# WA-1 Water Supply Network Upgrading & Expansion

## Social and Economic Impact

Considering DOWASCO reported "a preliminary analysis of water supply and distribution system indicated high leakage losses of 40%" and we learned this number to be conservative, our infrastructure improvements stated above include the recommendation to replace old pipes contributing to lowering this overall leakage loss. Morrison Hershfield also studies methods to manage and minimize the non-revenue water lost in the system, such as illegal tie-ins where individuals were gaining access to treated water but not paying for it. These savings to DOWASCO directly contributes to the country's overall economic benefit.

The most significant advancement will be the social benefits related to improving the quality and reliability of potable water services for the residents of Dominica in the WA1 service area. DOWASCO reported "The water source, being a river, is subject to season fluctuations which impact reliability. In addition, during periods of heavy rains, the river water is subject to extreme turbidity resulting in the closure of the intake to avoid silting the supply lines." Introducing another river intake structure higher up in the mountains will allow for more flexibility in the system and greater reliability in water delivery.

The newly designed water treatment facility will also be able to handle and treat the water with greater sediment loading. Overall, people at all levels including residents and industry will benefit from this improved water distribution system.

The results of this project will assist Dominica in achieving their national goals related to economic wellbeing, health, and economic sustainability.

## Technology Transfer

For the duration of this project Morrison Hershfield worked with DOWASCO in an atmosphere of open and collaborative communication. As a result we were able to show DOWASCO our process for determining the technical requirements, the challenges of meeting these requirements, and the possible solutions to overcoming these challenges.

A number of technologies were evaluated to meet the recommendation for inline direct filtration followed by disinfection, and we now await DOWASCO's response regarding a preferred selection.

Our other recommendations included the initiation of a proper control system, making it possible to manage the water distribution system to meet the requirements of all users. Morrison Hershfield completed a computer model that showed the whole water storage and distribution system which showed that the existing gravity system required flow and pressure control at key pointes to maintain proper reservoir fills. The existing system contains reservoirs at differing elevations on the side of the mountain, and differing common pipe sizes for distribution and reservoir filling. As part of the design Morrison Hershfield worked with DOWASCO to understand the hydraulics of a complicated water distribution system and the importance of flow control and pressure sustaining valves to maintain the flow of water within the pipes and the required storage to meet demands of the local users.

Similarly, a supervisory control and data acquisition (SCADA) system with data radio transmitted to the DOWASCO head office would be a major asset, allowing advanced knowledge of issues within the

distribution system such as dropping or low reservoir levels before they were actually empty. The SCADA system can not only give remote readout of critical data to the operators but also local control reducing the need to travel to remote locations and manually operating valves.

This provides a cost effective use of limited staff and resources.

Our environmental assessment process is closely integrated with the engineering design process to ensure that environmental objectives are incorporated within the option assessment, and in the final design features. We prepared an environmental Management Plan, which was of interest to DOWASCO in meeting international best practices in Dominica's EIA guidelines

Overall our working relationship with DOWASCO, and our willingness to answer questions, provided them with the opportunity to broaden and improve their technical knowledge base, and to utilize Canadian technologies and technological processes in a manner suitable to their own goals.

### Environmental Impact

This design to upgrade the existing water distribution system, starting from a new river intake structure, new water main to a newly designed water treatment facility provides an obvious positive impact into the community and the environment considering less water is being wasted –when referring back to the estimated 40% water leakage statement. This water savings also translates to energy savings seeing how the existing treatment facility will need to use less power to operate the distribution pumps.

Morrison Hershfield also conducted an Environmental Impact Assessment on this project to ensure our design minimized any negative environmental effects to the surrounding area.

### Complexity

The Commonwealth of Dominica is commonly known as most closely resembling its un-inhabitant condition in comparison to the other Caribbean islands. Most of the island is untouched, presenting its own challenges when confronted with infrastructure projects that require a potential river intake structures high and deep into the mountainous jungle. Virtually every aspect of the project, from data gathering procedures such as survey work and Environmental Impact Assessments, required hiking through the thick jungles. Combined with the heat and humidity it was a formidable challenge to overcome.

