 1996). Species-by-species conservation can be useful for forest managers in protecting specifically endangered species. Habitat conservation is a more comprehensive approach to conservation and can often protect several species at once.

Falk, Millar, and Olwell (1996) argue that species-by-species conservation is often difficult and requires detailed knowledge of sites where particular species are known to exist. This type of conservation often blends with habitat conservation, because, often, rare plants of different types can be found growing together. The end

result, the theory tells us, is that protecting the entire area can often protect the individual species as well (Falk, Millar & Olwell, 1996).

According to the model, habitat conservation is the practice of preserving specified areas that contain a comprehensive representation of different naturally occurring types of environments. Careful maintenance and monitoring of these habitats allow warning signs of pests, diseases, and commercial infringement to be found early. Falk, Millar, and Olwell (1996) maintain that the preservation of these areas is the easiest route to having a good habitat site. They argue that it is often a much more difficult task for conservationists to completely reconstruct the ecosystems found in indigenous habitats that have been destroyed. These authors assert that the reestablishment of ecosystems in areas where habitats have been previously eradicated relies in part on guesswork (Falk, Millar, & Olwell, 1996). According to Falk, Millar, and Olwell, the more common trees and plants that should be included in the habitat reconstruction can usually be determined with a reasonable level of accuracy. The researchers caution that the introduction of rare species relies on pure speculation in the absence of historical records (Falk, Millar & Olwell, 1996).

2.4 Environmental Restoration

Environmental restoration seeks to return an ecosystem back to its natural state (Harker et al, 1993). Successful preservation of conservation areas, particularly those being constructed, is highly dependent on selecting the appropriate design according to Falk, Millar, and Olwell (1996) and Baskent and Jordan (1996). This challenge can be addressed in terms of space and ecological community.

According to Bradshaw (1987), restoration can also be identified as the two step process of first understanding what is wrong and then taking the appropriate steps to fix the situation. He considers restoration both a technical and practical process. From a technical standpoint, restoration may have any of the following goals: stabilization of land surfaces, pollution control, visual improvement, general amenity, productivity, diversity, species composition, and improved functionality of the ecosystem. Restoration efforts are only considered ecological when they include the final three goals in this list. Bradshaw presents speed of attainment, cost effectiveness, reliability in attainment, and stability as factors of restoration to be considered (Bradshaw, 1987).

2.4.1 Spatial Principles and guidelines

Baskent and Jordan (1996) maintain that spatial design may be the best way to maintain species diversity in an area. Spatial design takes into account the fact that large areas of natural communities sustain more species than small areas and that regional diversity can be maintained with small patches of natural communities (Harker et al, 1993). Additional considerations presented by Harker et. al (1993) for maintaining diversity include avoiding fragmentation of habitats and providing corridors to connect the communities. Another often implemented aspect of landscape design, according to Falk, Millar, and Olwell (1996) is the use of primary and secondary areas. The primary area is the area that serves as the main habitat and is it at the center of the preservation area. Characteristics of the secondary area are that it surrounds the primary area, it has only a small role as a habitat, and the secondary area serves as a buffer zone. Primary areas house the species selected for preservation, while secondary areas act as a buffer zone to minimize interaction between the primary area and the surrounding land (Falk,

Millar & Olwell, 1996). The reserve area at Janssen will serve as both a primary and secondary area. It is considered the primary area because it is the actual reserve that is the center of the educational area. It is considered a secondary area because it will serve as a buffer zone between the Janssen plant and the houses surrounding the Janssen property.

2.4.2 Ecological Community Principles and Guidelines

Falk, Millar, and Olwell (1996) argue that in order to ensure long-term success, the ecological needs of the priority species must be met. Success can be dependent on having an area large enough to allow for natural processes that species occasionally depend on such as fires, floods, and other natural hazards. Additionally, they continue that landscape designers need to take into account how the surrounding land is used and how usage might affect the reserve (Falk, Millar & Olwell, 1996). According to Harker, Evans, and Harker, other factors that must be considered include full restoration of native plant communities to maintain biodiversity, increasing structural diversity of vegetation to increase species diversity, and increasing diversity of plant species to serve as a food source for the greatest diversity of wildlife. In addition they argue that maintenance of minimum population levels is essential to ensure species survival, and that landscapers should use low intensity land management to minimize cost and sustain the maximum number of species (Harker et al, 1993). These ecological and community principles are effective tools to evaluate the success of the reserve area. It is our intention that Janssen will conduct an evaluation of the ecological success of the reserve as a follow up to our project, and we state that in our recommendations.

2.4.3 Forest Rehabilitation

Lugo (1997) conducted an intensive study of tropical tree plantations. As a result of his study, he suggested using tropical tree plantations for forest rehabilitation in Puerto Rico. Tree plantations are constructed by planting tree monocultures and are known to speed up the process of rehabilitation. Monocultures are already in a state of advanced growth, so they rehabilitate the area faster than it could naturally regenerate. According to Lugo, experts have criticized this method because it does not encourage biodiversity, it has low resource use efficiency, and there is a tendency to use exotic species in place of native species. He conceded that this opposition exists, but also cites a counterargument in favor of tree plantations. The argument presented by Lugo in favor of tree plantations is that tree plantations drastically speed up the land rehabilitation process.

Lugo's study reveals that some of the degraded forests in Puerto Rico were replanted as monoculture plantations, and others were left to regenerate on their own, becoming what is known as secondary forests. Monoculture plantations are agricultural or forest lands that support only a single type of crop or organism (Webster, 2001). Tree plantations, in the study, were shown to accumulate more above ground biomass, and secondary forests were documented as having accumulated more root biomass. The study of the *Pinus caribaea* pine plantation done by Lugo showed that the sum of the above ground and root biomass for plantation and secondary forests were nearly identical, implying that total net production was very close, just not allocated in the same way.

Tree plantations, according to Lugo's study, have both positive and negative aspects. Monocultures have been shown to regenerate forested areas faster than

secondary forests would by natural processes. However, tree plantations are more vulnerable to damage caused by hurricanes. This is because trees are planted in evenly spaced rows that act as wind tunnels and intensify they gusts of hurricanes. Thus concludes Lugo, tree plantations are a viable way to regenerate forests in a more time efficient manner than the natural regrowth of secondary forests, but that certain negative factors such as durability and sustainability should be considered as well.

2.5 Environmental Management

Lugo (1997) and Baskent and Jordan (1996) agree that environmental management is integral to maintaining healthy ecosystems. Environmental management includes working to protect target areas from outside influences. In addition, it encompasses encouraging biodiversity and ecosystem stability.

Integrated resource management is an environmental management method that protects the habitats of various wildlife species, recreational areas, historical sites and ecologically sensitive areas. Baskent and Jordan (1996) argue that integrated resource management has many shortcomings. They go on to assert that the integrated resource management approach often encourages the preservation of areas too small to maintain biodiversity and natural ecological processes (Baskent & Jordan, 1996). In addition, they argue that sectioning off areas for preservation carves up the natural forest area into disjointed pieces.

A new approach being used for the maintenance of biodiversity is ecosystem management, according to Lugo (1997). He asserts that the primary focus is to implement measures that attempt to counteract the problems caused by human activity. Human activity can turn out to be positive or negative, depending on the intent.

Behaviors having positive impacts include conservation and rehabilitation efforts. Negative behaviors include species removal, pollution, and deforestation, and any other behaviors that result in land degradation. The effects of human activity, he continues, also dictate which species will likely flourish in a given area. This means that exotic species, native species, or a combination of the two types must be carefully considered and evaluated against the changing climate and atmospheric conditions that have been altered as a result of human activity.

2.6 ISO 14001 Standards

The International Standard Organization (ISO) is an organization formed by members of numerous countries and includes people from the government and private sectors. ISO 14000 is a series of international standards pertaining to environmental management. ISO 14000 includes the subsection ISO 14001, which deals with the specific requirements for environmental management systems. An environmental management system (EMS), as defined by the ISO 14000 website, is the section of the overall management system that includes organizational structure, planning activities, responsibilities, practices, procedures, processes, and resources for developing, implementing, achieving, reviewing, and maintaining the organization's environmental policy. Figure 1 shows an overview of an EMS. Janssen defines an EMS to all of its new employees as a guide or list of things to do daily concerning the environment in order to reduce environmental risks, maintain compliance with environmental regulations, and improve environmental performance. Janssen's environmental policy is included in Appendix C, located at the end of this report.

ISO 14001 is the only part of ISO 14000 for which a company can attain certification. Although ISO 14001 certification is voluntary, it is becoming more necessary to stay competitive in the global market because companies are receiving more customer and competitive pressure. The fields that lead the way to compliance include electronics, semiconductor, printed circuit board, and chemical suppliers.

ISO 14001 requires companies to develop and maintain a system that includes key components of establishing an environmental policy, determining environmental aspects and impacts of products/activities/services, planning environmental objectives and measurable targets, implementation of programs to meet objectives and targets, checking and corrective action and management review.

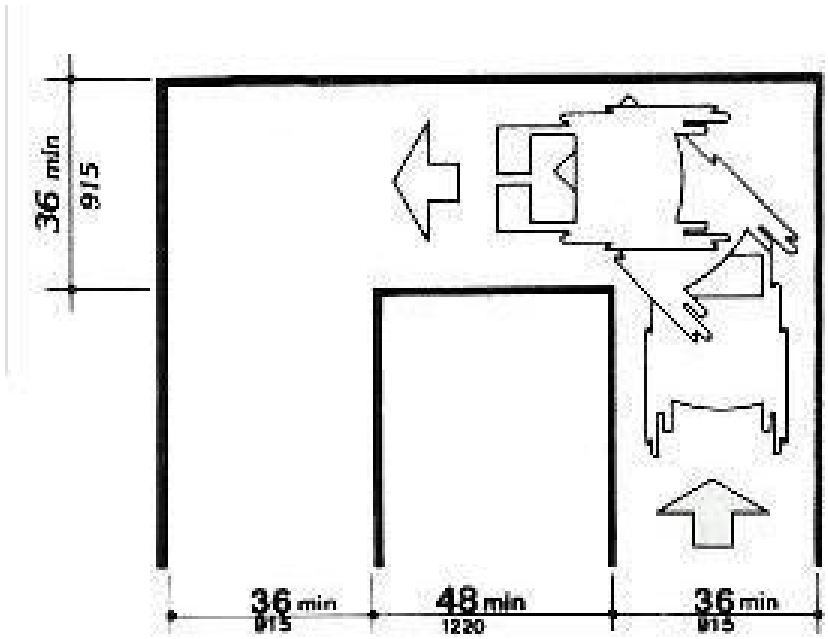
Our project is related to the compliance with ISO 14001 because we developed an environmental program that creates a good partnership with the local community. The forest reserve will be maintained and kept in good condition, and will directly involve the community in the education of indigenous and exotic species of trees.

2.7 Handicapped Accessibility

In order to make the Janssen forest reserve accessible to all potential visitors, we must comply with the American with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).

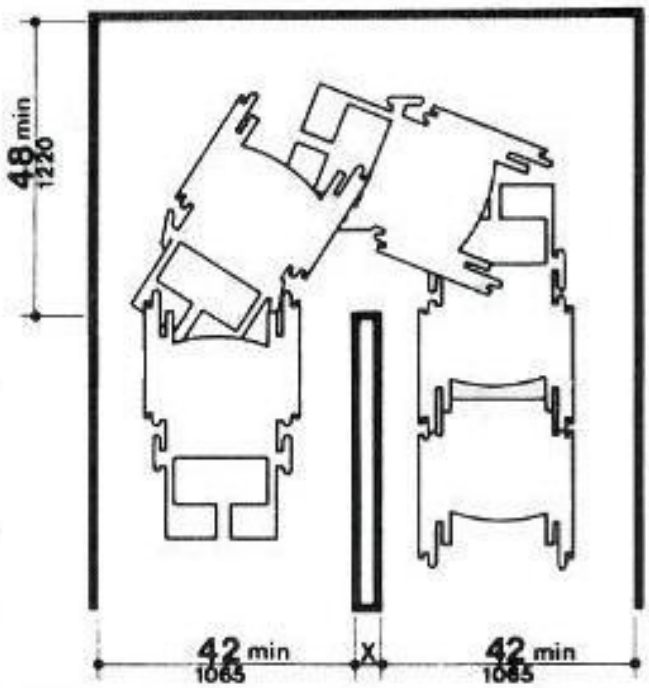
The ADAAG states that all paths must be at least 36 in. in width. In addition, ramps will be a minimum 36 in. in width, not including flared sides. The maximum slope for the ramp is 1:20 (the ramp must be 20 in. long for every 1 in. that it rises) and no ramp can rise more than 30 in. Each ramp needs to have level landings at the bottom and the top of each ramp and ramp run. The landing must be at least as wide as the ramp run

leading to it. The length of the landing must be at least 60 in. Also, if the ramp changes directions at a landing, the landing must be 60 in. wide by 60 in. long, as shown in Figure 3. Figure 4 illustrates the dimensions necessary for a path or ramp that makes a 180 degree turn around any type of obstruction. In this case, the path or ramp must be a minimum of 42 in. on the sides and 48 in. at the pivot point. If a ramp has a rise greater than 6 in. or a horizontal projection greater than 72 in., handrails must be constructed on both sides. Handrails are not required on curb ramps. The handrail must be continuous and have a continuous grip. Ramps and landings with drop-offs need to have curbs, walls, railings or projection surfaces that prevent people from slipping off the ramp. The curbs must be a minimum of 2 in. high (Americans with Disabilities Act Accessibility Guidelines, 1998).



(Americans with Disabilities Act Accessibility Guidelines, 1998)

Figure 2.2: Accessible Route, 90 Degree Turn



NOTE: Dimensions shown apply when x < 48 in (1220 mm).

(Americans with Disabilities Act Accessibility Guidelines, 1998)

Figure 2.3: Accessible Route, Turns Around an Obstruction

The ground surfaces along all accessible routes including floors, walks, ramps, stairs, and curb ramps must be stable, firm and slip resistant. Outdoor ramps and their approaches need to be designed so that water will not accumulate on walking surfaces (Americans with Disabilities Act Accessibility Guidelines, 1998).

Recommendations for handicapped parking spaces we made as well. The following chart lists the number of required accessible spaces based on the total number of spaces in the parking lot.

Table 2.1: Required Handicapped Parking Spaces per Total Number in Lot

Total Number of Spaces in Lot	Required Accessible Spaces
1-25	1
26-50	2
51-75	3
76-100	4

(Americans with Disabilities Act Accessibility Guidelines, 1998)

2.8 Education

One of the motivations for this project is to provide a service to the community by enhancing the environmental education process with an interdisciplinary approach. The environmental education provided to the community by Janssen is not meant to replace other educational efforts in the community, but rather to complement and expand upon the curriculum offered in the local schools and other local conservation efforts. There are numerous directions that can be taken in teaching different age groups, including the use of individual learning styles and the use of case studies. The case studies reviewed in the following section illustrate how knowledge about learning styles and have been included in schools to enhance environmental education.

2.8.1 Learning Styles

According to the Audubon Expedition Institute, a fully accredited traveling university, the best way to learn is through direct experience of the world around us. The Audubon Expedition Institute is accredited through Lesley University, housed under their graduate school/off campus programs. This idea is incorporated into their motto. One middle school teacher from Worcester Public School, Cheryl Lein, agrees that this is an integral part of learning (personal interview, 2/7/2001). Iris Rodriguez, a secondary

school teacher at Escuela Superior Dr. Conchita Cuevas in Gurabo, takes a similar approach to learning. She stresses the importance of learning by doing experiments. She maintains that the best way to learn about something is to directly experience it. Kellough and Roberts (1991) state a more complicated view: when creating lesson plans, to reach all students who have different learning styles, the teacher must incorporate not only hands on learning, but also research and observation.

According to Thomson and Diem (1994), everyone has specific perceptual strengths or preferred ways to process information. They argue that most can process information in many ways but absorb the information best in only one or two ways. Their perspective is that in the early stages of development, children are kinesthetic and tactile learners, moving and touching everything. The authors maintain that as children get older, visual learning becomes more prominent as they gain more information by reading and observing pictures. In late elementary school, they say, most students become auditory learners where they like to discuss and listen. They conclude by saying that in adulthood, the strength switches again back to the kinesthetic and tactual area.

Some of these topics, such as kinesthetics, visual aids, and discussions, are included in the Dunn model (Thomson & Mascazine, 1997). The model divides styles into five major categories called stimuli. Within these categories are different elements that influence learning. According to Thomson and Mascazine, as an individual grows, they come to rely on some elements more than others and teachers can focus on the individual differences of their students by being attentive to individual stimuli.

The categories are environmental, emotional, sociological, physical, and psychological. The environmental category includes light, sound temperature, and room

design. Attention to the teaching environment can include changing the physical layout of the room, and allowing for seating changes with regard to light, and temperature differences. Also, the student may be more inclined to study with music or some sort of background noise, or may need complete silence. Emotional factors are structured planning, persistence, motivation, and responsibility. Teacher Cheryl Lein (personal interview, 2/7/2001) provides anecdotal evidence that supports stressing the importance of emotional factors. She maintains if the student is not motivated and does not have a reason to learn the material, he or she simply will not learn it. Sociological concerns encompass pairs, peers, adults, self, and groups. The type of activity used can address these concerns. Teachers evaluate whether the activities are performed alone, in pairs or groups, with an authority figure, or in a class discussion. Physical attributes to be considered are perceptual strengths, mobility, intake and time of day. To accommodate these learners, Thomson and Mascazine believe that teachers should allow students to work at the blackboard, the bulletin board, or on the floor. The psychological category considers global/analytic, impulsive/reflective, and right- or left-brain dominance. Sequential and analytic learners prefer learning the details of a topic immediately, while global students may need a meaningful overview before the details are covered. The use of stories, jokes, cartoons, and diagrams can help these students view how the details fit into the larger scheme (Thomson & Mascazine, 1997). All of these factors must be considered when establishing the educational material and learning environment at the Janssen reserve. Essentially, the reserve will be an outdoor classroom for students of all ages and educational needs to come and experience the forest firsthand. It is imperative

that the reserve is structured in such a way that it can accommodate people with varied environmental, emotional, sociological, physical, and psychological needs.

2.8.2 Case Studies of Environmental Education

Case studies are an effective way to study learning styles in real life situations. The case studies that follow provide a context for some of the theories presented in the previous section of the literature review. Single case studies are not an appropriate basis for generalizations, but generalizations can be made after considering multiple case studies on similar topics. We reviewed the following case studies in order to present a context for what types of activities would be effective for teaching all age levels at the Janssen forest reserve.

The first two cases, written by Ludwig (1995) and Berg and Redington (2000) were found on www.carolina.com. This is the website for the Carolina Biological Supply Company, which was started in 1927 by Thomas E. Powell, Jr. Powell was a professor who collected natural specimen for his class and realized he could sell the surplus specimen to teachers and professors. In later years, he expanded his company to provide a centralized collection and distribution of educative materials, which today includes science kits, books, catalogs, and software. Carolina Biological Supply Company is relied upon by such agencies as the National Science Resource Center and North Carolina Zoological Park.

Ludwig (1995) incorporates different styles of learning in an example entitled "Encounter with an Unhuggable." She created an activity to help early elementary school children learn about and conquer their fear of insects. Beginning in the classroom, she had the students touch, feel, and measure a model of an insect while giving them specific

facts. She then presented a Madagascan roach in a clear container without identifying the creature. Ludwig then asked the students questions that pertained to the information she had provided about the model insect. Next, the students were instructed to brainstorm their own questions about the roach. One class created fifty-five questions. She asked her students how the answers could be found through observation, experimentation, or library research. She challenged her students to answer their own questions by using the methods above. At the end of this activity, the children were able to answer basic questions concerning the behavior of roaches.

Berg and Redington (2000) state that even though tropical rain forests and deserts of far away places are extremely exciting, it is just as exciting to explore nature in our own neighborhood. In their report "Investigating Schoolyard Ecology," they suggest teaching as much background information as possible about a habitat before continuing to study the specific plants and animals that live there. They suggest focusing on only one species at a time when studying ecology so that the students do not get confused. For example, after selecting a habitat, Berg and Redington suggest listing common species and then choosing one as the focus and continuing by making inquiries about such topics as type of food, predators, production of offspring, and survival in temperature changes. Observing the animal for a period of time and developing ways to enhance its environment and make more places available for animals and plants to live followed.

Berg and Redington (2000) also recommend surveying the different habitats around the schoolyard, noting any puddles where insects may reside and the structure and composition of vegetation. These factors limit the numbers and types of animals that are present. In evaluating the habitats, the authors created a worksheet to assign values to

different aspects and structures of the area. Berg and Redington state that to perform this activity, teachers should divide the students into groups, have each group investigate a different habitat, and combine the results. Finally, students should be asked if there are any ways to improve the habitats and if possible students should do so.

In a report commissioned by the National Environmental Education & Training Foundation (NEETF, 2000), there are seven separate examples that provide the education community with information about successful environment-based education programs in the United States. The NEETF report concludes that using the environment as an integrated learning tool has only positive effects and increases students' academic achievements greatly. Integrated learning is defined as learning that is interdisciplinary and problem based. According to the report commissioned by NEETF, some positive factors that influence achievement are motivation, the ability to connect with others, matching teaching style to learning style, collaborative learning, demanding subject matter, problem and issue based learning, and real-world instructional activities. The following material includes specific activities that each of the schools in the studies performed (NEETF, 2000).

In a study in Pasadena, Texas, a first grade teacher used what students noticed on a nature walk. She had them write about their observations and used that material as reading instruction for the subsequent days. The teacher integrated phonics into the curriculum by introducing environmental keywords such as nest building, feeding, and flying. To integrate mathematics, she had the children form groups to tally certain animals and their activities. The results were then charted.

In Asheville, North Carolina, a school uses outdoor service activities to engage the students. The principal of the school states that their educators amended the lesson plan to include an evaluation that would allow students to excel as well as identify their weak areas.

The report included three separate environmental projects conducted at this same elementary school. The school has a garden and science club. A garden coordinator visits the club once a week to teach a specific environmental concept. For example, the students were given an article about life cycles and biodegration. The students collected recyclable materials and created compost bins to feed the garden. Each project at the Asheville school included time to reflect upon what they had provided to the community and the earth.

The Ashville school has a Mountain Area Gardens in Community (MAGIC) program where students learn about such topics as nutrition by growing and studying food products. In each case, the project includes an academic component, hands-on activities, reflection, and assessment.

A nature trail was created behind the school. The community donated time and resources to build the trail. To highlight diversity, different learning styles, and environmental issues, the school developed trail guides and curriculum resources. The trail was opened to the public as well as the students.

In Milwaukee, Wisconsin, the staff of an elementary school rewrote the entire curriculum. The new version integrated four units of study and linked instructional activities, learning objectives, and educational resources. One of the projects this school participated in related mathematics, technology, and weather. Students observed and

recorded the weather. They performed activities such as measuring temperature and snow depth. Students then uploaded their findings into a nearby college's website. Via the internet, they worked with students in numerous countries to determine weather activity throughout the world.

A school at the Minnesota Zoo in Apple Valley, Minnesota had students learn skills in a logical context that was hands-on and experimental. The students performed a pond profile project, in which they sampled and tested pond water, analyzed the ecosystem, researched historical data, and addressed the spiritual and psychological benefits of the land. The goal was to determine the relationship between the pond and themselves. The students then recommend improvements to the city council.

Many of the schools mentioned in the report want students to become scientists by reading and researching topics on their own. They create their own questions, collect their own data, and learn to analyze this data by creating charts and graphs. Field experiences in natural settings are agreed upon for sharing this information with other students, in their class or abroad, as well as with community leaders.

3.0 METHODOLOGY

There were three main objectives of our project; evaluate the current ecosystem at the Janssen Ortho LLC forest reserve, develop a "Plan del Bosque", and construct a plan for the implementation of educational tools using the forest for the benefit of the surrounding community. Additional outcomes of the project included improving the appearance of the facility, providing a buffer zone between the plant and homes that surround it, making progress toward ISO 14001 compliance, contributing to the education of the Gurabo community, and helping to preserve and protect the environment in the area where Janssen is located.

The first step in the evaluation of the current ecosystem was for us to familiarize ourselves with the native and exotic species of trees in Puerto Rico. Samerith Sánchez, a representative from Departamento de Recursos Naturales y Ambientales (DRNA), met with us at Janssen and provided a slide show presentation of flora and fauna and provided literature concerning these topics.

