



Belize Water Services Assignment



OPERATORS WITHOUT BORDERS CANADIAN OPERATORS

ASSIGNMENT WITH BELIZE WATER SERVICES LIMITED REPORT

FEBRUARY 16 – MARCH 4, 2019

Summary

Operators Without Borders (OWB), is a Canadian Charity that dispatches volunteer professional Water and Wastewater Operators to assist countries during times of crisis or for educational and mentoring relationships. OWB assigned a team, at the request of BWS, to interact with Belize Water Services Limited (BWS) staff and provide training and field evaluation of their country wide water and wastewater systems.

The team consisted of five Canadians who were assigned various areas to review based on their backgrounds and education. Valerie Jenkinson (Operators without Borders founder), Ron Enns (Safety Training), Patrick Reeves (Distribution/Collection/Construction), Dan Skidmore (Wastewater Collection and Treatment) and Ian (Mac) McIlwham (Water and Wastewater treatment).

The project consisted of nine days of in class and on-site practical training for management and front-line staff in the areas of confined space entry, utility work, trenching and shoring, WHMIS, chemical safety and handling. In conjunction field visits and observations occurred over ten days at several water pollution control plants, pumping stations, water treatment plants, well systems, distributions systems and administrative areas.

This report outlines the results of the training and field evaluations, including areas where staff excelled, areas that require attention and other general opportunities for improvement.

Belize Water Services Limited.

Belize Water Services Limited (BWS) is, in comparison to many Caribbean water and wastewater utilities, in a better financial condition. Resources and infrastructure are not lacking and, in general, are well maintained and modern. The majority of infrastructure was installed since 1980's with continual improvements and expansion throughout the country taking place. However, without consistent maintenance and asset replacement there exists the potential for deterioration in service, particularly in the wastewater collections operations.

With a few exceptions, BWS produced a vibrant, respected and leading image for the company via the representation of their employees, prominent infrastructure and modern fleet.

Senior Management and the Union, in arranging and supporting the OWB project, reinforces BWS's commitment to the safety of its staff and the quality of its water for consumers. Its move towards decreasing its environmental impacts and its commitment to shareholders were all very evident.

Although access to education and training in the field of water and wastewater is limited throughout the country the staff have sought out opportunities for these services in the United States and other Caribbean Countries including the California State Operator courses. The degree of education and knowledge possessed by those in leadership roles was very evident. Continued future interaction with front-line staff for training and information exchanges with experienced staff, such as those provided by Operators without Borders, will benefit all parties. The train the trainer session provided should allow training to continue with decreased participation from external parties.

Having interacted over 17 days in work, social and home environments with various staff, it was evident the majority of the staff felt very well treated, well respected and enjoyed their career with BWS. Of note was the BWS organized social events that included children and spouses, and how seamlessly staff interacted and contributed to the overall success and fun during these events. Another impressive trait that was observed was staffs courteous, respectful nature towards the OWB volunteers as well as their willingness to accept OWB's observations and to provide us with ideas we could use. Sometimes, with outside sources coming into an organization, it is easy to reject ideas. We found staff to be open and receptive.

A final observation that speaks to the nature and commitment of BWS staff as a family and not just co-workers putting in time to earn a pay check, was the kidney walk. There was an excellent commitment, not only those who took part, but also from those who contributed funding and BWS staff and trucks delivering water on

route. The OWB volunteers wish to thank BWS for the opportunity to participate in this event and hope for a successful conclusion.

PRIORITY ACTIONS

- Form a lead team to review and identify action items under general themes and also individual locations from the report. Document this process including assigning responsibility and timelines for action on these items.
- Review and communicate the report and the action plan with all staff. This exercise cannot be simply seen as Canadian Operators coming to make suggestions then leaving BWS to its own accord. All recommendations may not necessarily be appropriate but an open, documented and shared evaluation will re-enforce the existing strong commitment to safety and overall operational opportunities for improvement shown by both management and workers.
- Re-establish one Sewage Pumping Station to an agreed upon level of service including a complete cleaning, inspection and replacement of faulty equipment, posted procedures on floats, alarms and control panels. Posted procedures on daily, weekly, monthly checks and maintenance activities. An evaluation of the hydraulics of the station. Secure the station and its contents such as electrical and water supplies. Once one is completed and evaluated for success, repeat with all stations then maintain. This activity would be easier to achieve under the guidance of an experienced operator such as Dan or Patrick or an equivalent who would solely focus on achieving the outcome for one station while leaving a blueprint of the process for all stations.
- Re-establish the lagoon system at San Pedro to its original design capacity and ensure it is capable and performing at a level that ensures it meets effluent Regulatory requirements. This process will include mapping the facility including liquid and sludge levels, cleaning out the cells to original capacity, figuring out and labelling all valves and chambers, conducting a trial with dosing of Alum to gauge the results versus the cost and labour of the dosing and installing stop logs into the distribution chamber and developing operational procedures. This activity would benefit from working under the guidance of an experienced operator like Mac or equivalent to focus directly on the San Pedro system but leaving a blueprint of the process to be repeated at Belmopan and Belize City.
- Focus some funding and efforts on the Seine Bright Water Facility. The immediate safety hazard of the deteriorated railing system and ladder to the upper reservoir tank must be addressed before it escalates to an accident. The work should include a power washing and or repainting of the facility to

- the standards of BWS as it resides on the main roadway into Placencia and is indicative of the reputation of BWS.