### Meeting/Exceeding Owner/Client Needs

The design of this project was completed on-time and on-budget. The client was very pleased with our design report and we await funding to proceed into the construction/implementation phase of this project.

# WA-1 Water Supply Network Upgrading & Expansion

## Project Background:

The Government of the Commonwealth of Dominica (GOCD) requested financial assistance from the Caribbean Development Bank (CDB) in upgrading its water supply network. The Commonwealth of Dominica, which forms part of the Windward Island chain, is approximately 750 square kilometers in area, and has a current population estimated at 70,000. This population is widely dispersed along the coastal areas, with the majority living between the coastline and the mountainous terrain at an altitude of approximately 244 meters (m).

The Dominica Water and Sewerage Company Limited (DOWASCO) is a registered company wholly owned by the Government of the Commonwealth of Dominica. The Company has the responsibility for the provision of potable water and sewerage services to the population. DOWASCO's current water production for local consumption is approximately 40,500 cubic meters per day (m3/d), from 43 discrete water systems. At present all water for the public supply is obtained from surface sources. The largest single source, Springfield/Antrim produces an estimated 18,000 m3/d and serves Water Area 1 (WA1), which has a population of 29,000. This area covers the capital city, Roseau, and environs, extending to St. Joseph in the north and Pointe Michel in the south. A preliminary analysis of the water supply and distribution system indicated high leakage losses of 40%.

The water from the Springfield/Antrim intake undergoes sedimentation and chlorination at Antrim before being fed to the distribution network. The water source, being a river, is subject to seasonal fluctuations which impact reliability. In addition, during periods of heavy rains the river water is subject to extreme turbidity, resulting in the closure of the intake to avoid silting the supply lines. In 2008, DOWASCO engaged Consultants to assess the continued vitality of the WA1 system, and to recommend potential new intakes which would be used for system expansion. Hydrological Studies conducted by the Consultants indicated that, in the absence of an improved catchment yield or significant reduction in unaccounted-for-water, the WA1 system will require an additional water supply source to meet future demand. The likely sources for augmentation of the WA1 water supply were proposed as new intakes on the River Claire, and a new reservoir at Morne Bruce. A new intake on the Checkhall River above Springfield was also recommended to get above some of the sources of silt and other sources of potential contamination from human activities.

DOWASCO has the responsibility for the provision of potable water and sewerage services to the people of Dominica. Water Area 1 (WA-1) covers the capital city, Roseau and environs, extending to St. Joseph in the north and Pointe Michel in the south. The largest single source that supplies WA-1, the Springfield intake on the Check Hall River, providing approximately 14,400 m3/day for a population of 29,000.

Water from the Springfield intake on the Check Hall River undergoes sedimentation and chlorination at Antrim before being fed to the distribution network. The water source is subject to seasonal flow fluctuations which impact reliability and the river water is subject to periods of extreme turbidity resulting in the closure of the intake to avoid silting the supply lines.

This project was developed to assess the alternatives to the existing intake on the Check Hall River and identifying a backup water supply source to increase system reliability.

As an overall summary DOWASCO has the following major goals they would like to see addressed:

- Identify and design a new intake (and associated pipeline) on the Check Hall River to replace the existing intake.
- Development of a back-up source. The current WA-1 network relies on the Springfield intake. There are a number of major risk factors that surround this intake; its supply line and treatment facilities at Antrim make it unreliable to provide good quality water 365 days of the year. In order to mitigate these risks a second major source must be developed.
- Improve treatment. The current sedimentation tanks at Antrim only provide time to allow heavy silt to settle. It does not significantly help remove the fine suspended matter.
- Increase storage in the system. This would allow them to maintain service for some periods when the intake(s) were shut down, and would assist in providing for fire flows and time to repair pipe breaks.