The species identification process involved numerous trips to the reserve as well as contact with numerous experts. The project team, an employee from the environmental department at Janssen, and the supervisor of the grounds maintenance workers, conducted a preliminary tour of the reserve for us. The maintenance supervisor has an extensive knowledge of trees was able to identify some of the trees in the intended reserve. The project team took notes and pictures with a digital camera to refer to later on in the identification process. Notes were entered into Microsoft Excel to start a database of characteristics observed. The spreadsheet served as a log of which trees had

been identified, where they were located, and how many others of the same type were present. In addition, visual characteristics were included for later reference.

Having begun the identification process, we needed a way to tabulate and identify the trees as well as differentiate among the species. Mail package tags were numbered and covered in clear packing tape. The weatherproof tags were then attached to every tree in the intended reserve. This allowed us to refer to every tree by number, making it easy to keep track of species type and location of the tree. Tags were placed close to the bottom of the trees so that they were consistently placed and easy to see. The first 200 tags used were manila in color, but we found those hard to notice easily. The remainder of the tags were vibrant red in color and proved to be much easier to locate when observing the trees. A total of 316 trees were tagged in the three-acre reserve. The following figures shows the tags that we used. Figure 3.1 shows the manila tags and Figure 3.2 shows the vibrant red tags.

Figure 3.1: Manila Tag **Figure 3.2: Red Tag**

We referred to the pictures and notes previously taken and began the process of associating tree numbers with species. This process left us with most of the trees still unidentified. As a result, we took samples of the trees that we could not yet identify. We made a list of all of the tree numbers that were the same as other trees in the reserve, and took samples of one of each kind of tree. The samples taken were small branches representative of the general growth of the tree with leaves, flowers, and fruit whenever present. The samples were taken to an interview with a Herbarium Technician, Dr. Frank Axelrod of the University of Puerto Rico – Rio Piedras. Dr. Axelrod was able to identify many of the tree species or at least offer a genus which we could further narrow down with a better sample. Questions for a structured interview were prepared for the meeting with Dr. Axelrod, but upon arrival at his office, the situation did not lend itself to a

formal interview. Instead, an informal interview was conducted while Dr. Axelrod identified tree samples. Intended interview questions are included in Appendix I.

We also consulted the books Arboles de Puerto Rico y las Islas Virgenes: Segundo Volumen and Common Trees of Puerto Rico and the Virgin Islands as tools to continue with the identification process based on Dr. Axelrod's input. Samerith Sánchez provided additional assistance in the species identification process. Ms. Sánchez returned to Janssen to see the trees in person and helped us to identify the remaining trees.

We consulted both Ms. Sánchez and Dr. Axelrod about the prospects of integrating additional species into the reserve and creating a "Plan del Bosque" for the reserve. Based on their recommendations, we used the climatic mapping program LATIN discussed earlier in the Literature Review, Section 2.0, to verify the feasibility of integrating those species into our forest reserve. The program shows areas that fit the climatic conditions that given species require to flourish. We used the climatic data discussed earlier in the Literature Review as well as the detailed information contained in the "Plan del Bosque" found in Appendix H.

By taking a self-guided tour of the University of Puerto Rico Botanical Garden, we encountered some of the trees that were also located on the Janssen site. We examined the pathways, signage, and other general operations of the Botanical Garden. We obtained general attendance information concerning the number and ages of visitors per day from an informal interview with the receptionist at the Botanical Garden.

We visited IPR Pharmaceutical, Inc., a pharmaceutical company that has created a similar site to the one we plan on creating at Janssen Ortho LLC. The tour of the reserve was led by three employees of IPR, including one of the IPR tour guides, as well as a

contractor hired by the company to create a training manual for the tour guides. We interviewed them about specific species present in the reserve, materials for construction of paths and signs, attendance data, logistics of tours, and educational materials distributed at their reserve. Interview questions are included in Appendix I.

The "Plan del Bosque" we created serves as a guide to the general climate of Puerto Rico and the Gurabo area, history about the development and reforestation of the intended reserve area, the descriptions of the species present, a general map of the intended forest reserve, and the benefits of the forest area. We obtained sample land management plans from Elaine Diaz, our liaison, Samerith Sánchez of DRNA, and from IPR Pharmaceutical about the development of their reserve. These served to provide a basic format for the "Plan del Bosque" included in Appendix H.

The "Plan del Bosque" details the ecological assessment of the area that we conducted. We followed the model of Myers and Shelton that was reviewed in Section 2.0, the Literature Review. According to the model, there are four main areas for environmental assessment. They are physical land characteristics, energy and weather, vegetation, and human attitudes. For the assessment of the physical characteristics, we observed the layout of the reserve; geographical features such as hills, dips, and wet areas; and obtained a soil index figure. Weather and climate were researched for the detailed climatic data included in the "Plan del Bosque". The vegetation was evaluated with the greatest detail of the four categories. The assessment of the vegetation was discussed earlier in the tree identification process. Little other vegetation exists in the reserve besides grass, so the vegetation inventory was completed by identifying the trees. Finally, we identified the human activities in and around the reserve and considered the

impacts that those behaviors had on the surrounding area. Human activities in the area that we considered included current activities such as the operation of the pharmaceutical plant, maintenance of the area by the grounds crew, and the daily life of the houses bordering the area. In addition we considered anticipated future activities such as the foot traffic in the area once the reserve is opened to the public as an educational resource.

Human activities and attitudes toward the reserve were considered major social aspects of the project. We conducted structured interviews with four Janssen employees who live in the housing development adjacent to the forest reserve. The reserve serves as a buffer zone between the plant and the housing development. The interviews of the four employees were performed to collect data regarding the relationship between the residents of the neighboring housing development and the intended forest reserve. In particular we examined impacts that the residents might have on the area by living in such close proximity, as well as the impacts that the intended reserve could have on the residents. Snowball sampling was used to identify some of these subjects. Initially, two names were provided to us by our liaison, and one of the subjects in turn referred us to two more employees to interview. Interview questions are included in Appendix I.

In order to develop the educational plan for the forest reserve, we conducted interviews and evaluated other educational material for environmental education. Interviews were conducted with one primary and one secondary school teacher, both from schools in Gurabo. In addition, environmentally aware students from the environmental club at Escuela Superior Dr. Conchita Cuevas were consulted. The structured interview with Iris Rodriguez of Escuela Superior Dr. Conchita Cuevas focused on methods for teaching and keeping the interest of high school students and

adults. Ms. Rodriguez is the advisor to the school's environmental club, and after the interview we had an opportunity to speak with some of the students in the club and hear their thoughts and ideas on the reserve as well. This was an unstructured interview that was not anticipated. A follow-up interview with the environmental club was conducted during their regular weekly meeting time. Four students were formally interviewed. Following the structured interview, the entire club was engaged in a brainstorming session about potential characteristics of the intended reserve. The second structured interview that we conducted was with a primary school teacher in the Gurabo area. The main focus of this interview was to determine the best teaching methods for an audience younger than high school age and keeping them interested as well. The learning styles discussed in the Literature Review along with the teacher and student interviews allowed us to make recommendations for interactive tours appropriate for all grades and age levels. Interview questions are included in Appendix I.

Other materials for environmental education were examined and evaluated. The material evaluated was from Janssen in Brazil and focused on teaching about recycling and safety. The material included crossword puzzles, word searches, word scrambles, coloring pages, mazes, matching phrases, a cutting and folding activity to form a small informative cube, and comparing two pictures and finding the differences. These are all activities that we may use at the Janssen Gurabo forest reserve for education and distributive material. We evaluated these activities and used them to benchmark our own plans for the educational curriculum.

We finally developed a set of recommendations and presented them to the Janssen executives. The detailed inventory of the forest area facilitated the successful completion

of the comprehensive "Plan del Bosque." This allowed for an accurate assessment of the land in its current state as well as provided a basis for all future plans for the reserve. The educational research provided a basis for the proposed educational material to be used at the reserve. All three of these points were covered in the recommendations presented to Janssen. In addition, we developed an informal presentation board for display at an Earth Day celebration held at Janssen upon completion of our project. All materials from this presentation board are included in Appendix F.

4.0 DATA AND ANALYSIS

Most of the data we collected was from the forest reserve. We have found sixty-two different species and identified thirty-seven of them. Of the 316 trees present, 281 of the trees were identified. The species present include both indigenous and exotic species. Among the native species found, only one was an endangered species. The reserve contains four trees of this endangered species, the Matabuey. We are fortunate to have more than one Matabuey because its chances for survival are greatly increased. Appendix H contains a comprehensive description of each species of tree identified. This information includes physical characteristics, distribution, and uses of the tree. Below is a chart displaying how many of each type of tree were present. A more detailed presentation of the data is provided in Appendix E.

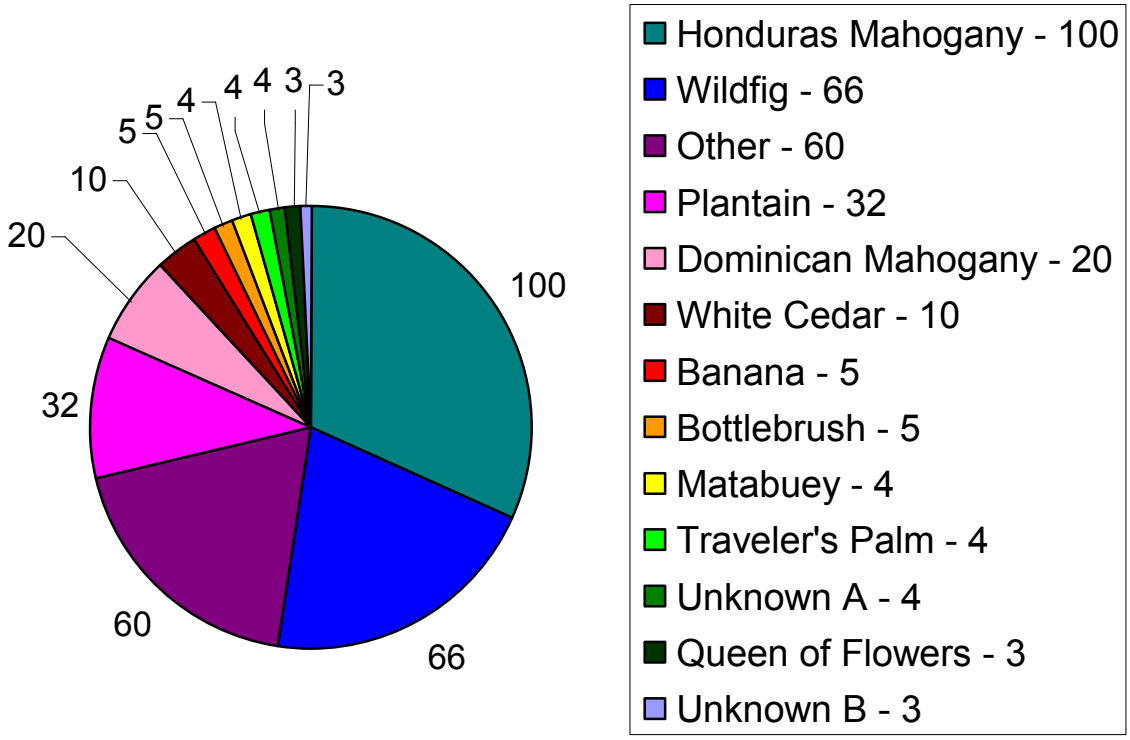


Figure 4.1: Distribution of tree species

Figure 4.1 shows the distribution of the tree species. The numbers outside of the graph represent how many of each tree were present in the reserve. Trees of which there were three or more are listed individually. Species that occurred only once or twice are shown in the category "other." For a breakdown of the composition of "other," the reader should refer to Appendix E.

The reserve borders the perimeter of the Janssen facility and is long and thin. It covers an area of three acres. The widest part of the reserve is at the current entrance. This is where the majority of the Honduras Mahogany trees are located. This is the most common tree in the reserve. The reserve is densely packed at the entrance and slowly thins out as it continues. The trees were all planted very close to each other in 1995. Now, six years later, there is an evident problem. The trees will become very large when they are full grown. As the trees continue to grow to mature size, there will be very little room, if any at all, between the trees. This observation affected the amount and type of trees proposed for integration into the reserve. Large trees were not feasible because there is not adequate space to accommodate them. Shrubs, flowers, and bushes are a more feasible option given the current layout. There are some small open areas towards the center of the reserve. It may be more beneficial to use these areas for a man-made pond or an interactive area for children rather than just planting more large trees. According to our case studies and interviews, interactive learning has the greatest impact on children.

We visited other reserves in Puerto Rico to examine the construction, operation, and maintenance of a typical forest reserve. At the University of Puerto Rico Botanical Garden, the main purpose of the area was for education and aesthetic appeal, the

admission was free of charge, and there was no specific target audience. The approximate number of visitors daily is 500 people on weekdays and 1000-1500 people on weekends. At the garden, individuals are welcome to come at any time and take a self-guided tour, and tours with guides are offered throughout the course of the day. Appointments may be made for large groups as well. A map is provided to visitors as they enter the garden. The metal signs that were used for labeling trees were nailed to them with springs behind them to allow room for growth. Other than the map that was handed out, there were no other handouts or educational materials distributed.

Another reserve we visited was located at IPR Pharmaceuticals, Inc. The purpose of the reserve at IPR Pharmaceuticals is very similar to the reserve being established at Janssen. The intentions of both reserves are to promote conservation and educate visitors about environmental awareness. Visits to the IPR forest reserve require an appointment. Due to a limited number of tour guides, IPR is able to accommodate tours only for groups and they must be scheduled in advance. The tour guides are volunteers from all departments at the facility. An extensive training program allows employees with little or no experience at educational forest reserves to participate as tour guides.

The number of visitors to the forest reserve is approximately 200 people once or twice a week, depending on availability and interest. IPR targets groups that are mainly comprised of school children, scouts, and the elderly.

We noted that the walkways at the reserve were originally constructed of small pieces of Puerto Rican white marble, but due to the hurricanes, most of the gravel was no longer on the path. We also noted that the pathways were straight and did not curve in and around the trees and vegetation in the area. The signs for labeling the trees were

plastic and nailed to the trees. The signs did not effectively withstand the weather conditions of the area and as a result, many of them were cracked, loose, and broken. The same contracted grounds crew that handles the IPR facilities handles the maintenance of the reserve.

IPR distributes a small informational pamphlet to all of its visitors, which describes the environmental features of the manufacturing facility and contains limited information about the trees and wildlife found in the reserve. The pamphlet also contains a small checklist of trees found at the reserve and asks the visitor to locate them.

Another reserve that we visited was the Humacao Reserve of the Departamento de Recursos Naturales y Ambientales (DRNA). The main purposes of the reserve are conservation, education, and recreation. The department protects a majority of the land and wildlife. Visitors may come individually or as a group, admission is free of charge, and no appointment is necessary to visit the reserve unless the visitors request a tour guide. There is twenty-four hour public access to the reserve so it is difficult for DRNA to monitor the attendance rates. Twenty-four hour public access is necessary because DRNA must make the area available for fishing in designated parts of the reserve. The paths are dirt roads that department vehicles can use for access to the reserve. Signs for the trees are present in only the entrance and parking area of the reserve. The names of the trees were burned onto a piece of wood and displayed on posts in front of the tree. Handouts were available in the office covering various conservation topics, and the materials were all educational or informational in nature consisting of text and pictures.

Table 4.1 below summarizes the attendance trends of the aforementioned reserves.

Table 4.1: Attendance Data Summary for Three Reserves

	IPR Forest Reserve	UPR Botanical Garden	DRNA Humacao Reserve
Appointment Necessary	Yes	No	No
Groups or Individuals	Groups only	Groups and Individuals	Groups and Individuals
Target Audience	School Groups, Scouts, Elderly	No specific Target Audience	No Specific Target Audience
Approximate Number of Visitors Daily	200 People One to Two Times per Week	500 People on Weekdays, 1000-1500 on Weekends	24 Hour Public Access
Main Purpose of Area	Conservation Education	Education Conservation Aesthetic Appeal	Conservation Education Recreation

Studying these reserves allowed us to observe and assess features that might be appropriate at the Janssen reserve. The reserve at IPR Pharmaceuticals was the most similar to ours. Aspects such as the above admission information for IPR appear the most feasible for implementation at the Janssen reserve. Like IPR, Janssen is a pharmaceutical manufacturing facility that is closely monitored by the Food and Drug Administration (FDA). FDA regulations state that all people on the property of a pharmaceutical manufacturing facility must have security clearance or be escorted by an individual with clearance. For this reason, it is most appropriate to have visitors come in groups and by appointment so that guides can arrange to be available for tours. Self-guided tours are not an option due to the FDA security regulations.

We could not model our path exactly like any of the paths at the reserves we visited. The paths at the UPR Botanical Garden and DNER in Humacao were made of dirt. There was no special material used for their construction. This is not a wise decision for the Janssen facility in Gurabo since is located in the subtropical moist forest region of Puerto Rico and it rains almost daily. Dirt paths would not be accessible after significant rainfall, so that is not a practical option. It is possible that a path such as the one at IPR could be feasible in Gurabo if the stones used were larger, to better withstand the weather. However, gravel and Puerto Rican white marble are not being considered due to the difficulty that wheelchairs would face operating on such loose material. Table 4.1 details the advantages and disadvantages of three different types of path materials that Janssen may consider.

Table 4.2: Advantages and Disadvantages of Path Construction Materials

Material	Advantages	Disadvantages
Brick	• More affordable than cobblestone • Offers adequate handicapped accessibility	• Less affordable than pavement • Bricks may shift over time • Wet soil and weather conditions will increase shifting
Cobblestone	• Visually attractive • Material will not shift • Will withstand inclement weather	• Most expensive • Might not be completely handicapped accessible
Pavement	• Least expensive • Offers the best handicapped accessibility • Will withstand inclement weather	• Equipment can not be brought into forest • Paving must be done by hand which will drive up the cost

Table 4.2 explains the attributes of each of three potential materials, brick, cobblestone, and pavement. As shown in the chart, brick will provide adequate performance at a reasonable cost, however it is the most subject to damage by weather and soil conditions. Cobblestone is an expensive option that will withstand weather and soil conditions. However, the rough surface may be difficult for handicapped visitors to traverse. Pavement is the least expensive and most weather resistant alternative. In addition, it provides the smoothest surface for handicapped visitors. The drawback of using pavement is that due to the positions of the trees in the forest, large equipment can not be brought in to do the paving. Paving by hand will drive up the cost significantly and will take much longer than it would with large equipment in use.

In addition to the path material, the route of the path is also important. Straight paths similar to the ones we encountered on our visits are uninteresting and allow the visitor to see what is ahead. Using a winding path that is tailored to the land's natural features is a better option because it engages the visitor in what is around them as opposed to what is up ahead. Also, due to the reserve's size, a curved path is ideal because it lengthens the visitors' stay and makes their visit worthwhile. A straight path through a three-acre plot of land could be traversed very quickly. Lengthening the visitors' stay is beneficial because more information can be given during the tour, and the visitors can gain a greater appreciation for conservation and the environment.

The signs for labeling the trees were very different from one reserve to the next. The signs at the UPR Botanical Garden and IPR were nailed directly into the tree. This was not something we wanted to do because we did not want to harm the trees in any way. Also, IPR's signs did not withstand the weather and would not hold up against the

frequent precipitation in Gurabo. The signs at DNER would work well and look very natural. However, they only had the name of the tree on the sign. There was no room for information about the tree. This was something we felt was important to incorporate into the reserve.

To collect information concerning the type and depth of material to be covered in the educational material, we interviewed a science teacher and students from the environmental club at a local high school. In our interview with the high school science teacher, who is also a computer teacher and the advisor for the environmental club, she informed us that the best way for students to learn is through hands on experiences or learning by doing. She said when it comes to teaching a topic such as science to different ages, it is not the material that matters but the depth of material. For high school students, it would be more appropriate to teach processes, benefits, and functions of environmental topics while for elementary students, it is more appropriate to teach basics, benefits, and get them to practice activities that impact the environment such as recycling. She also added that in order for people to appreciate the forest and the environment more, you have to make people conscience of the importance of the environment and its resources. The environmental students are very anxious to participate in the forest reserve at Janssen. Some of the activities that they have already completed include cleaning up beaches, doing a recycling project within their school, visiting El Yunque, and having an environmental song festival. Each of the four teachers interviewed has mentioned hands on learning as being the greatest learning tool possible. We believe interactive learning material would be best for retaining the students' attention and sparking their interest.

The final set of interviews we conducted was with the landowners adjacent to the forest reserve. The close proximity of their homes to the reserve made their actions and opinions of the reserve an important consideration. All of the landowners have lived in the development for at least one year. One interviewee claimed that the majority of the people moved to this development because they wanted to get away from the city. One resident stated that there is minimal noise coming from the plant and another claimed that it is only audible in the morning hours. All of the landowners interviewed stated that they can only see one building of the Janssen facility and that the majority of the view from their homes was of the reserve. One landowner said that in the past she used to be able to see many of the buildings at Janssen, but as the trees have grown, they have blocked all of the buildings except for one. All of the subjects interviewed are excited to have a forest reserve so close by because it is such a contrast to the highway that is also very close to their homes. These owners did not seem disturbed by the fact that there may be many people visiting the reserve. They thought it would be a great place to learn about trees and wildlife of Puerto Rico. All said that they would visit this area, but one said that even though it is a good place to learn about such topics, she might only take her younger children and not the older ones because she felt that they might not be interested. None of the owners have expressed negative feedback concerning the further development of the forest reserve.

Through data collection from the forest reserve, studying other reserves, and interviewing teachers, students, and landowners, we were able to collect enough data to make our final conclusions and recommendations found in chapter 5.0.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based on the significant patterns of data stated in the previous chapter as well as the interviews with experts in the field of botany and education mentioned in chapter 3.0 Methodology. Our recommendations include topics for education, design for paths and signs, as well as additional trees for integration into the forest reserve.

5.1 Education (Tours, Tour Guides and Training)

Conclusion 1: The tours of the reserve should be guided.

Recommendation 1: Tour guides should be volunteer employees from the Janssen facility and the tours should be by appointment only.

Because Janssen is a pharmaceutical manufacturing company and the FDA regulations state that people must have security clearance or be escorted by someone with clearance, it is appropriate to have only guided tours. Individuals are unable to visit the Janssen property unescorted; hence, there will be no self-guided tours available. It is our recommendation that the tour guides be regular employees of Janssen volunteering to take time out of their regular jobs to lead tours. This recommendation is based on a similar policy implemented at IPR Pharmaceuticals. Since tour guides will be taking time out of work to lead tours, it is implied that tour times will have to be restricted and by appointment only so that they do not interfere significantly with the guide's regular job duties. In the event that many guides are available, Janssen may consider having the reserve available to the public without appointments necessary.

<u>Conclusion 2</u>: The tour guides should be trained.

<u>Recommendation 2</u>: The training manual included in Appendix I should be used to train the guides in conjunction with an expert who has prior experience.

We have created a training manual that we recommend be used to train the guides that can be found in Appendix H. The manual includes the "Plan del Bosque" in order to teach the guides about the trees in the reserve, as well as some suggested educational, hands-on activities that the tour guides can conduct with the visitors. Within the "Plan del Bosque" is a list of all of the species and their tag/identification number, full descriptions of the trees that we were able to identify, a plot plan of the locations of the trees, and benefits of the forest area at Janssen. This specific information was requested to be included in the "Plan del Bosque" by the Environmental Regulatory Compliance Officer at Janssen and is intended to stand alone as a separate document. The "Plan del Bosque" is located in Appendix H.

A hired individual who has experience training tour guides should assist in the training. We recommend Alexis Molinares, an Ecological Consultant in Environmental Programs. He is qualified for this position at Janssen because he is currently in the process of training the tour guides at IPR Pharmaceuticals, Inc. His contact information is included in Appendix J.

<u>Conclusion 3</u>: The best method for teaching students is by conducting hands-on activities.

<u>Recommendation 3</u>: Hands-on activities should be used during the tours and the proper equipment should be bought for these activities.

We concluded from the data gathered in the interviews conducted with the local educators that hands-on activities are the most highly regarded method for teaching students. The educational material recommended in the manual incorporates the idea of hands-on learning. It includes activities such as measuring the acidity of water from either a pond or rain, measuring the oxygen, carbon dioxide, and carbon monoxide levels in the forest, measuring the temperature at different points in the reserve and comparing the data, and feeling the texture of different leaves.

In order to perform these activities with the visitors, the proper equipment is necessary. The equipment includes paper, pencils and crayons for activities such as leaf rubbing and coloring pages, litmus paper for testing the acidity of water, and binoculars and magnifying glasses to observe the animals and plants more carefully. Also, the proper equipment is necessary to measure the oxygen, carbon dioxide, carbon monoxide and nitrates in the air and water.

Additional educational material for distribution is included in Appendix D. This material includes handouts and activities that the visitors may take home or to school for completion.

