Eastpoint may make this technology impracticable due to environmental concerns of direct coral reef impacts. The sea conditions along the north coast of Eastpoint are much rougher and violent, which could cause difficulties with installing the undersea infrastructure.

Referenced from www.aloha.com/~craven/coolair.html, we found that Hawaii has a successful seawater cooling system and the authors (Dr. Joseph Van Ryzin, co-founder of Makai Ocean Engineering and Tore Leraand) suggest that large buildings such as hotel with thousands of rooms can achieve air conditioning from deep sea water cooling systems much more economically than from traditional electric-powered chiller systems. “In general systems smaller than 1,000 tons of air conditioning are not economical.” The website references that a typical hotel room requires about 0.75 to 1 ton of air conditioning. Therefore, we estimate that multiple hotels or other commercial facilities would need to join together, unless a mega resort hotel with over one thousand rooms by itself was developed under a single owner.

The article posted on www.aloha.com/~craven/coolair.html further discusses a study that Makai Ocean Engineering conducted on Curacao. They studied three hotel sites ranging from 540 to 2100 rooms. The article does not explain the precise locations of the study sites. The length of seawater intake piping was estimated between 5,150 feet and 11,750 feet and capital costs were estimated between US$2 to US$5 million. The authors further estimated that the intake pipe and pumping station makes up about 50% of the total system cost. The remaining 50% of cost includes the onshore distribution system and heat exchangers.

7.3 Telecommunications

Sustainable telecommunications should focus on underground infrastructure installations so that service disruptions are minimized due to weather or other incidental or accidental damage. A thorough as built mapping system should be
maintained so that the locations can be marked-out whenever other ground disturbance construction activities occur, to further minimize service disruptions and save on otherwise unnecessary repair work. Locations of infrastructure installation should avoid natural features of specific ecological importance. Cellular installations should be planned at higher topographical locations, but whenever possible be installed on buildings to minimize the need for additional infrastructure installation such as dedicated towers, which use additional lands that could otherwise be preserved.

### 7.4 Solid Waste

The Benefits of Recycling (Referenced from US EPA):
Recycling has environmental benefits at every stage in the life cycle of a consumer product—from the raw material with which it’s made to its final method of disposal. Aside from reducing GHG emissions, which contribute to global warming, recycling also reduces air and water pollution associated with making new products from raw materials. By utilizing used, unwanted, or obsolete materials as industrial feedstocks or for new materials or products, we can each do our part to make recycling work. Every ton of mixed paper recycled can save the energy equivalent of 165 gallons of gasoline. Recycling also provides significant economic and job creation impacts, a topic discussed at [www.epa.gov/epawaste/conserve/rrr/rmd/econ.htm](http://www.epa.gov/epawaste/conserve/rrr/rmd/econ.htm).

Recycling provides an annual benefit of carbon dioxide equivalent emissions being reduced. But the ultimate benefits from recycling are cleaner land, air, and water, overall better health, and a more sustainable economy.

Composting (Referenced from US EPA):
Composting offers the obvious benefits of resource efficiency and creating a useful product from organic waste that would otherwise have been landfilled. Composting achieves many environmental benefits including enriching soils,
preventing pollution, remediating contaminated soils and providing economic benefits such as reducing the need for water, fertilizers and pesticides.

Compost is organic material that can be used as a soil amendment or as a medium to grow plants. Mature compost is a stable material with content called humus that is dark brown or black and has a soil-like, earthy smell. It is created by: combining organic wastes (e.g., yard trimmings, food wastes, manures) in proper ratios into piles, rows, or vessels; adding bulking agents (e.g., wood chips) as necessary to accelerate the breakdown of organic materials; and allowing the finished material to fully stabilize and mature through a curing process. Finished compost can be applied to lawns and gardens to help condition the soil and replenish nutrients. Compost, however, should not be used as potting soil for houseplants because of the presence of weed and grass seeds.

If recycling and composting are successfully implemented as part of the Eastpoint development, then benefits such as reduced solid waste collection truck traffic and extended landfill lifespan can be realized as benefits to the entire island.

7.5 Wastewater

Wastewater treatment plants can be designed to include higher levels of treatment and disinfection such that the effluent can be partially or fully reclaimed and re-used for other non-potable uses.

Greywater:
Similar to Rainwater Reuse applications, greywater can be reused in a similar non-potable way. Therefore we have added a small discussion regarding greywater reuse. Greywater is generally defined as water used from showering, laundry washing machines and bath tubs (but not toilets, which is generally called blackwater or raw sewage and requires higher levels of treatment prior to reuse). Greywater can be reused much in the same ways as rainwater including
irrigation and car washing. Appendix C includes a brochure about a pre-manufactured greywater collection and reuse system.

Greywater collection calculations are more difficult to estimate especially for seasonally occupied structures. However, if we make assumptions then some volumes can be estimated.

**Individual Homes:**
Assume that the structures are occupied for 25% of the year (91 days) and that 0.75 cm per day (200 gallons per day) could be captured and stored in a protected manner from evaporation loss, then about 68 cm per year per home could be collected, which translates to 68 days of irrigation supply (at a rate of 1 cm/day for a typical home). An annual water budget savings for 18,834 homes could be as much as 1,280,712 cm per year (18,834 homes x 68 cm).

**Hotel Rooms:**
For the 2,400 projected hotel rooms, a possible assumption of 0.15 cm per day (40 gallons per day) and an occupation rate of 50% of the year (182 days) could yield as much as 65,520 cm per year (2,400 rooms x 182 days/year x 0.15 cm/day/room).

Total potential annual water budget savings could be:
- Individual Homes: 1,280,712 cm
- Hotel Rooms: 65,520 cm
- Total: 1,346,232 cm

### 7.6 Traffic & Transportation

**Mass Transportation:**
Mass transportation results in many benefits for the future communities located within the Eastpoint property and the existing communities located outside of the Eastpoint property. These benefits include less traffic congestion on the
internal and external roads, and a reduction of fuel usage and air pollution. Bus routes already exist on the island. As such, future development plans should provide for bus stops with each future Eastpoint community. Water taxi service could be considered to connect downtown Willemstad to Eastpoint as well near Fuik Baai, further reducing the impacts on the island’s major roads.

**Priority Parking for Fuel-Efficient Vehicles:**
Encouragement of the use of fuel-efficient vehicles has many environmental and economic benefits, such as less fuel usage and operating costs and less air pollution generation. Where common parking facilities are provided, preferred parking spaces could be created for use by drivers of fuel-efficient vehicles such as hybrids and electric cars or golf carts. These common parking facilities would be located at multi-family/condo residential living communities, hotels, retail and recreational centers, golf courses, and other commercial uses. The preferred parking spaces would be the closest parking spaces to the main access to the facilities/buildings with the exception of handicap parking spaces. If preferred spaces are adopted as a development strategy (and therefore the use of fuel-efficient vehicles), measures to ensure compliance will also need to be implemented.

### 7.7 Stormwater

**Rainwater Harvesting:**
Rainwater harvesting (collection and storage of rainfall) for non-potable uses is a potential sustainable practice that can be considered. Rainwater harvesting can result in a reduced demand on the central potable water distribution system. Below, we provide a sample calculation to show the potential savings on public water facilities that rainwater reuse can provide when implemented on a widespread basis.

Our calculations are based on assumed roof-top areas for single family homes in low density parcels and high density uses such as hotel or other common use
parcels such as a golf clubhouse. Our assumptions can then be adjusted once specific building footprints are established by the future development project engineers and the calculations can be revised fairly easily at that time to yield more accurate potential volumes.

Rainwater Reuse Calculations:
Rainwater can be collected locally from individual homes and larger buildings, using individual cisterns and products such as those included in Appendix D.

**Individual Homes:**
If we assume a typical single family home structure to have a building footprint of 100 square meters (sm) and we assume that annual rainfall is equivalent to 570 mm, then we can estimate a potential rainwater volume that can be captured and re-used by each home to be:

- $100 \text{ sm} \times 570 \text{ mm} / (1,000 \text{ mm/m}) = 57 \text{ cubic meters (cm)}$

Since during rainy periods, greater amounts of rainfall will occur then can be reasonably stored, we can consider a 50% capture rate, which would result in 28.5 cm of rainfall available for capture, storage and reuse by each home.

If we assume that 1 cm/day (264 gallons per day) is needed to irrigate a typical single family home property, then potentially 28.5 days per year of irrigation supply could be realized and reduced from the total annual potable supply systems. Considered for a total project build out of 10,000 homes, about 28,500 cm (10,000 homes x 28.5 cm) could be saved from the annual potable water supply budget.
Larger Buildings:
Similarly, larger buildings, such as hotels, a beach club or a golf club clubhouse could also yield rainwater volumes that can be captured from the roof into cisterns for future use in non-potable applications.

If we assume a building footprint of 1,000 sm, then the resulting potential volume that can be stored at a 50% capture rate would be:

- $1,000 \text{ sm} \times 570 \text{ mm} / (1,000 \text{ mm/m}) = 570 \text{ cubic meters (cm)}$ or 285 cm (at a 50% capture rate) per building

Porous Pavements:
Whenever possible, porous pavements could be encouraged. Porous or “pervious” pavements allow stormwater runoff to infiltrate back into the ground. Infiltration of stormwater provides two distinct environmental benefits. First, runoff rates and volumes can be reduced thus reducing flooding occurrences.

Second, infiltration helps recharge groundwater supplies. Groundwater supplies get depleted when they are excessively extracted through wells and when they are excessively covered with impervious development such as buildings and roads. Depleted groundwater supplies are then no longer available for potable water extraction and in some instances they are can negatively affect vegetative and animal life in the ecosystem.

The phrase “porous pavements” is an umbrella term for porous pavers, lattice pavers (also known...
as grassed pavers), porous concrete, and porous asphalt. Generally, this BMP allows stormwater to penetrate the respective surface material and flow directly into an underlying stone bed. The stone bed serves as a reservoir allowing the stormwater to be attenuated until infiltrating and recharging the groundwater.

**Benefits of Porous Pavements:**

- Research has concluded that approximately 97% of oils introduced into pervious pavements are trapped and biodegraded.
- Visual awareness of the BMP for public.
- Improves the health of surrounding landscape compared to traditional pavement.
- Eliminates “bird baths” in parking lots.
- Contributes to groundwater recharge.
- Overall reduction in runoff volume; this reduction can contribute to a relatively smaller stormwater pond.
- TSS (Total Suspended Solids) Removal can be as high as 80% in optimal conditions

**Stormwater Capture and Re-use:**

Where stormwater runoff is determined to simply run and discharge to the sea or discharge to an area that does not benefit from its contribution, the best practice can be to capture the stormwater and re-use it for other purposes such as lake replenishment and irrigation supply water. Other non-potable uses can also benefit from the collection and storage of stormwater runoff.

**Cisterns and Rainwater Harvesting Systems:**

Cisterns are stormwater storing structures located either above or below ground. The stormwater can be reused in irrigation, or other grey-water applications. The regional precipitation and the catchment area, usually a roof or other impervious surface, are directly proportional to the volume stored in the cistern.
Benefits of Cisterns and Rainwater Harvesting Systems:

- Reduces yearly cost of potable water and demand on infrastructure.
- Reduces stormwater runoff.
- Rainwater is generally soft water and lowers the need for detergents in laundry.
- In large cistern cases, potential to sell “extra” stormwater to neighbors for irrigation.

Erosion and Sedimentation Control:

Where stormwater conveyances and discharges exist or are proposed in the future, the conveyance channels should be stabilized with well-established vegetation or rock materials. Stabilized channels protect the underlying soils from eroding away and resulting in the deposition of sediments at downstream locations or the sea.

Natural Features:

When surface water conveyance systems (ditches and valleys) contribute to natural features such as wetlands and marshes, specific care should be taken to not divert or capture the runoff that contributes to those natural features. Instead, maintain the future runoff volumes and rates similar to existing runoff volumes and rates so as to not alter these natural features, which can sometimes be considered sensitive eco-systems.

In instances where developed area runoff flows into sensitive wetland or marsh features, water quality improvement methods should be installed prior to the natural discharge point to polish and improve the “urban” runoff thereby removing suspended solids and nutrients that the upstream urban development has added to the runoff.
Rain Gardens:

Rain Gardens are planted depressions, either naturally occurring or planned, that are designed to filter stormwater runoff and improve water quality. Rain gardens can be a stage in a treatment train where stormwater is attenuated prior to being discharged to a larger stormwater management facility.