FUTURE ACTIVITIES

- Continue to press forward with interactions and initiatives with members of Operators without Borders to tap into the large resource pool of connections from the visiting members and their colleagues at work and from member organizations such as the Canadian Water and Wastewater Association and its five-member associations spread throughout Canada.
- Work with Valerie to explore future opportunities and possible funding initiatives directed toward immediate priorities
- Consider an exchange visit to Durham Region and/or British Columbia to allow BWS staff to interact and observe the water and wastewater operations of the participants from Operators Without Borders.
- After allowing significant time for evaluation and implementation of recommendations from the report invite a member to return for a follow-up third party audit against the actions taken to resolve issues identified in the report.
- Working with an experienced operator and trainer as lead such as Ron or equivalent continue to develop a strong training program leading to a pool of in-house training staff capable of delivering a variety of training packages onsite at the various locations of BWS.
- Continue the facility classification process for all water and wastewater systems to establish a benchmark for the plants level of certification which can be used to drive training and staffing requirements. Although not regulatory, strive to use the concepts and the process of the requirements for operators to obtain the qualifications required to progress from Class I to Class IV operators. This process will give a common benchmark when dealing with other operators and facilities in the Caribbean and North America. Staff at the Doublerun lab should be addressed in a similar style as operational staff but using the Water Quality Analyst designation and requirements

GENERAL OBSERVATIONS AND FINDINGS

New Construction

New service install crew can be outfitted with a simple air shoring. Two 4 x 8 sheets of 3/4 plywood two air shore jacks. Shoring installed at the main where the tapping of a new service is to be done when it is deeper than 4ft. The air shoring is easy to assemble and take apart for transport. It is compact enough to be carried on the backhoe trailer.

Swabbing of tools and parts and the surface of the main with a bleach solution before a new installation is recommended.

Discussed trenchless technologies and tools with water Foreman for a solution to digging up roads to repair service leaks.

Practice of installing caution tape above mains the mains and services and tracer wire is crucial and must be repeated on every installation to ensure ease of location for future repairs



New connection in Belize City.

Wastewater Collection System

The wastewater collection system employees are all committed and willing to ensure that the systems are operating well. Our observations were that the operators did not seem to understand how all the parts come together to transfer the sewage to the plants.

I observed a crew using a sewer flusher to clean a sanitary main line near the Princess Casino. The crew was using a metal bar and pickaxe to open the manhole lids. Due to the possibility of sparks and unknown atmosphere below, we would recommend that a dead blow hammer be used instead of the metal bar. To prevent back strain, we would recommend a manhole hook instead of the pickaxe.



Dead blow Hammer

Manhole hook

In speaking to the operators, there did not seem to be a manhole inspection program. This program would help detect the issues within the system prior to the lift stations. Manholes can be a major contributor to infiltration and inflow (I/I), and should be considered first since the inspection and repair of manholes can make an immediate impact in reducing I/I to the entire system. Preventing I/I will help maintain the capacity of the wastewater collection system and help eliminate the extra costs of pumping water not needing treatment. Depending on the size of the collection system, a 1-4 year rotation to inspect all manholes in the system would help identify concerns.

A camera inspection program is recommended to locate partial blockages, broken pipes and confirm overall condition of the collection system.

A smoke-testing program can also be implemented to locate cross connections and illegal connections which could be adding to the unnecessary flow. Again the extra flows will cost in terms of extra electricity to pump water not needing treatment and extra wear and tear on the pumps due to longer run times.

Wastewater Pumping Stations

The wastewater pumping stations were the area of most concern during our tours. All locations seemed to have the same concerns. It appeared that many of the stations were not being operated as designed. It was noted that several stations were using by pass pumps due to failures with either valves, check valves or piping within the wet wells.



Station S6 – Note this station is presently being repaired.

Repairing the valves, check valves and internal piping would be the first step in returning the stations to the designed operation.

Several of the stations are working in a high level state allowing for the over flow pipes to transfer liquid to the next catchment area. This process does not remove the solids and will result in a build up at the bottom of the station creating

hazardous gases that will corrode metal structures and equipment. This will also take away the designed station capacity.



Station operating at overflow level.



Note: the debris on the catwalk may have deteriorated the integrity of the structure.

Returning the stations to operational design will allow the stations to transfer both liquid and solids to the treatment plant. Floats will need to be checked for proper operation to allow the pumps to turn on and off, cycling the station as per design.

Presently there is no alarming system for the lift stations. By installing one more float for high level, an operator could be notified before the station goes to over flow. We recommend a simple auto dialer system such as the Protalk system <http://www.barnettprotalk.com>

Many of the stations have exposed electrical which are hazards to anyone around the station. We recommend an electrician assess and repair exposed electrical.



Exposed electrical for generator connection at N3.



Exposed electrical.



Station N6 – Overhead wires create a hazard for pulling of the pumps.

Several stations had pump power cables running out of the hatches and across the ground to the panels. This exposes the cables to the possibility of being damaged. It is recommended these are returned to their conduits for protection. A review with an electrician may allow for pump quick connects to be added to allow for connection and disconnection of the pump at the wet well.



Exposed pump power cable.

It was observed that no hatches were locked at the stations. The concern is that anyone could open the station and fall in. It also has allowed people to use the station as garbage cans. It's recommended that the hatches be locked at all times.



Note: garbage in the stations.





Note: Flange should be sealed to prevent debris entering the system.

An option to assist with maintaining the cleaning of the stations and help keep fats, oils and greases in suspension is a wet well washer. <https://biomaxx.ca/wp-content/uploads/2018/01/EP-1100Series.pdf>

This device can help maintain the station and prevent the need to enter the station to remove built up fats, oils and greases.

A flush valve is another device that will help keep the wet well clean. Installing a flush valve on one pump within the station will help keep the settled solids in suspension and move them to the plant for treatment eliminating build up. <https://www.xylem.com/en-US/products-services/pumps-packaged-pump-systems/pumping-accessories/flygt-mechanical-accessories/sump-cleaning/flygt-flush-valve>

It was noted that control cabinets and main power disconnects were not locked to prevent unauthorized access. Cabinets and disconnects should be locked.



Control Cabinet.



Main Power Disconnect.