5.2 Paths, Signs, and Fencing

After visiting other forest reserves and viewing the materials used for paths and signs, we feel that the following recommendations are the best for the Janssen forest reserve.

<u>Conclusion 4</u>: Signs are necessary in the reserve to identify the species and should be able to withstand the weather.

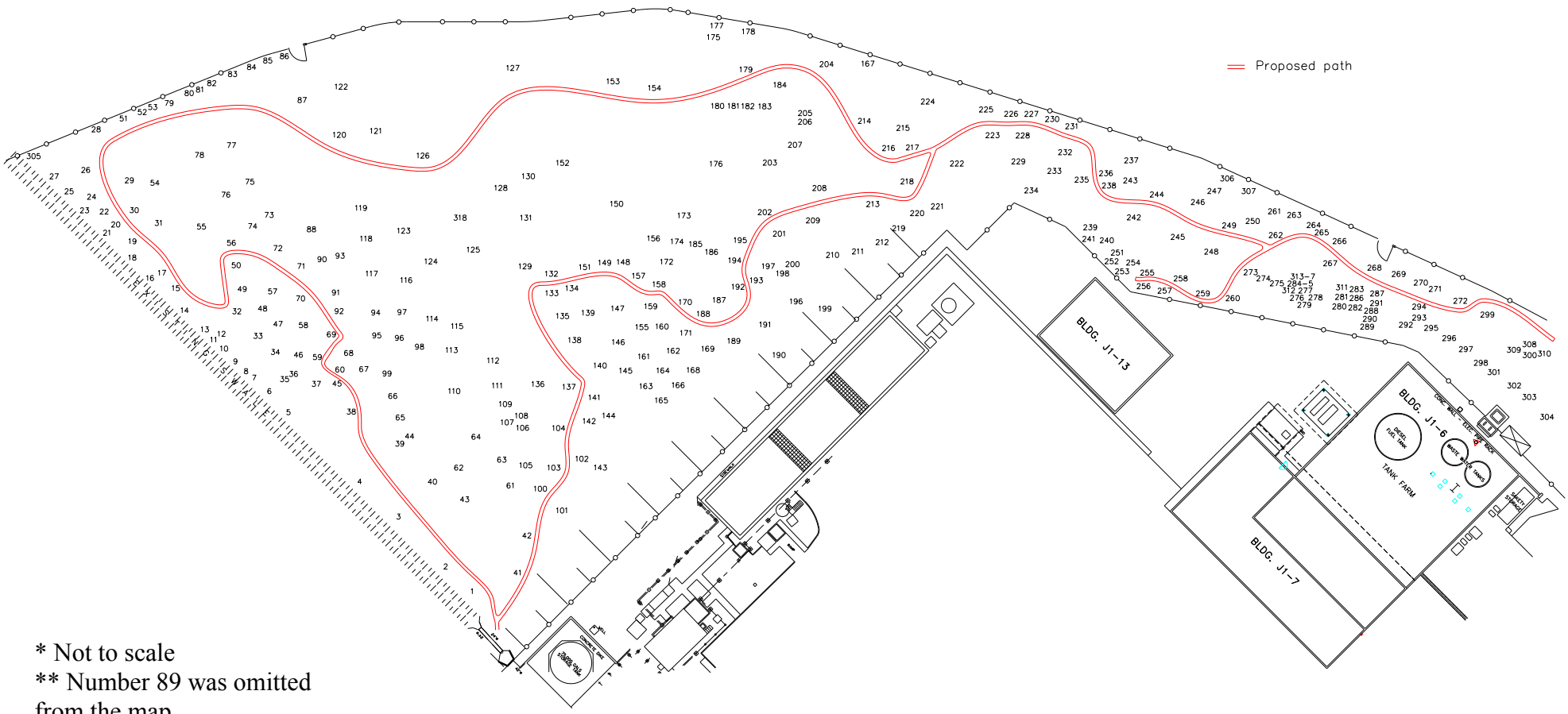
<u>Recommendation 4</u>: Wooden signs with the scientific and common name of the species burned into them should be used and should be staked into the ground beside the first occurrence of a group of the species along the path. If only one tree in a species exists, the sign should be placed beside it.

Since the plastic signs at IPR Pharmaceuticals, Inc. did not hold up to the weather and the metal signs at UPR Botanical Garden were not very attractive, we do not think that plastic or metal signs are a wise idea. We recommend that the signs be made of treated wood with the words burnt into the wood, as it is at DRNA Humacao, to stand up to the weather and blend the best with the natural surroundings. These signs should be placed on a sturdy post in the ground in front of the tree. This type of sign does not require damaging the tree by attaching the sign directly to the tree. At all of the reserves we visited, the signs contained only the scientific and common names of the tree. We, too, feel that this is the best option, leaving the additional information to be presented to the group by the tour guide. The signs should be posted at the first large occurrence of a species along the path. If there is not a large group of a particular species, the sign should be placed at the first occurrence of it. By placing the signs near groups of trees, the tree name and the physical tree will be better connected in the mind of the visitor and that association will be easier to recall later on.

<u>Conclusion 5</u>: A winding path is more interesting than a straight path.

<u>Recommendation 5</u>: We recommend using the included path design.

We have determined straight paths to be uninteresting after visiting other reserves where the paths were straight. A winding path should be incorporated into the Janssen reserve. We recommend the path in Figure 5.1.



* Not to scale
** Number 89 was omitted from the map

Figure 5.1: Proposed Path Layout

<u>Conclusion 6</u>: The reserve should be handicapped accessible and safe for all visitors.

<u>Recommendation 6</u>: We recommend a brick, cobblestone, or paved path be used. Also, there should be fencing on both sides of the trench coming from the pipe at the entrance of the reserve.

In order to make the reserve handicapped accessible, we must follow the Americans with Disabilities Act Accessibility Guidelines that are explained in detail in chapter 2.0, the Literature Review. For the material of the path, we do not recommend using gravel because it did not stay on the path at IPR during inclement weather and it is not easily traversable by wheelchairs. We recommend that a brick, cobblestone, or paved path be used. They provide the best option because wheelchairs can easily travel paths constructed with any of these materials.

We also recommend, for aesthetic purposes only, to have a wooden bridge that crosses the pipe at entrance of the forest area. The bridge should be made of wood and be arced over the pipe. The bridge should not incorporate any stairs and the angle should be acute enough to comply with the guidelines set forth in ADAAG. The bridge should have a latticework over it or a roof to give the illusion to visitors of walking into another room. On both sides of the trench coming from the pipe, there should be fencing to assure the safety of all visitors.

<u>Conclusion 7</u>: Fences are not appealing and do not blend well in the forest.

<u>Recommendation 7:</u> Vines should be planted in front of the fences to make the area look more like a forest.

We recommend, to make the area look more like a forest and to block the views of Janssen's buildings, vines should be planted and allowed to grow on the fences. These vines should be monitored so that they do not cover any of the trees that are close to the fence.

5.3 Trees for Integration

<u>Conclusion 8</u>: The reserve consists of only trees.

<u>Recommendation 8</u>: Trees should be added sparingly and they should be from endangered species.

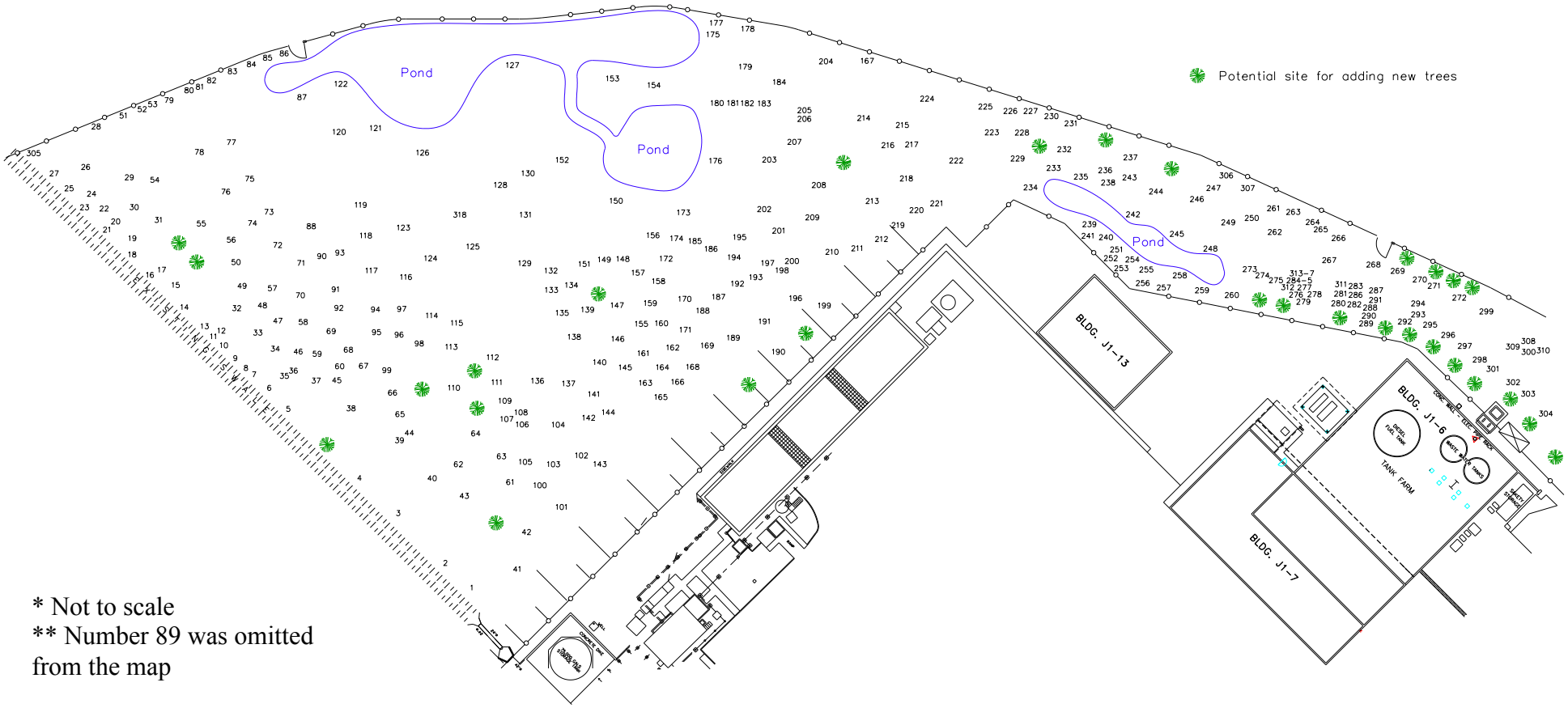
Based on our investigation and analysis of the forest reserve, we determined that since the forest contains an abundance of only trees and no small vegetation, trees should be added very sparingly. The addition of any flora should include small bushes and flowers. We recommend that if more trees are to be added, they should be from endangered species. This recommendation comes from the suggestions of the herbarium and the students. These subjects would like to see them in the reserve because they want to make visitors aware of the importance of protecting endangered trees. Also, we urge that they should be added because the only endangered tree that is presently in the reserve is the Matabuey. We suggest that since the four Matabuey are in close proximity to each other, the addition of the endangered trees should be kept in the same area to further emphasize the aforementioned importance of endangered trees. If any new trees are added, there should be at least two of the species to assure that if one of the trees does not survive, there is another present. We recommend the following endangered trees, listed in Table 5.1 with both scientific and common names, to integrate into the forest area because they produce both flowers and fruit that will attract more wildlife. Also, these

trees are small in size so they should fit in the reserve easily and they will do well in the climate of the Gurabo area.

Table 5.1: Trees Recommended for Integration

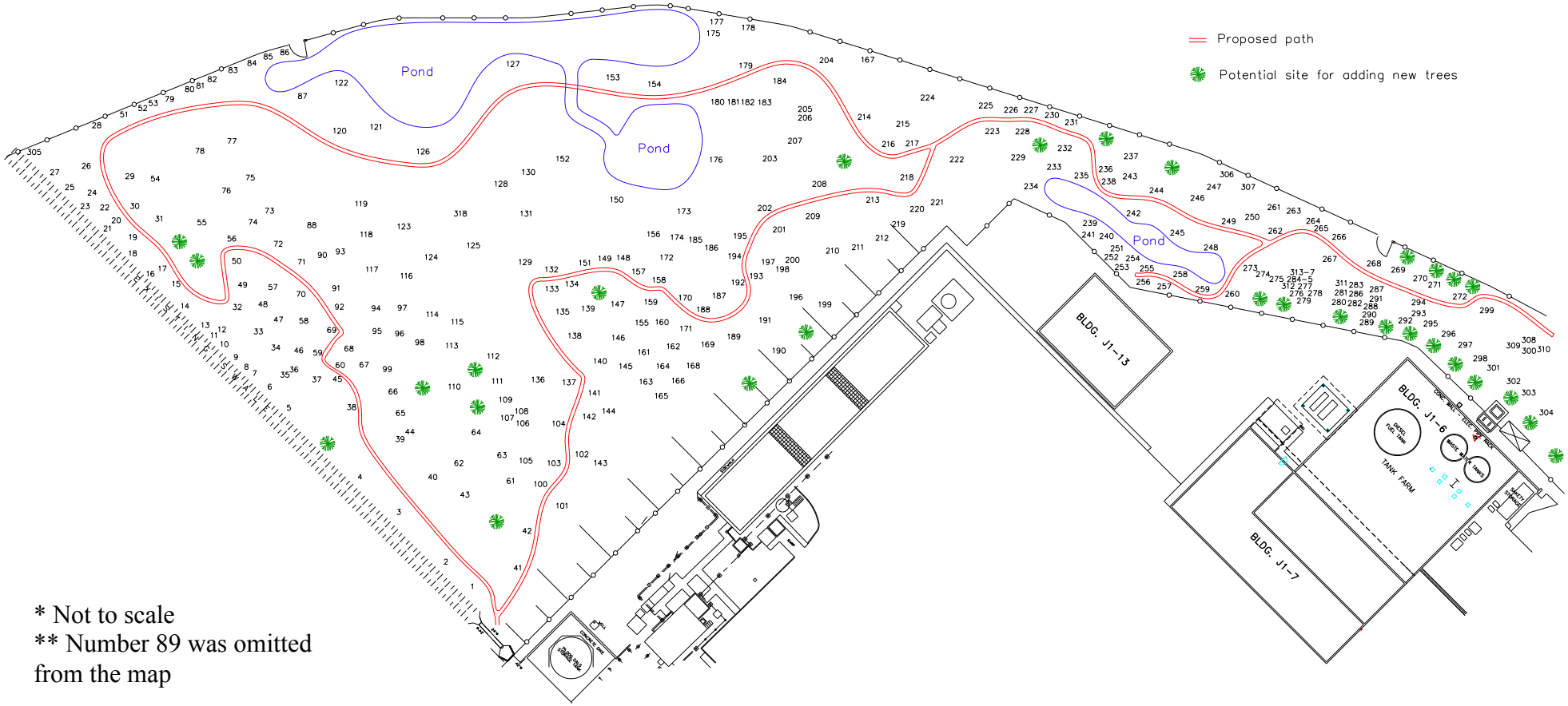
Scientific Name	Common Name
Chamaecrista glandulosa var. mirabilis	Cassia mirabilis
Crescentia portoricensis	Higüera de sierra
Buxus vahlii	Diablito de tres cuernos
Banara vanderbilti	Palo de ramon
Stahlia monosperma	Cóbana negra

The sites selected for potential integration of new species and trees are shown in figure 5.2. This map shows the spaces that were decided to have adequate open space and ensure that upon maturity, the trees are not overcrowded in the reserve. In addition, figure 5.2 includes potential sites for adding ponds if Janssen decides that it would like to do so. Figure 5.3 shows these sites as well as the proposed path design from figure 5.1.



* Not to scale
** Number 89 was omitted from the map

Figure 5.2: Proposed Sites for Integration of Trees



* Not to scale
** Number 89 was omitted from the map

Figure 5.3: Proposed Site Plan

<u>Conclusion 9</u>: We identified only thirty-seven of the sixty-two species in the reserve.

<u>Recommendation 9</u>: A botanist should be hired to complete the tree identification.

Given the tight timetable to complete this project, we were unable to finish the identification process of all of the trees in Janssen's forest area and to study bushes and ground cover. As mentioned in the previous chapter, 4.0 Data and Analysis, we were able to identify thirty-seven of the sixty-two species as time permitted. We recommend that Janssen hire a botanist to finish this process. Dr. Frank Axelrod from the University of Puerto Rico helped us to identify some of the trees as mentioned in chapter 3.0, Methodology. Since he helped us greatly in this process, we recommend that he be hired to finish with the identification. His contact information is included in Appendix J.

5.4 Importance of the Reserve

As stated in the introduction, one objective of companies today is to improve customer relations. Janssen has shown a significant commitment to both the community and the preservation of the environment by establishing this forest reserve. This is a key issue because they are committing to a sense of permanency with the reserve. By establishing the reserve on their property, Janssen will be unable to expand its facilities into that area if they wish to extend the size of their manufacturing facility in the future. From the amount of work already completed on the establishment of the forest reserve, it is evident that Janssen is willing to put time, money, and effort into the forest and that razing the reserve for the expansion of the company would be futile. It would not only

waste the resources put into the establishment of it, but relations with the community would become worse than if the reserve had not been initially established.

APPENDIX A: JANSSEN ORTHO LLC CORPORATE INFORMATION

Janssen Pharmaceutica is a subsidiary of Johnson & Johnson that became affiliated with the parent company in 1961. Founded by Dr. Paul Janssen, Janssen strives to rely on science and always seeks to be innovative in its work (Janssen Pharmaceutica Online - An Introduction). Dr. Paul Janssen - often referred to as "Dr. Paul" - is a widely known researcher, pharmacologist, and general practitioner of Belgian origin. The company founder was born in the town of Turnhout, Belgium, which is in very close proximity to the current Janssen Research Foundation headquarters located in Beerse, Belgium.

The Janssen Research Foundation (JRF) is the primary research facility for drug discovery within Janssen Pharmaceutica. JRF claims the synthesis and discovery of over 84,000 previously unknown chemical compounds. Janssen introduced over seventy-five medications in 150 countries that are used to treat cancer, mental illness and intractable pain, among other serious conditions. Janssen is credited with having five medications on the World Health Organization's Essential Drug List. JRF coordinates drug discovery efforts in five other countries as well: the United States, Japan, Germany, France, and Spain. Janssen employs over sixteen thousand individuals worldwide.

Initially located in New Brunswick, N.J., the first United States office of Janssen Pharmaceutica was opened in 1973 under the name Janssen USA, following the acquisition by Johnson & Johnson in 1961. The headquarters for Janssen USA were then moved to Piscataway, N.J. until 1992, when they moved to their present location in Titusville, N.J. Janssen has one thousand employees reporting to the Titusville, N.J. facility and 1,500 employees across the country. In the United States specifically,

Janssen USA has made drugs treating psychotic disorders, schizophrenia, chronic pain, fungal infections, and nighttime heartburn available to consumers. In addition, Janssen USA is in the process of developing treatments for cancer, Alzheimer's disease, depression, bipolar disorder, acute pain, ulcers, gastroesophageal reflux disease (GERD) and chronic constipation.

The Janssen mission is to "Meet customer needs for high-quality, cost-effective health care by developing, producing, and marketing differentiated pharmaceutical products and services that improve health outcomes" (Janssen Pharmaceutica Online - An Introduction). With the introduction of its Customer Action Center, Janssen claims to be one of the first pharmaceutical companies to implement a telephone call center with live operators to meet the specific needs of each customer. In addition, Janssen recently introduced the Janssen One-to-/One Customer Action Center[SM], an online derivative of the original call center.

The Gurabo, Puerto Rico facility was first established in 1974 with the purchase of approximately fifty acres of land. Additional purchases following the initial one have brought the total area of the facility to over one hundred acres. The primary purpose of the area was to house Johnson & Johnson Dental Care. The construction of a chemical plant and pharmaceutical plant were completed in 1982 and 1984 respectively. At this time, Johnson & Johnson Dental Care left the site, leaving Janssen to occupy the entire one hundred acre facility. These two plants were one entity known as Janssen, Inc. and were overseen by the Belgian branch of Janssen Pharmaceutica. Subsequently, the company underwent multiple name changes. The name Janssen, Inc. was changed to OMB Pharmaceutical Partners, and then to Johnson & Johnson Pharmaceutical Partners

in 1992. With this last name change, the company fell under the domain of Janssen USA and was supervised by the Titusville, N.J. facility. In the mid-1990's, the company acquired a new name, Janssen Products. The most recent change occurred in November of 1998 when the facility became known as Janssen Ortho LLC. Currently, approximately 800 employees work at the Gurabo, Puerto Rico site.

As a subsidiary of Johnson & Johnson, Janssen operates under the same guide as all other Johnson & Johnson employees, the Johnson & Johnson Credo. According to the Credo:

> We believe our first responsibility is to the doctors, nurses and patients, to mothers and fathers and all others who use our products and services. In meeting their needs everything we do must be of high quality. We must constantly strive to reduce our costs in order to maintain reasonable prices. Customers' orders must be serviced promptly and accurately. Our suppliers and distributors must have an opportunity to make a fair profit.
>
> We are responsible to our employees, the men and women who work with us throughout the world. Everyone must be considered as an individual. We must respect their dignity and recognize their merit. They must have a sense of security in their jobs. Compensation must be fair and adequate, and working conditions clean, orderly and safe. We must be mindful of ways to help our employees fulfill their family responsibilities. Employees must feel free to make suggestions and complaints. There must be equal opportunity for employment, development and advancement for those qualified. We must provide competent management, and their actions must be just and ethical.
>
> We are responsible to the communities in which we live and work and to the world community as well. We must be good citizens - support good works and charities and bear our fair share of taxes. We must encourage civic improvements and better health and education. We must maintain in good order the property we are privileged to use, protecting the environment and natural resources.
>
> Our final responsibility is to our stockholders. Business must make a sound profit. We must experiment with new ideas. Research must be carried on, innovative programs developed and mistakes paid for. New equipment must be purchased, new facilities provided and new products launched. Reserves must be created to provide for adverse times. When we operate according to these principles, the stockholders should realize a fair return.
> (Janssen Pharmaceutica Online - The J&J Credo)

Due to the influence of these values, both Johnson & Johnson and Janssen are supportive of worldwide community outreach programs to make a contribution to the communities in which facilities exist. The primary goal for our IQP for D term 2001 will help Janssen in meeting its goal of educating the local community about indigenous forests at the managed forest area to be located at the Janssen facility in Gurabo, Puerto Rico. The establishment of the forest reserve will also improve relations with the Gurabo community and help Janssen in its commitment to preserving and protecting the environment, as specifically stated in the third paragraph of the J&J Credo. Attendance at the reserve will give the general public an opportunity to visit the Janssen facility and further solidify the relationship with the community.

APPENDIX B: PROJECT DESCRIPTION LETTER

JANSSEN ORTHO LLC

November 8, 2000

Worcester Polytechnic Institute
Dr. Susan V. Gerstenfeld
100 Institute Road
Interdisciplinary and Global Studies Division
Worcester, MA 01609-2280

Dear Dr. Susan:

Attach we are presenting you with our proposal for the Interactive Quality Project for next session in March – May 2001. With this project, the students will interact with employees from different governmental agencies such as *Department of Natural Resources and Environment* and the *Department of Education*. In addition, it will provide them the basics for teaching skills and how to reach different levels of students in the area of science.

If you have any question/comments, do not hesitate to contact the undersigned at 787-272-7434.

Waiting for your prompt response regarding acceptance of the project.

Sincerely,

Elaine Díaz Cavalliery
Environmental Regulatory Compliance Officer

JANSSEN ORTHO LLC

WORCESTER POLYTECHNIC INSTITUTE

Project Scope for Interactive Quality Project

PROJECT SCOPE

As a reference for future use, prepare a Forest Management Plan that should include:

- Classify existing trees in our facility's conservation area in terms of: native, endangered or exotic species.
- Identify trees by scientific (botanical) and common name.
- Prepare a plot plan of the location of the different trees.
- For each identify specie, a written description of its characteristics (such as: origin, climate, flowers (if any), leaves (form, color, season changes, etc.), fruits (if any), height, roots form, commercial uses (wood, etc.), etc.
- Benefits of the forest (buffer zone between industry and residential areas, etc.)

To ensure that current and future visitors (employees, community, schools, and biology students) understand the importance of the trees:

- Develop educative material for distribution to the visitors that address the different levels of education in science.
- Prepare material that could be use in audiovisuals, such as video.
- Prepare educative material that could serve as learning tools for students in schools (quizzes, facts, etc.).

REFERENCES

THE FOLLOWING AGENCIES should be consulted:

1) Department of Natural Resources and Environment.

2) Department of Education.

3) Conservation Trust of PR.