**Benefits of Rain Gardens:**

- Requires less maintenance than lawns. Once garden is established it will not need to be mowed, fertilized, or irrigated.
- Visual awareness of the BMP for public.
- Creates a wildlife habitat and aesthetically pleasing landscaping.
- Contributes to groundwater recharge.
- Reduces mosquito breeding.
- Removes a wide range of pollutants such as suspended solids, nutrients, metals, hydrocarbons, and bacteria.
FIGURES
APPENDIX A

MEETING MINUTES FROM 10 FEBRUARY 2011
A meeting with UTS was held on 10 February 2011, at UTS’ offices: Rigelweg 2, Willemstad, Curacao, Netherlands Antilles. The following were present:

**Langan International**
Eric Schwarz

**Eastpoint Planning Committee**
Donald de Palm

**UTS**
Shairon Offerman MSC, Manager Network Operations & Maintenance  
+599-9-777-1564, s.offerman@uts.an  
Irl. Sandro Y. A. Every, Manager Engineering  
+599-9-777-1508, s.every@uts.an  
Shurmel Elias, Corporate Business Strategist  
+599-9-777-1215, s.elias@uts.an  
Danilo Zabala, Chief Commercial Officer  
+599-9-777-1500, d.zabala@uts.an

Langan asked for an overview of the telecommunications systems available on the island and for the future development of the Eastpoint property. In summary, UTS is well prepared to serve the Eastpoint property with telecommunications services.

The following were discussed:

1. Existing (older) telecommunications systems are copper based, but all new development is done with fiber optics.
2. Fiber optics are run to the curb in existing developed areas and run all the way to the home in new developments.
3. Fiber optics are installed underground simultaneously with electric.
4. UTS’ concession mandates that they bring service to the home.
5. Hotel/commercial developments enter into an agreement for infrastructure costs reimbursement. They also utilize re-sale agreements in some instances.

6. New cellular sites will be needed within the Eastpoint property.

7. Television requires repeaters, service is over the air today, but soon to be fiber optics based.

8. Today, telephone and internet are delivered over fiber optics and TV is delivered over the air – but soon all services will be delivered by fiber optics.

9. UTS’ has 3 submarine cables (Aruba, Bonaire and the America’s Loop) plus connection to the ARC System (Puerto Rico, Venezuela).

10. Today: SDH, Soon: NPLS

The preceding represents the writer’s observations and understanding of the items and issues discussed and the decisions or direction made or agreed to. Please contact the writer at eschwarz@langan.com within three (3) working days with any suggestions for additions, deletions, corrections, or clarifications.

**Distribution**

UTS, Shairon Offerman, Sandro Every, Shurmel Elias, Danilo Zabala

Eastpoint Planning Committee, c/o Donald de Palm

Wolff Landscape Architecture, Ted Wolff

Eastpoint Planning Study Team
A meeting with Selikor was held on 10 February 2011, at Selikor’s offices: Parera z/n, Curacao, Netherlands Antilles. The following parties were present:

**Langan International**  
Eric Schwarz

**Selikor**  
Drs. Yahaira C. M Hofdam-Davelaar, **Marketing Manager**  
+599-9-434-1312, ydavelaar@selikor.com

Langan asked for an overview of the solid waste collection and disposal systems and processes available on the island and for the future development of the Eastpoint property. In summary, Selikor is well prepared to provide service to the Eastpoint property.

The following were discussed:

1. Residential waste is collected once per week. Selikor has 15-16 trucks that make collections in five separate zones around the island Monday through Friday. On Mondays, the western portion of the island is collected, then the zones proceed to the east throughout the week.
2. One-two bins are typically at each house depending on how many people live there. A typical house has 4 people = 1 bin.
3. There is a separate monthly collection for bulk waste such as appliances, furniture, and other non-typical household waste.
4. Selikor is a government-private company (an LLC owned by the government since 1996), which is funded through government collected taxes. The typical household waste tax is about $20 Guilders (ANG) or the equivalent to US$36 per month. The waste tax is paid to Aqualectra along with the electric/water payments.
5. Commercial businesses arrange individual contracts for collection and disposal of solid waste. Wheeled containers, roll-off dumpsters and compactors are available for commercial businesses.
6. Selikor also provides additional services such as street cleaning for the downtown area, which is separately funded by a downtown area tax.
7. Selikor manages one landfill and one substation/transfer station. The operating landfill is located in an undeveloped area northwest of Willemstad. The transfer station is located on the site of the old (now-closed) landfill southeast of Willemstad. The old landfill was closed in 1986.

8. The current landfill has an expected lifetime capacity of 30 years from now based on current disposal rates, which includes recyclable items.

9. Selikor has an education program underway to encourage separation and recycling of solid waste. Voluntary glass separation began in the Year 2000 through drop-off containers located generally at gas stations.

10. Construction and Demolition waste is recycled by Selikor and re-sold.

11. Automobile waste (old cars) is shipped off-island.

12. If the planned recycling programs are successful, then the landfill capacity will double to 60 years from today.

13. Selikor has an agreement with Aqualectra to investigate the feasibility of developing and operating a waste-to-energy plant. Further discussion should be held with Aqualectra.

14. The old, closed landfill is tested for methane emissions, but methane is not otherwise collected.

15. Year 2009 data shows that Selikor collected 183,000 tons per year of total waste entering the landfill. 70,000 tons was from the weekly routine collections (not including yard waste, etc.).

16. Selikor has not been specifically planning service to the Eastpoint property, but sees no problem providing collection and disposal services for Eastpoint.

The preceding represents the writer’s observations and understanding of the items and issues discussed and the decisions or direction made or agreed to. Please contact the writer at eschwarz@langan.com within three (3) working days with any suggestions for additions, deletions, corrections, or clarifications.

**Distribution**

Selikor, Yahaira C. M Hofdam-Davelaar  
**Eastpoint Planning Committee**, c/o Donald de Palm  
**Wolff Landscape Architecture**, Ted Wolff  
**Eastpoint Planning Study Team**
Meeting: Eastpoint Planning Study – Government Representatives

Date / Location: 10 February 2011

Attendees: Eric Schwarz, Drs. L.J. Janga, Frensel Mercilia, Raymond Florentina, Chaleinela Corasol, Owen de Windt, Caroline Manuel

Prepared By: Eric Schwarz

Date Prepared: 15 February 2011

A meeting with multiple government representatives (planning, public works, and land management) was held on 10 February 2011, at the government offices: Plasa Horacio Hoyer 19, Willemstad, Curacao, Netherlands Antilles. The following were present:

**Langan International**

Eric Schwarz

**Eastpoint Planning Committee**

Drs. L.J. Janga, lionel.janga@curacao-gov.an

**Government Representatives**

Frensel Mercilia, frensel.mercilia@curacao-gov.an
Raymond Florentina, raymond.florentina@curacao-gov.an
Chaleinela Corasol, chaleinela.corasol@curacao-gov.an
Owen de Windt, owen.dewindt@curacao-gov.an
Caroline Manuel, caroline.manuel@curacao-gov.an

**Summary:**

Langan asked a series of questions pertaining to traffic, roadways and wastewater collection and treatment services and their possible ability to serve the future development of the Eastpoint property. In summary, very little information was available from the parties present during this meeting but instead we were instructed to submit a list of requested information and questions via email. This list of questions was emailed on 15 February 2011 and is predominantly focused on wastewater collection and treatment and traffic studies and information is listed at the end of these meeting minutes for reference.

The following were discussed:

1. No traffic studies for the Eastpoint property, areas nearby or leading to the Eastpoint property or for the city of Willemstad.
2. 20-25 years ago a study might have been completed with respect to a northern road from the airport toward the Eastpoint property. No one at the meeting could say if the study was available to us.

3. Peak traffic heading into Willemstad generally occurs from 6:30 am to 8:00 AM.

4. Peak traffic leaving Willemstad generally occurs from 4:30 PM to 6:30 PM.

5. Overall traffic conditions throughout the island are not considered poor.

6. The island population is approximately 145,000.

7. The tourism department would have to be contacted separately to get an estimate of typical tourism visitors on the island. Mr. Hugo Clarenda should be contacted at 434-8200.

8. When a new development occurs, it is possible for the government to ask the developer to contribute to the cost of off-site road improvements, but there are no specific traffic impact fees.

9. Mass transit (public buses) is available on the island. For more information, we need to contact Mr. Cristina at 511-0226 (cell).

10. Two wastewater treatment plants exist on the island. The plants do not discharge to the sea or the ground, but instead all treated water is reclaimed and used as irrigation water to select commercial properties through a piped re-use main to those properties.

11. No further information about the wastewater treatment plants such as treatment technologies, capacities, wastewater engineering/construction standards or the ability to provide service for the Eastpoint property was made available during the meeting. Refer to the questions below, which were emailed to the meeting attendees on 15 February 2011.

15 February 2011 email request for information (shown in red):

From: Eric Schwarz  
Sent: Tuesday, February 15, 2011 10:57 AM  
To: raymond.florentina@curacao-gov.an; frensel.mercilia@curacao-gov.an  
Cc: Donald J.G. de Palm (donald.depalm@curacao-gov.an); Drs. L.J. Janga (lionel.janga@curacao-gov.an); Ted Wolff RLA (twolff@wolfflandscape.com)  
Subject: Eastpoint Planning Study - Request for Information

Dear Mr. Florentina, Mr. Mercilia and Mr. Janga,

Thank You for meeting with me last Thursday to discuss our study for Eastpoint. I have the following requests for information with respect to Wastewater and Traffic:

Wastewater Services:

1. What is the current operational (constructed) capacity of the nearest wastewater treatment plant?

2. What is the current inflow to the treatment plant?

3. How much larger can the treatment be expanded?

4. Are there any plans for expansion of the treatment at this time or in the near future?

5. How large is the treatment plant property?

6. How much of the treatment plant property already contains structures and is therefore not available for further expansions?

7. Please forward a copy of the treatment plant site plan or aerial photograph with property boundary, if available.

8. What is the treatment plant processes?

9. What are the effluent standards that the treatment plant must meet?
10. Is it true that there is no treated effluent discharge to the sea or the ground and that all treated effluent is reclaimed and used for irrigation water by other private properties? Please explain if this statement is not true or accurate.

11. Please provide me with a copy of the Curacao wastewater treatment and conveyance systems (all wastewater infrastructure) engineering design standards, which a new developer would be required to meet.

12. Please provide any other wastewater master plans, planning documents or engineering standards that are available.

Traffic:
I understand from our meeting that there is no existing Traffic Study for the EastPoint property or even Willemstad and the surrounding roadway systems today.

1. Please confirm that no traffic or transportation studies are available that would assist our study for access to the Eastpoint property.

2. Please provide me with a copy of the public works engineering standards for new construction of roadways, drainage systems or other land development infrastructure.

Please email me any of the information that is available in digital format. My mailing address is below if you have documents that must be mailed.

Thank you for your assistance with these requests. We are under a tight schedule to complete our studies quickly, so I appreciate your attention to my requests.

Eric Schwarz, P.E., LEED AP
Senior Associate
Direct: 786.264.7222
Mobile: 201.563.0782
Fax: 201.398.4741

Langan Engineering & Environmental Services
Phone: 786.264.7200  Fax: 786.264.7201
Parkside Corporate Center
15150 N.W. 79th Court, Suite 200
Miami Lakes, FL 33016
www.langan.com

The preceding represents the writer’s observations and understanding of the items and issues discussed and the decisions or direction made or agreed to. Please contact the writer at eschwarz@langan.com within three (3) working days with any suggestions for additions, deletions, corrections, or clarifications.

Distribution
Eastpoint Planning Committee / Department of Planning & Housing, Drs. L.J. Janga
Department of Public Works, Frensel Mercilia, Raymond Florentina
Department of Land Management, Chaleinela Corasol
Owen de Windt
Urban Development and Planning, Caroline Manuel
Eastpoint Planning Committee, c/o Donald de Palm
Wolff Landscape Architecture, Ted Wolff
Eastpoint Planning Study Team
\langan.com\data\EP\data\100234301\Engineering Data\Site\2011-02-10 Eastpoint Planning Study Meeting Minutes - Curacao Government.docx
A meeting with Aqualectra was held on 10 February 2011, at Aqualectra’s offices: Rector Zwijssenstraat 1, Curacao, Netherlands Antilles. The following were present:

**Langan International**
Eric Schwarz

**Eastpoint Planning Committee**
Donald de Palm

**Aqualectra**
Anthon Casperson MBA, President Directeur, President and CEO  
+599-9-463-2168, acasperson@aqualectra.com  
Ing. Karel Tujeehut, Manager Corporate Strategy & Business Development  
+599-9-463-2000, ktujeehut@aqualectra.com

Langan asked for an overview of the electric power and water systems and processes available on the island and for the future development of the Eastpoint property. Mr. Casperson proceeded with a detailed presentation of Aqualectra’s services. Mr. Schwarz then asked a few follow-up questions and Mr. Casperson provided Mr. Schwarz with a November 2010 presentation document via email for further information. In summary, Aqualectra is well prepared to provide services to the Eastpoint property.