There were some secondary goals that we also attended to during this project which included:

- The potential of groundwater as a supplemental source.
- Adding pipes (grid network) to reduce the reliance in single supply and trunk mains.
- Replacing some of the older pipes that have a history of leaks, corrosion or other problems.
- Improving storage and piping to provide fire flows.
- Covering the one million gallon open reservoir at Morne Daniel to preserve and protect its water quality.
- Check and rehabilitate where necessary the key supply main down the mountain. There are places where it is at risk due to slides.
- Determine what can be done to manage and minimize the non-revenue water lost in the system.
- Do a risk assessment of the system to determine what work is needed to protect the supply during natural disasters such as hurricanes.

## Identification of Intake Sites

In order to mitigate the risks of relying on a single intake and transmission main to supply the main commercial area of Dominica, a second source will be identified that could be developed as a back-up during times when the primary intake is disrupted for any reason. The following is a list of other potential backup surface water sources that were examined in a preliminary assessment conducted in late September/early October 2010:

- Intake directly from Boeri Lake
- New river intake along the Boeri River
- Intake from the Laudet Hydropower Plant Outfall
- Intake from the Trafalgar Hydropower Plant Outfall
- Drawing additional water from the existing river intake at the River Douce
- Drawing additional water from the existing Giraudel Intake
- New river intake along the River Claire
- Water sources along the Wotten Waven / Trafalgar / Copt Hall Water System

### Recommendations for the Selection of a Preferred Main Water Supply and Backup Option

The following are WA-1 water supply recommendations based on the environmental and social assessment conducted on the main water supply and backup water supply alternatives, as well as the geohazard and surface water assessment.

*Main Intake*

Establish a new intake on the Check Hall River upstream of the existing intake (1,465 ft), particularly to reduce the influence of human activity on drinking water quality.

Maintain the existing intake on the Check Hall River for emergency use (e.g. during dry season when flows at the upstream intake may be insufficient).

*Backup Intake*

Establish a new intake at the location upstream of the existing Giraudel intake on the River Claire (1,490 ft). Based on the assessment conducted, this site provides the following benefits:

- It is above the influence of current and potential human-induced impacts (compared to River Blanc and other alternatives on the River Claire).
- Provides opportunity for protection of mature rainforest in the upstream catchment.
- Provides adequate surface water flows. Similar flow rates to that estimated for the Springfield intake are predicted.
- Lower natural and human-induced landslide and erosion risk (compared to downstream option on the River Claire and River Blanc).
- Low impact to current and potential land use opportunities.

## Water Treatment Options

The main treatment objectives are turbidity reduction and disinfection; these two objectives are closely related. The effectiveness of disinfection is impacted by the raw water turbidity levels and hence it is important to reduce Turbidity as much as possible through filtration.

Chlorination in the form of Chlorine gas injection is used as the primary disinfection process in the existing Antrim treatment site. At this stage it is assumed that the existing Chlorination system will continue to be in use. The existing Antrim settlement tank could also be used as a contact tank to optimize Chlorine dosage and also to provide a contact time for 3-4 log Virus removal.

The raw water turbidity levels are generally low (below 10 NTU) except during extreme events when the turbidity levels are very high.

The preference to use gravity to drive the filtration process restricts the number of filtration technologies available in the market. The treatment system recommended at this stage is an inline direct filtration followed by disinfection. If sustained high turbidity is expected, then the system would likely require additional pre-treatment in the form of coagulation followed by settlement. Under these circumstances, with additional pre-treatment (coagulation and settlement) a full gravity concept (without pumping) may be a challenge.

In light of the above facts, a number of technologies were evaluated; however, the final process supplier will be selected at the tender stage based on the most cost effective process that meets the design criteria.