Additional observations at the Sewage Pumping Stations

- Backflow prevention required on water supply at all stations to prevent contamination.
- Repair water supply at stations that are leaking and consider moving or extending lines that are accessible to the public through the fencing.
- Constant positive ventilation for all wet wells to reduce buildup of hazardous gases.
- All pump control panels should be locked.
- Inspect and repair all generator connection points at each station.
- Signage on the entry gates should be at every station, clearly marked with BWS contact info and site ID.
- A red curb to indicate no parking in front of each stations compound for ease of access.
- Current height of all wet wells makes set up of Confined space tripod difficult.

A Davit arm system would be the most cost effective. This would be a permeant base socket poured at each site with a removable Davit arm that can be used at each site.



- Permanent work lights at every station that can be switched on manually for emergencies.
- Wells should have a weekly, bi weekly and monthly cleaning routine.
- All fencing around the wells should be repaired and maintained.
- Vegetation control around compounds

Site N7. There is a large round concrete lid / manhole. There is no safe way to remove it no handles no holes to lift, it should be replaced with a more user friendly lid.

Site N2: There is a decommissioned manhole within the compound that has a piece of metal over it. The metal is rusting through. A permanent solution is needed.

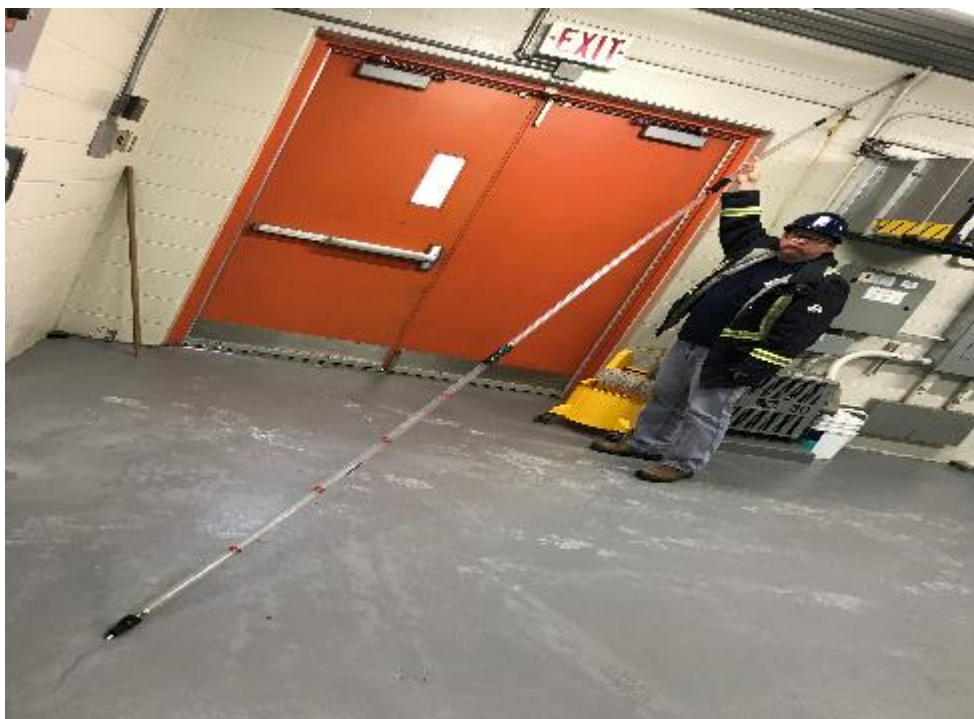
Wastewater Treatment Plants

We visited both the Belmopan and San Pedro wastewater treatment plants. Both plants are facultative lagoons. The Belize City plant was unavailable to visit due to security issues and timing.

One possible tactic for observing the conditions of the Belize City plant with limited access and the conditions out in the center of other lagoons would be to utilize a simple drone that could fly out over the area and map/film the conditions. This would facilitate staff getting access to certain areas while maintaining a safe working environment.

Staff indicated that there was currently issues with meeting Regulatory limits on effluent discharge. This is likely the result of decreased retention time in the lagoons due to loss of capacity from settled solids that should be cleaned out to re-establish the design capacity.

Staff should find or estimate the original design dimensions of the lagoons to calculate a capacity and then using this capacity and the average influent flow rate establish a retention time. To aid in this exercise staff should take a boat and a “sludge judge” or other tool and determine both the liquid depth and solids depth throughout the lagoon to map the available capacity.



Sludge judge that measures both liquid content and solids content of tanks or lagoons. Also, can be used to get sample for testing of solids in lagoons

Effluent appeared heavy in solids which may be a result of the excessive solids build up in the lagoons or short circuiting of the lagoons carrying solids with them particularly in times of high flow. In order to assist in settling a coagulant such as Alum could be added either directly to the lagoon utilizing a boat to evenly spread or by adding into the wastewater stream at the last pumping station prior to the lagoons which would aid in mixing of the product. If the boat option is chosen the lagoon should be isolated for as long as possible after seeding with Alum to allow maximum coagulation and settling while utilizing the alternate lagoon for filling. After settling start a discharge cycle.

The Belmopan plant could use a rack to hang the ultraviolet sections for cleaning. This would prevent the possible damage to the sleeves or bulbs when completing maintenance.

Both plants would benefit from a regular berm inspection. A berm inspection manual can be provided to gauge its applicability moving forward to retain the integrity of the berm should higher volumes of wastewater need to be retained.

Although simple in design there appeared to be a lack of knowledge of how the systems worked in regard to valves and chambers observed at the systems. It should be possible to isolate any individual cell and allow it to settle while filling a different cell. If original drawings cannot be located then field drawings should be made identifying all possible wastewater flows and each valve and chamber.



Purpose of valve was unknown, they are at each chamber, current method of lowering pipe to adjust lagoon height is cumbersome and limited.