The following were discussed:

**ENERGY:**

1. Aqualectra re-evaluates the energy needs of the island every few years. Studies were completed in 1999, 2002, 2005, 2008 and the next will be completed by June 2011. The studies are based on a 20-30 year outlook.
2. Current island electric demand is about 120 MW (normal), 130 MW (peak). The peak demand is expected to reach 145 MW by Year 2015.
3. The energy demand is seasonal with the peak occurring in August through October, when the climate is warmer with little wind; current peak during this period is 137 MW.
4. Aqualectra will consider the Eastpoint project is the June 2011 planning outlook study.

5. Energy production can be understood from five sources:
   a. Wind,
   b. Two existing diesel plants,
   c. One new diesel plant
   d. One new waste-to-energy plant,
   e. One existing diesel plant located at the on-island refinery

6. The first source is wind power and wind power can grow to 40% of the island’s needs. Two wind farms exist and a third is proposed. The first farm is located southeast of the airport and produces 9 MW. The second farm is located northwest of the airport and produces 15 MW. These two wind farms are undergoing renovation and will produce 30 MW total by 2012, which is equivalent to 15-20% of the island’s needs. A third wind farm is planned to be located just north of Sint Jorgis Bay and will produce an additional 15 MW by 2015. Aqualectra has a goal of reaching 40% of the island’s power to be generated by wind. The wind turbines are manufactured by Vestas in Denmark.

7. The second source is the two existing diesel power plants totaling 80 MW, which are fueled by heavy, #6 oil, which is locally refined in Curacao. The oil is imported from Venezuela.

8. The third source is one new diesel (heavy, #6 oil fuel) power plant, which will be constructed to produce 84 MW, using six 14 MW modules (the most efficient size module was found to be in the 12-16 MW range). Bids are being tendered at this time and the plant will be dual-fuel capable if LNG becomes available.

9. The fourth potential source is one waste-to-energy plant in the 7-10 MW range, which is under technology review at this time.

10. The fifth source is the Curacao refinery that has its own diesel power plant that can produce 22 MW beyond its own power needs. This 22 MW can be made available to Aqualectra.

11. Aqualectra has a goal to reduce greenhouse gas emissions (GHGs) by 55-60%.

12. The power transmission network utilizes a 66 kv lines that extend out north, south, east and west from the center ring road network located around Willemstad.

13. Eleven substations exist on the island that step-down the 66 kv to a 30 kv grid.

14. Twelve substations exist on the island that step-down the 30 kv to a 12 kv grid.

15. The 12 kv grid is then stepped-down by 1800 transformer stations to 127/220 v electric supply.

16. Aqualectra expects to have a capacity at 240-245 MW by Year 2015 with 51 MW of wind included. It is important to note that during a couple of months per year the wind dies down and wind power is not as effective or not available during those months.

17. Loss of Load Probability (LOLP), defined as a measure of the probability that a system demand will exceed capacity during a given period; often expressed as the estimated number of days over a long period, is currently at 24 hours/year/person. Aqualectra has a goal of 9 hours/year/person.

18. The generation and production companies have been integrated into one company as of this year; a work force of about 680 is being reduced to 580.

19. With respect to renewable energy, wind is the most favored technology on the island. Seawater air conditioning is being investigated and is considered favorable. Solar power
may become cost effective in another ten years, but current studies consider solar to be not as efficient as wind.
20. The government is working on a formal energy policy for the entire island now.
21. The government is drafting regulations now.
22. Transmission easement on Eastpoint should be planned at about 30 meters wide.
23. New electric meters are installed outside of buildings (old meters were sometimes allowed inside the buildings).
24. Electricity is pre-paid.
25. The island is 99% serviced.

WATER:

26. Current water demand is about 37,000 cubic meters per day (cm/day).
27. Water demand expected to be 45,000 cubic meters per day by year 2015.
28. Production for the country comes from two Sea Water Reverse Osmosis (SWRO) plants.
29. SWRO #1 is located in Santa Barbara – today is runs 3 trains of 6,000 cm/day but will be expanded to 4 modules by April 2012 for a total production of 24,000 cm/day. This plant is located about 800 meters from the sea. SWRO #1 can be further expanded beyond the 4 modules.
30. SWRO #2 is in planning and will be located in the middle of the island and will operate 5 modules at 6,000 cm/day each for a total production of 30,000 cm/day.
31. The SWRO plants utilize technology from France.
32. The health department requires a 12-day water supply reserve when only one SWRO plant is in operation to protect against disasters that could shut down the supply plant. Current storage is only 4 days. Storage is planned to grow to about 7-10 day supply.
33. Today, a water plant located adjacent to the office of this meeting will be phased out of production once the SWRO #2 plant is constructed.
34. The island is divided into fifteen distribution areas that are all interconnected.
35. Advanced Metering Infrastructure (AMI) is being investigated now. The water system is currently on the world coordinate system in GIS all the way to the home meter location.
36. Smart growth for Eastpoint would be to develop from west to east to minimize infrastructure investment costs.
37. Water meters are installed at the curb location (outside of buildings).

The preceding represents the writer’s observations and understanding of the items and issues discussed and the decisions or direction made or agreed to. Please contact the writer at eschwarz@langan.com within three (3) working days with any suggestions for additions, deletions, corrections, or clarifications.

Distribution
Aqualectra, Anthon Casperson, Karel Tujeehut
Eastpoint Planning Committee, c/o Donald de Palm
Wolff Landscape Architecture, Ted Wolff
Eastpoint Planning Study Team
APPENDIX B

ITE TRIP GENERATION RATES
Curacao  
Summary of Trip Generation Calculation  
For 2400 Rooms of Resort Hotel  
April 27, 2011

<table>
<thead>
<tr>
<th></th>
<th>Average Rate</th>
<th>Standard Deviation</th>
<th>Adjustment Factor</th>
<th>Driveway Volume</th>
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<td>Avg. Weekday 2-Way Volume</td>
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Note: A zero indicates no data available.  
Source: Institute of Transportation Engineers  

TRIP GENERATION BY MICROTRANS
### Summary of Trip Generation Calculation

For 4709 Dwelling Units of Single Family Detached Housing  
April 27, 2011

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Note: A zero indicates no data available.  
The above rates were calculated from these equations:

24-Hr. 2-Way Volume: \[ \ln(T) = 0.92 \ln(X) + 2.71, R^2 = 0.96 \]

7-9 AM Peak Hr. Total: \[ T = 0.7(X) + 9.74 \]

4-6 PM Peak Hr. Total: \[ \ln(T) = 0.91 \ln(X) + 0.51, R^2 = 0.91, 0.63 \]  Enter, 0.37 Exit

AM Gen Pk Hr. Total: \[ T = 0.7(X) + 12.37 \]

PM Gen Pk Hr. Total: \[ \ln(T) = 0.88 \ln(X) + 0.62, R^2 = 0.91, 0.64 \]  Enter, 0.36 Exit

Sat. 2-Way Volume: \[ \ln(T) = 0.95 \ln(X) + 2.55, R^2 = 0.92 \]

Sat. Pk Hr. Total: \[ T = 0.89(X) + 9.56 \]

Sun. 2-Way Volume: \[ T = 8.84(X) - 13.31, R^2 = 0.94 \]

Sun. Pk Hr. Total: \[ \ln(T) = 0.91 \ln(X) + 0.35, R^2 = 0.87, 0.53 \]  Enter, 0.47 Exit

Source: Institute of Transportation Engineers  

TRIP GENERATION BY MICROTRANS
## Summary of Trip Generation Calculation

For 14125 Dwelling Units of Residential Condominium / Townhouse

April 27, 2011

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<thead>
<tr>
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<th>Standard Deviation</th>
<th>Adjustment Factor</th>
<th>Driveway Volume</th>
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Note: A zero indicates no data available.

The above rates were calculated from these equations:

- **24-Hr. 2-Way Volume:** \(\ln(T) = .87\ln(X) + 2.46, R^2 = 0.8\)
- **7-9 AM Peak Hr. Total:** \(\ln(T) = .81\ln(X) + .26\)
  
  \(\hat{R}^2 = 0.76, 0.17\) Enter, 0.83 Exit
- **4-6 PM Peak Hr. Total:** \(\ln(T) = .82\ln(X) + .32\)
  
  \(\hat{R}^2 = 0.8, 0.67\) Enter, 0.33 Exit
- **AM Gen Pk Hr. Total:** \(\ln(T) = .82\ln(X) + .15\)
  
  \(\hat{R}^2 = 0.8, 0.19\) Enter, 0.81 Exit
- **PM Gen Pk Hr. Total:** \(T = .34(X) + 35.87\)
  
  \(\hat{R}^2 = 0.82, 0.64\) Enter, 0.36 Exit
- **Sat. 2-Way Volume:** \(T = 3.62(X) + 427.93, \hat{R}^2 = 0.84\)
- **Sat. Pk Hr. Total:** \(T = .29(X) + 42.63\)
  
  \(\hat{R}^2 = 0.84, 0.54\) Enter, 0.46 Exit
- **Sun. 2-Way Volume:** \(T = 3.13(X) + 357.26, \hat{R}^2 = 0.88\)
- **Sun. Pk Hr. Total:** \(T = .23(X) + 50.01\)
  
  \(\hat{R}^2 = 0.78, 0.49\) Enter, 0.51 Exit

Source: Institute of Transportation Engineers

TRIP GENERATION BY MICROTRANS
<table>
<thead>
<tr>
<th></th>
<th>Average Rate</th>
<th>Standard Deviation</th>
<th>Adjustment Factor</th>
<th>Driveway Volume</th>
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<td>4-6 PM Peak Hour Exit</td>
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Note: A zero indicates no data available.
Source: Institute of Transportation Engineers
Curacao  
Summary of Trip Generation Calculation  
For 7500 Dwelling Units of Residential Condominium / Townhouse  
April 27, 2011

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Note: A zero indicates no data available.

The above rates were calculated from these equations:

- 24-Hr. 2-Way Volume: $\ln(T) = 0.87\ln(x) + 2.46$, $R^2 = 0.8$
- 7-9 AM Peak Hr. Total: $\ln(T) = 0.82\ln(x) + 0.26$
- 4-6 PM Peak Hr. Total: $\ln(T) = 0.82\ln(x) + 0.15$
- AM Gen Pk Hr. Total: $\ln(T) = 0.82\ln(x) + 0.15$
- PM Gen Pk Hr. Total: $T = 0.34(x) + 35.87$
- Sat. 2-Way Volume: $T = 3.62(x) + 427.93$, $R^2 = 0.84$
- Sat. Pk Hr. Total: $T = 0.29(x) + 42.63$
- Sun. 2-Way Volume: $T = 3.13(x) + 357.26$, $R^2 = 0.88$
- Sun. Pk Hr. Total: $T = 0.23(x) + 50.01$

Source: Institute of Transportation Engineers  

TRIP GENERATION BY MICROTRANS
### Curacao

**Summary of Trip Generation Calculation**

For 2500 Dwelling Units of Single Family Detached Housing

April 27, 2011

<table>
<thead>
<tr>
<th></th>
<th>Average Rate</th>
<th>Standard Deviation</th>
<th>Adjustment Factor</th>
<th>Driveway Volume</th>
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**Note:** A zero indicates no data available.