## Related Components

### *Access Road to the New Check Hall Intake, New River Claire WTP and Intake*

Construction of an access road to the intake will encounter challenges as it will need to cross steep terrain in some areas. There are fewer constraints with respect to grade and alignment for an access road compared to the pipeline, which should afford it more flexibility with respect to potential routings. The road route will be optimized to take advantage of existing trails, gentle terraces along the valley bottom and local benches on steeper slope sections. The road will be constructed using appropriate techniques that minimize the potential for landslides and sediment generation. Side-casting fill materials onto slopes in excess of about 55% will be avoided and these materials will be end hauled to a stable area for disposal. Large cuts into the hillside will be avoided, as well as crossing areas of previous slope instability to minimize the potential for landslide initiation, where possible. Concentrated road drainage will not be discharged onto steep potentially unstable slopes. Existing roads in the area of each facility will be used where possible and extended to the new facilities saving some new cost and minimizing activity in the river valley.

### *Supply Pipelines*

The approximate length of a new supply pipeline is provided in Table ES-3.

**Table ES-3. Total Length of New Pipeline**

| Option | Elevation (Feet msl) | Indicator Value |
|---|---|---|
| **Check Hall Alternative** | | |
| Check Hall – New Intake | 1,465 | 2,000 metres (6,500 feet) |
| **Backup Supply Alternatives** | | |
| River Claire (Upstream) | 1,490 | 2,300 metres (7,550 feet) |

*From New Check Hall Intake to Antrim*

It is understood that the pipeline will likely comprise an above-ground ductile iron or HDPE pipe of appropriate size supported on concrete pedestals. The final location of the pipeline and concrete pedestals will need to field fitted to suit local site conditions at the time of construction.

*From New River Claire Intake to New WTP and to Connect to WA-1 System*

Throughout the study area, the river tends to migrate back and forth across the valley bottom and there is typically a gently sloping valley bottom terrace on one side of the valley that provides a suitable location for construction of a pipeline. To access these gentle terrace slopes, a number of river crossings will be required for the pipeline. At a few locations the valley bottom narrows and there are no wide lateral terraces. At these locations, the river channel appears to be less stable and old or seasonal overflow channels are common, which will require locating the pipeline on mid bars or 'islands' between these channels. Some localized armouring of the channel and pipeline supports will likely be required in these reaches and landslide hazards are typically higher as wide benches on which landslide debris can deposit are lacking.

It is understood that the pipeline will likely comprise an above-ground ductile iron or HDPE pipe of appropriate size supported on concrete pedestals. The final location of the pipeline and pedestals will need to field-fitted to suit local site conditions at the time of detailed design and/or construction.

### *Water Treatment Plant Site*

Below about elevation 920 feet the valley bottom widens and there is a wide gently sloping river terrace located along the right side of the valley at about river elevation 915 feet that would be a suitable location for a treatment plant. The surface of the terrace slopes to the west (downstream) at about 5% and is raised above the river level by about 12 to 15 feet. It extends both to the north and west for at least 200 feet. The terrace is likely underlain by loose to compact silty sand and gravel with cobbles and boulders. The valley walls upslope of the site are approximately 650 feet high and slope at an overall angle of about 55%. There is a *low landslide hazard* at this site.

Subsurface investigations (i.e. test pits) are recommended at the treatment plant site prior to construction to confirm subsurface conditions and bearing capacity.

## Geological Hazards

The following hazards are expected to be encountered along the pipeline route.

***Tree fall hazards*:** During our site reconnaissance we observed many large trees that have fallen into and across the river channel due to localized bank instability/undercutting, from shallow debris slides, and due to windthrow and natural deadfall. Danger trees will need to be felled at the time of pipeline construction to minimize the hazard of large trees falling onto the exposed pipeline.

***Rock fall hazards***: The pipeline will be exposed to localized rock fall from the frequent bedrock exposures and from boulders contained within the overlying soil cover. There were no specific areas identified along the valley bottom, however, where chronic rock fall was occurring (e.g. active talus slopes). Rock fall hazards will need to be addressed during final pipeline routing and construction by avoiding any locally active rockfall areas that may be encountered, removing noticeably loose or potentially unstable boulders or large blocks of rock on slopes directly above the pipeline, or by protecting the pipe from rockfall (e.g. locally burying or armouring the pipe) where possible.

