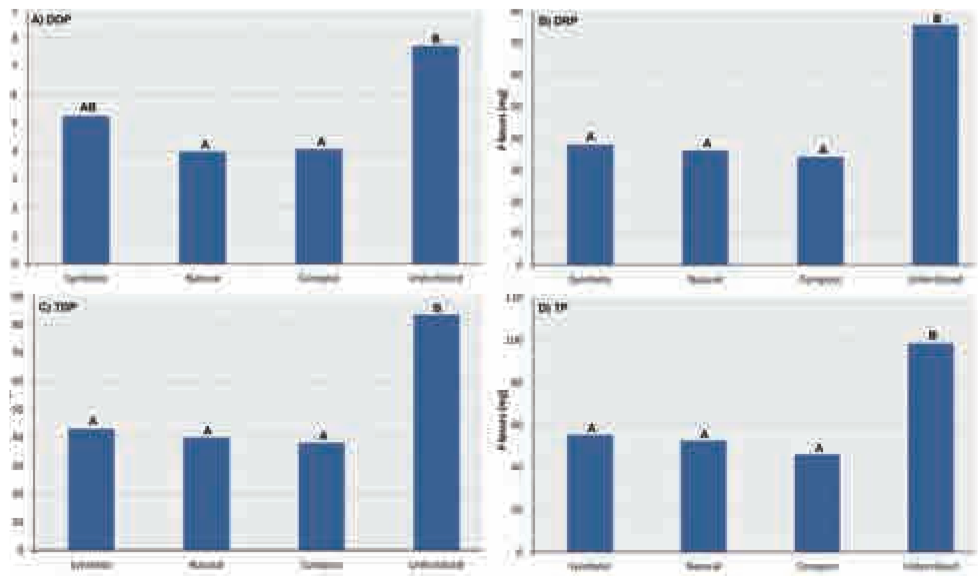

Figure 7. Total phosphorus load in runoff water during the 2012 season. Column with the same letters are not significantly different. (DOP = dissolved organic P, DRP = dissolved reactive P, TDP = total dissolved P and TP= total P).

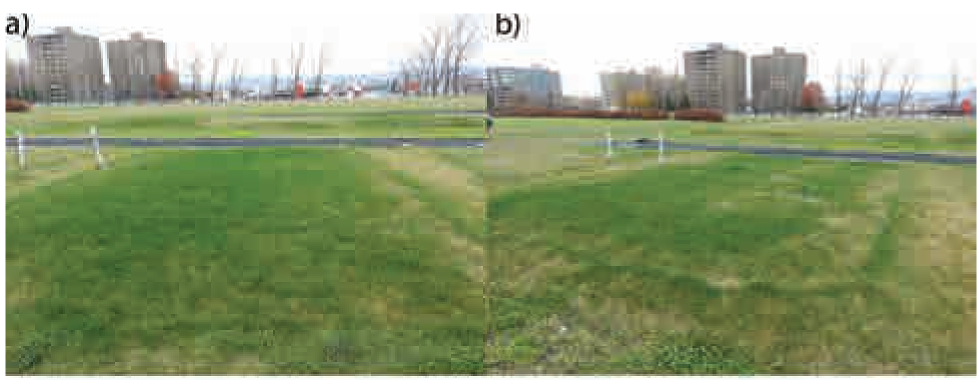

Figure 8. Visual appearance of the fertilized plots at the end of the 2012 season. A) Synthetic treatment, B) Natural treatment, C) Compost treatment.

Also, even if nitrate losses were higher from fertilized plots, the average NO_3- concentration (3 mg L-^{1}) was far below the Québec threshold for potable water (10 mg / L-^{1}) (data not shown).

Runoff. We did not observe any significant differences in runoff volumes between the different treatments (data not shown). However, we did observe differences in phosphorus losses through runoff (Figure 7). We measured four different forms of phosphorus in the water: total P (TP), total dissolved P (TDP), dissolved organic P (DOP) and dissolved reactive P (DRP). The concentration of all these forms of phosphorus was significantly lower in runoff from fertilized plots compared to the unfertilized plots (data not shown). Over the growing season, fertilized turf resulted in a 50% decrease in P load in runoff water compared to unfertilized turf. This effect is probably due to vegetation density and composition on the unfertilized plots.