The above rates were calculated from these equations:

- **24-Hr. 2-Way Volume:** \( \ln(T) = 0.92\ln(X) + 2.71, R^2 = 0.96 \)
- **7-9 AM Peak Hour Total:** \( T = 0.7(X) + 9.74 \)
  \( R^2 = 0.89, 0.25 \) Enter, 0.75 Exit
- **4-6 PM Peak Hour Total:** \( \ln(T) = 0.91\ln(X) + 51 \)
  \( R^2 = 0.91, 0.63 \) Enter, 0.37 Exit
- **AM Gen Pk Hr. Total:** \( T = 0.7(X) + 12.37 \)
  \( R^2 = 0.89, 0.26 \) Enter, 0.74 Exit
- **PM Gen Pk Hr. Total:** \( \ln(T) = 0.88\ln(X) + 62 \)
  \( R^2 = 0.91, 0.64 \) Enter, 0.36 Exit
- **Sat. 2-Way Volume:** \( \ln(T) = 0.95\ln(X) + 2.59, R^2 = 0.92 \)
- **Sat. Pk Hr. Total:** \( T = 0.89(X) + 9.56 \)
  \( R^2 = 0.91, 0.53 \) Enter, 0.47 Exit
- **Sun. 2-Way Volume:** \( T = 8.84(X) - 13.31, R^2 = 0.94 \)
- **Sun. Pk Hr. Total:** \( \ln(T) = 0.91\ln(X) + 35 \)
  \( R^2 = 0.87, 0.53 \) Enter, 0.47 Exit

**Source:** Institute of Transportation Engineers


TRIP GENERATION BY MICROTRANS
<table>
<thead>
<tr>
<th></th>
<th>Average Rate</th>
<th>Standard Deviation</th>
<th>Adjustment Factor</th>
<th>Driveway Volume</th>
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Note: A zero indicates no data available.
Source: Institute of Transportation Engineers

TRIP GENERATION BY MICROTRANS
### Summary of Trip Generation Calculation

#### For 18750 Dwelling Units of Residential Condominium / Townhouse

**April 27, 2011**

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<tr>
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<th>Driveway Volume</th>
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**Note:** A zero indicates no data available.

The above rates were calculated from these equations:

- **24-Hr. 2-Way Volume:** \( \ln(T) = 0.87 \ln(X) + 2.46, \ R^2 = 0.8 \)
- **7-9 AM Peak Hr. Total:** \( \ln(T) = 0.87 \ln(X) + 0.26 \)
- **4-6 PM Peak Hr. Total:** \( \ln(T) = 0.82 \ln(X) + 0.32 \)
- **AM Gen Pk Hr. Total:** \( \ln(T) = 0.82 \ln(X) + 0.15 \)
- **PM Gen Pk Hr. Total:** \( T = 0.34(X) + 35.87 \)
- **Sat. 2-Way Volume:** \( T = 3.62(X) + 427.93, \ R^2 = 0.84 \)
- **Sat. Pk Hr. Total:** \( T = 0.29(X) + 42.63 \)
- **Sun. 2-Way Volume:** \( T = 3.13(X) + 357.26, \ R^2 = 0.88 \)
- **Sun. Pk Hr. Total:** \( T = 0.23(X) + 50.01 \)

**Source:** Institute of Transportation Engineers


**TRIP GENERATION BY MICROTRANS**
### Curacao
Summary of Trip Generation Calculation
For 6250 Dwelling Units of Single Family Detached Housing
April 27, 2011

<table>
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<tr>
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<th>Standard Deviation</th>
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<th>Driveway Volume</th>
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<td>0.00</td>
<td>1.00</td>
<td>1898</td>
</tr>
<tr>
<td>Sunday Peak Hour Total</td>
<td>0.65</td>
<td>0.00</td>
<td>1.00</td>
<td>4039</td>
</tr>
</tbody>
</table>

**Note:** A zero indicates no data available.

The above rates were calculated from these equations:

- **24-Hr. 2-Way Volume:**
  \[ \text{LN}(T) = 0.92 \text{LN}(X) + 2.71, \text{R}^2 = 0.96 \]
- **7-9 AM Peak Hr. Total:**
  \[ T = 0.7(X) + 9.74 \]
  \( \text{R}^2 = 0.89, 0.25 \) Enter, 0.75 Exit
- **4-6 PM Peak Hr. Total:**
  \[ \text{LN}(T) = 0.91 \text{LN}(X) + 0.51 \]
  \( \text{R}^2 = 0.91, 0.63 \) Enter, 0.37 Exit
- **AM Gen Pk Hr. Total:**
  \[ T = 0.7(X) + 12.37 \]
  \( \text{R}^2 = 0.89, 0.26 \) Enter, 0.74 Exit
- **PM Gen Pk Hr. Total:**
  \[ \text{LN}(T) = 0.88 \text{LN}(X) + 0.62 \]
  \( \text{R}^2 = 0.91, 0.64 \) Enter, 0.36 Exit
- **Sat. 2-Way Volume:**
  \[ \text{LN}(T) = 0.95 \text{LN}(X) + 2.59, \text{R}^2 = 0.92 \]
- **Sat. Pk Hr. Total:**
  \[ T = 0.89(X) + 9.56 \]
  \( \text{R}^2 = 0.91, 0.53 \) Enter, 0.47 Exit
- **Sun. 2-Way Volume:**
  \[ T = 8.84(X) - 13.31, \text{R}^2 = 0.94 \]
- **Sun. Pk Hr. Total:**
  \[ \text{LN}(T) = 0.91 \text{LN}(X) + 0.35 \]
  \( \text{R}^2 = 0.87, 0.53 \) Enter, 0.47 Exit

**Source:** Institute of Transportation Engineers

**TRIP GENERATION BY MICROTRANS**
APPENDIX C

Flowtender Greywater Reuse Brochure
**Completely Automated**

The Flotender™ Greywater System is fully automated. When greywater enters the system it is automatically filtered, pressurized, and pumped out to irrigate your plants. The pressurized water moves to varying levels in the landscape while delivering 15-20 PSI to each emitter. When most of the water has been pumped out, the system automatically turns off. Performance indicators let you know when the Flotender™ Greywater Drip Irrigation System is functioning properly.

**When You Go On Vacation**

Even when you go on vacation, the Flotender™ System can still take care of your plants. An optional AutoFlush™ device connects to an outdoor spigot and includes a battery operated timer to ensure that your plants are being watered daily even when no showers, baths or washing machines are being used.

**Easy Out-Of-The-Box Installation**

The Flotender™ Greywater System comes fully assembled with all components securely installed and ready for use. Simply connect the Flotender™ to the greywater source(s), attach the tee filter and performance indicators, connect the greywater drip irrigation system and plug the cord into a 110v power source.

Multiple system sizes available, see www.flotender.com for details.

Flotender™ by Filtri®
15500 Woodinville-Redmond Road
Suite C-100 Woodinville, WA 98072
P: 800.906.0604 • F: 425.482.9559
www.flotender.com

Copyright 2010 by Filtri® Company LLC.
Conserve Water with Every Shower!

Imagine having the ability to water your plants, while simultaneously lowering your water consumption and environmental footprint. The Flotender™ Greywater System provides you a constant source of water for your plants everyday of the year by using recycled water from your shower, bath, or washing machine for irrigation. This second use of water allows you to care for your plants throughout the year, even in seasons of drought and allows you to reduce your water usage by up to 70%

How Much Water Can I Conserve with Flotender?

Landscape irrigation makes up approximately 32% (70% on the west coast) of all residential water usage. By recycling the water you are already using with a greywater irrigation system, you could significantly reduce your water usage!

25 Gallons of water is used in a 10 minute shower
50 Gallons of water is used in a bathtub
25 Gallons of water is needed to do a load of laundry

In One Week’s Time...
Which Adds Up to...
For an Annual Total of...

300 gallons / week
15,600 gallons / year

With a Flotender Greywater System, your plants are watered automatically every time you take a shower, a bath, or wash clothes.

1. Water is Captured.
   When you use your washing machine, bathtub, or shower, water flows down the drain, through the pipes, and into the Flotender™.

2. Water is Filtered, Pressurized, & Pumped
   When the greywater enters the Flotender™, the fine lint and hair is immediately filtered out. The water is then pressurized and pumped into the drip irrigation system.

3. Water is Delivered to Your Plants
   The filtered, pressurized water is then delivered evenly to each dripper at the root zone of your plants.

Precise Greywater Filtration

Drip irrigation is the most efficient way to water plants but it requires precise filtration. Without very fine filtration, debris from greywater will clog and ruin the drip system. The Flotender™ Greywater Recycling System filters all water through a 150-mesh particle filter basket. The intricate design of the greywater filter basket incorporates a unique sealing gasket which allows the filter basket to be easily removed for cleaning without compromising the drip irrigation system.

A self-regulating spray system offers constant cleaning of the greywater filter basket, which helps maintain an unobstructed flow through the basket, and maximizes time between maintenance.
APPENDIX D

Flowtender Rainwater Reuse Brochure
**Accent Rain Gardens**

Besides irrigating your landscape with rainwater in the summer, in the winter InstaDrip™ can add interest to a rain garden with a waterfall, bubbling rock column or statuary piece.

**Uphill Pumping**

Many urban gardens are built on a slope, or terraced, and require a high pressure pumping system to deliver water to the upper areas. Equipped with a high pressure pump, an InstaDrip™ system easily accommodates for terrain fluctuation.

**Flexible Placement**

To accommodate Urban constraints, the InstaDrip™ system has been engineered to be placed nearly anywhere in the landscape. Place it above ground, below ground, in a garage, a garden shed or anywhere else you like.

Multiple system sizes available, see www.flotender.com for details.

Flotender™ by Filtri®,
15500 Woodinville-Redmond Road
Suite C-100 Woodinville, WA 98072
P: 800.906.0604 • F: 425.482.9559
www.flotender.com

Copyright 2010 by Filtri® Company LLC.
Using Urban Rainwater in the Landscape

Water conservation begins on the individual level at homes across the country, where the owners choose to be part of the movement to steward our earth’s resources responsibly. On average 32% of household water usage is used to irrigate gardens across the country. Instead of using drinking water to irrigate your landscape you can use rainwater from your roof or patio to irrigate your plants. InstaDrip™ by Flotender makes the process possible by providing a completely automated and ultra-compact system well suited for urban environments where space is limited.

Immediate Release

InstaDrip™ is unique from other rainwater systems on the market because of its integrated immediate release technology. Upon rainwater entering the system, it is immediately pressurized and dispersed to the root systems of the plants via drip irrigation. This allows for the soil to store the water naturally in the root zone and eliminates the need for big tanks storing large amounts of water.

Summer Rainfall Without InstaDrip™
Most Rainfall is Deflected Outside of the Root Zone
Minimal Rainfall Penetrates the Root Zone

Summer Rainfall With InstaDrip™
Rainfall on roof or patio is captured by the InstaDrip™ System
Concentrated Rainwater is delivered directly to plants root zone via drip irrigation
Root Zone Stores Water

When It Doesn’t Rain

Perfect for Climates with Occasional Summer Rainfall

Because InstaDrip™ provides far superior soil saturation than a plant would receive from a normal rainfall, plants can go longer between waterings and can often thrive with minimal, if any, supplemental city water. For younger plantings with undeveloped root systems, or if periodic supplemental city water is desired, InstaDrip™ can be configured to pull from city water to supplement the lack of rainfall.

InstaDrip™ Operation with City Water to Supplement

Irrigation Zones:
Zone 1 - Front Lawn
Zone 2 - Back Lawn
Zone 3 - RainAssist™ Shrub Zone (year 2, reduce watering time 50% or more)

Rainfall Example:

Below is an example of intermittent rainfall over 1/4” per day highlighted.

By utilizing condensed rainwater, the use of city water use can be significantly reduced. See www.flotender.com for sizing information.
APPENDIX E

ITE Internal Capture Methodology
Trip Generation Handbook
Second Edition
An ITE Recommended Practice

June 2004
Institute of Transportation Engineers
This version of the *Trip Generation Handbook, Second Edition*, RP-028B, incorporates changes necessary for consistency with the data contained in the Seventh Edition of *Trip Generation*, which was released in November 2003. The recommendations in this publication have not changed from the 2001 edition of the handbook. Additional data have been added to Chapter 5, Pass-By, Primary and Diverted Linked Trips. All other changes were strictly editorial updates to the material contained in the 2001 handbook.

The *Trip Generation Handbook*, RP-028A, was approved in November 2000 as a recommended practice of the Institute of Transportation Engineers (ITE). It supersedes the proposed recommended practice, RP-028, dated October 1998. The comment period on the proposed recommended practice closed on January 1, 2000. Comments on the October 1998 document have been incorporated into this document.

Certain individual volunteer members of ITE's recommended practice development bodies are employed by Federal agencies, other governmental offices, private enterprise, or other organizations. Their participation in ITE recommended practice development activities does not constitute endorsement by these government agencies or other organization endorsement of any of ITE recommended practice development bodies or any ITE recommended practices that are developed by such bodies.

The Institute of Transportation Engineers is an international educational and scientific association of transportation and traffic engineers and other professionals who are responsible for meeting mobility and safety needs. ITE facilitates the application of technology and scientific principles to research, planning, functional design, implementation, operation, policy development, and management for any mode of transportation by promoting professional development of members, supporting and encouraging education, stimulating research, developing public awareness, and exchanging professional information; and by maintaining a central point of reference and action.