***Debris slide hazards**:* Shallow debris slides were observed on steep slopes at a number of locations within the river valley during the site reconnaissance and from review of air photos and GoogleEarth imagery. These events have transported soil and vegetation including boulders and trees into the river channel where the valley is confined, or have deposited material onto the surface of gentle benches/terraces adjacent to the river channel There is a high likelihood that additional small to medium landslides will occur from the valley sides in the future. Final pipeline routing should avoid, where possible, crossing or passing beneath steep slopes where there are signs of previous debris slide activity. When crossing gentle benches or valley bottom terraces, the pipeline should be positioned as far away from the toe of slope as possible to minimize the potential for damage should a debris slide occur.

***Coarse bed load and woody debris*:** The Rivers have the potential to transport large boulders and large woody debris during periods of high flows. Impact to the pipeline and the concrete pedestals supporting the pipeline from boulders and large woody debris could result in damage to the pipeline. The pipeline should be raised to an elevation above the design high water plus freeboard, and concrete pedestals that are located in or adjacent to the river channel should be suitably protected/armoured.

***Debris flows*:** There was no evidence of previous debris flow events down the main River channels. Due to the relatively gentle channel gradients (generally <10%) the potential for landslides to initiate large debris flows down the river is considered to be low. Small debris flows may initiate within some of the steeper gradient tributary streams of the Check Hall River. When crossing tributary streams, the pipe should be suitably elevated to minimize the potential for impact by debris should debris flows occurs down the tributary streams.

***Landslide dams*:** A large or very large landslide within the River valley could result in temporary damming of the river and subsequent breaching causing a dam break flood. A

review of the available air photos did not identify any signs of a potential or pending large scale landslide. Such events, although relatively uncommon, could potentially occur in the Check Hall River valley upstream of the intake. Overloading of slopes with fill and creating large cuts into weak soils during pipeline and access road construction should be avoided to minimize the potential for initiating large deep-seated landslides.

## Issues Identified by Regulatory Stakeholders

A number of representatives from regulatory agencies were interviewed between October 21 and 27, 2010 to determine potential issues that should be considered in the alternatives analysis.

Overall, the project is viewed by regulatory agencies as providing significant benefits to the country by improving the quality and reliability of potable water services for the residents of Dominica in the WA1 service area. However, a number of potential environmental and social issues were identified and are summarized in Table ES-4.

**Table ES-4. Summary of key issues identified during regulatory stakeholder consultations.**

| Regulatory Agency | Key Issue(s) Identified |
|---|---|
| Forestry, Wildlife and National Parks Division, Ministry of Agriculture and Forestry | ▪ Impacts to water quality associated with increased landslide risks.<br>▪ Enhanced land protection measures upstream of the intakes that would support the Division's mandate.<br>▪ Potential interaction with future geothermal energy exploration and power development. |
| Environmental Coordinating Unit, ministry of Environment, Natural Resources, Physical Planning and Fisheries | ▪ Consistency with existing multilateral environmental agreements.<br>▪ Consideration of climate change impacts.<br>▪ Interaction with other major future development including potential Geothermal Energy development. |
| Environmental Health Department, Ministry of Health | ▪ Potential for formation of carcinogenic disinfection by-products.<br>▪ Level of treatment provided to water source.<br>▪ Management measures to ensure treatment system is operated as designed.<br>▪ Ability of treated water to meet latest World Health Organization (WHO) standards.<br>▪ Water quality analysis of raw water source. |
| Physical Planning Division, Ministry of Environment, Natural Resources, Physical Planning and Fisheries | ▪ Land use.<br>▪ Potential interaction with future geothermal energy exploration and power development.<br>▪ Commitment that community consultation will be undertaken prior to construction. |
| Geothermal Project Management Unit, Ministry of Public Works, Energy and Ports | ▪ Potential interaction with future geothermal energy exploration and power development in the Wotten Waven area. Possible conflict between water needs for power facility (steam condensing) and water needs for domestic water supply. |