Turfgrass quality. It is difficult to compare turf visual quality between unfertilized turf composed of mixed species and fertilized turf made from Kentucky bluegrass, since some of the broadleaf "weeds" could be desirable to a homeowner who does not fertilize their lawn. However, we did compare the effects of the three fertilizer sources on turfgrass quality during the growing season. The highest visual quality was observed on plots fertilized with the synthetic treatment, followed with plots fertilized with the natural program (data not shown). The compost treatment, based on a city by-law, resulted in the lowest visual quality. A comparison of the visual appearance of the fertilized plots at the end of the season (November 5, 2012) is shown in Figure 8.

Conclusion

While the results of this experiment are certainly promising from the perspective of turfgrass managers, it is important to reiterate that they are based on only one year of research. Thus, they should be considered preliminary for the moment and taken with a certain reserve. We currently are reviewing data from 2013, and we have requested funding for an additional five years in order to be able to observe the long-term evolution of our research plots. We hope that results from this experiment will be useful for both turfgrass managers and government bodies that want to implement fertilizer regulations. Any question related to this project can be directed to Guillaume Grégoire, research associate at Université Laval (guillaume.gregoire@fsaa.ulaval.ca).

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ornementale du Québec (ASHOQ), Association québécoise de la commercialisation en horticulture ornementale (AQCHO), Fédération interdisciplinaire de l'horticulture ornementale du Québec (FIHOQ) and Canadian ornamental horticulture alliance (COHA). In order to be fully transparent, we plan to publish all the raw data from this experiment once it is over and published in scientific journals. •

References

1. Easton, Z. M. & Petrovic, A. M. Fertilizer Source Effect on Ground and Surface Water Quality in Drainage from Turfgrass. J Env. Qual 33, 645–655 (2004).
2. Bierman, P. M., Horgan, B. P., Rosen, C. J., Hollman, A. B. & Pagliari, P. H. Phosphorus Runoff from Turfgrass as Affected by Phosphorus Fertilization and Clipping Management. J Env. Qual 39, 282–292 (2009).
3. Cole, J. T. et al. Influence of Buffers on Pesticide and Nutrient Runoff from Bermudagrass Turf. J Env. Qual 26, 1589–1598 (1997).

Air-Supported Structures and Synthetic Turf Fields

Ian McCormick, *Business Development Manager, The Farley Group*

Photos credit: Ian McCormick, The Farley Group

A synthetic turf field is an ideal playing surface for a wide variety of sports and activities – when it's not covered with a foot of snow. Fortunately, there's a building system that can allow for a synthetic turf field to be used during all seasons. Air-supported structures are lower cost alternatives to traditional buildings, particularly for facilities that require large, open, clear span interior spaces. But the most unique feature of these structures is their ability to be taken down and put back up seasonally. Many domes have been installed to cover sports facilities for the winter months and are taken down to allow for outdoor activity in the summer months. Of course, a dome can also be constructed for use as a permanent, year round facility. An air-supported structure is a versatile and cost effective building system for covering large, clear span space – seasonal or year round.

The Market Forces

With the exponential growth in participants in soccer and other field sports and the evolution of the synthetic turf industry, the last decade has seen a significant increase in the number of installations of synthetic turf fields with no signs of slowing down anytime soon. Unfortunately, many of these fields are in areas that are affected by the cold and snow that winter weather brings, rendering them unplayable for several months every year. So, what's the solution for a field that can't be used during the winter months? Well, you can "bubble" it.

Air-supported structures have been installed for a wide range of applications, including warehousing and manufacturing facilities, construction covers, and even bulk storage in the coal industry. However, the demand for air-supported structures has been primarily driven by recreational facilities requiring indoor space during the winter months and the recent growth in field sports has certainly brought the latest push.

Historical Overview

When air structures were first introduced to North America in the early 1970's by industry pioneer Ralph Farley, covering a single tennis court for the winter season was an ambitious endeavour. With the technology already established in Sweden, Farley saw an opportunity to make use of these "bubbles" in areas in Canada and the United States where long, cold winters made it impossible

Main heat and inflation unit and standby inflation fan (Greenville, PA).