4) http://www.civila.com/ambiental/foro-virtual/mensajes/311.html.

5) http://fortaleza.govpr.org/gobierno/recursos1.htm

6) http://fajardo.inter.edu/recicla/index-page97n.htm

7) http://www.prstar.net/default1a.htm

8) http://ponce.inter.edu/proyecto/fidei/fidei.html

APPENDIX C: JANSSEN ENVIRONMENTAL POLICY

Our credo commitment

"We are responsible to the communities in which we live and work and to the world community as well… We must maintain in good order the property we are privileged to use, protecting the environment and natural resources".

Policy statement

Janssen-Ortho LLC is committed to pollution prevention and environmental protection by promoting high environmental values in all employees, endeavoring to minimize environmental impacts, by implementing the best environmental practices in all out processes and striving for continuous improvement to achieve environmental excellence.

IT IS OUR POLICY TO:

Comply with all applicable governmental environmental laws and regulations, as well as Johnson & Johnson Worldwide Environmental Practices, and other voluntary principles to which we subscribe.

Minimize the environmental impacts related to air quality, water consumption, and solid waste generation and disposal.

Set, review and exceed environmental objectives and targets to minimize the possible impacts of our operations.

Educate and train management and associates to achieve awareness on environmental issues related to their responsibilities and enable them to contribute for the achievement of our objectives and targets.

Maintain good partnerships with government agencies, local communities and industries to create mutual respect and understanding for the protection of the environment we share.

APPENDIX D: EDUCATIONAL MATERIAL FOR DISTRIBUTION

The following materials are intended to supplement interactive activities conducted by tour guides. Materials are given in both Spanish and English in order to reach the widest possible audience.

HISTORY OF FOREST

In 1995, trees were planted in the three-acre area of land with the intent of creating a forest.

At that time, there were no records kept of which species were planted.

Several of the originally planted trees were destroyed during Hurricane George in 1999. Since that time, some of the trees have grown back, but those that did not were cut down and removed.

Today, there are over 300 trees on this three-acre area of land. Of these 300 trees, over 60 different species have been identified.

BENEFITS OF THE FOREST

There are many benefits as a result of the development of the forest reserve at the Janssen facility.

❖

The forest serves as a buffer zone between the manufacturing facility and the residential area bordering the Janssen property.

❖

Janssen is able to make a contribution to the community by ensuring that visitors to the forest become aware and understand the importance of trees.

❖

By establishing the reserve, Janssen is able to preserve and protect the environment in which they reside.

ENVIRONMENTAL POLICY

Our credo commitment

"We are responsible to the communities in which we live and work and to the world community as well… We must maintain in good order the property we are privileged to use, protecting the environment and natural resources".

Policy statement

Janssen-Ortho LLC is committed to pollution prevention and environmental protection by promoting high environmental values in all employees, endeavoring to minimize environmental impacts, by implementing the best environmental practices in all out processes and striving for continuous improvement to achieve environmental excellence.

IT IS OUR POLICY TO:

Comply with all applicable governmental environmental laws and regulations, as well as Johnson & Johnson Worldwide Environmental Practices, and other voluntary principles to which we subscribe.

Minimize the environmental impacts related to air quality, water consumption, and solid waste generation and disposal.

Set, review and exceed environmental objectives and targets to minimize the possible impacts of our operations.

Educate and train management and associates to achieve awareness on environmental issues related to their responsibilities

and enable them to contribute for the achievement of our objectives and targets.

Maintain good partnerships with government agencies, local communities and industries to create mutual respect and understanding for the protection of the environment we share.

WELCOME TO JANSSEN'S FOREST

SPONSORED BY
JANSSEN ORTHO LLC
IN
GURABO, PUERTO RICO

Exhibit D.1: Page 1 of English Brochure

Janssen Forest Reserve

Highlights of the Tour

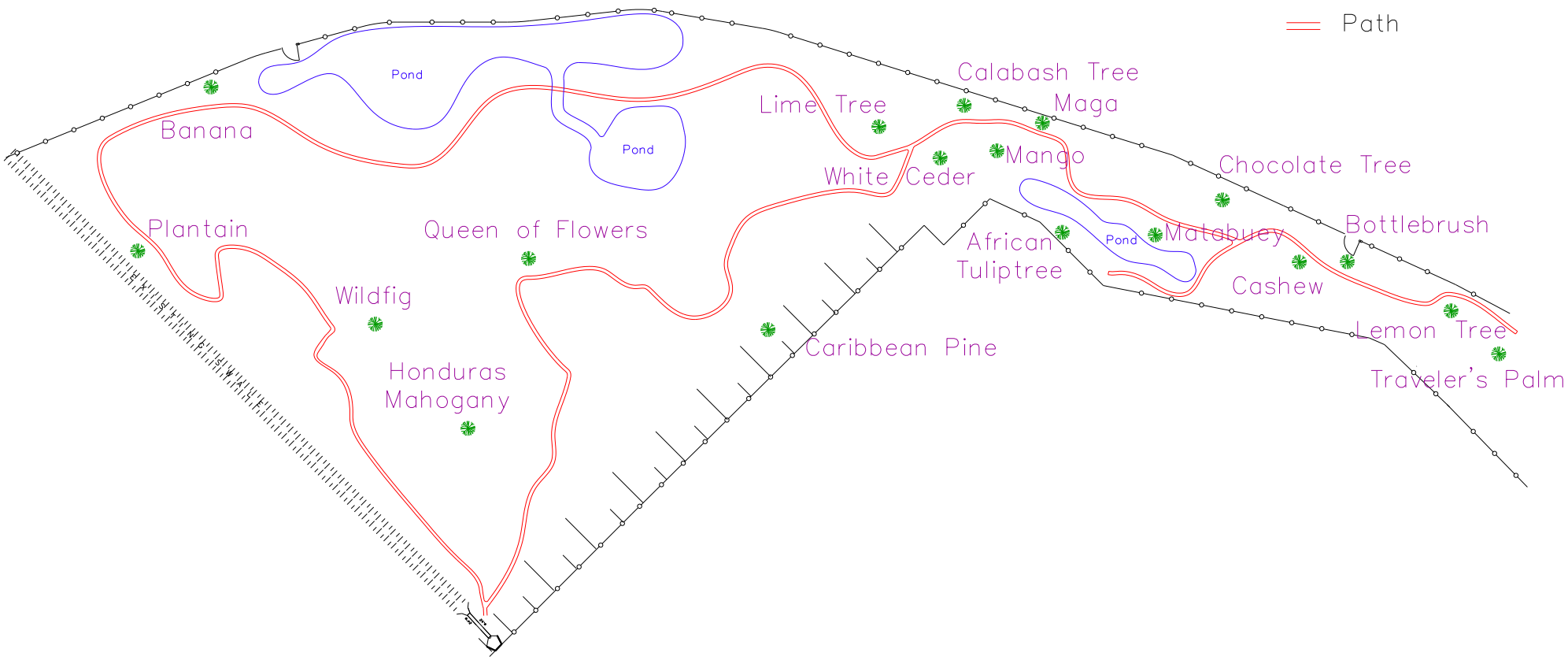


Exhibit D.2: Page 2 of English Brochure

HISTORIA DEL BOSQUE

En 1995, árboles estaban sembrado en el terreno de tres acres con las intenciones de hacer un bosque.

En ese tiempo, no había documentos que dijeran que árboles estaban sembrados.

Muchos de los arboles originales fueron destruidos durante el Huracán George en 1999. Desde entonces, muchos de los árboles se crecieron pero los que no fueron cortados y removidos.

Hoy, hay mas de 300 árboles en esto terreno de 3 acres. En estos 300 árboles, hay más de 60 especies identificadas.

BENEFICIOS DEL BOSQUE

Hay muchos beneficios como resultado del desarrollo de la reserva del bosque en la facilidad de Janssen.

❖

El bosque sirvió como un "buffer zone" entre la facilidad de Janssen y la urbanización.

❖

Janssen puede hacer una contribución a la comunidad de Gurabo para enseñarle a los visitantes acerca de la importancia de los árboles.

❖

Al hacer la reserva, Janssen puede preservar y proteger el ambiente.

POLITICA AMBIENTAL

Nuestro compromiso con el credo

"Estamos comprometidos con las comunidades en que vivimos y trabajamos, al igual que con la comunidad internacional…Debemos conservar en buen estado la propiedad que nos honramos en utilizar, protegiendo el ambiente y los recursos naturales"

Declaración política

Janssen-Ortho LLC está comprometida a prevenir la contaminación y proteger el ambiente promoviendo altos valores ambientales en todos sus empleados, tratando de minimizar los impactos ambientales, mediante la implementación de las mejores prácticas ambientales en todos nuestros procesos y esforzándonos por el continuo mejoramiento para poder alcanzar excelencia ambiental.

E S N U E S T R A P O L Í T I C A :

Cumplir con todas las leyes y regulaciones ambientales gubernamentales aplicables, así como con las Prácticas Ambientales Mundiales de Johnson & Johnson, y otros principios voluntarios a los cuales nos suscribimos.

Minimizar los impactos ambientales relacionados a la calidad del aire, consumo del agua y la generación y disposición de desperdicios sólidos.

Establecer, revisar y exceder las metas y objetivos ambientales para minimizar los posibles impactos de nuestras operaciones.

Educar y adiestrar a nuestra gerencia y asociados para alcanzar un conocimiento en los asuntos ambientales relacionados a sus responsabilidades y habilitarlos para que contribuyan en el logro de nuestros objetivos y metas.

Mantener acuerdos ventajosos con las agencias de gobierno, las comunidades locales y las industrias para crear un entendimiento y respeto mutuo en la protección del ambiente que compartimos.

BIENVENIDOS AL BOSQUE DE JANSSEN

AUSPICIADO POR
JANSSEN ORTHO LLC
EN
GURABO, PUERTO RICO

Exhibit D.3: Page 1 of Spanish Brochure

Reserva del Bosque de Janssen

Los Mas Notables del Paseo

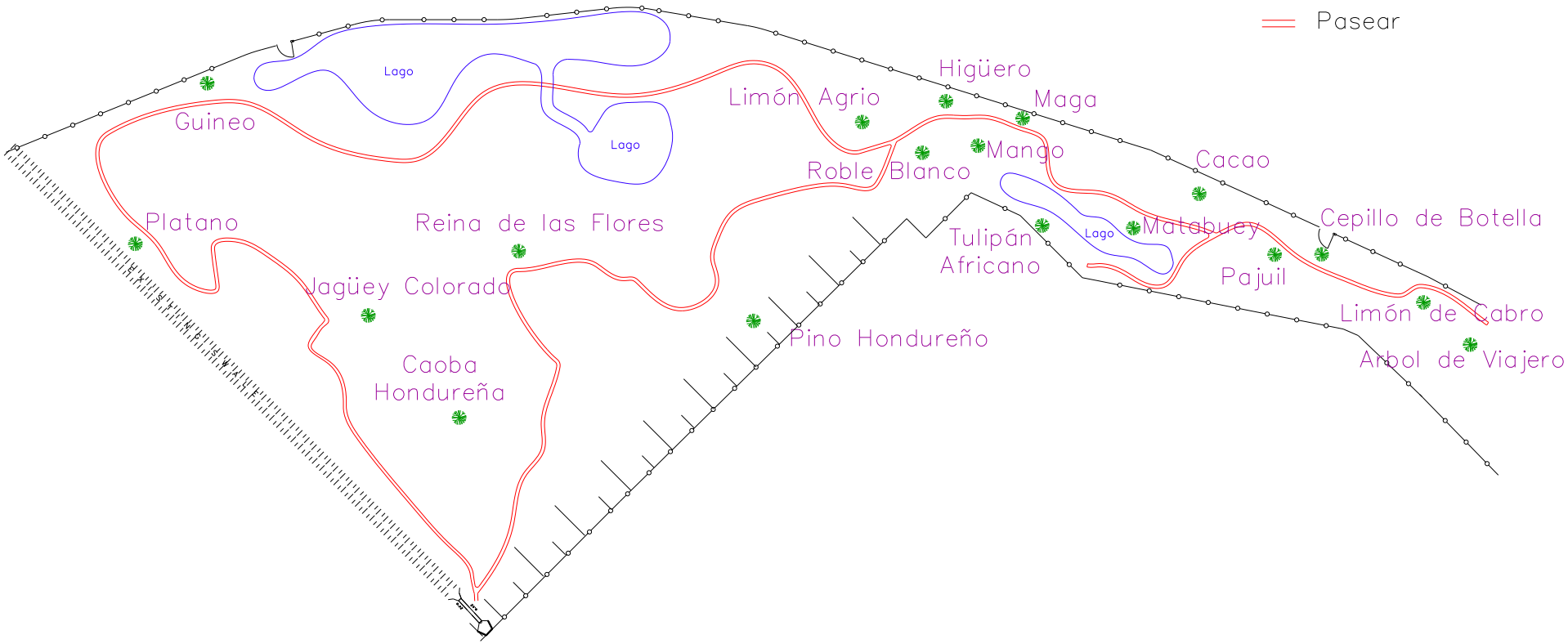
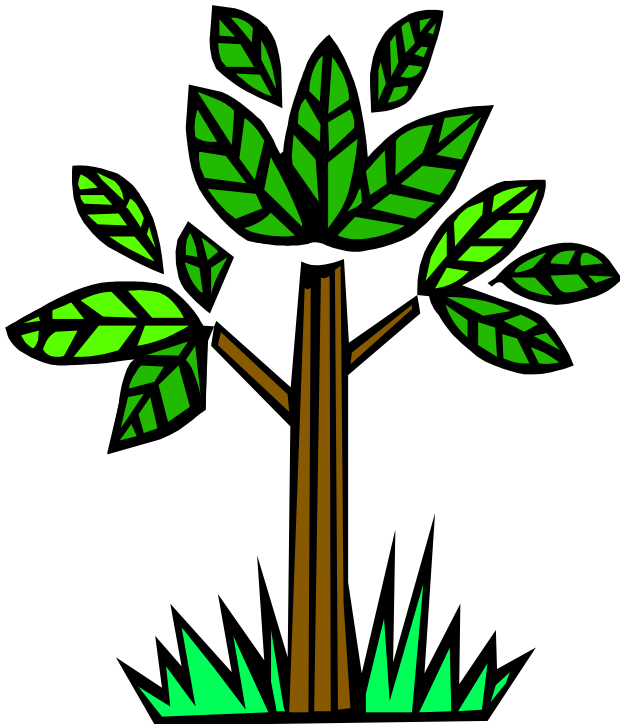


Exhibit D.4: Page 2 of Spanish Brochure

Can you unscramble the following tree names?



AFRICAN TULIPTREE _

WILDFIG _ _ _ _ _ _ _

MANGO TREE _ _ _ _ _ _ _ _ _ _

WHITE CEDAR _ _ _ _ _ _ _ _ _ _ _

EARPOD TREE _ _ _ _ _ _ _ _ _ _

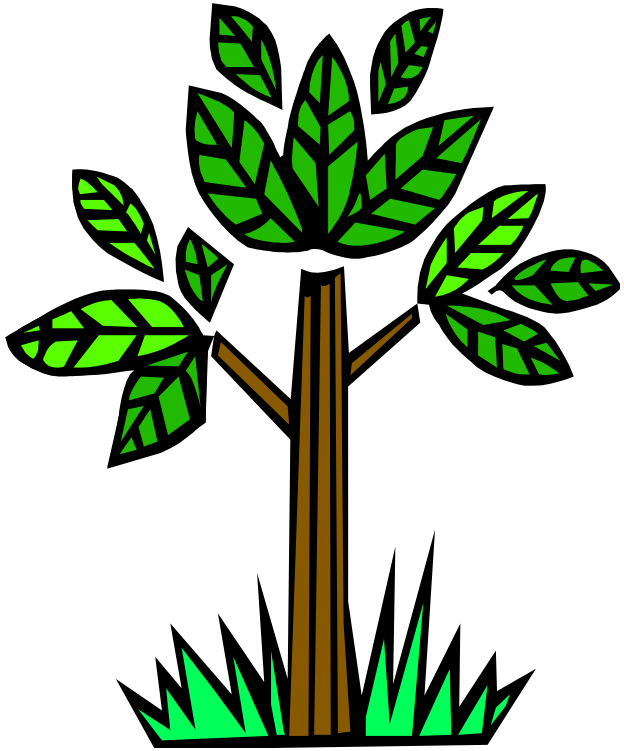
CHOCOLATE TREE _ _ _ _ _ _ _ _ _ _ _ _ _ _

HONDURAS MAHOGANY _

WHITE FIDDLEWOOD _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Exhibit D.5: Word Scramble Key in English

Can you unscramble the following tree names?



IRNACAF EEITRTLUP _

WGIFDLI _ _ _ _ _ _ _

NMOAG ERET _ _ _ _ _ _ _ _ _ _

TWIEH DRAEC _ _ _ _ _ _ _ _ _ _ _

APRDOE EETR _ _ _ _ _ _ _ _ _ _

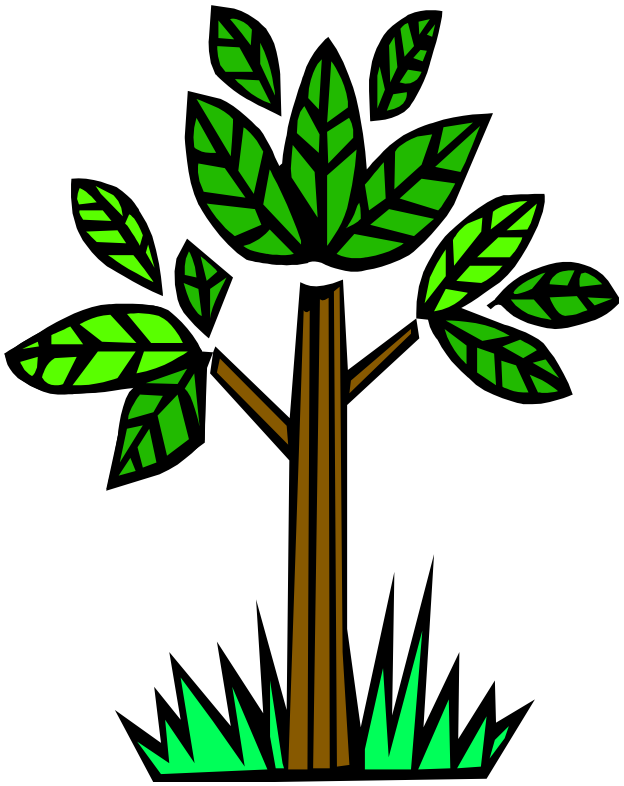
OOCLATHEC ERTE _ _ _ _ _ _ _ _ _ _ _ _ _ _

SARUNODH GMAAHOYN _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

EWTIH EFILWDDDOO _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Exhibit D.6: Word Scramble in English

¿Puede degatear los nombres de estos arboles?



TULIPÁN AFRICANO _

JAGÜEY COLORADO _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

MANGO _ _ _ _ _

ROBLE BLANCO _ _ _ _ _ _ _ _ _ _ _ _ _ _

GUANACASTE _ _ _ _ _ _ _ _ _ _ _

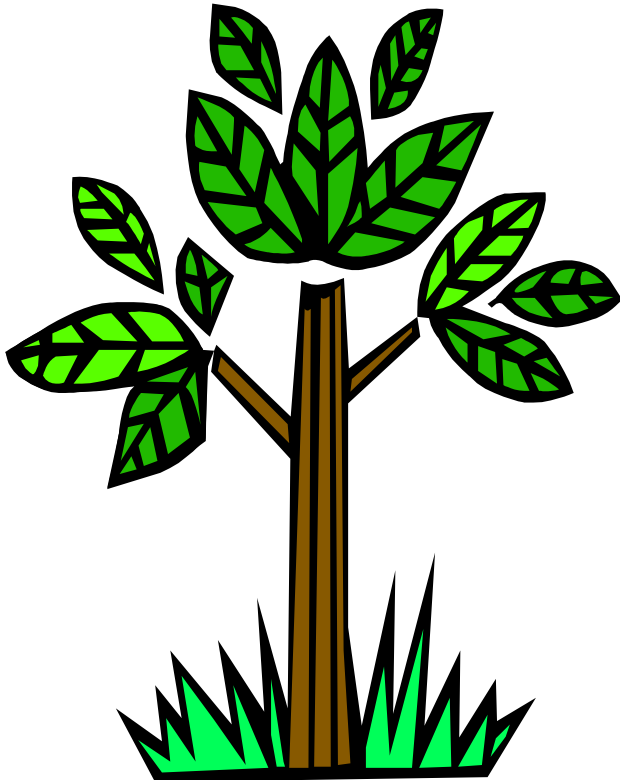
CACAO _ _ _ _ _

CAOBA HONDUREÑA _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

HIGÜERILLO _ _ _ _ _ _ _ _ _ _ _

Exhibit D.7: Word Scramble Key in Spanish

¿Puede degatear los nombres de estos arboles?



ÁNPTULI OARICNFA _

YÜJGAE DOLOCAOR _

NMAOG _ _ _ _ _

RELBO OLCANB _ _ _ _ _ _ _ _ _ _ _ _ _ _

ECANUGAAST _ _ _ _ _ _ _ _ _ _ _

OAACC _ _ _ _ _

ABAOC ÑADHUOREN _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

LÜLIHEORGI _ _ _ _ _ _ _ _ _ _ _

Exhibit D.8: Word Scramble in Spanish

TREE SPECIES WORD SEARCH

AFRICANTULIPTREE
BANANA
BOTTLEBRUSH
BUTTERFLYBAUHINIA
CALABASHTREE
CANAFISTULA
CARIBBEANPINE
CASHEW
EARPODTREE
FLAMBOYAN
HONDURASMAHOGANY
MAGA
MATABUEY
PLANTAIN
REINADELASFLORES
SEAGRAPE
TECA
VOMITEL
WASHINTONIAPALM
WESTINDIANCHERRY
WESTINDIESMAHOGANY
WHITECEDAR
WILDFIG

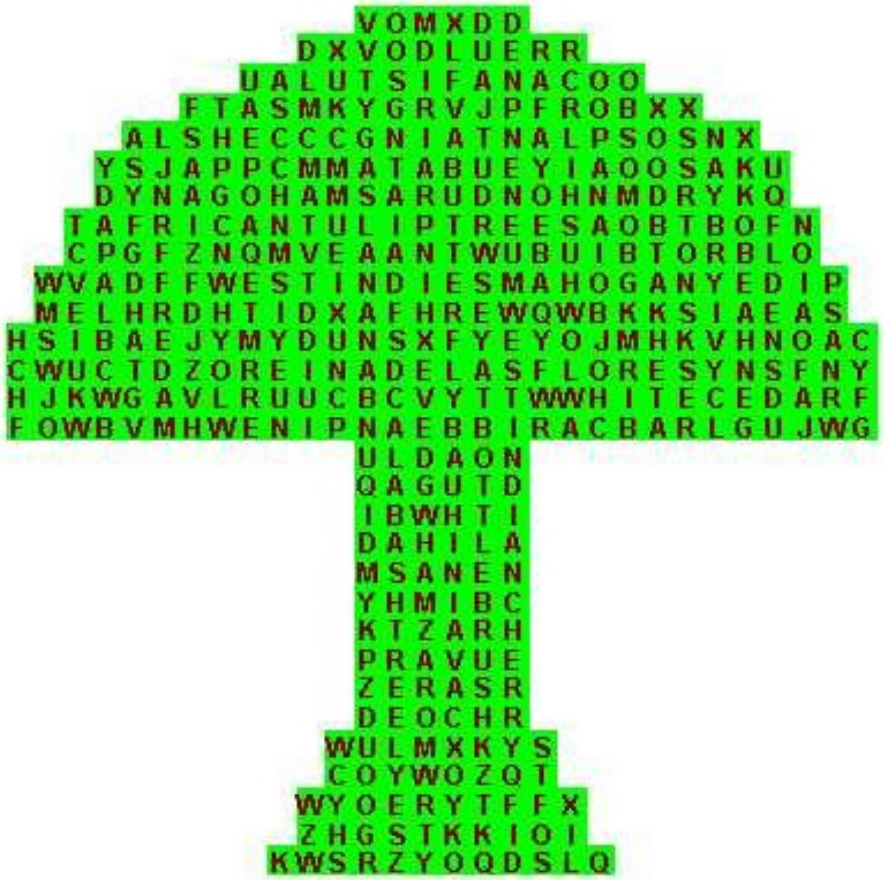


Exhibit D.9: Word Search in English

BUSQUEDA DE PALABRAS DE ARBOLES

ACEROLA
CANAFISTULA
CAOBADOMINICANO
CAOBAHONDURENA
CEPILLODEBOTELLA
FLAMBOYAN
GUANACASTE
GUINEO
HIGUERO
JAGUEYCOLORADO
MAGA
MARIPOSA
MATABUEY
PAJUIL
PALMAWASHINGTONIA
PINOHONDURENO
PLATANO
REINADELASFLORES
ROBLEBLANCO
TECA
TULIPANAFRICANO
UVADEPLAYA
VOMITEL