## Ground Water Potential

It is possible that a relatively small (100,000 to 250,000 gpd) supplemental or emergency groundwater supply system could be developed. There are potentially some productive aquifers on the west side of the island. It is not possible to provide a firm estimate for the potential production yield of a groundwater source at this time, due to the relative lack of site-specific information on wells on the island. Overall, the groundwater potential is moderately good and a supplemental clean groundwater system could benefit DOWASCO during heavy rainfall and siltation events. A conjunctive groundwater supply would also allow the water company to meet peak demand periods without expanding its surface water intake/treatment system and would provide additional reliability and security to have multiple water sources (groundwater and surface water).

## Existing Distribution System Analysis Using New Intakes

To review how the existing distribution system operates, two scenarios have been run for 48 hours under extended period conditions. The first scenario is if the supply source is only from Antrim WTP, and the second scenario is when both Antrim and Claire WTP's supply together.

From these two analyses it can be concluded that it is not only the quantity of water from the sources that was creating water shortage, but the elevation at which the tanks installed and the capacity of storage tanks may have a role.

## Existing Storage Tanks Available and Required Volumes

The capacity of the existing storage tanks have been evaluated whether they provide sufficient storage to meet the required demands throughout the day. Most of the tanks have sufficient capacity to provide the balancing storage required, except storage tanks at Castle Comfort, Elmshall, and Kings Hill. Moreover, additional storage volume is required for the service areas supplied by PRV's. It has to be noted that these volumes are rough estimates and would change based on actual population and non-domestic customers each tank is serving and the estimated demand patterns. The model indicates that significant additional storage is required for Canefield (1,076 m3), Goodwill (1,144 m3) and Elmshall (1,284 m3) or an adjacent convenient location that can serve central Roseau.

## Possible Upgrading and Control Options

It has been observed that the storage tanks located at higher elevations and far from the sources couldn't fill because storage tanks located at lower elevation and PRV supplied areas are always dominant to get water first. To limit the influence of lower elevation tanks, different control mechanisms can be implemented so that the tanks at higher elevations can get a chance to fill. For this preliminary review pressure sustaining valves (PSV) and Flow Control Valves (FCV) have been used. PSV are proposed at upstream larger volume dominant tanks, while FCV proposed on the inlet of large volume tanks at higher elevations.

PSV's are proposed upstream of the Morne Daniel and Elmshall Tanks with initial set pressure of 120 and 155 psi respectively. In the same way flow control valves are proposed at Antrim and Canefield tanks. FCV at Antrim is set to allow only WA1 total average day flow while FCV at Canefield set to allow only the average day demand of the area supplied from the tank.

The model result illustrates how the water level in all tanks varies with time during the extended period simulation over 48 hours. The majority of the tanks are able to fill to cover their respective peak demands, with few exceptions tanks.

### Water Model Conclusions:

From the model it is understood that operating large number of tanks located at different altitudes and distances would be very difficult. However, with the installation of a proper control system it would be possible to manage the distribution system so that it can meet the requirement of all the users. This preliminary model is reviewed based on the number of assumptions. The outcome of the model result may differ based and on the accuracy of the assumed information.

## Recommended WA-1 Improvements

### Check Hall River

The following works are planned for the Check Hall River:

- New Intake including gauging station.
- Pipeline to the Antrim water treatment plant. (DOWASCO is currently constructing a new water treatment plant at Antrim)
- Access road to the new intake site
- Existing intake is to remain in service as a backup.

### River Claire

The following works are planned for the River Claire:

- New Intake including gauging station. The upstream intake would be the primary source for providing water to the WA-1 system and to supplement the Giraudel system, if necessary. This could be achieved with a series of valves and piping.
- Pipeline to the WTP site and down to connect to existing WA-1 system.
- WTP including chlorination & treated water Reservoir and standby power.
- Access road to the WTP and Intake site.