Interior view of fabric connections for mechanical equipment and vehicle airlock (King City, ON).

for outdoor surfaces such as tennis courts to be played on after the warm season was over. He teamed up with a tennis club in Toronto and imported a "bubble" from Sweden, specifically patterned and manufactured to cover one tennis court. The fabric membrane was attached to an anchoring system around the perimeter and an electric inflation fan pressurized the interior of the bubble. That winter, people played tennis on the same court that they enjoyed their favourite pastime on in the summer months. The dome was deflated the next spring, rolled up and stored away and the court was played on in the summer as usual.

The next project was even more ambitious, covering three outdoor tennis courts instead of just one. Since then, Ralph and his associates have been involved in hundreds of air-supported structure projects throughout North America and around the world. Today, a three-court tennis dome would be considered a relatively small project compared to the very large field house domes that can cover as much as 100,000 square feet of interior space.

The Technology

An air-supported structure, also known as a "dome" or a "bubble", is a truly unique building system. The entire structure is supported by maintaining slightly higher air pressure within the fabric membrane than the atmospheric pressure outside. This is achieved by an inflation fan constantly introducing fresh air to the interior of the structure.

The inflation unit that maintains the internal pressure of the dome is also a furnace, keeping the interior of the structure at a comfortable temperature. To ensure the dome remains inflated at all times, a standby inflation system is always ready to take over the inflation requirements, even during a power failure.

The interior lighting system is comprised of either fixtures installed on stands around the perimeter, or hung from the fabric membrane, or a combination of both. The industry standard for sports lighting is 1,000 watt metal halide fixtures. These fixtures require a ballast to drive them, which can be placed around the perimeter of the interior, at the base of the light stand poles, or housed in a remote cabinet or other storage building outside of the dome. Several other technologies are being introduced as sports lighting solutions, which hopefully will eventually lead to energy savings without sacrificing light levels required for competitive sports.

The fabric membrane is manufactured using architectural grade vinyl coated polyester fabric. The pattern is specific to every project to create the shape of the structure. This outer material is backed by a 15 to 20-year prorated warranty and can be expected to last anywhere from 18 to 25 years before needing to be replaced. A liner fabric is added to the interior of the membrane to improve thermal and acoustic qualities. Insulation material is placed between the outer structural fabric and the inner liner fabric to maximize energy efficiency, bringing the equivalent insulation value from

Two full field seasonal domes (Downsview Park, Toronto, ON).

R2 to R10. On medium to large sized domes, structural cables are installed over top of the fabric membrane to help stabilize it.

The shape of the dome's membrane adheres to certain design parameters, taking into consideration the wind loads and other climatic data of the site and creating a curvature that promotes snow shedding off the sides and ends of the structure. If an air structure's height to width ratio is too low, the top of the structure becomes too flat, allowing snow to accumulate and putting too much weight on the fabric membrane. To achieve the proper curvature, a dome's height at the peak typically needs to be 30% of the width of the structure (i.e. a dome that is 200' wide would be a minimum of 60' high at the curvature's apex).

Because pressurizing the interior air space supports this fabric membrane, a significant uplift load needs to be offset. This uplift is accomplished by anchoring the membrane to a concrete grade beam around the perimeter of the dome. Soil friction and the weight of the concrete resist the uplift pressure that's created by inflating the dome. An aluminum channel is cast into the top of the grade beam, creating a profile that accepts the fabric membrane. This membrane has a rope edge manufactured into it at the anchor point. Pressure-treated lumber fits into the channel around the entire perimeter of the structure, locking the fabric membrane into the grade beam (Figure 1).

In order to maintain the internal air pressure, specially designed airlocks are installed to allow for easy access into the dome, including revolving doors, pedestrian airlocks for barrier-free access and vehicle airlocks for maintenance and lift equipment. Emergency exit doors are located around the perimeter of the structure to comply with occupancy codes and are only to be used during emergency situations as they will allow the internal air pressure of the dome to escape.