Founded in 1930, ITE serves as a gateway to knowledge and advancement through meetings, seminars and publications; and through a network of some 16,000 members working in some 90 countries. ITE also has more than 70 local and regional chapters and more than 120 student chapters that provide additional opportunities for information exchange, participation and networking.

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CHAPTER 7

Multi-Use Development

7.1 Background

A basic premise behind the data presented in *Trip Generation* is that data were collected at single-use, free-standing sites. However, the development of mixed-use or multi-use sites is increasingly popular. While the trip generation rates for individual uses on such sites may be the same or similar to what they are for free-standing sites, there is potential for interaction among those uses within the multi-use site, particularly where the trip can be made by walking. As a result, the total generation of vehicle trips entering and exiting the multi-use site may be reduced from simply a sum of the individual, discrete trips generated by each land use.

A common example of this internal trip-making occurs at a multi-use development containing offices and a shopping/service area. Some of the trips made by office workers to shops, restaurants, or banks may occur on site. These types of trips are defined as internal to (i.e., "captured" within) the multi-use site.

A key characteristic of a multi-use development is that trips among the various land uses can be made on site and these internal trips are not made on the major street system. In some multi-use developments, these internal trips can be made either by walking or by vehicles using internal roadways without using external streets.

An internal capture rate can generally be defined as a percentage reduction that can be applied to the trip generation estimates for individual land uses to account for trips internal to the site. It is important to note that these reductions are applied externally to the site (i.e., at entrances, adjacent intersections and adjacent roadways). The trip reduction for internally captured trips is separate from the reduction for pass-by trips. These are two distinct phenomena and both could be applicable for a proposed development. The internal trips, if present, should be subtracted out before pass-by trip reductions are applied (refer to Chapter 5 for a complete discussion of pass-by trip estimation).

![Multi-Use Development](image-url)

- Typically planned as a single real-estate project,
- Typically between 100,000 and 2 million sq. ft. in size,
- Contains two or more land uses,
- Some trips are between on-site land uses, and
- Trips between land uses do not travel on major street system.

Not a(n)

- Central business district,
- Suburban activity center, or
- Existing ITE land use classification with potential for a mix of land uses, such as
  - Shopping center,
  - Office park with retail,
  - Office building with retail, or
  - Hotel with limited retail and restaurant space.
7.3 What Is Not a Multi-Use Development?

In literal terms, a multi-use development could mean any combination of different land use types within a defined, congruous area. But that definition would encompass a wide range of potential applications, many of which are not intended to be the focus of this chapter.

A traditional downtown or central business district (CBD) is not considered a multi-use development for purposes of this handbook. Downtown areas typically have a mixture of diverse employment, retail, residential, commercial, recreation and hotel uses. Extensive pedestrian interaction occurs because of the scale of the downtown area, ease of access and proximity of the various uses.

Automobile occupancy, particularly during peak commuting hours, is usually higher in the CBD than in outlying areas. Some downtowns have excellent transit service. For these reasons, trip generation characteristics in a downtown environment are different from those found in outlying or suburban areas. The focus of the data presented throughout Trip Generation is on sites in suburban settings with limited or no transit service and free parking. Accordingly, trip generation characteristics in this chapter, and specifically in the case of capture rates at multi-use developments, are directly applicable only to sites outside the traditional downtown. The potential effects of transit service and on-site parking fees are discussed in Appendix B.

A shopping center could also be considered a multi-use development. However, because data have been collected directly for them, shopping centers are considered in Trip Generation as a single land use. The associated trip generation rates and equations given in Trip Generation reflect the “multi-use” nature of the development because of the way shopping center data have been collected. Accordingly, internal capture rates are not applicable and should not be used to forecast trips for shopping centers if using statistics and data for Land Use Code 820. However, if the shopping center is planned to have out-parcel development of a significantly different land use classification or a very large percentage of overall GLA, the site could be considered a multi-use development for the purpose of estimating site trip generation.

Likewise, a subdivision or planned unit development containing general office buildings and support services such as banks, restaurants and service stations arranged in a park- or campus-like atmosphere should be considered as an office park (Land Use Code 750), not as a multi-use development. Similarly, office buildings with support retail or restaurant facilities contained inside the building should be treated as general office buildings (Land Use Code 710) because the trip generation rates and equations already reflect such support uses. A hotel with an on-site restaurant and small retail falls within Land Use Code 310 and should not be treated as a multi-use development.

7.4 Methodology for Estimating Trip Generation at Multi-Use Sites

Internally captured trips can be a significant component in the travel patterns at multi-use developments. However, more studies are needed to thoroughly quantify this phenomenon. Section 7.5 presents a recommended procedure for estimating internal capture rates (and a worksheet for organizing and documenting the analysis assumptions used in the estimation of the internal capture rates) for multi-use development sites.

The internal trip-making characteristics of multi-use development sites are directly related to the mix of on-site land uses (which are typically a combination of residential, office, shopping/retail, restaurant, entertainment and hotel/motel). When combined within a single mixed-use development, these land uses tend to interact and thus attract a portion of each other’s trip generation.

The recommended methodology for estimating internal capture rates and trip generation at multi-use sites is based on two fundamental assumptions. First, the proportions of trips between interacting land use types (which will be satisfied internally by pairs of land uses) are assumed to be relatively stable. Second, if sufficient data were available, these internal capture percentages could be predicted with adequate confidence. The need for additional data collection at multi-use developments is described in Section 7.7.
As should be expected, the observed internal capture rates for multi-use developments vary by time of day, the site's mix of land uses and size of the development.

Several premises frame the recommended methodology. An example to illustrate its application is presented in the highlighted text to the side. Key to the success of this methodology in replicating internal capture patterns at multi-use sites is its iterative, balancing steps that constrain internal trip-making levels to what are realistic given the mix of land uses.

Illustration of Methodology Overview

Assume a multi-use development with a mix of office, retail and residential uses. Assume that the office building generates 500 exiting trips during the evening peak hour (based on factors presented in Trip Generation).

Based on surveys at other multi-use developments (for illustration purposes), it is estimated that the 500 peak hour trips could go to the following destinations: 5 trips to another office building within the development, 115 trips to a retail site within the development, 10 trips to residential units on-site and 370 to external sites (as illustrated in Figure 7.1a).

What if there are no on-site residential units? The number of trips from the office to an internal residential destination changes to zero and the number of trips to external destinations becomes 380 (i.e., the total trips from the office building remains constant at 500).

What if there are a large number of on-site residences? Assume the residential uses generate 1,000 entering trips during the evening peak hour. As illustrated in Figure 7.1b, the trips are assumed to originate as follows: 20 trips from an on-site office building, 310 trips from on-site retail, no trips from another on-site residential component and 670 trips from external origins.

With the larger number of residences, as many as 20 trips could come from on-site office buildings. But the actual on-site office buildings generate only 10 trips to the on-site residential land use. So, 10 trips would be expected from on-site office to on-site residential in Figure 7.1c. The key assumption is that the "balanced" number of internal trips will match the controlling (i.e., lower) value.
Figure 7.1 Illustration of Internal Trip Balancing for a Multi-Use Development

**Distribution of Potential Destinations of Trips from Office Use**

- 5 trips to a separate on-site office building
- 115 trips to on-site retail
- 10 trips to on-site residential
- 370 trips to external destinations

**Distribution of Potential Origins of Trips to Residential Use**

- 20 trips from on-site office
- 310 trips from on-site retail
- 0 trips from other on-site residential
- 670 trips from external origins
- 1,000 trips

**Balance\(^1\) Distribution of Origins of Trips to Residential Use**

- 10 trips from on-site office
- 310 trips from on-site retail
- 0 trips from other on-site residential
- 680 trips from external origins
- 1,000 trips

\(^1\) Only the office-to-residential values have been "balanced." Similarly, all other land use pairs would need to be balanced.

**Premise 1:** The distribution of trip purposes among motorists entering or exiting a development site is relatively stable. The distribution of destination land uses is likewise assumed to be relatively stable. For example, the destinations of trips from an office building are distributed among the many potential destinations (e.g., retail, residential, other office) in roughly the same pattern whether the office is stand-alone or in a multi-use development.

**Premise 2:** The converse of Premise 1 is also true, that the distribution of origins for trips to a particular land use is relatively stable.

**Premise 3:** The number of trips from a land use within a multi-use development to another land use within the same multi-use development (i.e., an internal trip) is a function of the size of the "receiving" land use and the number of trips it attracts, as well as the size of the "originating" land use and the number of trips it sends. The number of trips between a particular pair of internal land uses is limited to the smaller of these two values.
7.5 Procedure for Estimating Multi-Use Trip Generation

The recommended procedure for trip estimation, although complex, simplifies the actual trip-making dynamics within a multi-use development. For example, the procedure does not take into account a number of key variables that are likely to affect the internal capture rate, such as proximity of on-site land uses (and pedestrian connections between them) and location of the multi-use site within the urban/suburban area (and the proximity of competing or complementary land uses). The analyst is encouraged to exercise caution in applying the data presented herein because of the limited sample size and scope. Additional data should be collected where possible (refer to Section 7.7 for guidance). The analyst is also encouraged to make logical assumptions in his/her use of this procedure. In summary, use good professional judgment.

WORDS OF ADVICE

- Collect additional data if possible
- Exercise caution
- Be logical
- Use good professional judgment

Step 1. Document Characteristics of Multi-Use Development

Enter the following information onto the worksheet:

- Name of development;
- Description of each land use in the development and its ITE land use code; and
- Size of each land use, corresponding to the most appropriate independent variable used in Trip Generation (e.g., gross leasable area, gross floor area, dwelling units).

If the site has two or more buildings containing the same land use, combine the sizes of the multiple buildings if they are situated within a reasonable and convenient walking distance of each other. If the buildings are not close to each other, treat them as separate land uses on the worksheet (for example, as Office A and Office B).

If the site has multiple residential components (single-family apartment, etc.), compute the trip generation for each residential type separately (later in Step 3), but record as only a single land use on the worksheet.
**Step 2. Select Time Period for Analysis**

Enter the time period for which the analysis is being conducted onto the worksheet (for help in selecting the appropriate time period for analysis, refer to Chapter 2 of this handbook).

Internal capture rates vary by time of day. A separate worksheet should be completed for each distinct time period. It should be noted that typical internal capture rates are presented later in this chapter for the weekday midday, weekday evening peak and weekday daily.

Internal capture rates may also vary by day of the week. The typical internal capture rates used in a later step are based on data collected on a Tuesday, Wednesday, or Thursday (unless specifically noted otherwise). Analyses for a Friday or Saturday may need modified rates.

**Step 3. Compute Baseline Trip Generation for Individual Land Uses**

Compute the number of trips generated for the desired time period for each land use based on the given independent variable.

- Refer to notes in Step 1 if there are multiple buildings of the same land use within the site.
- Compute number of trips generated by direction (enter/exit).
- Use the Trip Generation rate, Trip Generation equation, or local data for each land use. Refer to Chapter 3 for guidance on how to select the appropriate rate or equation for each land use. Do not adjust for pass-by or diverted linked trips at this time.

Record trip generation values in worksheet. For each land use, record the baseline trip generation in the column under the “total” heading.

**SAMPLE PROBLEM**

Step 1. For our example problem, we are analyzing a multi-use site comprised of a 200,000-sq. ft. shopping center; a 120,000-sq. ft. office building; and 200 low-rise apartments. On the worksheet in Figure 7.2, the three land use types and their corresponding ITE land use codes and sizes are recorded.

Step 2. We will assume the analysis time period is the evening peak hour of adjacent street traffic (as indicated in the worksheet in Figure 7.2).

Step 3. For Land Use Code 820, use the equation from page 1,453 of Trip Generation, Seventh Edition, to compute trips; for Land Use Code 710, use the equation from page 1,160; for Land Use Code 221, use the equation from page 337. The results are listed in the worksheet in Figure 7.2.
Step 4. Estimate Anticipated Internal Capture Rate Between Each Pair of Land Uses

Tables 7.1 and 7.2 present unconstrained internal capture rates that have been estimated on the basis of a series of studies conducted in Florida. These are the only data available to ITE prior to publication that are detailed enough for credible use. Readers are encouraged to collect and submit additional data to ITE using procedures described in Section 7.7. As the best available applicable data, it is recommended that these internal capture rates be used unless local data are collected.

SAMPLE PROBLEM (continued)

Step 4. The sample worksheet in Figure 7.3 shows the recorded "internal capture" rates for each pair of land uses.