### Treated Water Reservoir

DOWASCO is planning a new 500,000 gal. treated water reservoir at Morne Bruce outside the scope of this project.

Additional storage is recommended for Canefield (1,500 m3), Goodwill (1,500 m3) and Elmshall (1,500 m3), or an adjacent convenient location that can serve central Roseau.

### Improvements to Morne Daniel 1 MIG Earthen Reservoir

The open earthen reservoir at Morne Daniel has had some issues with its geomembrane liner in the past. This project will include re-lining the reservoir and covering it with a floating cover.

**SCADA network**

The WA-1 system covers a wide geographic area. Some components such as the intakes and water treatment plant are relatively remote. A SCADA system with data radio transmitted to the Dowasco head office would be an major asset as it would allow advanced knowledge of issues such as dropping or low reservoir levels before they were actually empty and the phone calls started coming in from irate customers. It would allow better system management by controlling valves to balance reservoir levels and ensure they were filled when needed. Water quality issues at the water treatment plants could be identified early and staff deployed to resolve the issue. Operational data could be collected electronically from numerous points in the system such as flow meters and reservoir levels. In summary a great management tool for an operation with limited staff and resources.

**Other Works and Management Plans**

*Integrated Water Resource Management Plan*

In order to better manage Dominica's important water resources, the starting place would be an overall Integrated Water Resource Management (IWRM). A good IWRM would assist Dominica to achieve their national goals related to economic well being, health and economic sustainability. Part of a good IWRM plan is development of a risk management plan as it relates to floods, droughts and perhaps more particularly for Dominica, hurricanes.

*Watershed Protection and Control*

Management of the watershed is essential in order to protect this valuable resource and the investment being made to develop the water source and supply potable water to the WA-1 customers. Water management can be considered effective when it:

- When the water available to the users is sustainable over many years.
- Water Quality is maintained at required levels.
- Establishes and allows sustainable economic development over the short and long term.

Successful implementation requires that the program be under one single lead agency to act as facilitator. There may be several competing interests in the watershed and they must be dealt with on a consistent basis by someone who understands the whole picture and not just the interests of one specific group or area. There must be strong linkages to existing programs including local and regional land use planning processes, as well as water quality and flow monitoring programs in order to minimize duplication of effort and ensure consistency in the information being given out. There must be clear allocation of responsibilities and understanding of the costs and staff training needs. Effective laws, regulations and policies need to be put in place. The plan will need to be supported by ongoing public communication and education programs to enhance consensus and understanding of the plan.

*Water Demand Management*

Water resources are limited in the WA-1 zone. Eventually a demand management program will be required to keep the water demand within the ability of the supply system to deliver. This is happening in a limited scale now during drought periods when DOWASCO asks people to limit

watering their gardens or washing vehicles. Water demand management can be defined as any method; whether technical, economic, administrative, financial or social; that will accomplish one (or more) of the following five things:

1. reduce the quantity or quality of water required to accomplish a specific task;
2. adjust the nature of the task or the way it is undertaken so that it can be accomplished with less water or with lower quality water;
3. reduce the loss in quantity or quality of water as it flows from source through use to disposal;
4. shift the timing of use from peak to off-peak periods;
5. increase the ability of the water system to continue to serve society during times when water is in short supply.

*Improve the DOWASCO Laboratory Capabilities*

As DOWASCO moves into a new era where they are treating water to international standards it is important that they be able to properly monitor the water quality being produced in a timely manner. The DOWASCO Lab has the ability to undertake many of the basic tests now, but should work towards increasing their capabilities to cover key additional elements.