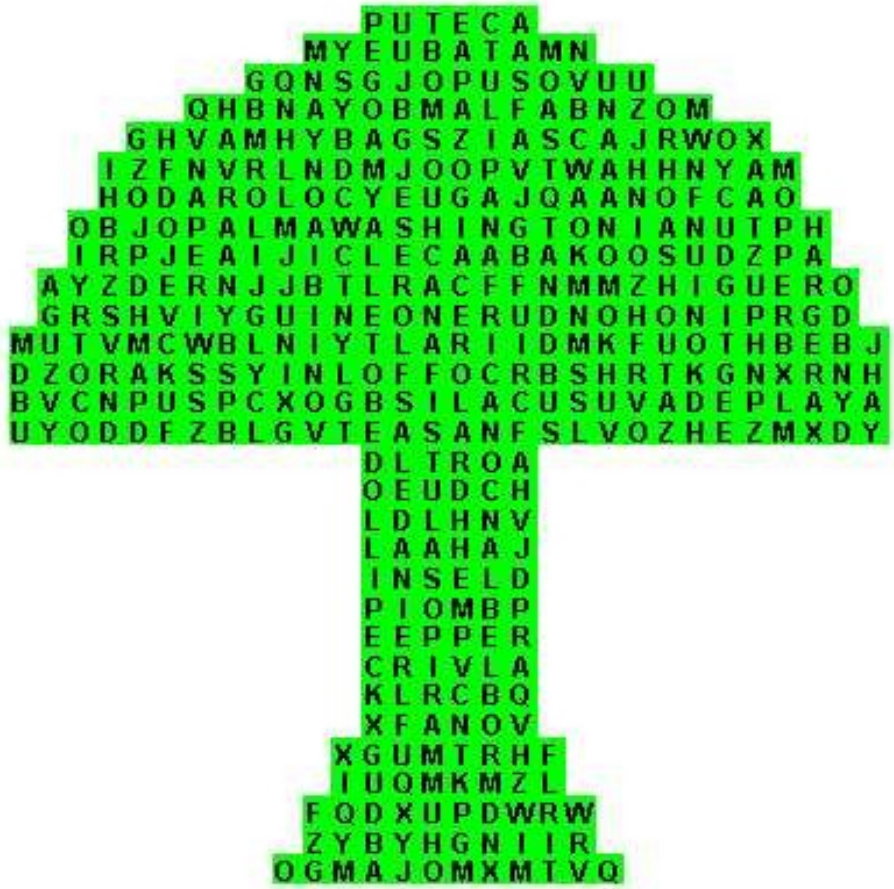


Exhibit D.10: Word Search in Spanish

Exhibit D.11: African Tuliptree

Tulipán Africano

Exhibit D.12: Bottlebrush

Cepillo de Botella

Exhibit D.13: Chocolate Tree

Cacao

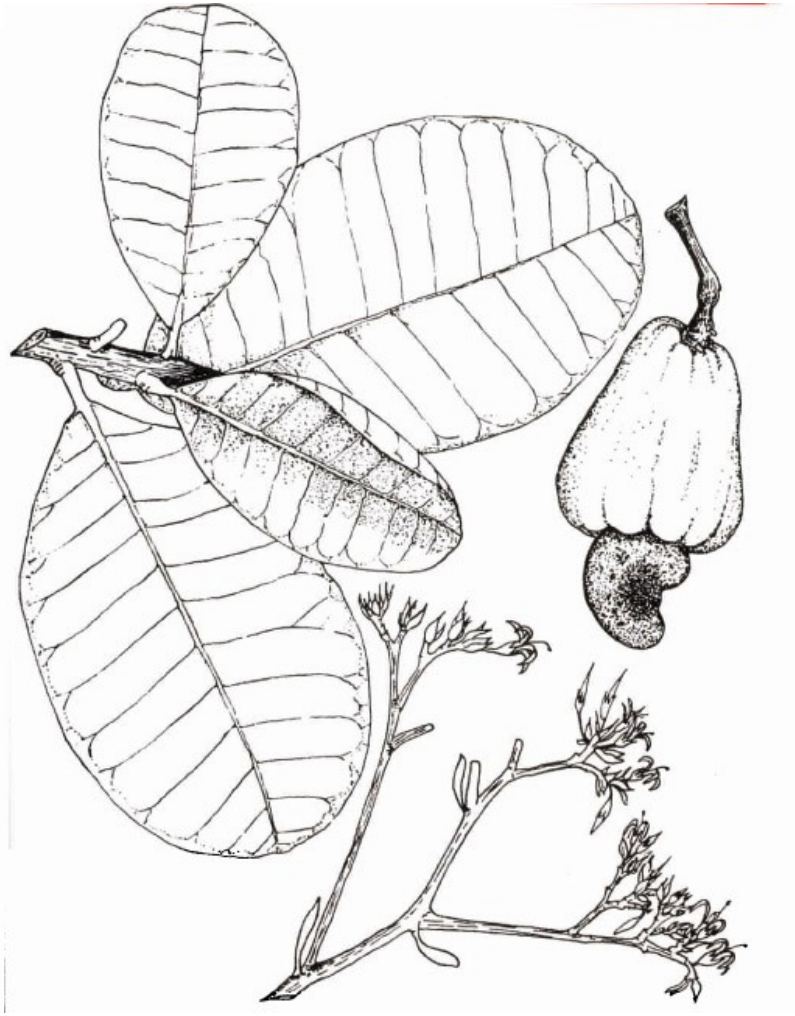


Exhibit D.14: Cashew

Pajuil

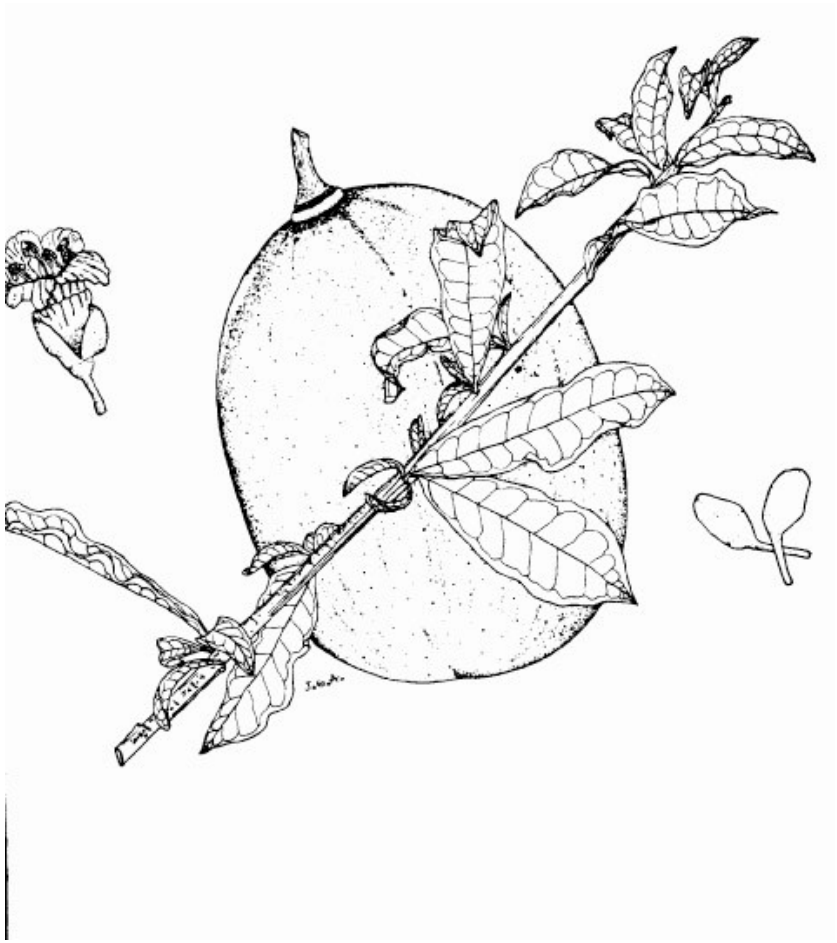


Exhibit D.15: Calabash Tree

Higüero

Exhibit D.16: Matabuey

Matabuey

Exhibit D.17: Queen of Flowers

Reina de las Floras

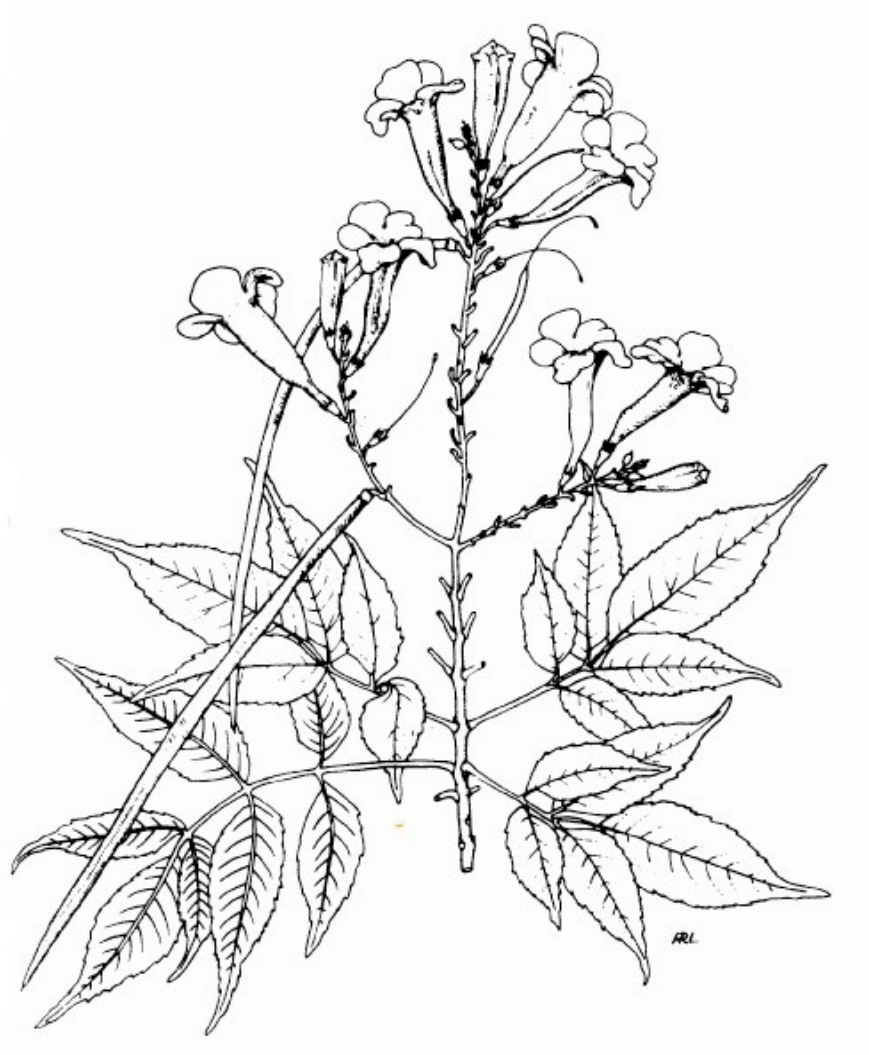


Exhibit D.18: Ginger Thomas

Roble Amarillo

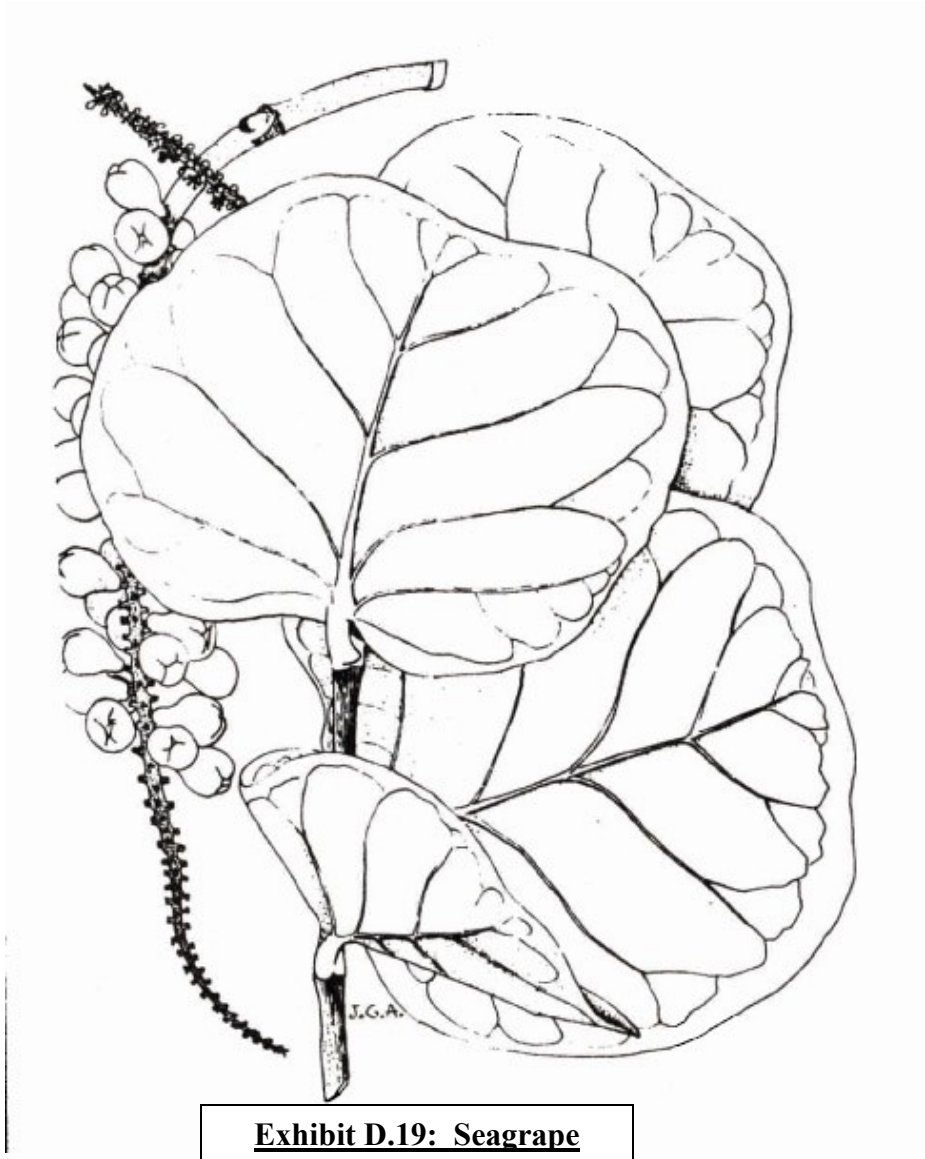


Exhibit D.19: Seagrape

Uva de Playa

APPENDIX E: COMPOSITION OF FOREST BY TREE TYPES

This graph contains all of the identified trees of which there are one or two.

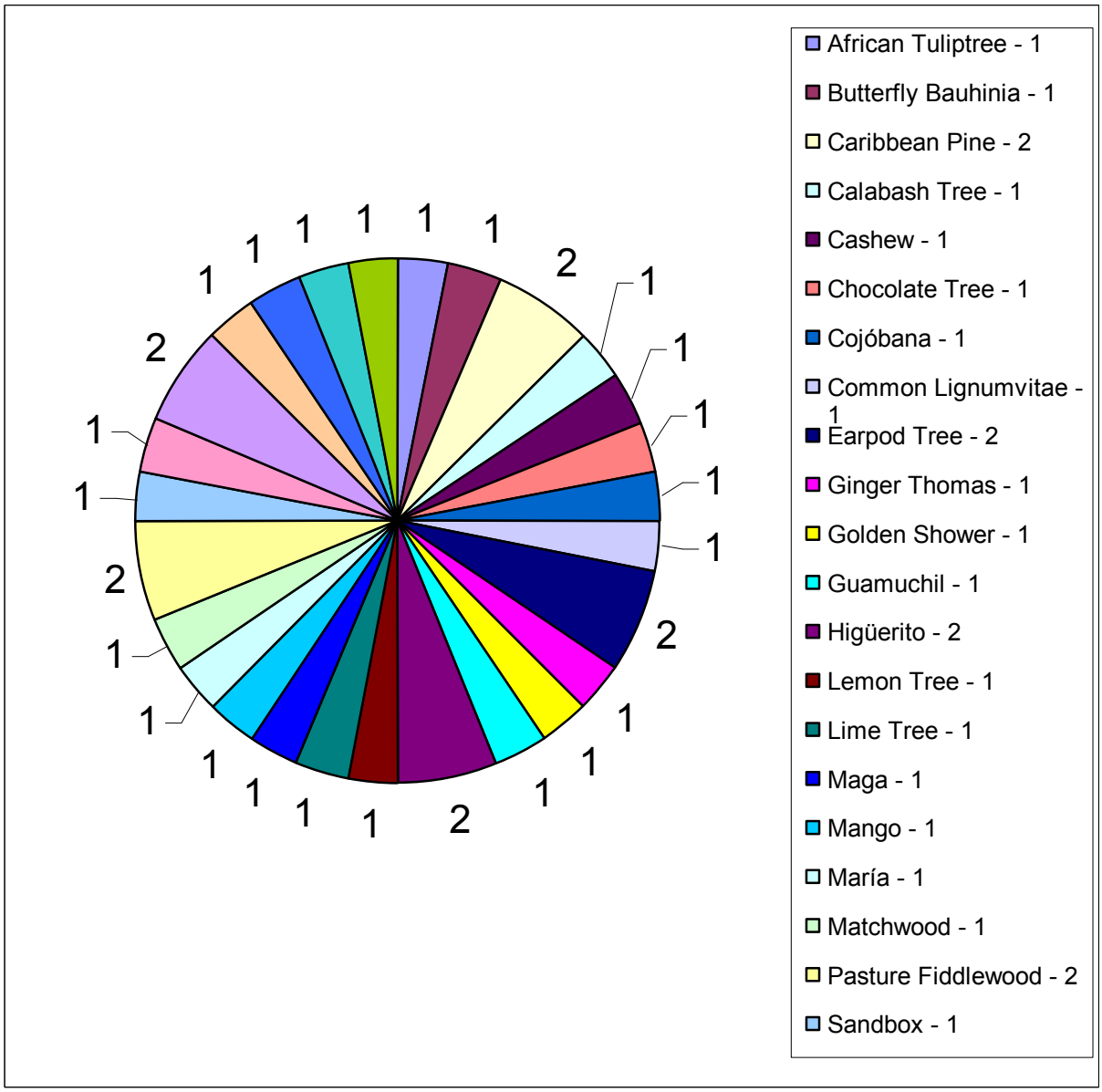


Exhibit E.1: Distribution of Identified Trees With Quantities

Less Than Two of the Species

APPENDIX F: MATERIALS FOR EARTH DAY PRESENTATION

The following materials were used for a presentation board seen by all Janssen employees during the week preceding Earth Day. The presentation board helped make the employees not directly involved with the establishment of the forest reserve more aware of where the project stood and the benefits of completing the project. Photographs were included to show the Janssen employees parts of the identification project as they were being completed. All written exhibits are presented in both English and Spanish. The Spanish versions were used for the actual Earth Day presentation. The corresponding English versions were used for a presentation made to the visiting WPI faculty. In addition to the Earth Day Presentation, we held a contest among all of the Janssen employees to name the forest reserve. A box was put out in front of the presentation board over a period of three days. All of the answers were compiled and a winner was selected and random from the pool of the most popular answer. It was decided to name the forest "El Bosque de Johnny Perez" after the man who initiated the forest reserve project. The winner of the contest to name the forest reserve received a Bonsai Tree as the prize. This contest helped increase employee awareness of the forest reserve and to get them excited about the project.

Exhibit F.1: Pat, Alison and Amy Identifying the Wilfig

Exhibit F.2: Alison and Amy Identifying the Bottlebrush

Exhibit F.3: View of Forest Showing Buffer Zone

Exhibit F.4: Pat and Alison Tagging the Traveler's Tree

Benefits of the Janssen Forest

- Make a contribution to the community
- Preserve and protect the environment
- Serve as a buffer zone between the facility and surrounding houses
- Move toward compliance of ISO 14001
- Improve the appearance of the facility

Exhibit F.5: Benefits of Forest in English

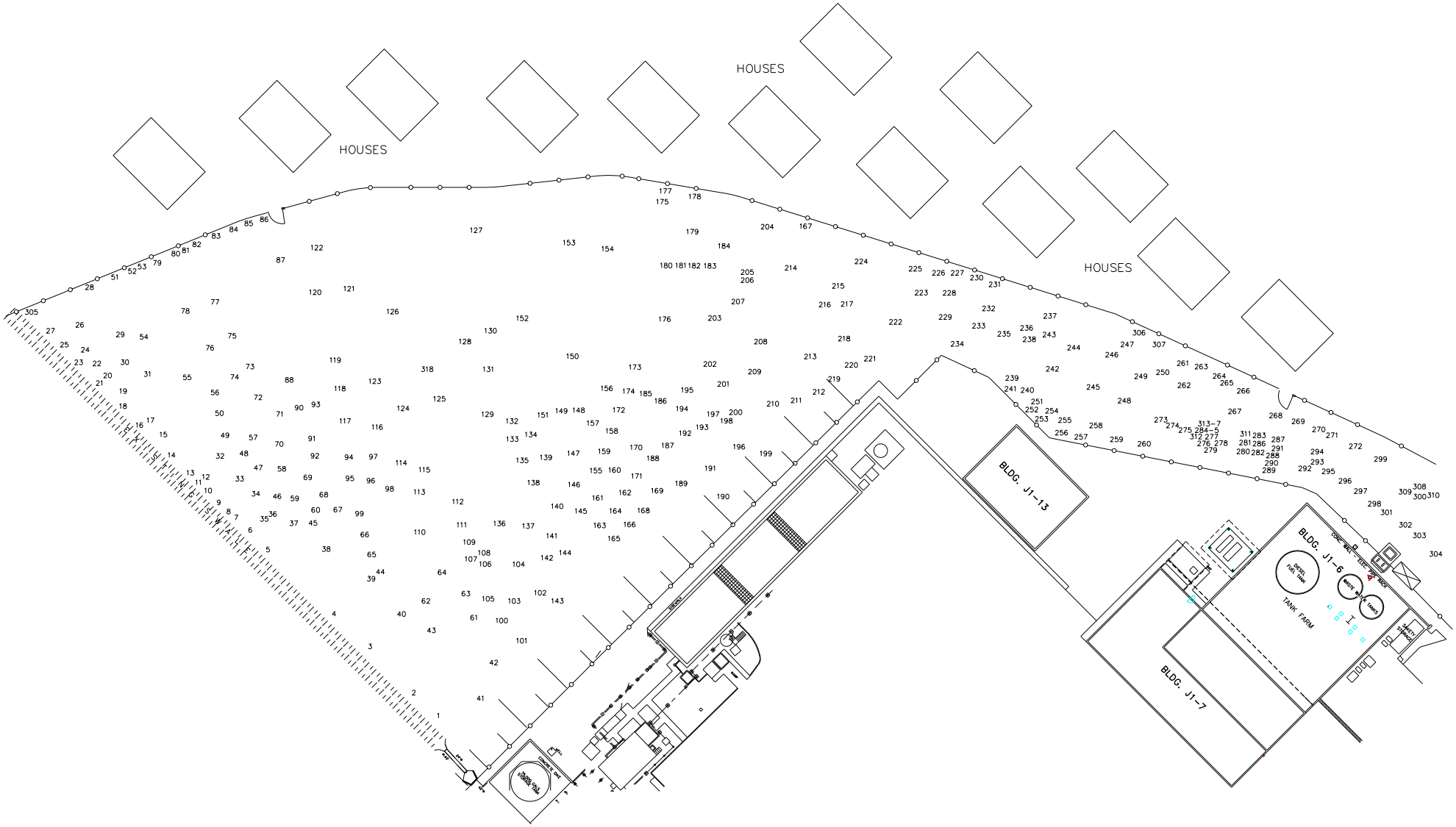
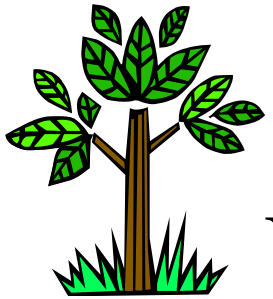
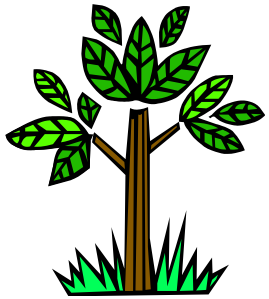


Exhibit F.6: Map of Forest in English



What is a *buffer zone*?