In order to increase retention time in the lagoons a plastic pipe was used to cover the outlet pipe in the chamber and essentially increase the height of the lagoon before discharging by gravity out the outlet pipe to the polishing lagoon via the chamber. This pipe was one size and appeared difficult for staff to fit onto and remove from the discharge elbow pipe. The chamber would benefit from using stop logs that would be slotted into "U" shaped railing mounted onto the sides of the chamber then 4X4 stop logs stacked into the channel to increase the height in 4-inch increments. If a bolt is run into the logs on both sides it would act as an anchor and handle for staff to use for ease of removal. Examples can be provided if interested.



Replace system with stop logs for more precise control and ease of installation. Discover what valves due beside chambers

Cleanout should be performed on all existing lagoons in a scheduled fashion. Staff have reached out for information on the use of GEO-Tubes and other portable



Belize Water Services Assignment

techniques such as belt presses or drum thickener. Details and contacts will be provided.

Sewer Use Group

Not only must staff be aware of their facilities but in order to prepare for and react to whatever is discharged from commercial and industrial sources in the collection system that may affect their plants a sewer use group would be beneficial.

This group would oversee identifying potential sources of pollution to the system via site visits to the industries that are connected to the wastewater collection system. This group would map out the facilities, take an inventory of potential sources of contamination should the industry have a spill and sample and test to get a general awareness of the quality of sewage leaving the industry. Then should events occur at the WPCP then staff would know where to visit and sample to track the source of the problems.

It is typical in North America to identify industries with over-strength discharges and charge them a fee for the additional capacity and issues they may cause at the plants.

This group could also conduct source water protection activities involving interaction with neighbors of your well sites.

Instrumentation

Staff identified that the member who used to look after some of the instrumentation was involved in an accident and there was a void in that area. Key staff members should be replaced, or additional staff trained to assist or take over these functions.

Numerous examples of instrumentation that was out of calibration, improperly mounted or giving alarm signals were observed. In order for staff to make competent decisions at facilities any existing instrumentation must be cleaned, maintained, calibrated and verified for proper installation.



Flow meter and on-line analyzer require calibration at Belmopan

An inventory of all instrumentation should be taken then, at a minimum, annual calibration should occur and be documented and displayed on the instrument with a ticker so staff know they are taking reliable readings. Any major deviations must be

reported so the units can be corrected if required. Units should be regularly verified using a grab sample and lab analysis.

Chemical Rooms

Due to the nature of design and age of the facilities the status of the chemical rooms and mixing areas varied at each facility. The most modern was observed at Dangriga which had recently been upgraded and included separate storage rooms for product and for mixing and pumping from the tanks. This location also had two new working eye-wash/shower stations. Belmopan had no eye-wash/shower facilities available in the area of the chemical usage. This item should be addressed either in the short term via portable bottles or stations and working towards a permanent solution of a standalone eye-wash/shower.

Ventilation in general was addressed in the chemical mixing areas with the exception of Doublerun. Due to the volume of chemical required for storage and use, it is one large area that serves as both the mixed storage area, chemical mixing tank area and chemical pumping area. Significant corrosion and impacts from the potential by-products of mixing calcium hypo-chlorite were observed including potential damage from chlorine gas formations.

**Two out of six fans have no blades and are not functioning**

The room at Doublerun had six evenly spaced ventilation fans with three on each side of the building supplemented by windows that could open. Only the windows were being used for ventilation. Upon observation, two of the fans on one side were lacking fan blades and thus not functional. Of the remaining 4 fans, two were blowing directly at each other thus negating the ventilation capability. The remaining two fans were blowing out from the room. All six fans should be restored to working condition, configured to have the three fans on the wall where chemical is stored blowing outward and the three fans on the opposite wall blowing fresh air into the building. In this set up fresh air would be carried into the building and blow across the tanks and stored chemical and out the opposite site assisted by the outward blowing fans. This would move potentially corrosive gas away from the pumps, electrical panels and piping.

Possibilities exist for walling off the chemical tanks using plastic curtains that would block fumes but allow complete access to the mixing motors. If this option was implemented thought should be given to a roof exhaust system over the curtained off tanks.



Chemical curtains to isolate fumes and mists while allowing complete access

The mixing of 20 kg bags of alum is a labor intensive process involving lifting bags off pallets and placing them on the wall of the tank then cutting them open to add slowly to the existing alum mixture. This operation would benefit from the use of a hopper that could be mounted on the side of the tanks. Staff could then fill the hopper and slowly open the hopper to release the desired amount of granular alum into the tank for the desired concentration. This would also cut back on the amount of bag fiber evident in the tanks that must be skimmed out with a pool skimmer before it impacts pumps or mixers.

Safety Equipment and PPE

For the majority of locations safety equipment was purchased and installed or provided to staff. It was verified that the respirators being used were of the proper type for the two main chemicals of concern, the granular chlorine and the powdered alum. However, attention must be paid to the very limited life span of the cartridges. Eliminating the hazard of fumes via engineered solutions and ventilation is preferred over staff having to don a respirator. In order to extend the life of the cartridges, awareness of this issue should be communicated to staff and, ensure respirators are not exposed to use when not specifically being used while mixing chemicals to extend their lifetime.

Some eyewash/shower stations were not properly functioning or blocked from access. A routine monthly check should be performed on these and all other pertinent safety equipment. This check should involve a form that is signed beside the equipment similar to a fire extinguisher check to let staff know the units are safe and operational. Staff should be trained on the requirements of the equipment and what to do when a unit is found not working.



Nonfunctioning eyewash doublerun



eyewash blocked in lab area

Some equipment such as very outdated life jackets well past their expiry date were still being used. Other equipment was new but left in the original packaging which would limit its use in the time of an emergency. All equipment would benefit from a monthly check as suggested above.



Ensure equipment is ready to use and original packaging removed

The stores room had an adequate stock of gloves, respirators, safety glasses and other supplies readily available. However, several staff indicated the gloves or other equipment was not well suited for the work being performed while wearing them. Suggest further investigation be conducted into available PPE. This investigation should include awareness of latex allergies and non-latex gloves. Some samples were brought from Canada by the volunteers.