Construction Requirements

While overall project costs are indeed significantly less than a traditional building, site infrastructure costs such as excavation and site preparation, parking lot requirements, storm water management and the supply and distribution of electrical and natural gas utilities are required for an air structure just as they would be for any other type of building. Professional services need to be considered for site planning, such as architectural and engineering drawings and stamps, as well as the applications and approvals required with your local building department.

One difference with the site infrastructure required for an air-supported structure, is the installation of a concrete grade beam to hold the dome down as opposed to a traditional foundation that supports the weight of the building on top of it. The design and engineering of the grade beam depends on the size of the dome and the wind loads of the site's location, as well as the soil conditions at the site. Once these factors are determined, the air structure manufacturer will design the anchoring system accordingly, including requirements for equipment pads for mechanical units and entrance and exit components. The air structure manufacturer will provide a set of construction drawings stamped by a qualified structural engineer.

With new projects, the concrete grade beam and other infrastructure required for the dome, including electrical and natural gas service and distribution are planned and constructed in conjunction with the rest of the site development. Whether or not the dome will be seasonal or year round will need to be considered during the planning stages of the project. There are some subtle changes to the design of the dome and its anchoring system between seasonal and permanent structures. Outside of the scope of the air structure and its related construction, however, is the requirement for field drainage. Simply put, if the dome is going to be seasonal, field drainage will be required because the field will be open to the elements for part of the year; if the dome is going to stay up year round the field won't require this drainage infrastructure.

When the dome and field are being constructed together in new developments, the final installation of the synthetic turf is typically completed after the air structure has been installed. The installation process for the dome typically involves driving around the interior with heavy lift equipment, potentially damaging the brand new field. Plywood can be laid down for the lift equipment

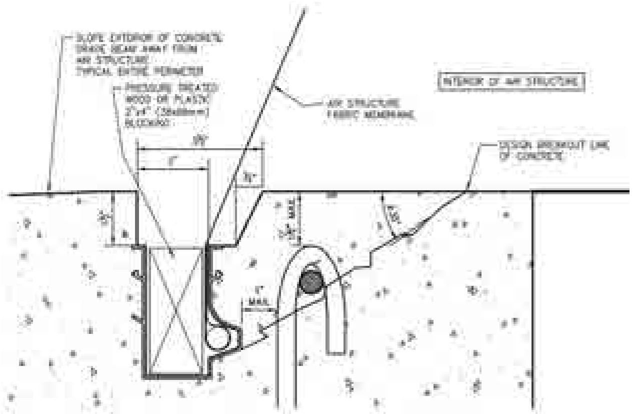

Figure 1. Cross section of cast-in anchoring profile.

to drive on if the field is installed first, or in the case of installing a dome on an existing field.

For existing fields, where the grade beam is installed around the outside of the field, the turf typically needs to be disturbed around the perimeter of the field to install the grade beam. Once the grade beam is completed, the turf is repaired and shored up to the edge of the new concrete. The concrete is flush to grade for seasonal domes, leaving little evidence of it being installed, or it can be raised for permanently installed domes to create a curb on the outside that can be useful for a guideline when clearing snow in the winter time. The grade beam can also be installed across an existing turf field if the plan is to have a seasonal dome cover a portion of the field. Turf fill-in pieces can then be created to cover up the grade beam and allow for regular use when the dome is taken down for the summer.

Installation

Once the grade beam construction and all other site work is complete, the air-supported structure and its related components are ready to be installed. Depending on the size of the dome, the fabric membrane will be manufactured in as few as 2 to 3 or as many as 8 to 10 sections, which are folded and rolled up into bundles for shipping and ease of handling on site. These sections are unfolded, spread into place and connected to one another using aluminum joint plates.

The fabric membrane is then connected to the grade beam around the perimeter and locked into the anchoring channel. If applicable, the structural cables are laid in place and connected to their anchors in the grade beam. The furnace and inflation equipment are connected to the duct work for the dome, which is either a fabric connection through the side of the dome or underground ducts from the equipment pad to floor grates inside the dome. Flip the switch to the inflation equipment and 1 to 2 hours later the dome is fully inflated.

The rest of the installation process includes placing and connecting all of the entrance and exit components to their fabric curtains on the dome, and installing the insulation material, interior

Fabric membrane being locked into anchoring system (Greenville, PA).