Estimate the interaction between each pair of land uses for the selected time period.

- Use Tables 7.1 and 7.2 (or local data) as the basis for the estimate. (Note: there are no data provided for the weekday morning peak period or for the Saturday midday peak period.)

- Table 7.1 presents estimated unconstrained internal capture rates for trip origins within a multi-use development. For example, during the weekday midday peak period, of all the vehicle-trips exiting an on-site office use, 2 percent of the trips could be destined for another on-site office use and 20 percent destined for on-site retail use.

- Table 7.2 presents estimated unconstrained internal capture rates for trip destinations within a multi-use development. For example, during the weekday midday peak period, of all the vehicle-trips entering an on-site retail use, 4 percent of the trips could originate at an on-site office use and 3 percent at an on-site residential use.

Record the estimated capture rates on the worksheet (in the boxes marked "demand").

- For each land use pairing, record four values; for example, for the pairing of retail and office uses, the following four values should be recorded:
  - Percent of trips from on-site office destined to an internal retail destination
  - Percent of trips to on-site retail originating from an internal office use
  - Percent of trips from on-site retail destined to an internal office destination
  - Percent of trips to on-site office originating from an internal retail use

- Each value represents the unconstrained demand (or maximum potential trip interaction between the two land uses), by direction.

Because of the limited database on trip characteristics at multi-use sites, the analyst is cautioned to review the particular characteristics of the multi-use development under analysis before using the factors presented in Tables 7.1 and 7.2. Specifically, the analyst must assess whether each set of internal trip capture rates makes sense considering the particular individual land uses within the multi-use development.

If local data on internal capture rates by land use pair can be obtained, the local data should be given preference.

The data in Table 7.1 are limited to trip interaction among the three land uses for which sufficient data were available. If an on-site land use does not match a land use category in Table 7.1, either (1) collect local data to establish an internal capture rate, according to procedures described in Section 7.7 of this chapter, or (2) assume no internal capture. (Note: although this assumption of no internal capture may be unrealistic, in the absence of any data it is better to overestimate off-site vehicle-trips.)
Table 7.1 Unconstrained Internal Capture Rates for Trip Origins within a Multi-Use Development

<table>
<thead>
<tr>
<th></th>
<th>MIDDAY PEAK HOUR</th>
<th>P.M. PEAK HOUR OF ADJACENT STREET TRAFFIC</th>
<th>DAILY</th>
</tr>
</thead>
<tbody>
<tr>
<td>from OFFICE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to Office</td>
<td>2%</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>to Retail</td>
<td>20%</td>
<td>23%</td>
<td>22%</td>
</tr>
<tr>
<td>to Residential</td>
<td>0%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>from RETAIL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to Office</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>to Retail</td>
<td>20%</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>to Residential</td>
<td>7%</td>
<td>12%</td>
<td>11%</td>
</tr>
<tr>
<td>from RESIDENTIAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to Office</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>to Retail</td>
<td>34%</td>
<td>63%</td>
<td>38%</td>
</tr>
<tr>
<td>to Residential</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Caution: The estimated typical internal capture rates presented in this table rely directly on data collected at a limited number of multi-use sites in Florida. While ITE recognizes the limitations of these data, they represent the only known credible data on multi-use internal capture rates and are provided as illustrative of typical rates. If local data on internal capture rates by paired land uses can be obtained, the local data may be given preference.

N/A—Not Available; logic indicates there is some interaction between these two land uses; however, the limited data sample on which this table is based did not record any interaction.
Table 7.2 Unconstrained Internal Capture Rates for Trip Destinations Within a Multi-Use Development

<table>
<thead>
<tr>
<th></th>
<th>MIDDAY PEAK HOUR</th>
<th>p.m. PEAK HOUR OF ADJACENT STREET TRAFFIC</th>
<th>DAILY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WEEKDAY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to OFFICE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>from Office</td>
<td>6%</td>
<td>6%</td>
<td>2%</td>
</tr>
<tr>
<td>from Retail</td>
<td>38%</td>
<td>31%</td>
<td>15%</td>
</tr>
<tr>
<td>from Residential</td>
<td>0%</td>
<td>0%</td>
<td>N/A</td>
</tr>
<tr>
<td>to RETAIL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>from Office</td>
<td>4%</td>
<td>2%</td>
<td>4%</td>
</tr>
<tr>
<td>from Retail</td>
<td>31%</td>
<td>20%</td>
<td>26%</td>
</tr>
<tr>
<td>from Residential</td>
<td>5%</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>to RESIDENTIAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>from Office</td>
<td>0%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>from Retail</td>
<td>37%</td>
<td>31%</td>
<td>33%</td>
</tr>
<tr>
<td>from Residential</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Caution: The estimated typical internal capture rates presented in this table rely directly on data collected at a limited number of multi-use sites in Florida. While ITE recognizes the limitations of these data, they represent the only known credible data on multi-use internal capture rates and are provided as illustrative of typical rates. If local data on internal capture rates by paired land uses can be obtained, the local data may be given preference.

N/A—Not Available; logic indicates there is some interaction between these two land uses; however, the limited data sample on which this table is based did not record any interaction.
Figure 7.3 Step 4 for Multi-Use Trip Generation Calculation Sample Problem

**LAND USE A: Retail**

<table>
<thead>
<tr>
<th>ITE LU Code</th>
<th>820 (pa1,453)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>200,000 sf GLA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter</td>
<td>475</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exit</td>
<td>514</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>989</td>
<td></td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LAND USE B: Office**

<table>
<thead>
<tr>
<th>ITE LU Code</th>
<th>710 (pa1,180)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>120,000 sf GSF</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exit</td>
<td>177</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>213</td>
<td></td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LAND USE C: Residential**

<table>
<thead>
<tr>
<th>ITE LU Code</th>
<th>221 (pa337)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>200 DU</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<th>Total</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter</td>
<td>81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exit</td>
<td>43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>124</td>
<td></td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Net External Trips for Multi-Use Development**

<table>
<thead>
<tr>
<th></th>
<th>LAND USE A</th>
<th>LAND USE B</th>
<th>LAND USE C</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Exit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Single-Use Trip Gen. Est.**

Source: Kalas Associates, Inc.
Step 5. Estimate "Unconstrained Demand" Volume by Direction

Multiply the internal capture percentages by the appropriate directional trip generation value in the worksheet.

- For each pair of land uses, compute a directional value from the percentages that were entered. (Note: these values will be balanced later in Step 6.)

Record the "unconstrained demand" volumes by direction on the worksheet in the boxes marked "demand" next to the percentages.

Step 6. Estimate "Balanced Demand" Volume by Direction

Compare the two values in each direction for each land use pairing and select the lower (i.e., controlling) value.

Record the value as the "balanced demand" (the lower of the directional internal volumes) between each pair of land uses.

- Record the lower value for each land use for each direction
- Record in the worksheet boxes marked "balanced."

Step 7. Estimate Total Internal Trips to/from Multi-Use Development Land Uses

For each land use, first sum the internal trips to each other land use. Then for each land use, sum the internal trips from each other land use. Record these total internal trip values in the worksheet in the summary table for each land use.

Compute and record the internal percentages for each land use in the summary table for each land use. Review values and verify that they are reasonable.

---

SAMPLE PROBLEM (continued)

Step 5. The "unconstrained demand" volumes are computed by multiplying the directional trip generation value by the "unconstrained demand" percentage, as shown in the sample worksheet in Figure 7.4. For example,

- Trips from retail to office: 514 outbound trips × 3% = 15 trips
- Trips to office from retail: 36 inbound trips × 31% = 11 trips
- Trips from office to retail: 177 outbound trips × 23% = 41 trips
- Trips to retail from office: 475 inbound trips × 2% = 10 trips

Step 6. Select the controlling value (i.e., the lower value) for each pair of land uses for each direction. For example, in the Figure 7.4 worksheet,

- For trips from retail to office, the retail could generate 15 internal trips but the office could only receive 11 internal trips; the controlling value is 11 internal trips.
- For trips from office to retail, the office could generate 41 internal trips but the retail could only receive 10 internal trips; the controlling value is 10 internal trips.

Step 7. The sample worksheet in Figure 7.5 illustrates Step 7. For the retail land use, 10 internal trips are estimated from the on-site office and 23 internal trips from the on-site residential. Therefore, the total internal trips entering the retail land use is 33. The internal trips exiting retail sum to 36 (11 to the on-site office and 25 to the on-site residential). In total, seven percent of the retail trips (69 of 989) are internal to the multi-use site. This procedure is followed for each land use.
Figure 7.4 Steps 5 & 6 for Multi-Use Trip Generation Calculation Sample Problem

**LAND USE A - Retail**

<table>
<thead>
<tr>
<th>ITE LU Code</th>
<th>820 (sq.1,485)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>200,000 sf GLA</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter</td>
<td>475</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exit</td>
<td>514</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>989</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% 100%

**LAND USE B - Office**

<table>
<thead>
<tr>
<th>ITE LU Code</th>
<th>710 (sq.1,660)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>120,000 sf GSF</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exit</td>
<td>177</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>213</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% 100%

**LAND USE C - Residential**

<table>
<thead>
<tr>
<th>ITE LU Code</th>
<th>221 (sq.337)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>200 DU</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter</td>
<td>81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exit</td>
<td>43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>124</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% 100%

---

**Net External Trips for Multi-Use Development**

<table>
<thead>
<tr>
<th></th>
<th>LAND USE A</th>
<th>LAND USE B</th>
<th>LAND USE C</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

INTERNAL CAPTURE

Source: Kabu Associates, Inc.
Step 8. Estimate the Total External Trips for Each Land Use

Calculate the number of external trips (by direction) by subtracting the estimated internal trips from the total trips for each individual land use. Record values in tables for each land use and in the boxes marked “exit to external” and “enter from external.”

SAMPLE PROBLEM (continued)

Step 8. The sample worksheet in Figure 7.5 lists the external trip volumes for each land use. For the retail use, there are estimated to be 442 trips entering from outside the site (computed by subtracting 33 internal trips from 475 total trips) and 478 trips exiting to outside the site (514 minus 36).

Step 9. Calculate Internal Capture Rate and Total External Trip Generation for Multi-Use Site

Record the final external trip estimates for each land use onto the worksheet and in the table of “net external trips.”

Compute the net external trip generation for the entire site by summing the external volumes for each of the site land uses.

Record the original estimates for total trip generation for each land use onto the worksheet in the row denoted “original trip generation estimate.” Compute the overall internal capture rate by dividing the net external trip generation estimate by the original total trip generation estimate, and subtracting the quotient from 100 percent.

Step 9. The sample worksheet in Figure 7.5 lists the net external volumes for each of the three land uses in the summary table. The entering volume estimate of 521 peak hour trips is the sum of the external trips entering retail (442 trips), entering office (25 trips), and entering residential (54 trips). The net external volume for the multi-use site is 1,184 (521 plus 663) and represents an 11 percent reduction.

7.6 Cautions Regarding Recommended Procedure

The data presented in Section 7.5 quantify the influence of several key factors on internal capture rates. Numerous other factors have a direct influence on travel at multi-use sites, factors for which the current data do not account. Additional data and analysis are desirable to better quantify the relationships between these factors and multi-use development trip generation and internal capture rates. A summary description of the pertinent information contained in several existing documents is included in Appendix C of this handbook.