*Increased Metering*

There is lack of accurate data on the volume of water being delivered and that being consumed by the customers in the WA-1 zone. This data is essential to proper management of the system. In the past it was not a major issue as the demand was small and there was always clean water in the river to draw from. As the population expands, development moves further up the mountain, industry increases and standard of living increases, the capacity of the existing system to provide sufficient water at the quality expected by the customers becomes an increasing challenge. A greater investment in water system infrastructure is required to meet these needs which increase the cost of producing and delivering a unit of water. It now becomes more important to know where that water is going and to reduce the waste or unaccounted for water. Losses are now estimated in the region of 40%.

Metering in and out of the water treatment plant, reservoirs, and at delivery connections including at public facilities will help immensely to identify the real water demands in the system and where losses are occurring that need attention. Metered connections can be used for billing but more importantly the data will first help to understand and manage the water system.

*On-going Leak Detection Program*

As the cost of producing good quality water increases it becomes of increasing importance to cut down on the loss of this valuable resource. Dowasco should start with the areas that are easiest to tackle, such as repairing the taps at public facilities and fixing all reported pipeline leaks as fast as possible. As the metering program is implemented, data should be analyzed to identify areas with the highest levels of unaccounted for water and concentrate on identifying and resolving those trouble areas first, along with areas that have a poor record for multiple repairs. Dowasco can then move into an acoustic leak detection program, again starting with priority areas that have been identified through the metering program.

*Increase Collection of Record Drawings and System Data*

The WA-1 system is complicated with multi pressure zones and a very diverse service area. Having an accurate water system model can be a huge help in analyzing existing system problems and planning for system expansion to better serve their customers. It helps to identify where increased capacity is needed and to size pipes and establish pressure zones to meet demands. The only way to do this with any reliability is to input accurate record information on the supply system and distribution network. Dowasco should continue to collect record information and survey areas where data in incomplete or suspect.

*Ground water investigations*

It appears there could be a 100,000 to 250,000 gpd supplemental or emergency groundwater supply system that could be developed provided there is sufficient land in the productive groundwater areas. A detailed groundwater mapping and investigation phase is needed followed by drilling of test wells at select locations and tested to determine well yield and water quality properties and assess the ultimate feasibility of developing supplemental ground water supplies.

## Priority Recommendations

1. **River Claire Supply Improvements and Water Treatment Plant Site Development & Treatment Process (on the River Claire) and Connection to the WA-1 Distribution System**
   The Check Hall River system is already in place although it has its issues. It is more important to develop a back-up system which is the River Claire intake, water treatment plant, access roads and transmission lines to connect it to the WA-1 system.
2. **Check Hall River Supply Improvements**
   The second priority is to improve the quality of raw water being delivered to the Antrim WTP. This involves the new intake, raw water line and access road.
3. **Distribution System Control Valves**
   With the reservoirs at various levels within the system it has been noted that some reservoirs are starved while others are overflowing. With the addition of 4 pressure sustaining valves and two flow control valves, the system can be balanced allowing water to be more evenly distributed throughout the WA-1 system.
4. **Additional Distribution Storage**
   Calculations show that there is insufficient storage in parts of the WA-1 system to cover peak demand periods. This should be the next priority in order to increase the level of service to the area.
5. **Repair & Cover for Morne Daniel Earthen Reservoir**
   This is related to priority 5 above. This is lined earthen reservoir for which the liner needs repair and which should be covered to prevent contaminants from entering the water.
6. **WA-1 Network SCADA System**
   If all the intake levels, reservoir levels and treatment system data can be brought back to the DOWASCO head office for monitoring, it will greatly improve DOWASCO's ability to locate and address problems quickly. DOWASCO current has to rely on complaints and then drive to location to investigate.

7. **Increased Metering & Leak Detection**
   This is an on-going management issue to try and get control of and reduce the volume of unaccounted for water.

The other water source and system management activities noted previously can be budgeted and implemented over time. The only exception might be the investigations into the groundwater availability in the area. Two or three high production wells that could meet the WA-1 demand for a short period would provide another level of risk protection in the event Dominica was hit by a hurricane and both rivers became so silt laden that the water treatment plants could not keep up.