Although individual staff are issued appropriate PPE it would be beneficial to have an additional set in key areas, like the chemical mixing areas, so staff can quickly utilize if they did not have their own personal set readily available. Once provided two access points to PPE there is no excuse for staff not to be wearing it.



One complete set of spare PPE for each chemical mixing room

The lab/works technicians had adequate lab coats and other PPE however, it appeared female staff were not issued general clothing for wear underneath the lab coats that are suitable for an outside working environment. They appeared to be issued similar inside office attire as all other female staff. This is not appropriate.

Although there is a policy of requiring hardhats at the various locations it was often not occurring or enforced, with the exception of the construction crews. If this level of safety is not required for plant or administration areas perhaps it should be re-evaluated and maybe bump style ball caps would be sufficient. If determined to be required enforcement is needed.

First aid kits and spills kits should be verified for contents then sealed with a small sticker. This way during monthly inspections if the sticker is still in place the contents are full and stocked. If the sticker is broken then the contents need to be inventoried and replaced if necessary. Remember, if a first aid kit was opened and the contents used an accident form should have been filled out. Also to avoid unnecessary opening of first aid kits, a supply of band aids should be available beside the kits.

General Safety Items

Staff should be conducting monthly documented safety inspections of their area. This would lead to easily identifying and correctly fixing safety hazards. This would include numerous slip, trip and fall hazards at the facilities. This includes lips, raised concrete, open channels, drop off from walkways with no chains or safety device, access to locations during rainy season etc..

Storage of chemicals, gas cylinders and other items near electrical panels. Several examples were observed where housekeeping issues have created a hazard for preventing access to safety equipment such as eye washes or for limiting access to electrical panels due to items stored against them. Although storage can sometimes be limited, a different solution should be found. Staff need unimpeded access to work and to safety equipment.

Staff informed us that workers can be removed from certain duties due to evidence or examples of lack of safe work practices that could endanger themselves or co-workers. This is a very good and strong practice that, although sometimes difficult as it can effect a worker's pay, is necessary. Alongside this there must be a method for re-training the staff member and a series of trials that, if passed, allows the staff member to regain their place after demonstrating their desire and ability to work safely.



Chain compressed cylinders in place - Do not block electrical panels or controls



Grates to be put back in place



Area has one story drop, chain area



Be aware of path required to access areas for work and during rainy season

Seine Bight

This location requires immediate remediation. The metal ladder work and guardrails on the upper portion of the facility have completely eroded to the point of no longer being functional. They are starting to rot out to the point of becoming dangerous with overhead threats during wind events for staff or equipment below.

Scaffolding should be taken from the Doublerun plant or another source and constructed upon the roof of the stand-by power building to allow access to the catwalk at the upper reservoir tank. Having securely tied off a worker, the worker should torch or cut out all damaged and destroyed metal railings. A company will be required to remove the damaged main ladder and safety restore these features.

This facility was also the only facility in the public eye that appear to be unkept on its exterior. Being centrally located on the major roadway in Placencia, and known to be a BWS building, this can potentially tarnish the reputation of the company in the eyes of customers. Perhaps when scaffolding or other measures such as a lift bucket are used to correct the failed railings the facility could be painted or at least power washed.



Security of the Product

Although physical security existed at the majority of locations, including armed guards and gates, the goal was directed at the protection of personnel and infrastructure. An additional concern to be added to this list is protection of the product which, in turn, is protection of the public and BWS reputation.

If opportunities exist to degrade or alter the quality of the water these must be examined, eliminated or addressed through procedures or safeguards.

The mile six booster station and chemical addition point. This facility appeared to have no alarms on the door. There was evidence of previous tampering by neighbors to acquire electrical power for their activities, so it is vulnerable. The pipe leading to the injection point for chlorine was exposed and easily could be cut or tampered with. This pipe needs to be re-established and protected. It also needs to be accessible as staff indicated the buildup from the Alum needs to be rodded out on occasion. We suggest a quick connect Tee be placed at this location to allow staff to shut off the flow, disconnect either the feed site of the pipe or the side leading to the injection point for cleaning.



Chlorine injection line exposed at back of building



Debris or liquid can enter

Properly guarded against objects

The hatches on the roof to the reservoirs at various locations were inconsistent. The preferred system is a locked access hatch that is supported at least 4-6 inches off the roof or ground surface. This prevents accidental liquids or foreign objects entering the water storage tank when staff are opening the lids for inspection. If a location exists that is not monitored, or staffed where direct access to treated water can be achieved, the access to the water must be locked, or even better the lid should have a contact alarm that would signal if opened outside of times that the alarm system is disabled as, for instance, when staff are present.

The water treatment facilities have a connection that is monitored by the guard for filling water trucks or other vessels. These lines should have a backflow prevention device to protect the water in the reservoir in the event of backpressure in the line to prevent any foreign material from the trucks getting into the system.



If the level in the truck gets higher than the reservoir at times of high demand it could back syphon.

Numerous pressure reliefs valves exist throughout the systems due to the long distance the water travels in the mains. A concentrated effort is required to restore the security of these units. It was apparent some had been tampered with and numerous units were leaking. Leaking valves were also observed at the plants due to an issue with reseating. Perhaps a new vendor or type should be examined as these create opportunity for lost revenue and for contamination of the product.

Source Protection and Water Intakes

The intakes along the Belize River are highly susceptible to source protection issues. As it is not possible to isolate the intakes to prevent accidental or purposeful contamination, procedures must be in place at the plants to isolate the reservoirs and high lifts should contamination be discovered. If the source water becomes contaminated the goal is to stop or eliminate the amount of contaminated water directed to customers by containing it within the plant and shutting down the highlift pumps.

An alarmed, on-line pH meter could be installed to notify operators of any sudden large variation in pH that may be indicative of another contaminant.

An engineered solution must be investigated for the Dangriga intake with the goal of limiting the number of times an operator must enter the river to clean the screens around the intake.