Limited Sample Size—The estimated typical internal capture rates presented in Section 7.5 in Tables 7.1 and 7.2 rely directly on data collected at a limited number of multi-use sites in Florida. While ITE recognizes the limitations of these data, they represent the only known credible data on multi-use internal capture rates and are provided as illustrative of typical rates. If local data on internal capture rates by land use pair can be obtained, the local data should be used (and the data submitted to ITE for use in future publications).
Figure 7.5 Steps 7-9 for Multi-Use Trip Generation Calculation Sample Problem

LAND USE A Retail

ITE LU Code 820 (pg 1,453)
Size 200,000 sf GLA

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter</td>
<td>475</td>
<td>33</td>
<td>442</td>
</tr>
<tr>
<td>Exit</td>
<td>514</td>
<td>36</td>
<td>478</td>
</tr>
<tr>
<td>Total</td>
<td>989</td>
<td>69</td>
<td>920</td>
</tr>
</tbody>
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% 100% 7% 93%

LAND USE B Office

ITE LU Code 710 (pg 1,169)
Size 120,000 sf GSF

<table>
<thead>
<tr>
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<th>Total</th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter</td>
<td>36</td>
<td>11</td>
<td>25</td>
</tr>
<tr>
<td>Exit</td>
<td>177</td>
<td>12</td>
<td>165</td>
</tr>
<tr>
<td>Total</td>
<td>213</td>
<td>23</td>
<td>190</td>
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</table>

% 100% 11% 89%

LAND USE C Residential

ITE LU Code 221 (pg 337)
Size 200 DU

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Internal</th>
<th>External</th>
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</thead>
<tbody>
<tr>
<td>Enter</td>
<td>81</td>
<td>27</td>
<td>54</td>
</tr>
<tr>
<td>Exit</td>
<td>43</td>
<td>23</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>124</td>
<td>50</td>
<td>74</td>
</tr>
</tbody>
</table>

% 100% 40% 60%

Net External Trips for Multi-Use Development

<table>
<thead>
<tr>
<th></th>
<th>LAND USE A</th>
<th>LAND USE B</th>
<th>LAND USE C</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter</td>
<td>442</td>
<td>25</td>
<td>54</td>
<td>521</td>
</tr>
<tr>
<td>Exit</td>
<td>478</td>
<td>165</td>
<td>20</td>
<td>663</td>
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<tr>
<td>Total</td>
<td>920</td>
<td>190</td>
<td>74</td>
<td>1184</td>
</tr>
</tbody>
</table>

Source: Kaku Associates, Inc.

INTERNAL CAPTURE

Single-Use Trip Gen. Est. 989 213 124 1326 11%
ADDITIONAL LAND USE MIXES

The analyst should exercise caution when considering the effects of additional land use mixes. For example, one of the newer types of multi-use developments is the large entertainment center complex with cinemas, restaurants, nightclubs and retail space. Customer interviews in Florida and California have suggested that as many as 40 percent of cinema users also eat at on-site restaurants. In another survey, only 20 percent of visitors to the complex report visiting only one land use at the site. However, reliance on interview data alone will tend to overstate the actual amount of internal capture. Actual counts should be taken to supplement these data.

Competing Markets—Proximity to competing markets is expected to influence internal capture rates. The greater the distance to external competing uses, the greater the likelihood of capturing trips internally within a multi-use development site. Developments in a suburban community may have higher capture rates than those in urban developments since urban areas provide a higher number of alternative opportunities than many suburban developments. For example, residents in an urban mixed-use development have more choices in shopping opportunities and thus may travel outside the development site for their shopping needs, even though there are retail uses in their development site. Suburban residents, on the other hand, may not have as many alternative opportunities and therefore may be more likely to confines their trips to the mixed-use site for their shopping or other needs. However, at this time there are no site-trip generation data available on which to base adjustment factors of this type.

Pass-By Trips—The application of pass-by trip reductions presented in Chapter 5 should be likewise applicable to multi-use sites. However, none of the internal trips can be of a pass-by nature because they do not travel on the adjacent (external) street system. Pass-by trip percentages are applicable only to trips that enter or exit the adjacent street system. Use the pass-by trip estimation procedure in Chapter 5 of this handbook.

Proximity and Density of On-Site Land Uses—The proximity and density of the residential, retail, office and hotel uses will affect internal trip-making. Generally, the greater the density and the closer the proximity of the complementary uses on site, the greater the level of internalization of trips. The proximity should be measured in terms of both distance and impedance to the traveler. For example, the presence of foot paths or bicycle paths, protected crosswalks or overpasses and pedestrian refuge areas greatly enhance the accessibility of paired on-site land uses. At this time, however, no site-trip generation data are available on which to base adjustment factors of this type.

Key Premise

Internal capture should increase with an increase in proximity, density and number of complementary land uses within a multi-use development.

Other Site-Specific Issues—Many other issues potentially affect trip making at multi-use sites. For example, can those who work on-site afford to live on-site? How long will it take for the office uses to attract work trips from on-site residences? Is there an internal circulation system that enhances or discourages internal trips?

Shared Parking—Shared parking and multi-use trip generation estimation methodologies, though similar, are not interchangeable. Shared parking factors cannot be applied to estimate trip generation at multi-use developments.

Shared parking factors cannot be applied to estimate trip generation at multi-use developments.
8. Summary of Recommendations for Sustainable Development and Protection of Ecological Systems
Recommendations for Sustainable Development

The following “Recommendations for Sustainable Development” are excerpted from the “Infrastructure Assessment and Sustainability Report” prepared by Langan International, a report which is also included in its entirety in this report.

7.1 Water

Water usage is a significant area that should be considered for sustainable practices. Wherever possible, new construction should consider the use of low-flowing efficient plumbing fixtures. Outdoor features such as swimming pools and fountains should recycle their water to minimize the use of fresh potable water supplies.

Potable water uses can be considered for re-capture after their initial use and then re-used for non-potable uses such as centralized car washing facilities and irrigation supplies.

Irrigation systems should be considered to use soaking technologies and timer or moisture controlled equipment to avoid the loss of water to evaporation and usage when the ground is already irrigated from storm events. Irrigation systems should be operated during nighttime hours to reduce the demand on the public potable water systems during peak daytime hours of usage. Landscaping should use native and drought tolerant species to further reduce irrigation demands.

Rainwater harvesting systems are discussed in the Stormwater Section 6.7 below.

7.2 Electricity – Power – Renewable Energy

Wind Power

The northern shoreline of the Eastpoint property provides excellent conditions for the installation of a wind farm. Aualectra already operates a wind farm located further northwest from the Eastpoint property and is currently planning a new wind farm even closer to the northern boundary of the Eastpoint property. The topography is flat for a distance of hundreds of meters from the shoreline and the winds are consistent for much of the year at this location. The Curacao Wind Resource Map was provided to us by Dr. Lionel Janga. The map confirms that the northeast shoreline of the Eastpoint property has similar wind class power ratings as the other wind sites currently operated by Aualectra, which are among the best available areas on the island. Langan attempted to obtain the report that is the basis on this map. We were told by the researchers that we do not have rights to the report and were therefore unable to review the inventory or analysis behind the map.

Solar Power

Solar energy can easily be installed in bulk solar farms or on individual buildings throughout a large percentage of the overall property, since much of the property has open line of sight to sunlight throughout much of the daytime hours. However, Aualectra explained to us that on the island of Curacao, the cost efficiency of wind power is far less expensive than solar at this time. Aualectra stated that perhaps in 10 years or more, the cost of solar energy infrastructure may become competitive with wind and have more potential for use on the island in the future.

Solar Power versus Wind Power Comparisons

In addition to Aualectra’s statement to us that their research and studies have found wind power to be considerably more cost effective than solar at this time, we assembled the below references about solar power versus wind power:
1. From [www.treehugger.com](http://www.treehugger.com), “Due to the larger magnitude of solar (photovoltaic) PV power output fluctuations relative to those of wind at time scales shorter than 3.5 hours, the costs of large scale solar PV integration are likely to be larger than those of wind.” Carnegie Mellon researchers compared solar to wind at a research site in Arizona and found: “While wind’s capacity factor varies from 32% to 40% at excellent sites, the capacity factor for a 4.6 MW PV array in Arizona is determined to be 19% over two years.”

   From Wikipedia: The net capacity factor of a power plant is the ratio of the actual output of a power plant over a period of time and its output if it had operated at full nameplate capacity the entire time. To calculate the capacity factor, total energy the plant produced during a period of time and divide by the energy the plant would have produced at full capacity.

   We do not have a specific solar versus wind study performed on Curacao to reference. For the purposes of this report, we believe that the example study performed in Arizona provides a sufficient comparison of solar versus wind energy potential. We recognize that Arizona is not Curacao; however both are locations with typically sunny, dry and windy climates. The quoted statement above about larger magnitude of solar output fluctuations is not specific to a geographic location, but rather a general reference about the solar versus wind technologies.

2. From [www.greenerpeople.com](http://www.greenerpeople.com), In general some pros and cons for solar and wind are:

   **Solar:**
   - **Pros:** Almost maintenance free
   - Easily scalable
   - **Cons:** Only generates during the daytime
   - Higher cost than wind

   **Wind:**
   - **Pros:** Generates during daytime and nighttime
   - Lower cost than solar
   - **Cons:** Noise generation
   - Bird Hazard

   “In general you would have solar power for small amounts of power (like a small number of electronic devices).” An example would be a remote weather monitoring station. “Wind would be the better option if you want to produce a significant amount of power. Wind farms would be better than solar farms if replacing power plants.”

**Waste to Energy**

Waste to energy plants perform more efficiently cost-wise when large supplies of solid waste are available. The estimates in this report of Eastpoint’s base case full development (18,834 residential units and 2,400 hotel rooms) would only generate 58 tons per day of solid waste. Traditionally waste to energy plants require larger quantities such as 250 tons per day to be cost efficient. Therefore, a dedicated waste to energy plant for the Eastpoint property does not appear to be an effective renewable energy source. Future advancements in waste to energy technology may change the feasibility someday. The Eastpoint property’s solid waste could contribute towards the potential Aqualectra-Selkor waste to energy plant, thus being a part of the entire island’s benefit of renewable energy shared by the entire population.

The future developer will need to assess electric power needs based on a more specific and detailed development plan, and also consider the degree to which future development will depend on extensions of existing infrastructure, and the degree to which future development will operate independently of existing infrastructure through use of solar power associated with buildings, on-site wind power generation, and the potential contribution of the site development to a waste-to-energy plant.

**Deep Seawater Cooling**

Deep seawater cooling and seawater air conditioning involves pumping seawater from ocean depths of several hundred meters, where the temperature is between 4 and 8 degrees Celsius. The pumped cold water is then used with onshore heat exchangers for large-scale air conditioning systems. Our research indicates that the only likely cost effective way to implement this technology at Eastpoint would be if multiple hotel and commercial
developments shared in a system. Impacts to coral reefs and the marine park on the south side of Eastpoint may make this technology impracticable due to environmental concerns of direct coral reef impacts. The sea conditions along the north coast of Eastpoint are much rougher and violent, which could cause difficulties with installing the undersea infrastructure.

Referenced from www.aloha.com/~craven/coolair.html, we found that Hawaii has a successful seawater cooling system and the authors (Dr. Joseph Van Ryzin, co-founder of Makai Ocean Engineering and Tore Leraand) suggest that large buildings such as hotel with thousands of rooms can achieve air conditioning from deep sea water cooling systems much more economically than from traditional electric-powered chiller systems. “In general systems smaller than 1,000 tons of air conditioning are not economical.” The website references that a typical hotel room requires about 0.75 to 1 ton of air conditioning. Therefore, we estimate that multiple hotels or other commercial facilities would need to join together, unless a mega resort hotel with over one thousand rooms by itself was developed under a single owner.

The article posted on www.aloha.com/~craven/coolair.html further discusses a study that Makai Ocean Engineering conducted on Curacao. They studied three hotel sites ranging from 540 to 2100 rooms. The article does not explain the precise locations of the study sites. The length of seawater intake piping was estimated between 5,150 feet and 11,750 feet and capital costs were estimated between US$2 to US$5 million. The authors further estimated that the intake pipe and pumping station makes up about 50% of the total system cost. The remaining 50% of cost includes the onshore distribution system and heat exchangers.

7.3 Telecommunications

Sustainable telecommunications should focus on underground infrastructure installations so that service disruptions are minimized due to weather or other incidental or accidental damage. A thorough as built mapping system should be maintained so that the locations can be marked-out whenever other ground disturbance construction activities occur, to further minimize service disruptions and save on otherwise unnecessary repair work. Locations of infrastructure installation should avoid natural features of specific ecological importance. Cellular installations should be planned at higher topographical locations, but whenever possible be installed on buildings to minimize the need for additional infrastructure installation such as dedicated towers, which use additional lands that could otherwise be preserved.

7.4 Solid Waste

The Benefits of Recycling (Referenced from US EPA)

Recycling has environmental benefits at every stage in the life cycle of a consumer product—from the raw material with which it's made to its final method of disposal. Aside from reducing GHG emissions, which contribute to global warming, recycling also reduces air and water pollution associated with making new products from raw materials. By utilizing used, unwanted, or obsolete materials as industrial feedstocks or for new materials or products, we can each do our part to make recycling work. Every ton of mixed paper recycled can save the energy equivalent of 165 gallons of gasoline. Recycling also provides significant economic and job creation impacts, a topic discussed at www.epa.gov/epawaste/conserve/rrr/rmd/econ.htm.

Recycling provides an annual benefit of carbon dioxide equivalent emissions being reduced. But the ultimate benefits from recycling are cleaner land, air, and water, overall better health, and a more sustainable economy.