A *buffer zone* is a narrow strip of land that borders an area. It can include trees, vegetation, and wildlife. *Buffer zones* are often found along wetlands, streams, and rivers and are called *streamside buffers*. Another type is called a *visual buffer*. This type of buffer is used to screen the view of some man-made construction. The forest reserve here at Janssen serves as a visual buffer for the residents in the development that borders the facility.

Exhibit F.7: Buffer Zone Information in English

Composition of Trees in the Janssen Forest Reserve

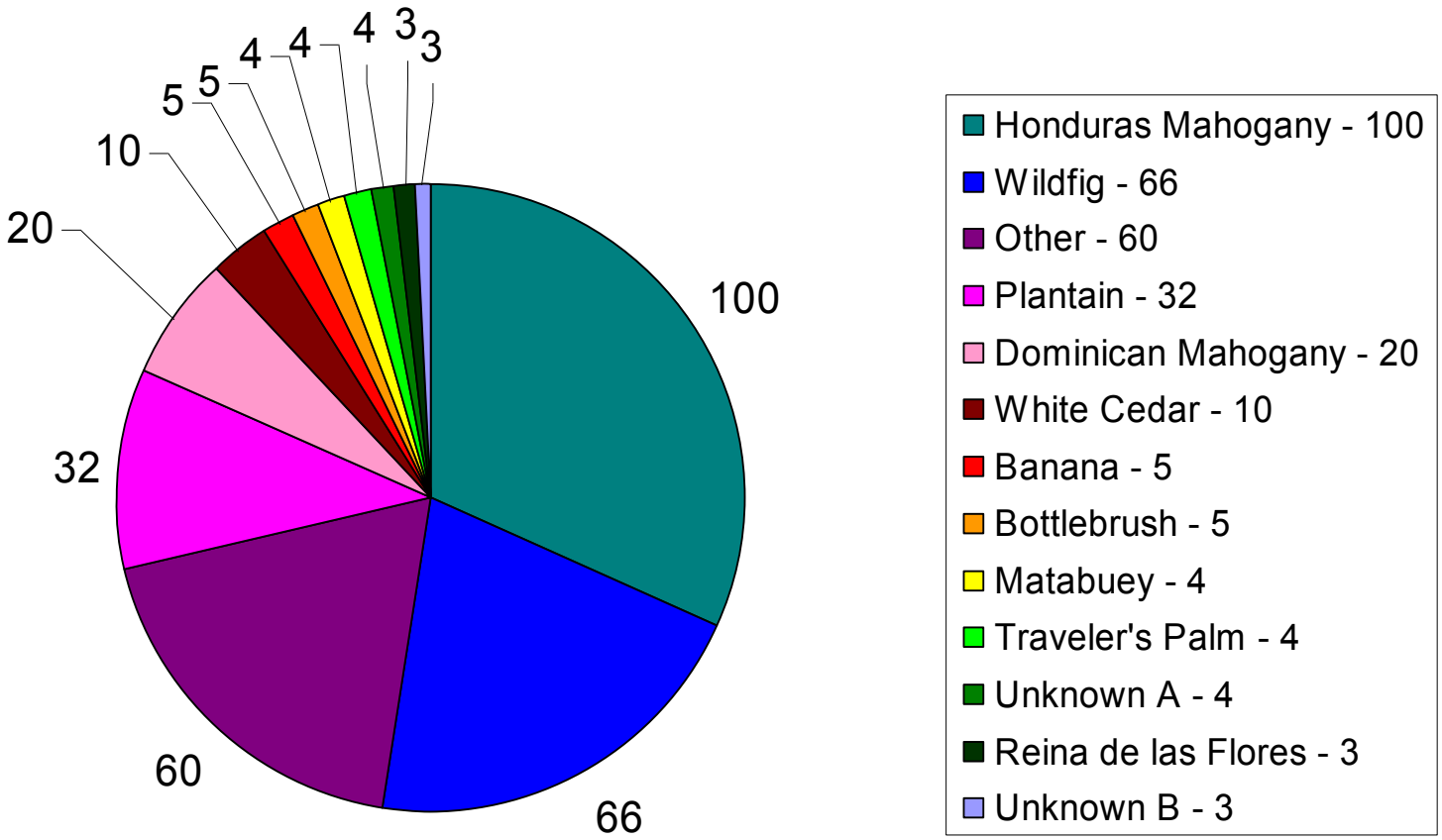


Exhibit F.8: Composition of Trees in English

How well do you know trees?

1. The White Cedar has _____ flowers.
    A. Red
    B. Yellow
    C. Pink
    D. White

2. Which of the following trees is an endangered species?
    A. Maga
    B. Matabuey
    C. Ficus
    D. Reina de las Flores

3. The fruit of the _____ tree is poisonous.
    A. Lemon
    B. Lime
    C. Mango
    D. Cashew

4. A deciduous tree
    A. Has pine needles
    B. Sheds its leaves
    C. Is evergreen
    D. Does not have leaves

Check your score on the board to find out how well you know trees!

Exhibit F.9: Quiz in English

1) C

Do not be deceived by the name…the flowers of the White Cedar are pink in color. The White Cedar is native to Puerto Rico, although it is not found in the Upper Luquillo and Upper Cordillera forest regions. The White Cedar is used in Puerto Rico to make furniture, cabinets, flooring, paneling, boats, and for general construction.

2) B

The Matabuey is an endangered species. The Janssen forest reserve contains four Matabuey. We hope to do our part for conservation and help protect endangered endemic species of Puerto Rico by taking care of these trees.

3) D

The fruit of the Cashew Tree is poisonous. The cashew nut that people eat is actually the seed of the fruit of the Cashew Tree. The nut is surrounded by the poisonous oil of the shell and the nuts must be boiled to remove the oil.

4) B

A deciduous tree is a tree that sheds its leaves over the course of the year. Many of the trees in the forest reserve are deciduous.

Exhibit F.10: Quiz Answers in English

Beneficios del Bosque de Janssen

- Hacer una contribución a la comunidad
- Preservar y proteger el ambiente
- Servir como un “buffer zone” entre la urbanización y la facilidad
- Encaminar hacia cuplimient de ISO 14001
- Mejorar la apariencia de la facilidad

Exhibit F.11: Benefits of Forest in Spanish

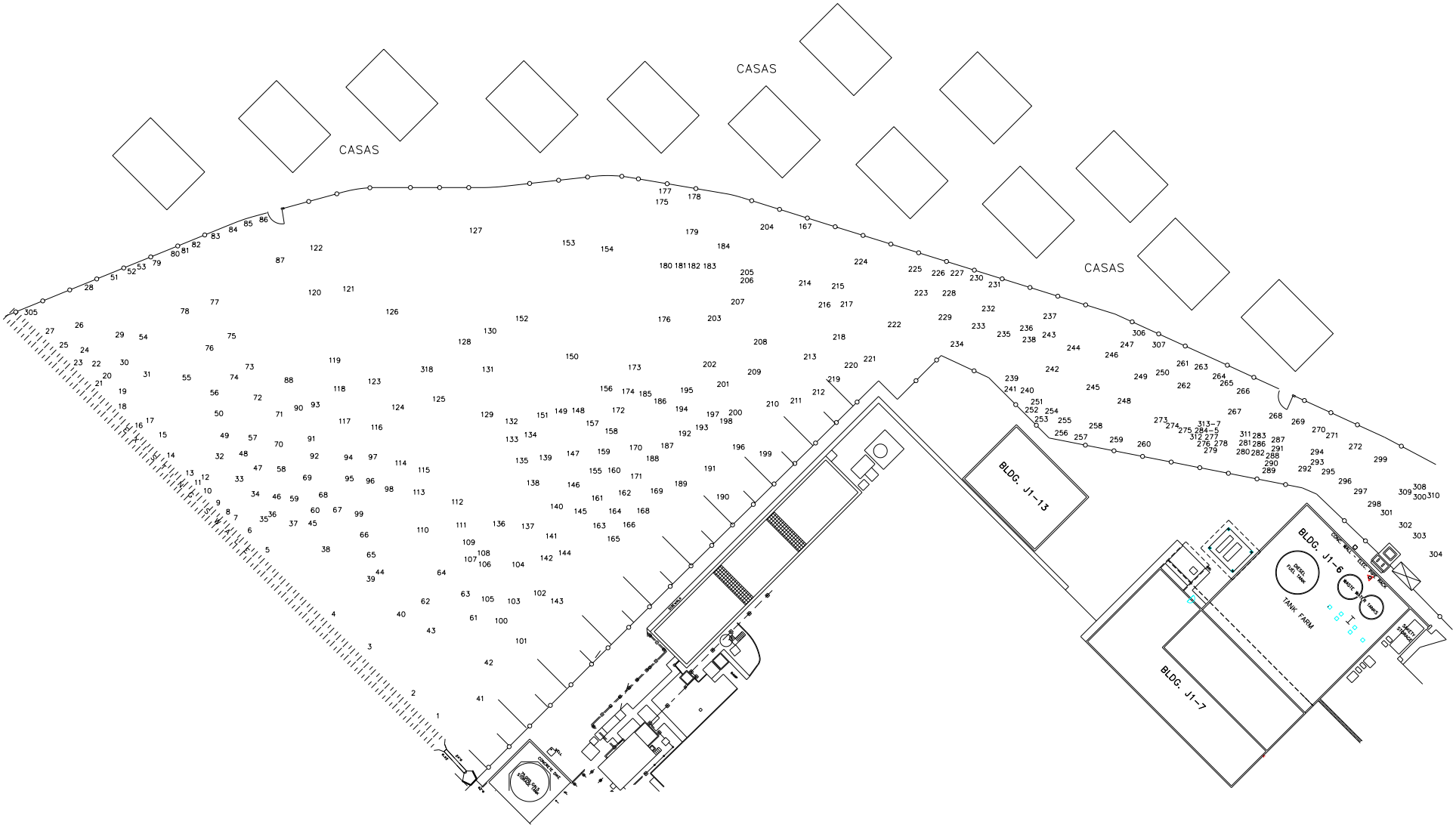
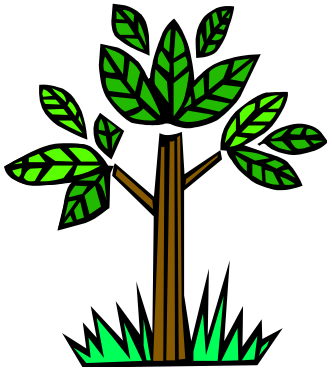
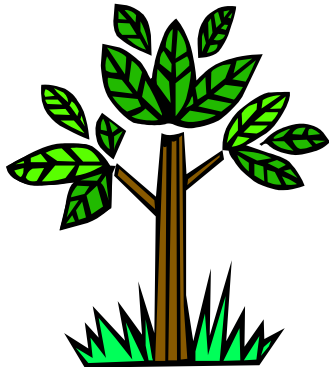


Exhibit F.12: Map of Forest in Spanish



¿Qué es un "*buffer zone*" ?



Un *"buffer zone"* es un pedazo de terrena que es una seperación entre dos areas. Puede includir árboles, vegetación, y animales. Puede encontrar *"buffer zones"* junto a humedales y ríos y se llaman *"buffer zone" de cuerpos de agua*. Otro tipo de "buffer zone" se llama *"visual buffer"*. Este tipo de buffer se usa bloquear el campo visual de una estructura. El bosque de Janssen sirve como un *"visual buffer"* y de ruido para los residentes en la urbanización que bordean la facilidad.

Exhibit F.13: Buffer Zone Information in Spanish

Tipos de Árboles que existen en el Bosque de Janssen

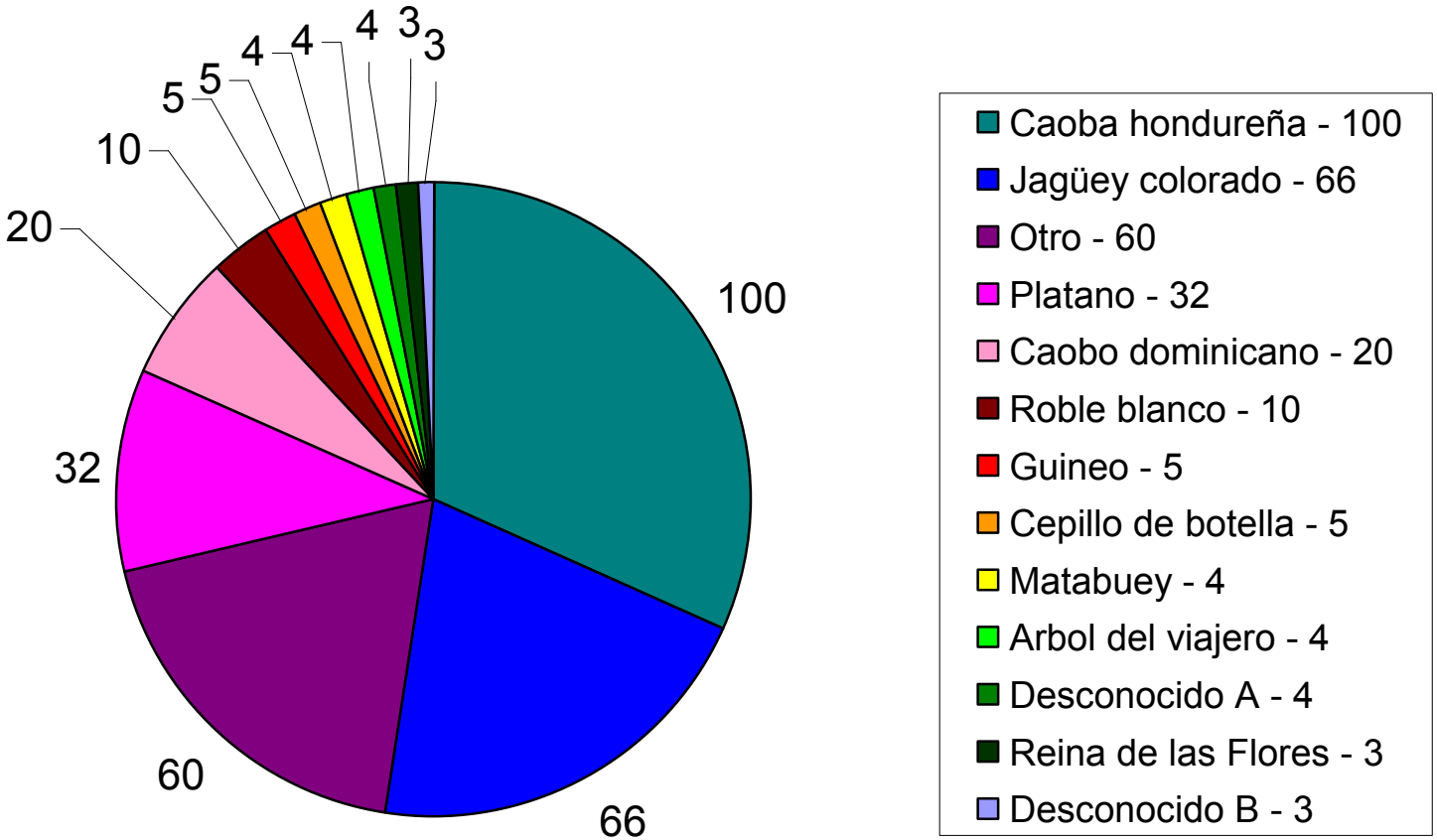


Exhibit F.14: Composition of Trees in Spanish

¿Cuánto conoces de los Árboles?

1. El cedro blanco tiene flores _____.
    E. Rojo
    F. Amarillo
    G. Rosa
    H. Blanca

2. ¿Cuál de los siguientes árboles es una especie en peligro de extinción?
    E. Maga
    F. Matabuey
    G. Ficus
    H. Reina de las Flores

3. La fruta del árbol de _____ es venenoso en su estado natural.
    E. Limón
    F. Lima
    G. Mango
    H. Pajuil (Cashew)

4. Un árbol se deshoja:
    A. Una vez en un año
    B. Dos veces en un año
    C. Nunca
    D. A, B, y C

¡Vamos a ver cuanto sabes de los árboles!

Exhibit F.15: Quiz in Spanish

1) C

No ser engañar por el nombre…las flores del cedro blanco son rosas en color. El cedro blanco es endemico a Puerto Rico, pero no puede encontrarlo en los regions de bosque de Luquillo y Cordillera. El cedro blanco se usa en Puerto Rico para hacer muebles, gabinetes, pisos de madera y para construcción en general.

2) B

El Matabuey es una especie en peligro de extinción. El bosque de Janssen tiene cuatro Matabuey. Esperamos hacer nuestra parte para su conservación y ayudar a proteger las especies endemicas de Puerto Rico y en peligro de extinción.

3) D

La fruta del arbol de pajuil es venenosa. La nuez de pajuil que comemos es la semilla de la fruta del arbol de pajuil. La nuez está rodeado por el aceite venenoso de la vainay las nueces tienen que hervirse para remover el aceite.

4) D

Algunos árboles se deshoja y algunos árboles no se deshoja. Muchos de los árboles en el bosque de Janssen se deshoja una o dos veces en el año.

Exhibit F.16: Quiz Answers in Spanish

JANSSEN ORTHO LLC

Job Description: Volunteer Tour Guide for Janssen Forest Reserve

Applications are now being accepted for volunteer tour guides for the forest reserve here at our Gurabo facility. Tour guides will receive training about the forest reserve, trees present in the reserve, benefits of the forest, and how to educate visitors about our reserve. No experience in any of these areas is necessary because adequate training will be provided, but any expertise is always helpful.

Tours will be given to groups of various sizes from local schools, scouts, and any other groups that wish to come visit. Our target audience is very diverse. Guides will be responsible for educating visitors ranging in age from primary school students to the elderly.

Tours will take place during normal business hours and tour guides will take time out of their regular workday to conduct tours. Approval from supervisors will be necessary in order for employees to be offered the tour guide position.

Above all, we are looking for motivated tour guides who are excited about teaching visitors about the benefits of environmental awareness and conservation. We look forward to reviewing your completed application.

Any questions should be directed to Elaine Diaz in the Environmental Department.

Tour Guide Application for Janssen Forest Reserve

NAME_____

DEPARTMENT _____ SUPERVISOR _____

PHONE EXTENSION_____ NORMAL WORK HOURS _____

On a separate sheet of paper, please briefly answer the following questions.

1. Why would you like to become a volunteer tour guide for the Janssen forest reserve?

2. What special skills or interests do you have that make you a good candidate for a tour guide position? (i.e. works well with children, loves the outdoors, etc.)

3. How much time per week can you make available for training and giving tours? How will taking time away from your regular job affect your performance or the performance of anyone else in your department?

4. What are your initial impressions of the forest reserve? How familiar are you with the set up and trees found in the reserve?

5. Would you feel comfortable giving tours in Spanish and in English?

Please return completed applications to Elaine Diaz in the Environmental Department.

Training Manual for Tour Guides

And

"Plan del Bosque"

For the Forest Reserve

At

Janssen Ortho LLC

Gurabo, Puerto Rico

April 2001

Submitted by:

Amy J. Fuller Alison Hughes Patrick Saggal

The first section of this document is the “Plan del Bosque” for the forest reserve at Janssen Ortho LLC located in Gurabo, Puerto Rico. This document is intended to stand alone without the attached training manual and includes information concerning the climate of Puerto Rico and the Gurabo area, a list of the trees in the forest and their descriptions, a map of the locations of the trees, and the benefits of the forest at Janssen. The second section includes the activities and suggestions for the tour guides of the forest. It is to be used in conjunction with the “Plan del Bosque” when training the tour guides.

1.0 Introduction of Area

The forest area that we will be discussing in this plan is located in Gurabo, Puerto Rico and is approximately three acres in size. Gurabo is located in the east central part of the island approximately 20 miles from the eastern coast and 15 miles from the northern coast. The town of Gurabo is approximately 73 km² in size.

On the island of Puerto Rico, the temperature fluctuation is quite small. However, different parts of the island have different temperatures ranges. Temperatures of inland areas fluctuate more than areas on the coast. This can be attributed to the coastal waters whose temperature fluctuates only from 77.9°F during the coolest season to 82.5°F during the warmest (Ruffner, 1985). The steady temperatures of the coastal waters maintain a more stable temperature along the coastal areas. The average temperature on the island ranges from 68°F to 80°F (Rivera, 2001).

Janssen Ortho LLC is located in east central Puerto Rico within the subtropical moist forest region of Gurabo. This area has an annual rainfall of 63.5 inches. The temperature ranges from 65.9°F to 86.7°F (National Weather Service, 2000) with an average temperature of 78°F.

Since different parts of the island have different types of weather, biologists who are experts on the flora and fauna of Puerto Rico have divided the island into six regions. These regions are the subtropical dry forest, moist forest, wet forest, rain forest, lower montane wet forest, and lower montane rain forest (Wiley, 2001). The subtropical dry forest is located on the southwestern corner of Puerto Rico and is the driest of all the regions. It has an annual rainfall of 23.6 to 43.3 inches. The subtropical lower montane

rain forest is located on the slopes of the Sierra de Luquillo. This is the wettest and smallest region of all with an annual average rainfall of 180 inches (Wiley, 2001).

Surrounding the forest reserve on the southeast side is a residential area. The forest reserve will serve as a buffer zone between that residential area and the Janssen manufacturing facility located on the western side of the forest area. For further information on the buffer zone, see Section 4.0 of this document. On the north and northeastern sides of the forest area, there is a highway. The plot plan in Section 3.0 that displays the placement of each species also shows the areas surrounding the forest reserve.

In 1995, trees were planted in the three-acre area of land with the intent of creating a forest. There were no records kept of which species were planted at that time and several of the originally planted trees were destroyed during Hurricane George in 1999. Since that time, some of the trees have grown back, but those that did not were cut down and removed.

There are approximately 3,000 distinct types of plants that can be found in Puerto Rico including both native and exotic species. Of those 3,000 species, it is estimated that approximately 268 are endemic (DRNA, 1998). The largest concentration of species, both native and endemic, can be found in the mountains of Maricao, Toro Negro and Luquillo (DRNA, 1998). Forested areas that are planted often include exotic species that would otherwise not grow there naturally, although these trees may thrive in the area following their introduction. Many trees, both exotic and native in nature, are found in the Gurabo region. Trees specific to the reserve established at Janssen were researched following the identification of the trees present. Complete descriptions of each species

and a plot plan of the locations of the trees at the Janssen site can be found in sections 2.0 and 3.0 of this document, respectively.

Many of the trees identified at Janssen are part of a list of recommended trees for planting published by Departamento de Recursos Naturales y Ambientales. The guide, Manual de Forestacion Urbana para Puerto Rico, recommends the following trees which are also found at the Janssen reserve: West Indies Mahogany, Honduras Mahogany, Golden Shower, Bottlebrush, Common Lignumvitae, Maga, María, Washingtonia, Queen of Flowers, White Cedar, Ginger Thomas, Seagrape, and Geiger tree. This list includes a mix of endemic, native, and exotic trees.

2.0 Species of Trees at Janssen

Table 2.1 is a list of all of the species of trees present in the Janssen forest reserve. The table includes the scientific and common names, how many of each species there are, and the tree number that corresponds to the plot plan in Section 3.0. A total of 318 trees are present in the Janssen forest reserve. Among the 317 trees, we found that 61 different species exist. Due to lack of time, we were able to identify only 36 of the 61 species. The list contains the names of all of the trees that were identified. We denoted the unidentified trees by placing "Unknown" in the tree name column. Following the list is a complete description of each of the species, that including where the species is native, where it is cultivated, overall size of the species, uses of the tree, and descriptions of leaves, fruits, flowers, and pods. Trees are separated into native and exotic species and are organized alphabetically within those categories. Tables 2.1, 2.2, and 2.3 list the native, exotic, and unknown species, respectively. Information for the tree descriptions was taken from two books: Arboles de Puerto Rico y las Islas Virgenes: Segundo Volumen and Common Trees of Puerto Rico and the Virgin Islands.