Dome spread out and connected to the grade beam, beginning inflation (Greenville, PA).

lighting system, and divider netting or curtains. All in all, the initial installation process usually takes anywhere from 1 to 3 weeks, depending on the size and complexity of the air structure package.

The Ups and Downs

Seasonal domes that are taken down in the spring and reinstalled in the fall basically go through the reverse of the process outlined above every spring and then repeat the process every fall. Of course, the seasonal ups and downs are more efficient than the initial installation, taking about a third of the time. The furnace and inflation equipment typically stays in place while the dome sections and the other attached components are stored away for the summer months. The cost associated with these seasonal take downs and reinstallations can add up for large full-field structures, given the man power and rental equipment required to accomplish the task.

Operating and Maintenance

Operating costs for an air-supported structure include electrical costs for the inflation equipment and the interior lighting system, and heat fuel costs for the furnace. Although air structures have a lower capital cost than traditional buildings and have the unique ability to be removed and reinstalled seasonally, they do require a slightly higher operating budget for utilities than other buildings that can be better insulated and don't require an electric fan for inflation. That being said, significant improvements have been made in the way of insulating the fabric membrane of an air structure with further innovations to this technology on the horizon.

A very important maintenance consideration is snow clearance around the perimeter of the dome. Because an air-supported structure is designed to shed the snow off the fabric membrane, the snow accumulates around the perimeter once it does so. It's extremely important that it gets cleared away from the fabric membrane so it doesn't jeopardize the structural integrity of the dome.

Other maintenance required includes regular checks on the backup inflation equipment to ensure a seamless transition in the event of a power failure, as well as regular maintenance for all mechanical equipment associated with the air structure.

Summary

The evolution of synthetic turf fields over the last decade has brought an abundance of improvements and the industry has seen dramatic growth during this time. There seems to be an ever-increasing demand for the use of these fields with the growing number of participants involved in field sport activities. However, for many parts of North America, these outdoor fields are not able to be used during the winter months. As a cost effective, versatile solution to covering large, clear span space for both seasonal and year round applications, an air-supported structure is a building system that can allow such fields to be used in all weather conditions. •

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FROM ROYAL CITY TO TIGER TOWN

The STA's Michael Bladon asks the University of Guelph's Bill Clausen, and Stephen Day and Steve Lowe of the Hamilton Tiger-Cats Football Club how it came about that the team's 2013 season home games would be played at the UoG's Alumni Stadium after Hamilton's Ivor Wynne Stadium was to be demolished.