Composting (Referenced from US EPA)

Composting offers the obvious benefits of resource efficiency and creating a useful product from organic waste that would otherwise have been landfilled. Composting achieves many environmental benefits including enriching
soils, preventing pollution, remediating contaminated soils and providing economic benefits such as reducing the need for water, fertilizers and pesticides. Compost is organic material that can be used as a soil amendment or as a medium to grow plants. Mature compost is a stable material with content called humus that is dark brown or black and has a soil-like, earthy smell. It is created by: combining organic wastes (e.g., yard trimmings, food wastes, manures) in proper ratios into piles, rows, or vessels; adding bulking agents (e.g., wood chips) as necessary to accelerate the breakdown of organic materials; and allowing the finished material to fully stabilize and mature through a curing process. Finished compost can be applied to lawns and gardens to help condition the soil and replenish nutrients. Compost, however, should not be used as potting soil for houseplants because of the presence of weed and grass seeds. If recycling and composting are successfully implemented as part of the Eastpoint development, then benefits such as reduced solid waste collection truck traffic and extended landfill lifespan can be realized as benefits to the entire island.

### 7.5 Wastewater

Wastewater treatment plants can be designed to include higher levels of treatment and disinfection such that the effluent can be partially or fully reclaimed and re-used for other non-potable uses.

#### Graywater

Similar to Rainwater Reuse applications, graywater can be reused in a similar non-potable way. Therefore we have added a small discussion regarding graywater reuse. Graywater is generally defined as water used from showering, laundry washing machines and bath tubs (but not toilets, which is generally called blackwater or raw sewage and requires higher levels of treatment prior to reuse). Graywater can be reused much in the same ways as rainwater including irrigation and car washing. Appendix C includes a brochure about a pre-manufactured graywater collection and reuse system.

Graywater collection calculations are more difficult to estimate especially for seasonally occupied structures. However, if we make assumptions then some volumes can be estimated.

**Individual Homes**

Assume that the structures are occupied for 25% of the year (91 days) and that 0.75 cm per day (200 gallons per day) could be captured and stored in a protected manner from evaporation loss, then about 68 cm per year per home could be collected, which translates to 68 days of irrigation supply (at a rate of 1 cm/day for a typical home). An annual water budget savings for 18,834 homes could be as much as 1,280,712 cm per year (18,834 homes x 68 cm).

**Hotel Rooms**

For the 2,400 projected hotel rooms, a possible assumption of 0.15 cm per day (40 gallons per day) and an occupation rate of 50% of the year (182 days) could yield as much as 65,520 cm per year (2,400 rooms x 182 days/year x 0.15 cm/day/room).

Total potential annual water budget savings could be:

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Individual Homes</strong></td>
<td>1,280,712 cm</td>
</tr>
<tr>
<td><strong>Hotel Rooms</strong></td>
<td>65,520 cm</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,346,232 cm</td>
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7.6 Traffic & Transportation

Mass Transportation

Mass transportation results in many benefits for the future communities located within the Eastpoint property and the existing communities located outside of the Eastpoint property. These benefits include less traffic congestion on the internal and external roads, and a reduction of fuel usage and air pollution. Bus routes already exist on the island. As such, future development plans should provide for bus stops with each future Eastpoint community. Water taxi service could be considered to connect downtown Willemstad to Eastpoint as well near Fuik Baai, further reducing the impacts on the island’s major roads.

Priority Parking for Fuel-Efficient Vehicles

Encouragement of the use of fuel-efficient vehicles has many environmental and economic benefits, such as less fuel usage and operating costs and less air pollution generation. Where common parking facilities are provided, preferred parking spaces could be created for use by drivers of fuel-efficient vehicles such as hybrids and electric cars or golf carts. These common parking facilities would be located at multi-family/condo residential living communities, hotels, retail and recreational centers, golf courses, and other commercial uses. The preferred parking spaces would be the closest parking spaces to the main access to the facilities/buildings with the exception of handicap parking spaces. If preferred spaces are adopted as a development strategy (and therefore the use of fuel-efficient vehicles), measures to ensure compliance will also need to be implemented.

7.7 Stormwater

Rainwater Harvesting

Rainwater harvesting (collection and storage of rainfall) for non-potable uses is a potential sustainable practice that can be considered. Rainwater harvesting can result in a reduced demand on the central potable water distribution system. Below, we provide a sample calculation to show the potential savings on public water facilities that rainwater reuse can provide when implemented on a widespread basis.

Our calculations are based on assumed roof-top areas for single family homes in low density parcels and high density uses such as hotel or other common use parcels such as a golf clubhouse. Our assumptions can then be adjusted once specific building footprints are established by the future development project engineers and the calculations can be revised fairly easily at that time to yield more accurate potential volumes.

Rainwater Reuse Calculations

Rainwater can be collected locally from individual homes and larger buildings, using individual cisterns and products such as those included in Appendix D.

Individual Homes

If we assume a typical single family home structure to have a building footprint of 100 square meters (sm) and we assume that annual rainfall is equivalent to 570 mm, then we can estimate a potential rainwater volume that can be captured and re-used by each home to be:

\[ 100 \text{ sm} \times 570 \text{ mm} / (1,000 \text{ mm/m}) = 57 \text{ cubic meters (cm)} \]

Since during rainy periods, greater amounts of rainfall will occur then can be reasonably stored, we can consider a 50% capture rate, which would result in 28.5 cm of rainfall available for capture, storage and reuse by each home.
If we assume that 1 cm/day (264 gallons per day) is needed to irrigate a typical single family home property, then potentially 28.5 days per year of irrigation supply could be realized and reduced from the total annual potable supply systems. Considered for a total project build out of 10,000 homes, about 28,500 cm (10,000 homes x 28.5 cm) could be saved from the annual potable water supply budget.

**Larger Buildings**

Similarly, larger buildings, such as hotels, a beach club or a golf clubhouse could also yield rainwater volumes that can be captured from the roof into cisterns for future use in non-potable applications.

If we assume a building footprint of 1,000 sm, then the resulting potential volume that can be stored at a 50% capture rate would be:

\[
1,000 \text{ sm} \times \frac{570 \text{ mm}}{1,000 \text{ mm/m}} = 570 \text{ cubic meters (cm)} \text{ or } 285 \text{ cm (at a 50% capture rate) per building}
\]

**Porous Pavements**

Whenever possible, porous pavements could be encouraged. Porous or “permeable” pavements allow stormwater runoff to infiltrate back into the ground. Infiltration of stormwater provides two distinct environmental benefits. First, runoff rates and volumes can be reduced thus reducing flooding occurrences. Second, infiltration helps recharge groundwater supplies. Groundwater supplies get depleted when they are excessively extracted through wells and when they are excessively covered with impervious development such as buildings and roads. Depleted groundwater supplies are then no longer available for potable water extraction and in some instances they can negatively affect vegetative and animal life in the ecosystem.

The phrase “porous pavements” is an umbrella term for porous pavers, lattice pavers (also known as grassed pavers), porous concrete, and porous asphalt. Generally, this BMP allows stormwater to penetrate the respective surface material and flow directly into an underlying stone bed. The stone bed serves as a reservoir allowing the stormwater to be attenuated until infiltrating and recharging the groundwater.

**Benefits of Porous Pavements**

- Research has concluded that approximately 97% of oils introduced into pervious pavements are trapped and biodegraded.
- Visual awareness of the BMP for public.
- Improves the health of surrounding landscape compared to traditional pavement.
- Eliminates “bird baths” in parking lots.
- Contributes to groundwater recharge.
- Overall reduction in runoff volume; this reduction can contribute to a relatively smaller stormwater pond.
- TSS (Total Suspended Solids) Removal can be as high as 80% in optimal conditions

**Stormwater Capture and Re-use**

Where stormwater runoff is determined to simply run and discharge to the sea or discharge to an area that does not benefit from its contribution, the best practice
can be to capture the stormwater and re-use it for other purposes such as lake replenishment and irrigation supply water. Other non-potable uses can also benefit from the collection and storage of stormwater runoff.

**Cisterns and Rainwater Harvesting Systems**

Cisterns are stormwater storing structures located either above or below ground. The stormwater can be reused in irrigation, or other grey-water applications. The regional precipitation and the catchment area, usually a roof or other impervious surface, are directly proportional to the volume stored in the cistern.

**Benefits of Cisterns and Rainwater Harvesting Systems**

- Reduces yearly cost of potable water and demand on infrastructure.
- Reduces stormwater runoff.
- Rainwater is generally soft water and lowers the need for detergents in laundry.
- In large cistern cases, potential to sell “extra” stormwater to neighbors for irrigation.

**Erosion and Sedimentation Control**

Where stormwater conveyances and discharges exist or are proposed in the future, the conveyance channels should be stabilized with well-established vegetation or rock materials. Stabilized channels protect the underlying soils from eroding away and resulting in the deposition of sediments at downstream locations or the sea.

**Natural Features**

When surface water conveyance systems (ditches and valleys) contribute to natural features such as wetlands and marshes, specific care should be taken to not divert or capture the runoff that contributes to those natural features. Instead, maintain the future runoff volumes and rates similar to existing runoff volumes and rates so as to not alter these natural features, which can sometimes be considered sensitive eco-systems.

In instances where developed area runoff flows into sensitive wetland or marsh features, water quality improvement methods should be installed prior to the natural discharge point to polish and improve the “urban” runoff thereby removing suspended solids and nutrients that the upstream urban development has added to the runoff.

**Rain Gardens**

Rain Gardens are planted depressions, either naturally occurring or planned, that are designed to filter stormwater runoff and improve water quality. Rain gardens can be a stage in a treatment train where stormwater is attenuated prior to being discharged to a larger stormwater management facility.

**Benefits of Rain Gardens**

- Requires less maintenance than lawns. Once garden is established it will not need to be mowed, fertilized, or irrigated.
- Visual awareness of the BMP for public.
- Creates a wildlife habitat and aesthetically pleasing landscaping.
- Contributes to groundwater recharge.
- Reduces mosquito breeding.
- Removes a wide range of pollutants such as suspended solids, nutrients, metals, hydrocarbons, and bacteria.
Recommendations for Protection of Ecological Systems

1. No development in tidal, brackish, freshwater wetlands, or salinjas; all such areas to be designated as “Conservation.”

2. No development in mangrove swamps; all such areas to be designated as “Conservation.” Mangrove areas in lagoons (Fuik Bay, Lagun Blancu) to be designated as ‘Conservation.

3. No development in major drainage swales, and maintain a 50 meter buffer corridor on each side of these swales (100 meters total). The proposed buffer corridor width meets or exceeds the observed width of the vegetation corridors associated with major drainage swales, and there are no relevant standards for Curacao.

4. Treat natural rainfall as a valuable and precious resource that should be stored and used, not as something that is to be conveyed offsite as quickly as possible, and incorporate Best Management Practices (BMPs) regarding water management in the future development phases. Stormwater runoff after development should not exceed the amount or rate or fall below the quality prior to development so that there are minimal impacts on the existing water reception areas such as freshwater ponds, wells, salinjas, tidal marshes, lagoons, mangroves, and the coastal zone.

5. No development on peaks, hilltops, ridgelines, or other unique and important geological features, and limit development to lower slopes of these landforms such that the natural silhouette remains undisturbed.

6. No development on steep slopes.

7. Limited development within lagoons for water-related uses such as marinas and “South Seas” type bungalows over the water near the shoreline, with such areas to be designated as “Tourism.”

8. No other development within lagoons other than as noted above, with such protected or undeveloped areas to be designated as “Water.” Mangrove areas in the lagoons will be designated as ‘Conservation’.

9. No development on narrow barrier beaches between the lagoons and the sea, with such areas to be designated as “Conservation.”

10. Establish “wildlife corridors” that connect sensitive habitats throughout Eastpoint, to mitigate the effects of habitat fragmentation by connecting conservation areas.

11. Requirements for future development plans are assumed such that there are no direct impacts on the offshore coral reefs from physical disturbance such as dredging or channelization, and minimal or no indirect impacts from wastewater discharge, stormwater runoff, or point source or non-point source pollution.

12. Requirements for future wind turbines / wind farms, including location and design, are assumed such that there are minimal or no impacts on the resident bat populations and the resident and migratory bird populations.

13. Preserve important historical and cultural artifacts and sites.

14. No development immediately around Landhuis Fuik, in order to preserve the historic relationship of Landhuis Fuik to the surrounding agricultural land.

15. No development immediately around Landhuis Klein Sint Joris, in order to preserve the historic relationship of Landhuis Klein Sint Joris to the surrounding agricultural land and to allow the Landhuis to continue to function as an active residence.