Exhibit H.1: Distribution of Native Trees

Scientific Name	Common Names	Quantity	Plot Plan Number
Crescentia cujete	Calabash Tree	1	225
Anacardium occidentale	Cashew	1	267
Piptadenia peregrina	Cojóbana	1	263
Guaiacum officinale	Common Lignumvitae	1	244
Tecoma stans	Ginger Thomas	1	256
Crescentia linearifolia	Higüerito	2	159,217
Montezuma speciosissima	Maga	1	231
Calophyllum brasiliense	María	1	148
Goetzea elegans	Matabuey	4	226,235,245,248
Schefflera morototoni	Matchwood	1	33
Citharexylum fruticosum	Pasture Fiddlewood	2	239,301
Hura crepitans	Sandbox	1	271
Coccoloba uvifera	Seagrape	1	252
Tabebuia heterophylla	White Cedar	10	119,156,160,174,203, 222,227,230,233,243
Zanthoxylum martinicense	White Prickle	1	218
Ficus Americana	Wildfig	66	25,27,29,30,34,38,45-48,57-59, 67,72-78,81,92,94,95,97,98, 106-108,134,139,141,142,161, 163,164,166,187,188,197,198, 212-215,219-221,238,240,242, 247,251,254,255,258-260,279, 292,296,298,302-304

Exhibit H.2: Distribution of Exotic Trees

Scientific Name	Common Names	Quantity	Plot Plan Number
Spathodea campanulata	African Tuliptree	1	241
Musa sapientum	Banana	5	53,80,82,84,86
Callistemon citrinus	Bottlebrush	5	266,268,272,273,275
Bauhinia monandra	Butterfly Bauhinia	1	51
Cassia fistula	Cañafistula	1	223
Pinus caribaea	Caribbean Pine	2	190,199
Theobroma cacao	Chocolate tree	1	250
Enterolobium cyclocarpum	Earpod tree	1	35, 206
Cordia sebestena	Geiger Tree	1	228
Pithecellobium dulce	Guamá Americano	1	274
Swietenia macrophylla	Hondurus Mahogany	99	1-4,6-11,13, 14,18,21,26,31,32, 39-44,50, 54-56,60-64,66, 68, 71,79,83,88,90,91,93, 99,100, 103-105,109, 111,112,114,115, 120,121,124-128,131,133, 136-138,140,143,147, 152,153, 155,157,162,165,167-172,178, 179,185,186,189,191,193-196, 200-202,207,208,210,211, 305,318
Citrus limon	Lemon Tree	1	299
Citrus aurantifolia	Lime Tree	1	216
Mangifera indica	Mango	1	229
Musa paradisiaca	Plantain	32	16,17,19,20,22-24,257,276,277, 280-291, 293,294,299,311-317
Lagerstroemia speciosa	Queen of Flowers	3	129,132,149
Ravenala madagascariensis	Traveler's Tree	4	300,308-310
Tectona grandis	Teak	2	204,249
Washingtonia robusta	Washingtonia Palm	1	295
Malpighia punicifolia	West Indian Cherry	1	253
Swietenia mahogoni	West Indies Mahogany	20	5,12,36,37,49,65,69,70,116-118, 123,135,151,158,175,177,184, 192,209

Exhibit H.3: Distribution of Unknown Trees

Scientific Name	Common Names	Quantity	Plot Plan Number
	Unknown 1	1	96
	Unknown 2	1	102
	Unknown 3	1	85
	Unknown 4	1	28
	Unknown 5	1	205
	Unknown 6	4	180-183
	Unknown 7	1	297
	Unknown 8	1	306
	Unknown 9	1	224
	Unknown 10	2	15,113
	Unknown 11	2	101,110
	Unknown 12	3	150,173,176
	Unknown 13	1	154
	Unknown 14	2	278,307
	Unknown 15	1	270
	Unknown 16	2	264,269
	Unknown 17	1	265
	Unknown 18	2	262
	Unknown 19	1	246
	Unknown 20	1	261
	Unknown 21	1	232
	Unknown 22	1	234
	Unknown 23	1	236
	Unknown 24	2	87,122
	Unknown 25	1	52

Section 2.1 Tree Descriptions

Section 2.1.1 Native Trees

The Calabash tree, also known as the Higüero or Common Calabash tree, has the scientific name Crescentia cujete. The Calabash tree is native to Puerto Rico, Mona, Desecheo, St. Croix, St. Thomas, St. John, Tortola, the Florida Keys, southern Florida, southern California, Bahamas, Cuba, Trinidad, southern Mexico, Peru, and Brazil. The Calabash tree was introduced in Bermuda as well. The Calabash tree is an evergreen tree, but acts deciduous in areas that have dry seasons. It grows to a mature height of 6-9 m and has a trunk diameter of approximately 30 cm. The leaves of the Calabash tree are green and slightly shiny. They are widest at the tip and taper at the base of the leaf, curling up slightly along the edges. The Calabash tree has bell-shaped, light green flowers that grow directly from the trunk and branches. The fruit of the Calabash tree is large, green, and oval or round in shape. This fruit is used to make bowls, cups, jugs, water containers, utensils, ornamental objects, and musical instruments. The wood of the tree is used for fuel, tool handles, ox yokes, saddles, and vehicle parts.

The Cashew tree, or Pajuil, is known by the scientific name Anacardium occidentale. It is native to the West Indies, Mexico, Peru, and Brazil. The Cashew tree grows to approximately 6 m high and has a trunk diameter of about 15 cm. This evergreen tree is characterized by a dense irregular crown of rough elliptical leaves that are blue-green in color. It also has fragrant pink flowers with five petals that are located near the end of the branches. The flowers attract bees, so the Cashew tree can also be classified as one of the honey plants. The edible cashew nut is found inside a poisonous shell that hangs from the true fruit of the tree, a thick-skinned yellow ball. The

moderately strong wood is not usually used in Puerto Rico and is susceptible to infestation by dry-wood termites. In other areas of the world, the wood is used for boat building and carpentry.

The Cojóbana is known by the scientific name Piptadenia peregrina. It is a deciduous tree native to Puerto Rico, Hispaniola, Dominica, St. Vincent, Grenada, Venezuela, British Guiana, and Brazil. The Cojóbana is also found in Trinidad, though it is not native to the area. This tree grows to height of approximately 6-12 m with a trunk diameter of about 20 cm. The bark of the Cojóbana is gray or brown with notable warts and ridges. The leaves of the Cojóbana are formed by a long stem with 20-35 branches off of the main stem. These smaller branches each have 30-100 pairs of tiny leaflets that are slightly hairy. The Cojóbana has small whitish-yellow flowers that are small balls grouped together. The tree also bears thin brown pods with tiny scales. The hard wood is difficult to use for carpentry and as a result, it is used only for posts in Puerto Rico. In addition, finely ground seeds were historically used as a narcotic snuff for religious ceremonies in Hispaniola, Venezuela, and Brazil. Currently, this compound is being studied for possible uses as a medicine.

The Common Lignumvitae, also known by the Spanish name Guayacán, has the scientific name Guaiacum officinale. The small evergreen tree is native to Puerto Rico, St. Croix, St. Thomas, St. John, Bahamas, Martinique, Bonaire, Curaçao, Aruba, Panama, Colombia, Venezuela, British Guiana, southern Florida, Bermuda, Trinidad, Tobago, and Surinam. The Common Lignumvitae has been almost wiped out in the Virgin Islands and the only occurrences of the tree in that area are a result of cultivation. The Common Lignumvitae grows to a height of 4-9 m and has a trunk diameter of approximately 10-45

cm. The bark is smooth and light brown and peels off in thin strips. The leaves are elliptical in shape and dark green with a shiny upper side. The flowers are pale blue and star-shaped with a slight fragrance. The wood of the Common Lignumvitae is highly regarded and is sold by weight. It is used for bearings, bushing blocks, propeller shafts, pulley sheaves, deadeyes, bandsaw guides, awning rollers, furniture casters, mallets, bowling balls, and turned novelties. The extract of the wood was used for medicinal purposes as a stimulant.

The Ginger Thomas, or Roble Amarillo, has the scientific name Tecoma stans. The Ginger Thomas is native to Puerto Rico, St. Croix, St. Thomas, St. John, Tortola, Bahamas, Cuba, Trinidad, Florida, southern Texas, southern New Mexico, southern Arizona, Mexico, Bolivia, northern Argentina, and Brazil. It has also been cultivated in the Dutch West Indies. This evergreen tree covers a wide geographical range and as a result, some characteristics vary slightly by location. It grows to a mature height of approximately 3-7 m with a trunk diameter of about 7 cm. In general, the leaves of the Ginger Thomas are elliptical and have toothed-edges, growing in clusters of 5-13 leaflets. The Ginger Thomas has large yellow flowers that are tubular in shape. The tree bears long, narrow pods that are dark brown in color. The wood of the Ginger Thomas is used in cabinetmaking, wood turning, and construction.

The Higüerito is a close relative of the Calabash Tree, known by the scientific name Crescentia linearifolia. It is native to Puerto Rico, St. Thomas, St. John, and St. Martin. The leaves are narrow, shiny, and stiff. They grow very closely together and are often very pointy at the ends. The flowers are tubular in shape and green in color. The Higüerito bears a round or elliptical shaped fruit that is similar to that of the Calabash

Tree. The fruit of the Higüerito is smaller than the fruit of the Calabash Tree and is used locally to make maracas.

The Maga tree has the scientific name Montezuma speciosissima. It is native only to Puerto Rico and cultivated in St. Thomas, Dominican Republic, Cuba, Jamaica, southern Florida, and British Honduras. The Maga is an evergreen tree that grows to a mature height of 9-15 m with a trunk diameter of 15-45 cm. The large leaves of the Maga are heart-shaped and light green with prominent yellow veins. The Maga has large red flowers that grow on long stalks stemming from the base of the leaves. The tree also bears a small green fruit with rounded edges and is slightly pointed at either end. The Maga has become a rare tree in Puerto Rico. The wood was once widely used for furniture, turnery, musical instruments, posts, and poles when it was readily available. Extensive planting of the Maga was halted when it was realized to be a host of the pink bollworm, a threat to crops in the cotton region. In addition, slow growth and susceptibility of the flowers to scale insects further discouraged planting. Some believe that since the Maga is native only to Puerto Rico, it should be considered for adoption as the official tree.

The María tree, or Santa María tree, has the scientific name Calophyllum brasiliense. This tree is native to Puerto Rico, been introduced in southern Florida, and the same species can be found naturally occurring in Cuba, Jamaica, the Lesser Antilles, and Bermuda. The María tree is an evergreen tree of medium size. It grows to a mature height of 12-20 m and a trunk diameter of 50 cm or more. The María has elliptical leaves that are dark green and shiny. The flowers of the María are small, white, and very fragrant. The tree also bears small round fruits that are light brown and have only one

seed. The tree produces small quantities of white latex from the trunk. The wood of the tree is classified as construction wood, but is mainly only used for posts.

The Matabuey has the scientific name Goetzea elegans. It is a rare tree that is only native to Puerto Rico. The Matabuey grows to a mature height of 6-9 m and has a trunk width of approximately 13 cm. This evergreen tree has elliptical leaves with many parallel veins. The Matabuey has orange flowers found at the base of the leaves. The fruit of the Matabuey is small and round or elliptical, also orange in color. The Matabuey grows best in humid climates and is only found naturally occurring along the northern coast of Puerto Rico. This tree is often planted as an ornamental tree because of its attractive leaves and flowers.

The Matchwood, or Yagrumo Macho, has the scientific name Schefflera morototoni. It is native to Puerto Rico, St. Thomas, St. John, Tortola, Cuba, Hispaniola, Guadeloupe, Trinidad, Mexico, Bolivia, Argentina, Brazil, and Guianas. The Matchwood is also planted in southern Florida. This evergreen tree grows to a mature height of over 18 m and has a trunk diameter of 15-45 cm. The leaves of the Matchwood are green and hairless with a slightly leathery feeling. They can be shaped subtly heart-shaped at the base. Leaves grow with roughly 10 or 11 leaflets per stalk. Flowers are clumped at the end of the branches and are small, round, and brown or gray. The fruit of the Matchwood is small and gray. The wood is used for boxes, crates, general carpentry, interior construction, matchsticks, matchboxes, plywood, toys, pulp, and as a balsa substitute.

The Pasture Fiddlewood, also known as the Florida Fiddlewood or Péndula, has the scientific name Citharexylum fruiticosum. The small evergreen tree is native to

Puerto Rico, central and southern Florida, the Florida Keys, the West Indies, Bahamas, Cuba, St. Vincent, Grenada, Trinidad, Venezuela, and Surinam. The Pasture Fiddlewood grows to a mature height of approximately 3-12 m and has a trunk diameter of approximately 30 cm. The leaves of the Pasture Fiddlewood are elliptical yellow-green leaves dotted with pink or orange. The flowers of the Pasture Fiddlewood are small and white and have a very subtle fragrance. The tree bears a reddish-brown or black round fruit that is round and very small. The wood of the Pasture Fiddlewood is used in Puerto Rico for fence posts, furniture, construction, violins, guitars, and other musical instruments.

The Sandbox, or Molinillo, has the scientific name Hura crepitans. It is native to Cuba, Jamaica, Puerto Rico, Trinidad, Tobago, Costa Rica, Peru, Bolivia, Brazil, and Guianas. The tree is also planted in southern Florida, southern California, and Bahamas. The Sandbox is a deciduous tree that grows up to 24 m in height and has a trunk diameter of .6-1.2 m. The leaves of the Sandbox are heart-shaped and dark green. The flowers of the tree are small and dark red. The Sandbox bears a seed capsule that splits when it is dry. This makes a loud noise and projects the seeds away from the tree. The wood of the tree is used for fenceposts, fuel, general carpentry, interior construction, boxes, crates, veneer, plywood, furniture, joinery, and poles.

The Seagrape, or Uva de Playa, is known by the scientific name Coccoloba uvifera. The Seagrape is a small evergreen tree native to the rocky shores of Tropical America. It can be found in Puerto Rico, the Florida Keys, Bermuda, the West Indies, Bahamas, Cuba, Trinidad, Tobago, Curaçao, Aruba, Mexico, Venezuela, Columbia, Guianas, St. Croix, St. Thomas, St. John, Tortola, Virgin Gorda, and Anegada. The

Seagrape varies greatly in size. Along rocky shores it is usually very small and shrub-like. In more protected areas, the Seagrape can grow up to 9 m in height with a trunk diameter of up to 30 cm. A distinguishable feature of the Seagrape is that the thin bark peels off from larger trunks. The leaves of the evergreen tree are green or blue-green and grow upward and are slightly curved. They are slightly heart-shaped and thick and leathery. The flowers of the Seagrape are white or light green and very fragrant. The Seagrape has clusters of purple fruits that grow in clusters, closely resembling grapes. The wood is used in Puerto Rico for posts and fuel. The bark and roots have been used for medicinal purposes. The fruit of the tree can be eaten raw or used to make jelly and beverages similar to wine. The hardiness of the Seagrape makes it an ideal tree for planting along shorelines as a windbreaker.

The White Cedar, or Roble Blanco, has the scientific name Tabebuia heterophylla. The White Cedar is classified as a small to medium-sized tree and grows to a mature height of up to 18 m and a trunk diameter of up to 45 cm. The White Cedar is native to Puerto Rico, as well as Haiti, the Virgin Islands, Granada, and Barbados. The leaves of the White Cedar have five or fewer leaflets that are elliptical in shape. The White Cedar has tubular pink flowers that are abundant across the crown. The tree also bears dark brown pods that are 8-20 cm long. The wood of the White Cedar is used in Puerto Rico as construction wood and for posts and poles. The White Cedar is easily grown in land degraded by farming.

The White Prickle, or Espino Rubial, has the scientific name Zanthoxylum martinicense. The tree is native to Puerto Rico, and is especially common in the Gurabo area. The White Prickle is and evergreen tree that stands 6-20 m tall and has a trunk

diameter of approximately .5 m. The leaves of the White Prickle are slightly oblique at the base and are pointed at the top. They are thin and green with a slightly lighter underside. Cone-shaped spines about 2.5 cm long are found along the trunk and smaller spines can be found along the twigs. Small greenish-white flowers with five petals are found in addition to dark brown dry fruits. The wood is not durable when it is exposed, so it is seldom used for building, but occasionally it is used for inexpensive furniture and light construction.

The Wildfig or Jagüey Colorado has the scientific name Ficus Americana. It is an evergreen tree that grows to a mature height of 15-20 m and has an approximate trunk diameter of 30 cm. The Wildfig is native to Puerto Rico and is only found on the island. The leaves of the Wildfig are small and elliptical. They are thick and leathery leaves with many close veins. The leaves are dark green and shiny on the upper side of the leaves and a lighter green on the underside. The Wildfig has small fruits similar to figs. The fruit is pink or red when mature and flowers and seeds are produced from within the fruit. The wood of the Wildfig is soft and light. It is used in Puerto Rico for fuel and posts.

Section 2.1.2 Exotic Trees

The African Tuliptree or Tulipán Africano is known by the scientific name Spathodea campanulata. This tree is native to West Africa and is commonly planted in Southern Florida, the West Indies, Central and South America. The African Tuliptree reaches a mature height of 15-25 m and has a trunk diameter of 30-50 cm. The leaves of the African Tuliptree are large and pointed on the ends. They are dark green and shiny. The most notable feature of this tree is its flower. The flowers are a brilliant orange-red color, horn shaped, and very large in size. The African Tuliptree also has flattened green or brown pods that can grow up to 25 cm in length. The wood of this exotic tree is not used in Puerto Rico. The African Tuliptree is cultivated as a shade tree and for its ornamental appeal.

The Banana belongs to the class Liliopsida and the family Musaceae. The scientific name is Musea sapientum. It is native to Asia, but is now widely cultivated in the tropics. It is a tree that has palm like characteristics, but is not a palm. It has very large leaves which form a "false trunk" that grows 3 to 6 meters. As the plant matures, its true stem rises from the ground and pushes through the center of the false trunk emerging at the top. It then hangs down bearing yellowish male and female flowers. The female flowers produce the fruit and since it bears only once, the entire plant is cut down for harvesting. The dead plant is replaced with shoots from the underground stem at about six month intervals. The banana is a staple food in the tropics and can be eaten raw or cooked.

The Bottlebrush, or Cepilla de Botella, is identified by the scientific name Callistemon citrinus. It is native to Australia and is found cultivated throughout various

tropical areas. This small evergreen tree grows to a mature height of approximately 6 m with a trunk diameter of approximately 15 cm. The leaves of the Bottlebrush are dull green, very thin, and extend in all directions from the central stem. The Bottlebrush has bright red flowers that are bunched together along the stem of the leaves. The thin flowers extend straight outward and the way that they are bunched resembles a bottlebrush. The seeds of the tree are also found along the main stem that holds both the leaves and the flowers. The seeds are small, round, and maroon. The wood of the bottlebrush is used to make handles for tools.

The Butterfly Bauhinia or Mariposa is identified by the scientific name Bauhinia monandra. It is native to southeastern Asia and has been introduced in Cuba, Jamaica, Barbados, Trinidad, Puerto Rico, southern Florida, French Guiana, Columbia, and El Salvador. The Butterfly Bauhinia is a small evergreen tree. It grows to a mature height of 3-9 m with a trunk diameter of approximately 30 cm. The leaves of the Butterfly Bauhinia are very distinctive. They are two-lobed, similar in shape to a butterfly. The Butterfly Bauhinia has large flowers that are pink with red dots on the petals and flat pods that become twisted as they open to spread the seeds of the tree. The Butterfly Bauhinia is mainly cultivated in Puerto Rico for ornamental appeal, but the wood is used for fuel as well.

The Cañafístula tree is also known as the Golden Shower. The scientific name is the Cassia fistula and it is native to tropical Asia. It is widely cultivated in the West Indies and continental tropical America. The Golden Shower is a deciduous tree that grows to about 15 m in height and about .5 m in trunk width. It has large paired leaves and long drooping clusters of golden yellow flowers with five petals. The tree also bears

cylindrical black pods that are about 38-60 cm in length. This seeds of this that are found in the pods are used to make the drug cassia fistula, a mild laxative. The reddish wood is hard and heavy, occasionally used for construction and cabinet building.

The Caribbean Pine, or Pino Hondureño, has the scientific name Pinus caribaea. It is native to Bahamas, Cuba, Belize, Guatemala, Honduras, and Nicaragua. The Caribbean pine is an evergreen tree that grows to a mature height of 24-30 m and has an approximate trunk diameter of 30-60 cm. The leaves of the Caribbean Pine resemble needles and are usually found in bunches of two to five needles. The tree also bears pinecones with two seeds at the base of the cone. The Caribbean Pine is used for landscaping and small trees are appropriate for use as Christmas trees.

The Chocolate tree, also known as the Cacao tree, has the scientific name Theobroma cacao. The Chocolate tree is native to southern Mexico and Central America, while distribution through cultivation has spread through most of the West Indies. Growing to an approximate height of 7.5 m and a trunk diameter of approximately 15 cm, it is a small evergreen tree that is often cultivated under the shade of larger trees. The leaves of the Chocolate tree can be recognized by their large elliptical shape and drooping nature. The flowers of the Chocolate tree are star shaped pinkish flowers found growing in clusters along the trunk and branches. The tree bears large egg-shaped yellow or purple fruits that are pointed and grooved. The wood of the Chocolate tree is not used in Puerto Rico, but the seeds of the fruit or “beans” are roasted and used to make chocolate and cocoa. Chocolate trees can be found growing in active and abandoned coffee plantations in the western lower mountain regions of Puerto Rico.

The Earpod tree, also known as the Guanacaste, has the scientific name Enterolobium cyclocarpum. The exotic tree, often cultivated in Puerto Rico for shade and ornamental purposes, is native to Mexico, Belize, Venezuela, Trinidad, Guyana, and Brazil. This large tree grows to a mature height of approximately 18-30 m, and a trunk width of 0.9-1.8 m. The leaves are double pointed and the light green tubular flowers are formed at the base of the leaf. The wood of the Earpod tree is used for construction, carpentry, and furniture.

The Geiger Tree, or Vomitel, has the scientific name Cordia sebestena. This tree is native to southern Florida, the Florida Keys, Mexico, Columbia, and Venezuela. The Geiger Tree is a small evergreen tree that grows to a mature height of approximately 6 m with a trunk diameter of approximately 15 cm. The leaves of the Geiger Tree are oval-shaped and pointed at the end. The flowers are bright orange or red and grow in clusters away from the leaves. The Geiger Tree bears small, white fruit as well. This tree is primarily cultivated for ornamental purposes and grows best in dry areas.

The Guamá Americano, also known as the Guamuchil, is categorized by the scientific name Pithcellobium dulce. It is native to Mexico, Southern California, Columbia, and Venezuela and was introduced in Puerto Rico, Cuba, Jamaica, and Southern Florida for shade and ornament. This tree grows to 9.1-15.4 m with a trunk width of approximately .3-.6 m. The leaves are slender and green with small sharp spines at the base. The Guamá Americano has small creamy white flowers with small round heads that droop. In addition, the tree bears coiled pods that are pink or brown and 10-12 cm in length. The pods split along the sides and contain shiny black seeds covered in an edible pink or whitish pulp. Puerto Rico uses the wood of this tree for posts and fuel.

Honduras Mahogany, or Caoba Hondureña, has the scientific name Swietenia macrophylla. Honduras Mahogany is an exotic tree in Puerto Rico, being native to southern Mexico, Honduras, Panama, Columbia, Venezuela, northern Peru, Bolivia, and Brazil. In addition to Puerto Rico, Honduras Mahogany has been introduced in southern Florida, the Virgin Islands, Cuba, Trinidad, Tobago, and India. It is a medium to large deciduous tree that grows to a height of up to 18 m and can attain a trunk diameter of over .6 m. The leaves of the Honduras Mahogany are dark green and pointed on both ends. They are roughly elliptical in shape and the center vein is set off to one side. Honduras Mahogany has small greenish-yellow flowers that are very fragrant and bloom in May and June. Most flowers have five petals, but occasionally some have only four petals. The tree also produces seed capsules in late fall. The capsules are egg- or pear-shaped and approximately 11-18 cm long and spread up from the base into 5 sections. Honduras Mahogany is considered the world's premier cabinet wood. For this fact, it is considered by some to be the most valuable tree for timber in tropical America. This species has more commercial significance than its close relative, West Indies Mahogany, because it grows in a wider range of locations. Honduras Mahogany is used for cabinetmaking, face veneer, interior trim, paneling, burial caskets, interiors of boats and ships, musical instruments, molds, dies, and pattern making. Most of the mahogany used for building in Puerto Rico is imported from Mexico, but local plantations do produce limited quantities of small logs.

The Lemon tree, or Limón de Cabro, has the scientific name Citrus limon. The Lemon tree is considered possibly native to southeastern Asia. The origin of the species is uncertain and it is also considered that it may actually be a hybrid of related species.

This exotic species was possibly introduced to the Western Hemisphere by Columbus in Hispaniola. The Lemon tree is cultivated in Puerto Rico, the Virgin Islands, Bermuda, the West Indies, southern Florida, southern California, and from Mexico down to South America. A small evergreen tree, the Lemon tree grows to a mature height of between 3-6 m with a trunk diameter of approximately 10 cm. The elliptical leaves of the Lemon tree are aromatic, dark green, shiny, and toothed along the edges. The Lemon tree has small flowers that are white with a purple tint along the edges of the petals. The fruit of the tree is the lemon, an elliptical yellow fruit that is pointed at either end. The Lemon tree is used exclusively for the edible fruit to be used as a flavoring agent and for antiseptic purposes.