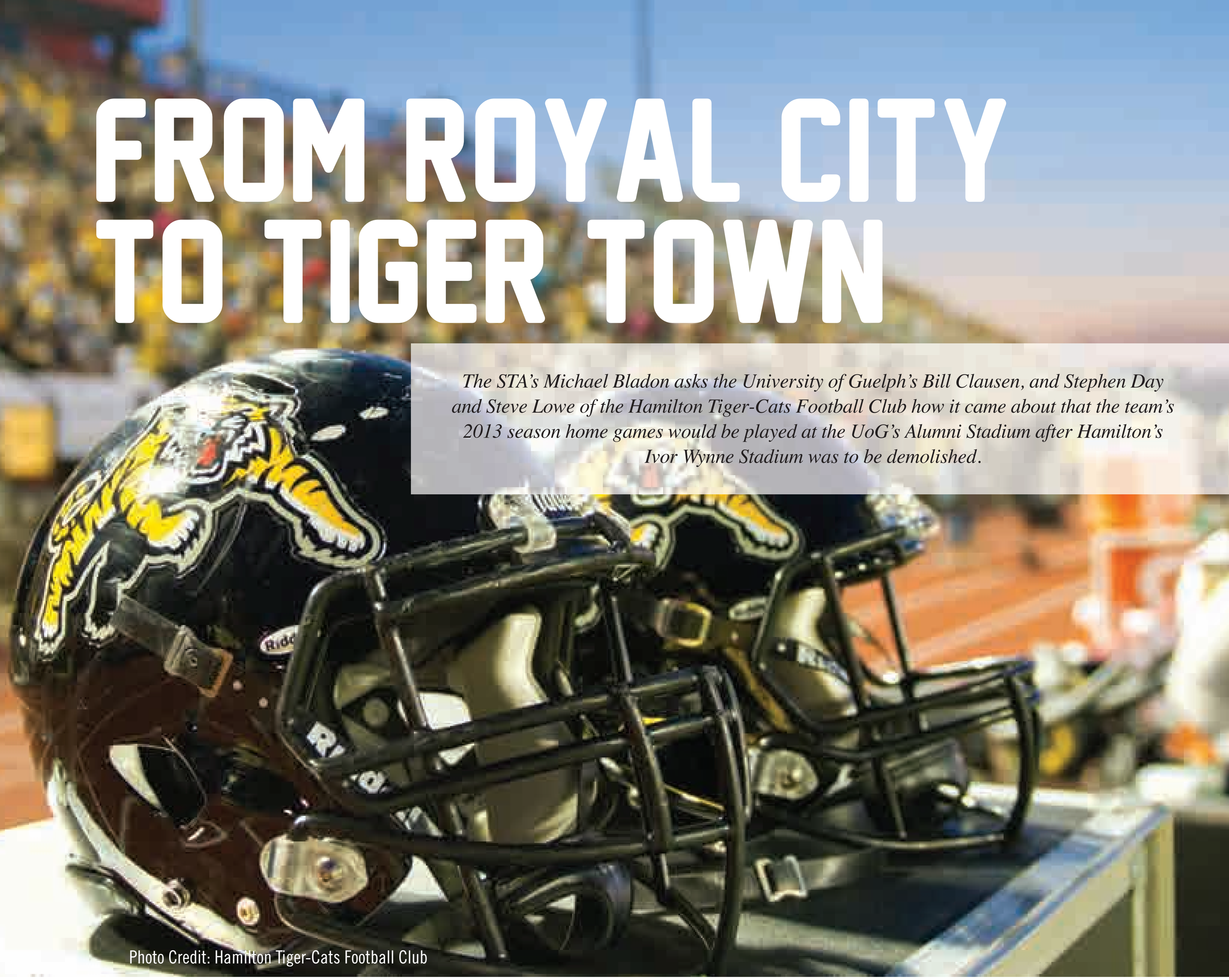

Photo Credit: Hamilton Tiger-Cats Football Club

Q&A with Bill Clausen, Facility Manager, University of Guelph

STA: *When were you first informed the Tiger-Cats would play at Alumni Stadium?*
Clausen: There were rumours back in August 2012 but nothing substantial was requested until October 2012. At that time negotiations went full time.

STA: *Did you participate in the initial meetings with the Tiger-Cats?*
Clausen: Once the decision to host the Tiger-Cats was made by the University's Senior Administration a number of people from various departments across campus were involved in finalizing a contract. Tom Kendall the Athletic Director, Frank Cain the Business Development Manager, Dave Easter the Marketing Manager and I were the Athletics Department staff involved. Campus Police Services led by Robin Begin and Pat Martin, Parking Services Manager Ian Weir, Hospitality Services Director Sylvia Willms, and Paul Mesman and Dan MacLachlan from Physical Resources were all part of the team led by Brenda Whiteside, Associate Vice President.

STA: *What was the involvement and what were the responsibilities of the University of Guelph before games?*
Clausen: Athletics ensured the field was groomed and safe to play on; we put out the corner flags, provided protective matting to cover the jumping pits and runways along the sideline, laid down track protection matting and put the team benches in place. Athletics staff setup the scoreboard controls and provided technical support during the games. Athletics staff also ensured the stadium was clean before each game. Physical Resources provide ongoing technical support for electrical, mechanical and structural issues ensuring the stadium infrastructure was operating in a safe and efficient manner. Campus Community Policing provided security support along with Guelph City Police and the private firm Star Security ensuring that no small issues developed into major problems.

STA: *And after games?*

Clausen: Working with the TiCat Customer Services Team, the Green For Life group and Chantler Environmental Services, Athletics staff ensured that the Stadium and the entire game day site was returned to normal state within hours of the game ending.