The stone covering over the intake at Belmapan should be fixed to prevent debris and mud from freely entering into the channel. Also procedures should be developed for the safe delivery of fuel to Belmapan as the diesel unit is uphill from the intake and any spill will travel to the river in the area of the intake.



The second well at the Independence Wells in Placencia appears to have open access to the casing at the wellhead which would enable contamination of the aquifer if not repaired.

**Well casing not protected and open for contamination**

Staff should be aware of, and monitor the activities, around the well sites. Activities such as farming, industrial activity, waste dumping and large supplies of fuel need to be noted. If an operation is of a scale that could potentially jeopardize the water in the aquifer from a spill or run-off, staff need to interact with those conducting the activity and ensure that measures are in place for well head protection within at least 150 meters of the well head. Measures could include limiting manure spreading in this area and ensuring fuel tanks have containment (this includes BWS as your tanks are always closest). Those storing chemicals should have a rough spills plan and annual site visits to verify no new activities are taking place. The same staff could look after sewer use.

Training sessions

Approximately 82 students received classroom and hands on training for Confined Space, working around Utilities, Trenching and Excavations and Chemical Handling and Safety. The goal was an introduction to these topics which then must be followed up upon with additional or refresher training to be conducted by BWS staff or an outside trainer. Below are comments provided by the trainers.

- Confined Space Entry Procedure for below ground chambers;
 1. **Make the area Safe** (Traffic Control, Vehicle as buffer, PPE)
 2. **Safety talk**, fill out CS permit, set up equipment, harness up the entrant & turn on Gas Tech in fresh air to warm up sensors
 3. **Test manhole lid** for methane gas
 4. **Open manhole lid and test all 3 levels** (1 second per foot using hose & pump)
 5. **Record** the highest results on permit
 6. **Add air using a blower** (5-20 minutes or more but enough time for 1 air exchange and ensure the blowers CFM's are enough for 6 air exchanges per hour)
 7. **Test all 3 levels** (1 second per foot using hose & pump)
 8. **Record** the highest results on permit
 9. **Add air & continuous air monitoring** with the Gas Tech
 10. **Hook up Entrant** and enter confined space
- Entering silos, tanks & reservoirs testing may be done using the hose taped to a long stick if above testing is not possible
- **NOTE: Always test the space before you enter!!**
- Make the PPT & course yours (BWS) take out BC stories and add your own stories
- Recommend the 2-day training course every 3 years for all outside employees
- Create BWS certificates and/or hardhat stickers for those workers that completed training
- Practice Confined Space Entries regularly until it becomes a normal thing to do
- Have crew supervisors do crew visits at least once a week, to check in and ensure they are using the proper PPE & safety procedures
- Keep the unions involved in BWS safety processes and get their buy in and support
- Coaching safety with your employees works better than enforcing safety, but after multiple warnings enforcement is necessary
- Take inventory on BWS trench shoring systems currently available and add a few more trench shields to build up inventory. (Please contact Ron Enns directly for types & prices, Ian Mciliwham will hook up to the right shoring / shielding providers)

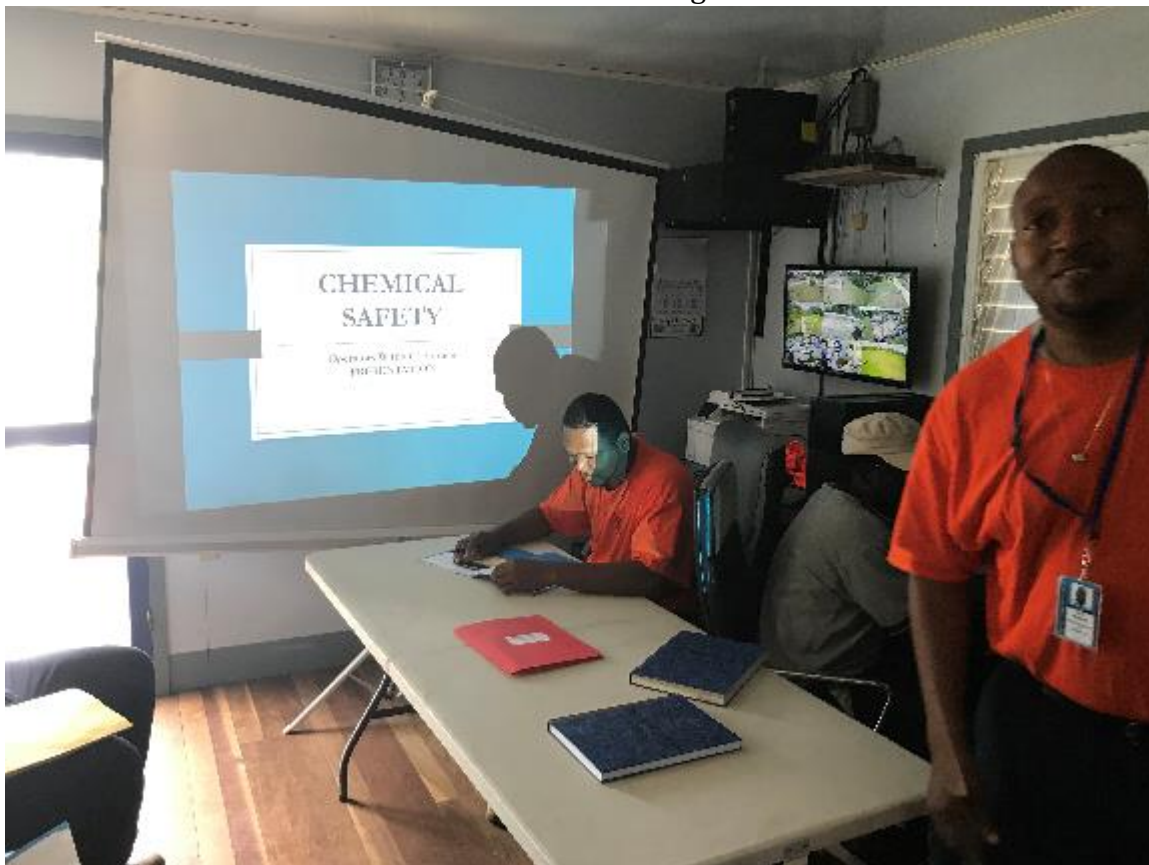
The Utility area in your group at BWS are doing well. They have fewer utilities in the ground then in Canada and in most cases the real challenge expressed was getting the works to hand expose properly which requires coaching and supervision.