The Lime tree, or Limón Agrio, has the scientific name Citrus aurantifolia. The Lime tree is native to the East Indian Archipelago of southern Asia and is cultivated in southern Florida, the Florida Keys, the West Indies, and from Mexico to South America. The lime tree is a small evergreen with sharp spines on the branches. It grows to a mature height of less than 6 m. The leaves of the Lime tree are dark green, elliptical, leathery, and aromatic. The Lime tree has white or light purple leaves that are dotted with glands. The fruit is the lime, a smooth green that turns to greenish-yellow when ripe and is slightly pointed at both ends. The only use of the lime tree is consumption of the fruit. Limes serve as the primary source of citric acid used for dying materials and occasionally used in medicine. Tea can be prepared using the leaves of the lime tree and oil from the rind was once used to prevent scurvy because it is rich in vitamin C.

The Mango tree has the scientific name Mangifera indica. The Mango tree is an exotic plant, native to tropical Asia. It is now found growing in southern California,

southern Florida, the West Indies, Mexico, Peru, and Brazil. The Mango tree is a medium to large evergreen tree that attains a mature height of 6-20 m with a trunk width of approximately 1 m. The leaves of the Mango tree are large and leathery, in an oblong shape with points at the ends. When first produced, the leaves of the Mango tree droop in red-brown clusters. The flowers of the tree are small and yellow-green or pink with five petals. Since the Mango tree is one of the honey plants, the flowers secrete nectar that attracts bees. The fruits are large, yellow, and elliptical in shape. The fruits have edible flesh and a large seed surrounded by many fibers. The mango tree is mostly used for shade and for producing fruit, but the wood is sometimes used in Puerto Rico for meat chopping blocks and for fuel.

The Plantain, or Platano, has the scientific name Musa paradisiacal. It is in the same family as the banana, and is originally from southeast Asia. It can grow 3 to 10 meters tall and as the banana does, it grows a conical "false trunk" formed by leaf sheaths of its spirally arranged leaves which are about 1.5 to 3 meters long and about 0.5 meters wide. The fruit is green and typically larger than a common banana. The fruit is usually cooked because of the high starch levels.

The Queen of Flowers, or Reina de las Flores, has the scientific name Lagerstroemia speciosa. This tree is native to India, China, Malay Peninsula, Phillipines, East Indies, and Australia. It is planted in southern Florida, Cuba, Jamaica, Puerto Rico, the Virgin Islands, Guadeloupe, Martinique, Trinidad, and Mexico. The Queen of Flowers is a small tree growing to a mature height of about 4-9 m with a trunk diameter of approximately 20 cm. The leaves of the Queen of Flowers are large and elliptical, pointed at both ends. The leaves are green on the upper surface and paler underneath and

they appear to grow in two rows because of the bending of the leaf stems. The flowers grow in clusters of brilliant lavender or purple, making this tree an attractive ornamental. The wood is used in India for small boats, shipbuilding, and piling. The trunk is often not straight when grown in Puerto Rico, therefore the chief uses of the tree are for shade and ornament.

The Traveler's Tree, or Arbol del Viajero, has the scientific name Ravenala madagascariensis. This tree is native to Malagasy and has been introduced throughout humid tropical climates. The Traveler's Tree is an evergreen tree that resembles a palm tree. It grows to a mature height of approximately 12 m with a trunk diameter of approximately 15-30 cm. The leaves of the Traveler's Tree are large and resemble fans. They are found at the top of the tree, forming a large crown atop a tall, narrow trunk. The Traveler's Tree is planted as an ornamental tree in low, humid areas. The clear watery sap of the tree is found at the base of the leaves, but can be extracted by cutting a small hole at the base of the trunk. The sap can be consumed as a beverage.

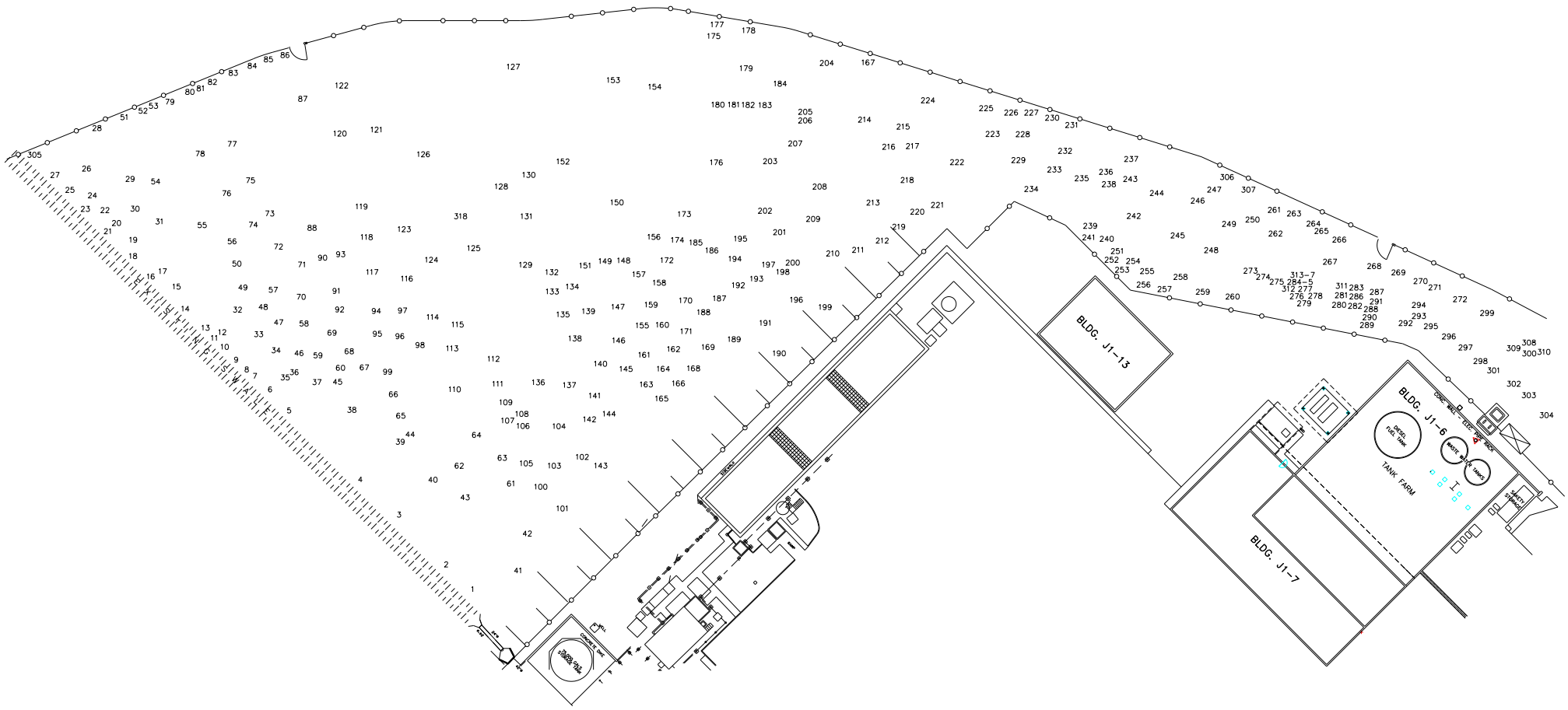
The Washingtonia, or Palma Washingtonia, is identified by the scientific name Washingtonia robusta and is part of the Palmáceas family. Its place of origin lies in México and has the distinct characteristic of its dead leaves adhering to the trunk for many years. If the leaves are not removed when they die, the form a solid column about 2.4 meters in diameter. The brilliant green leaves are at the end of each branch forming a fan. The leaves and branches together grow 2.7 to 3.7 meters in length, erect at first then begin to hang as new growth occurs, eventually forming part of the solid column with the other dead leaves. The trunk is reddish brown at the top and gets darker along the

bottom. The flowers are numerous, small and wrinkly and are in the shape of an oval. It is planted on streets providing shade, offering a view difficult to forget.

The West Indian Cherry tree is also known as the Acerola tree. The scientific name is Malpighia punicifolia. The West Indian Cherry tree is an exotic tree in Puerto Rico, native to Jamaica, Barbados, Trinidad, Mexico, Belize, Guatemala, Honduras, Columbia, and Venezuela and is commonly cultivated in other tropical locations. It is a small tree that grows to a mature height of approximately 6.1 m with a trunk diameter of approximately 10 cm. The leaves are mostly round at the base getting thinner toward the top and are lustrous green. The flowers of the tree are small and pink and the tree bears an edible fruit rich in vitamin C that is round and red or scarlet in color.

West Indies Mahogany, also referred to as Dominican Mahogany or Caoba Dominicana, has the scientific name Swietenia mahagoni. It is a close relative of Swietenia macrophylla, or Honduras Mahogany, coming from the same genus. West Indies Mahogany is also exotic to Puerto Rico, being native to the Florida Keys, Bahamas, Cuba, Jamaica, and Hispaniola. West Indies Mahogany has been introduced in Puerto Rico, the Virgin Islands, Bermuda, Trinidad, Tobago, and Curaçao. The tree grows to a mature height of between 12-18 m and a trunk diameter of 1-1.5 m. The leaves, flowers, and seed capsules of the West Indies Mahogany are almost identical to those of Honduras Mahogany, except that they are much smaller. The wood of the West Indies Mahogany is used for furniture, cabinetmaking, interior finish, and veneers. It was previously used for shipbuilding, construction, and beams. The West Indies Mahogany is considered superior in quality and durability to the Honduras Mahogany, and the stumps of Dominican Mahogany are held in high regard due to their irregular wavy grain.

3.0 Plot Plan



* Not to scale
** Number 89 was omitted from the map

Exhibit H.4: Plot Plan

4.0 Maintenance of the Forest Reserve

In order to keep the trees and plants healthy and give aesthetic appeal to the visitors, maintenance is important in the forest reserve. We recommend that while the trees are young, they be watered daily and special care should be used to assure their growth and health. Once the tree reaches it's first stages of maturity, no further special care should be taken and the tree should be left to survive on it's own. Special care includes fertilizer to help with growth and a thorough check every month for diseases on the trees. Tour guides and grounds keepers should briefly check for disease upon every entrance into the reserve. Any disease that is found on a tree should be acted upon immediately to assure that the disease does not cause permanent damage, or further infect other trees.

Upon completion, the path needs to be cleaned to assure that it is does not become slippery or covered in moss. We recommend a full cleaning of the path at least every six months, or as needed.

We recommend that the students in the environmental club at Escuela Superior Dra. Conchita Cuevas in Gurabo be permitted to help with the maintenance of the reserve. For example, the students could become involved in the planting and maintenance of any new trees added, or the removal of weeds.

If the decision is made to have a picnic area, it should be kept in main entrance area, by the parking. Food should not be allowed inside the forest, and there should be plenty of trash and recycling barrels provided in the eating area.

5.0 Benefits of Forest

There are many benefits as a result of the development of the forest reserve at the Janssen facility. As previously mentioned, the reserve serves as a buffer zone between the manufacturing facility and the residential area bordering the Janssen property. The reserve serves to almost completely block the view of the manufacturing facility and filters the noise level as well. In the eyes of the neighboring residents, preservation of the land along their property and using it for educational purposes is a favorable decision by Janssen.

In creating the educational aspect of the forest area, Janssen Ortho LLC is able to make a contribution to the community by ensuring that visitors to the forest area, such as employees of Janssen, schools, and the community, become aware and understand the importance of trees. Deforestation has been a severe problem especially in the 1940's when only 6% of the island was covered with forest because of a dramatic increase in the agricultural industry. Because of this, Puerto Rico was known as one of the countries with the most deforestation and the most problems with soil erosion. Other consequences of the elimination of the forest cover include the increase of sedimentation in forests and rivers, thus affecting the quality and availability of water. At the same time, elimination of the forest cover has destroyed the habitat of various flora and fauna, some of which are being threatened or are in danger of extinction. The canopy of the forest weakens the strength of harsh rains and regulates the falling of rain, which not only reduces erosion, but helps diminish the magnitude of floods and facilitates the conservation of resources (DRNA, 1998). By educating the community of the seriousness of

deforestation and the importance the trees, they will become more aware and conscience of their activities involving the environment.

Contributing to the community while preserving and protecting the environment will also fulfill Janssen's obligations to its parent company, Johnson & Johnson who has implemented a community outreach program to improve relations with the community and help the environment. Janssen is also in the process of becoming ISO 14001 certified. ISO 14001 requires companies to develop and maintain an environmental management system that includes key components of establishing an environmental policy, determining environmental aspects and impacts of products and/or actions, developing environmental goals and measurable targets, implementation of programs to meet these goals and targets, and checking and corrective action and management review (Official website of ISO 14001). The establishment of this forest reserve helps Janssen move toward this certification in that it is the development and establishment of an environmental program that affects the community and adheres to statements in the environmental policy.

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To begin the training, you must read through the "Plan del Bosque" included in this manual. This plan gives you general climatic information about Puerto Rico and the area of Gurabo, the history of the forest at Janssen, a list of all of the trees in the forest with their descriptions, a map of the location of the trees, and the benefits of the forest. As you give tours, this basic information should be given to the visitors, stressing the ecological and social benefits of the forest. The benefits of the Janssen forest and forests in general should include the forest acting as a buffer zone between the houses and the facility, preserving and protecting the environment—include a discussion about photosynthesis which is further discussed in suggested activity 1, and the prevention of erosion. You can decide how in depth you would like to discuss these topics.

Your decision should be based on the ages of the visitors and their attention span. If they do not seem interested in the tour, you can skip portions that will not catch their attention. Discuss with them some "fun facts" about the trees such as how the African Tuliptree's flower squirts a liquid when squeezed and how the agriculture of Puerto Rico is composed of plants like the ones in the reserve such as the plantain. Explain to the visitors that this forest is the habitat to many animals such as birds that live high in the trees, bees that live at different levels in the trees, lizards that live in the trees and on the ground, and frogs who live on the ground. Note how different animals live on different levels of the forest, and that each and every part of the forest is important because of this.

RULES OF THE FOREST

The following rules should be stated before the tour has begun. Make sure that everyone acknowledges and understands the rules before proceeding, and ask if there are any questions regarding these rules.

1. No food or drink is allowed inside the forest.
2. Please stay on the path and with the tour guide at all times.
3. Do not take anything into or out of the forest except for pictures, unless you -- the tour guide -- allow visitors to take it.
4. Do not harm and of the living organisms in the reserve.
5. Please do not hesitate to ask questions.

SUGGESTED ACTIVITIES

The following activities are only suggested. It is recommended that only one to three activities be performed with each group. The choice of the activity or activities should be based upon the age of the visitors, the number of visitors, and the depth of the activity.

1. Measure the oxygen, carbon dioxide, and carbon monoxide levels at different locations within the forest. These levels of these three compounds should be compared to each other, noting the location of the samples – is it an open area, in the middle of a large group of trees, by the highway – and the time of day and how long the sun has been up. Mention to the visitors that these locations and times may have something to do with the levels of these gases. During the day, plants go through a process called photosynthesis. Photosynthesis is the way that plants make energy from sunlight and carbon dioxide. This process in plants can be compared to human digestion. They release oxygen as a result of this process, making them very important to humans because we breathe in oxygen. At night, when there is no sun, plants release carbon dioxide. The amount of these gases can dictate the time of day, if they are measured very carefully, with very accurate equipment. Note the location of the highway next to the forest. Many cars drive on the highway every day producing a gas called carbon monoxide. This gas is very poisonous to humans if they breathe in too much of it at once. Carbon monoxide also depletes the ozone layer. The ozone layer is an invisible barrier around the world that keeps the earth cool from the sun and protects humans from the sun's ultra violet rays.

These three gases are very important to humans in both good and bad ways. Carbon monoxide can kill humans both directly by breathing it in and indirectly by depleting the ozone layer. Oxygen is what we need to breathe and is provided to us by trees. When we breathe out, we release carbon dioxide that is then taken in by the trees. It is a cycle that consistently repeats itself.

2. Take magnifying glasses into the reserve. Look at leaves, fruits, or just about anything that can be looked at through the magnifying glass. Ask your group what they see through the glass when they look at the leaves. Have the visitors note shape of any patterns on the leaf. When two trees are very similar, experts can tell the difference between them not only by how they feel or if they smell, but also by their structure. Looking closely with a magnifying glass, you can see if there are any ridges or hair that are not visible to the naked eye.
3. With the proper equipment, test the acidity or nitrate levels in the water. This water can be either previously collected from rain, or taken from the pond if one is added to the forest reserve. This is also a good time to mention the waste water treatment facility that Janssen has and explain how it cleans the water so that Janssen does not pollute the environment. Acidity is measured with litmus paper. It tells us if the water has high base or acid levels and is measured on a scale of one to fourteen where seven is neutral. Neutral is when a substance is neither acidic nor basic. The acid in the water comes from cars and factories that emit harmful gases into the air. When the gases go into the air, rain clouds absorb them, and then they are released back to earth in the form of rain. High nitrate levels can be harmful to humans. Having extremely high levels of nitrates in the

human's body can cause severe sickness in adults, and possible death in infants. If the levels are noticed early enough, treatment is available to these people who are affected by high nitrate levels. High nitrate levels are usually found in water that is located near cemeteries and farms because nitrates come from dead bodies as they are broken down and from fertilizers.

4. A scavenger hunt can be performed to test the knowledge of the visitors. At the end of the tour, give the visitors a map and let them search the reserve for specific trees, giving them a time limit. Doing the scavenger hunt at the end of the tour is a way to see if you as a tour guide were able to reach the visitors and test to see if they were paying attention. Another option to doing the scavenger hunt at the end would be to do begin it in the beginning, and have the visitors look for specific trees during the tour. At the end of the tour, ask them questions about those specific trees and if they remember the locations of them.
5. To show how different leaves have different structures and to help the visitors in identifying different trees, have the guests do a leaf rubbing. At the beginning of the tour, tell the visitors to collect leaves that are interesting to them. Tell them to take only a limited number of leaves – only 2 or 3 depending on the size of the group, as to not destroy habitats, or to hurt the trees. At the end of the tour, place the leaves under a sheet of paper and rub the side of a crayon or the side of a pencil to get the image of the leaf onto the paper. Ask the visitors if they remember the names of the leaves and have them write the name down on the sheet of paper.

6. Take binoculars with you into the reserve. Look for birds hidden in the trees and explain about the interaction of trees and animals. Birds build nests in trees and use them for protection from predators. Birds and bats eat the fruit, seeds, or sometimes both from the trees. They drop the seeds along the way back to their nests as they are flying. The seeds then grow into trees. Bees also help plants grow and reproduce. When bees go to flowers to collect honey/food for their hive, they are pollinating flowers with the pollen of other flowers. This allows the flowers to reproduce and create more flowers. Honey trees attract more birds. Point out the honey trees in the reserve. The description of the trees includes which ones are considered honey trees and is in the "Plan del Bosque" section of the manual. This is an activity that is best done with a small group because binoculars are difficult to share and take a few minutes for each individual to focus them properly.
7. Within this forest, there are many trees that produce fruit. Allow the visitors to touch the fruit. If there is a freshly fallen fruit on the ground touch this one, and try to avoid taking the fruit off of the tree. An exception may be made for the Acerola because they are small and reproduce rather quickly. Talk about the popularity of each fruit and have the visitors relate to each plant by asking them if they have ever tried each fruit before, what they had with it, and if they can think of another use of the fruit besides eating it. The last topic can be applied especially to the fruit of the Higuera and Higüerito, which are used to make maracas and bowls.

8. This activity can be performed at the reserve by the visitors, but tell them they can also do it at home. The visitors can plant trees. Discuss with the visitors the importance of trees including the information about photosynthesis discussed in activity 1. Also, talk about how deforestation causes erosion. Deforestation is a severe problem. When trees are removed from an area that has water, the soil can be easily washed away. The addition of this soil in the water increases the amount of certain sediments in the water. These sediments in large amount can harm the water vegetation, thus affecting the fish that use the vegetation for food and hiding. Also, the vegetation produces oxygen by photosynthesis. If the addition of soil blocks the sun, photosynthesis does not occur, killing the vegetation. By planting more trees and not cutting down additional trees, it decreases erosion, increases the oxygen levels in the air, provides habitats for animals, and makes our world a better place to live. Tour guides are encouraged to promote planting of trees, flowers, and vines at the reserve each year on Earth Day as an activity. Proper techniques for planting and taking care of young trees should be emphasized so that visitors can take the information home with them and plant their own trees.

APPENDIX I: INTERVIEW QUESTIONS

Questions for IPR Pharmaceutical

1. How long has the forest reserve been open?

2. Were the flora planted, or were they already there?

3. Are there tour guides to lead the visitors around or do they lead themselves? Were the tour guides trained?

4. How many people visit the reserve on weekdays and weekends? What are the specific age groups that attend? And how long do they stay for?

5. How has the interest from the people changed since the opening of the reserve?

6. Have you found the reserve to be successful? How to you gauge this success?

7. How did you go about choosing the species to integrate into the reserve?

8. Do you have endangered species in the reserve? How do you care for the endangered species?

9. What measures do you take to protect the trees from visitors? Such as to keep them from carving into the trees?

10. We would like information concerning the paths and signs.
    What are the materials used for the paths and their borders? What are the signs made out of? Do you have a sign making machine? Would you recommend having one? Where did you receive the information to decide on this information (references)?

11. Is there a separate department for maintenance? Who is in charge of it? Was there a training session for it, or were only experienced workers hired?

12. Do you have a snack booth for visitors?

13. What type of educational material do you have? Did you consult educators? Do you cater to specific age levels with different handouts or just one booklet? Can you give us the list of people you have for contacts in this area?

Questions for Frank Axelrod

1. Explanation of project.

2. What is your exact title, area of expertise and what is your job at UPR (maybe a business card or curriculum vitae)?

3. How do you go about identifying certain species?

   What do you look for when you are identifying flora?

4. Here we have some samples from the forest area on the Janssen facility. Would you please help us to identify them?

5. What types of things would you personally like to see in a reserve such as the one that we are creating (any suggestions to specific species to integrate)?

6. Are there any case studies, or literature that you may suggest to us to read or further investigate?

7. May we be permitted to contact you over the course of our project if we have any further questions?

Questions for Educators

1. What type of degree do you have and in exactly what field?

2. How long have you been teaching? To what grade levels?

3. What specific subjects have you taught?

4. What way do you feel is best for students to learn?

5. Have you had any experience with or created any interactive material?
    a. What type and give examples

6. What kind of material is appropriate for each grade level?
    a. How in depth should one go with certain subjects/topics?

7. If we were to go about designing a plan that can be implemented in numerous grades, how would we go about doing this?

8. How would you use the reserve in your lesson plan? Would you integrate it into your curriculum?

9. Since you are the advisor of the environmental club here, can you please tell us some of the activities that you do with the club?

10. How do you feel about getting the students involved in the maintenance of the forest?

11. Can you suggest any activities that may be interesting to the students/visitors?

12. If the students seem non-responsive to an activity, can you suggest anything that might regain their attention?

13. If you were to come to a reserve such as this, is there anything specific that you as a teacher would like to see, which may or may not be part of your curriculum?

14. Is there anything that you would like to add?

15. Any suggestions for resources, places to go, books, journals, etc?

Questions for Students

1. What specific grade are you in?

2. Have you visited other parks or gardens that were lead by a tour guide? Approximately how many?

3. Was there anything specific there that you most liked/disliked?

4. Are there any activities that you do with the environmental club that you think would work well at the reserve?

5. Is there anything that you can suggest to have at a forest area that you would really like to see or learn about? Are there any activities/topics that you would be really interested in?

6. Concerning handouts or signs, what would you like to see on them? For example, colors, pictures, activities, information written in two languages, etc.

7. How do you feel about coming to the forest to help maintain it?

8. Do you think that you or your families would enjoy coming to a forest reserve like this one?

Interview Questions – Adjacent Landowners

1. How long have you lived in your house?

2. Can you see the buildings of Janssen from your house? Do you hear noises or smell anything from the plant?

3. Can you see the forest area from your house?

4. How do you feel about the establishment of the forest area?

5. Are you happy that local students will be able to come and learn about environmental subjects at the reserve?

6. Do you plan to visit the reserve once it is opened to the public? Do you have children? If so, will you bring them to visit it?

7. What are some of the benefits of the forest that you can think of?

8. What are some of the negative aspects of the forest that you can think of?

APPENDIX J: CONTACT INFORMATION

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