STA: *What staffing did the University of Guelph provide for Tiger-Cat games?*

Clausen: I was the Project Manager for the TiCat contract and I was on site for each TiCat setup day and game day from early in the morning until well after the game ended. We also scheduled an Athletic Facilities operator to be present on game days to do last minute setup and cleanup jobs as well as provide technical support for the CFL supplied score clock operators.

STA: *How was the University of Guelph team affected?*

Clausen: Positively for the most part, I believe. They got to see football at the next level and have a greater appreciation of what they will have to do to get to that level themselves. There were a couple of times when the Gryphons had to practice on Varsity Field because the TiCats were playing or the stadium field was being prepared for a TiCat game.

STA: *Describe the field maintenance regime. Does it differ, and if yes how does it differ, from that before the Tiger-Cats came to town?*

Clausen: Field Maintenance was done as prescribed by Field Turf to ensure we maintained our warranty and it was no different than what we did before the TiCats came to town. Davan Landscaping, as part of the Stadium Construction project, is contracted to do the field maintenance at Alumni Stadium. They would groom the field based on hours of use. Early in the season when the field was not as heavily used it might be two or three weeks between groomings, later in the season it was weekly as hours used increased to 80 hours per week.

STA: *How is the stadium cleaned following each game?*
Clausen: Chantler's Environmental Services and Green For Life were contracted by the TiCats to provide complete environmental services before, during, and after each game. Despite some game days where the weather was just plain terrible, they did an excellent job.

STA: *On October 26th both the Hamilton Tiger-Cats and the Guelph Gryphons took to the field. How did that work behind the scenes?!*
Clausen: Very well. We knew about the potential double header well in advance. The Athletics Department Event Management staff Jill Taylor and Facility staff Andrew Godard met with the TiCat game staff, devised a plan of action and made it work. The TiCat game ended at 4:15pm and the Gryphons kicked off at 8:00pm. The switch-over worked exceptionally well with both teams doing the work necessary in an effective, efficient and economical manner.

STA: *What situations encountered during the season were the most difficult to resolve?*
Clausen: To be honest once the decision was made to host the TiCat games we really did not have any real difficult situations. We all worked together as a team with the goal that the players, coaches, spectators, officials and television audience had the best experience possible.

STA: *What were the easiest?*
Clausen: Dealing with the TiCat staff was exceptionally easy. Steve Day the Project Manager, Steve Lowe the Marketing Director, Maurice Grant, Game Day Manager and all the support staff were great to work with. As is normal there were some miscommunication moments but we worked through them to provide a great experience for all.

STA: *The Hamilton Tiger-Cats donated $500,000 to the University of Guelph. What was that to be used for?*
Clausen: The TiCats made a $400,000 donation to the University's Better Planet Project specifically to the Athletic Facility Project portion of the campaign. The remaining $100,000 has been used to fund minor renovations, repairs and upgrades to the stadium.
STA: *Was there revenue sharing with the Tiger-Cats? If so, what was shared?*
Clausen: No there was no revenue sharing with the TiCats.

STA: *What did you most enjoy about the experience?*
Clausen: Working with an excellent group of people from a wide range of backgrounds and experiences to make a once in a life time series of events happen successfully in Guelph at the University.

STA: *What did you dislike about the experience?*
Clausen: It would have been greatly appreciated if the weather had cooperated a little better!

Q&A with Stephen Day, Director of Stadium Operations and Guelph Project Manager, and Steve Lowe Director of Marketing of the Hamilton Tiger-Cats Football Club

STA: *When did the organization find out you would not be able to play at Ivor Wynne Stadium in 2013?*
Ti-Cats: We started looking into potential options for the 2013 season in December 2011. Talks with the University of Guelph began in August of 2012.

STA: *When you approached potential universities what requirements/guidelines did you present to them?*
Ti-Cats: We needed to present them with the CFL Operation Guidelines to make sure they fully understood the specifications and requirements that would need to be fulfilled in order to host a CFL game.

STA: *Was the University of Guelph high on your list as you entered negotiations?*
Ti-Cats: The University of Guelph was high on our list due to the proximity to Hamilton, the physical layout of their stadium footprint, and their strong desire to share in the tradition of the Hamilton Tiger-Cats Football Club. We wanted to keep the games in a commutable distance for our season seat holders while also moving to a market within our regionalization zone. The University had also done a