Confined Space Entry BWS have a great foundation to build on and, with the additional training materials and recommendations, it will just get better and safer.

Trench & Excavations is a big challenge for BWS. This area requires further training and a plan to be developed. Inventory for existing trench shoring & shielding systems as they are not available to all staff or they are not aware of them. More training is needed - especially hands on-training for shoring systems installation.

The one shoring challenge that was brought forward regarding the 24 inch water main beside the Highway, is being investigated by consulting engineers & professionals who will provide recommendations in the coming weeks.

The chemical safety training appeared welcome by staff, in particular the training on the MSDS sheets of the actual products being handled was well received. Although not required by law, the practice of obtaining and sharing SDS sheets should be maintained. All staffed locations should have an MSDS binder available for all staff in the case of emergency or for general review. The information contained in the MSDS should drive the PPE program, procedures for safe use and disposal of the product. As the chemical course was not a previously planned activity the subject should be revisited with an on-line course to be taken by all staff at some point. As operators by nature do not enjoy extended time in a classroom, taking the classroom to them and getting out into the plant to conduct hands on interaction with the chemicals would be the desired approach.



Water Treatment Plants

In general, all the water treatment facilities visited were in good condition with a few exceptions such as Seine Bight as noted above. It was evident staff are knowledgeable of the treatment process and took pride in their facility including the consultant operators in the River Valley wells area. The security measures were adequate, alarms existed and SCADA communications. The issues at the water facilities are covered off in the other areas of this document and are applicable at all locations such as electrical hazards, storing documents, chemical rooms, general safety items and more. When addressing issues all facilities must be addressed. It does not look good to staff to correct problems only in certain areas while the same issue exists elsewhere.

At the Doublerun facility the main feed is scheduled for replacement however there is currently a wooden stake being used to plug a leak in the pipe. This should be reinforced with a saddle or more permanent solution until the final replacement of the entire pipe occurs.



At the Dangriga facility there is a major project to install suitable access to the tanks via catwalks or bridges. Since this appears to be a longterm project the conditions of access to the tanks should be reviewed to ensure that the ladders are in good safe condition and investigate if for some tanks a set of scaffolding might be a better solution.

Maintenance and Capital Works

Although time did not permit a thorough investigation of the maintenance program of BWS it was evident through the site visits that maintenance is more a reactive than proactive program. This type of model lends itself to increased repairs and cost in the long term. Although a lengthy process, a strong preventative maintenance program must be developed. Starting with new equipment and then progressing to existing equipment a preventative maintenance schedule must be developed and implemented. The frequency of activities should be tracked and

adjusted were necessary. Several locations gave evidence of neglected or deteriorating equipment, in particular the sewage pumping stations.

If equipment came and was designed and installed in a certain condition then there was a reason for this. If not maintained in this condition it should be budgeted for replacement as the potential for failure increases resulting in a safety, environmental or customer related issue.

There was evidence of progression on capital projects and repairs or replacement on major items such as the transfer switch at Doublerun and the lowlift header at that location. However, additional measures need to be employed via equipment or procedures to cover the period up until the capital work is complete. The same observation was made at the Dangriga water treatment plant in regards to catwalks and platforms.

During site visits an audit of certain assets was being performed. It appeared to be both for asset life and to account for the asset from a theft or misplacement nature. This is a good practice but must be extended to larger physical assets like ladders, walkways, tanks, building etc. Just because no one is going to walk away with it or it is not a typical five-year replacement item, it does not mean it should not be evaluated, assessed and tracked for capital replacement. The failure of a computer, pump or welder can easily be corrected and replaced. However, the failure of a major piece of critical infrastructure may affect operations for months. The mindset during the assessment should always be a conversation with staff as to what piece of equipment or infrastructure, if it failed, would lead to an immediate environmental, health and safety or water quality impact.

It becomes easy to walk by items you see every day and not identify them as requiring restoration or replacement. We suggest a visit from non-operational staff would bring a fresh set of eyes to question everything they see.



Deterioration of support will lead to critical failure at wells near gravel pit

The fleet at BWS is modern, reliable and well maintained. However, it would greatly benefit from a vacuum truck or similar capable device. This would ensure sewage pumping stations could easily be maintained and assist in construction activities. Although a costly investment, senior staff should investigate funding opportunities for such a piece of equipment. Trucks could be modified with storage options to allow a greater variety of equipment to be readily available to crews.



Modern well-maintained fleet

Standby Power Facilities

The crucial ingredients to producing clean, safe water and compliant, environmentally stable effluent are operators, infrastructure, chemicals and power. Most do not have an available replacement, but power does and thus standby power facilities must be installed, tested and maintained at all times. Through a combination of permanent installations and portable generators BWS does a good job addressing this issue. However, there was evidence that certain areas, due to the age of infrastructure, where it can be assumed they are getting closer to their end life cycle and thus the opportunity for failure is increasing.

Due to budgeting restraints one cannot simply modernize all of the facilities. However, smaller steps such as consistent battery size and configuration can be achieved. Also for areas with questionable standby power, a plan should be in place. Battery terminals should have a small rubber mat across the top of them so if a tool is dropped it does not make contact and arc.



Properly sized batteries but requires protection Small single battery



Old single walled tank with limited access and poor containment, evidence of fuel spilled on floor (Placencia)

Due to the conditions and flooding during rainy season, the general practice appears to be locating standby power at a second story location. This is a good strategy, however, it creates issues with fuel delivery that must be addressed from an employee safety and an environmental standpoint. Few things are as dangerous in a water facility than the opportunity for fuel to enter a water system. Each facility should be examined for method of fuel delivery and engineered solutions explored to limit the hazards. One option would be to purchase an external fuel tank for a vehicle, complete with a motorized pump and a minimum 20 foot hose, that would allow easy filling of second story locations. It could also be used in emergencies to deliver fuel to these units or to construction equipment during normal operation.

The fuel tanks and containment systems varied widely from underbody, double walled tanks to older, single walled tanks with no containment. An effort should be

made to examine each location from a containment perspective and work towards strengthening this aspect with a long term replacement programme for tanks.

Health and Safety Committee

Although time was limited so a complete discussion did not occur, some steps should be taken to re-establish a functional health and safety committee. This committee should be comprised of a variety of management and worker representatives with one goal, safety for all as equals. This group should oversee the health and safety programme and be responsible for taking action on items brought to or discovered by them. This group should be relied upon to:

- spearhead training opportunities,
- evaluate safety equipment including PPE,
- investigate accidents and incidents,
- ensure safety checks are being performed and inspections occur at all facilities.

This group should meet on a regular basis with a set agenda. We suggest the meeting chair alternate between a management co-chair and a worker co-chair. Minutes of these meetings must be taken and shared with staff (safety boards). This committee must be empowered and supported by Upper Management and allowed to make recommendations on major safety issues to Management. A written formal response should be presented within an agreed upon timeline, such as one month. Negative responses are acceptable as long as a justification for not taking on the recommendation of the committee is stated.

Safety Inspections should be performed bi-monthly, or at a frequency relevant to the size and hazards at a facility, but .at an absolute minimum. every facility must be inspected once per year. The inspections should be performed by a group of two, one worker and one management member. The two must always be equals when it comes to safety - every employee's safety is equivalent regardless of position held within the company.

Inspections should be documented and freely available to all staff in that area. The reports should be posted on a safety board that is placed at each main, staffed location. The Board should have the names of the safety committee, reps. from that facility, the last inspection report from that facility. Any safety bulletins produced should be shared by the main health and safety committee, with the minutes from the last health and safety committee. This is also a good location for the first aid kit. Only Health and Safety related items are to be placed on this board. Those conducting the inspections are responsible for the upkeep of this board.

Drawings, Operations Manuals and Procedures

Although some evidence of Standard Operating Procedures were provided, BWS would benefit from a consistent format used for a wider range of tasks. This format should have a standard template including a safety section. As these procedures are developed, there should be staff input. The procedures should then be made available to staff in paper or electronic format and training on the procedures provided. Once staff have the proper tools, equipment, PPE, documented procedure and evidence of training they can be held more accountable for their work practices. The crew from Operators Without Borders can provide numerous examples to cover almost all aspects of operations which could be modified to suit conditions in Belize.

There appeared to be a lack of knowledge of the design and operational components of some systems, particularly the older system. Original documentation must be located, preserved and shared with staff. In the absence of original documents staff should be developing as-built drawings and operational and maintenance manuals. The systems installed are not unique to Belize- in particular the drop in sewage stations. If information is not readily available, the internet should have examples that can be modified to the specific requirements of Belize.



Sewage pumping station manual and drawings from San Pedro

Facility Licenses

With the assistance of staff some of the systems of BWS were evaluated against the Ontario Regulations for water and wastewater operator and facility classification.

Doublerun Water Treatment Plant Class IV

Belmopan Water Treatment Plant Class III

Dangriga Water Treatment Plant Class II

San Pedro Wastewater Treatment Plant Class I

All remaining systems should be classified. Ian Mcilwham alongside plant staff could assist. The Environmental Operators Certification Programme (EOCP), a founding member of Operators Without Borders, also has an award winning classification programme and has offered guidance.. Assigning a class to the system enables a target for training of staff to the level of the facility. It also enables a common terminology when dealing with outside agencies and countries when discussing your facilities.

Laboratory

The staff at the main laboratory were very knowledgeable in techniques and practices and demonstrated a desire to expand their roles. Initial inquiries were made about full certification which may be a timely and costly venture. However if not in pursuit of full accreditation the practices and methodology can still be followed to strengthen the work of the lab.

Since staff at this facility not only test samples, but collect samples, they are very similar to an operator certification in Ontario, "Water Quality Analyst". Operators with this designation are not qualified to operate a water or wastewater facility but are usually more technical and conduct sampling and analysis and would handle customer complaints and do investigations. They also produce the annual reports of water quality and wastewater treatment. It would be beneficial to investigate the requirements of a water quality analyst. These requirements map out the education, experience and courses required to maintain this certification.

The technicians at the lab would also be great candidates to form the basis of either a sewer use group or a source protection team as mentioned previously in the report. Their knowledge of both water and wastewater and chemistry in general would mesh well with these roles.

The main lab at Doublerun was organized but due to the lack of space some chemicals of opposite types were in close proximity to each other which may cause a reaction. Storage under the fume hood should be examined for compatible chemicals and the storage room itself.

The eyewash/shower area needs to be cleared to allow quick access in the event of need. The eyewash should be added to the housekeeping schedule that was posted and also add the storage drum for spent hazardous chemicals.

The spill kits in the lab existed but were very small in nature. If not located outside of the lab a larger supply of material to be used in the event of a major spill should be stored.

Glove and clothing options should be examined as work being conducted by lab staff is not the same as those working in maintenance or operations. Although provided with lab coats suitable clothing to be supplied and worn under these coats should be provided for when they are in the field conducting sampling.



Chemical compatibility to be reviewed for under fume hood



Seek an alternate location for spent hazardous chemicals



Belize Water Services Assignment

Respectfully submitted:

Ian (Mac) Mcilwham
Patrick Reeves
Dan Skidmore
Ron Enns
Valerie Jenkinson