# Cardinals Stadium boasts movable field tray

**By Mike Lloyd P.E.**

When the Arizona Cardinals open their new Cardinals Stadium against the Super Bowl champion Pittsburgh Steelers August 12, the team and their fans will be looking forward to an exciting season in their brand new NFL home.

For CMX Sports Engineers it will be an occasion to reflect on our design of the natural grass turf system for the stadium's movable field tray, the first ever in North America.

As a hometown Phoenix company, CMX has held a long relationship with the Cardinals. In 1990, we served as design engineer and construction manager for the team's training facility in Tempe, which includes three sand-based, natural grass fields.

Later, we oversaw the renovation of the natural grass playing field at ASU's Sun Devil Stadium when the Cardinals hosted Super Bowl XXX in 1996. NFL players have annually ranked the field among the top playing surfaces.

## FACTS AND FIGURES

**The field is a single movable structural pan and sod assembly with outside dimensions of 234 feet wide, 403 feet, 4 inches long, and 3 feet, 3 inches high. The total weight of the field and tray will be approximately 18.9 million pounds. The stadium door that the field will pass through measures 240 feet wide.**

**The pan structure supporting the sod and drainage system is about two feet deep and consists of 542 steel wheels riding on 13 parallel steel rails. The center row of wheels will be the guide wheels of the system, with 76 of the wheel sets powered by one-horsepower motors.**

**The field will travel approximately 740 feet from outside to inside Cardinals Stadium. Estimated time to move the field is about 65 minutes.**

**The entire 91,916-square foot area will be covered with natural grass turf except for an edge strip of artificial turf three feet wide around the perimeter of the field to allow maintenance staff to keep heavy equipment off the turf.**

**The 12-million pound turf system will have a uniform depth of 14 inches, consisting of 12 inches of sod and root zone materials with a two-inch drainage mat system at the bottom.**

**The top of the playing field will be crowned - with the center of the field two inches higher than the sidelines and end zones.**

**Water will drain through the system to area drains and feed into collector drain pipes running below the field decking.**

So, when plans for the team's new stadium were announced, featuring a retractable roof and a movable field, we really wanted to be involved. Consequently, to be selected by the Cardinals and Hunt Construction was a tremendous honor.

### Planning

Since a major selling feature of the new stadium would be its ability to host a variety of major events other than NFL and college bowl games, the use of a movable field to support the stadium's multipurpose aspect had always been envisioned.

Although we had recently designed artificial turf systems for the NFL's Baltimore Ravens, Cal-Berkeley and the University of Southern Mississippi, the Cardinals were strong proponents of playing their home games on natural grass. A stationary natural grass field, however, also would create issues. You would not only have to find a way to consistently grow grass inside the stadium, but more importantly, how to protect it when covered over multiple days for other events.

If the field was going to be natural grass, it would need to be moved into and out of the stadium. How, then, should it be designed? The project team first studied movable fields that had been built in Europe and Japan. Early discussions envisioned a field tray made of concrete or steel, operating on either steel or rubberized wheels. The design team created various wheel and tray concepts and developed cost estimates for different systems.

The final consensus was to build a giant steel tray, 234 feet wide, 403 feet long and three feet high with 14 inches available for the turf system, including drains and irrigation piping. The field would be carried by 542 steel wheels, 76 of them powered by one-

horsepower motors over 13 parallel-hardened steel rails. The system's total weight would be 18.9 million pounds.

Unisystems, already on board to design the stadium's retractable roof, and Walter P. Moore Engineers were selected to handle the mechanical and structural components of the tray respectively. CMX would design a natural grass turf system to fit inside.



Once we knew the parameters, we began our design work. While we were aware of other fields where the use of natural grass was adapted for covered stadiums, such as the small movable pallets at Reliant Stadium in Houston, we would be building a one-piece movable field in a single, very large container.

This created some unique challenges, including: What would be its rootzone medium? What type of grass would be best suited to the stadium and the wear and tear associated with NFL games? How would we irrigate the grass in a shallow, confined tray, both inside and outside the stadium? How would we create a drainage system workable both in the stadium on game day and in the field's stored position?

**Testing**

The project team agreed the next logical step in the design process would be to conduct an in-depth turf experiment. In May 2004, CMX oversaw the construction of two mockup field sections for testing and evaluation at the Cardinals' training facility. The mockups replicated, as nearly as possible, the anticipated field conditions at Cardinals Stadium. Their dimensions, 22 feet, 9 inches in length by 9 feet, 9 inches in width, represented two of the approximately 410 rectangular structural sections that would make up the overall stadium field. They were even sloped identically to the new field's slope.

Inside the mockups, there were eight sections that tested different combinations of natural grass systems including: (1) three types of root zone mix; (2) two types of grass, Tifway 419 and Celebration (each in sodded and sprigged applications); and (3) two types of drainage systems.

The testing also provided Tim Peterson, the Cardinals' talented turf manager, an opportunity to conduct a variety of moisture studies including the water retention capabilities of the various turfs. The data also is helping Tim as he maintains the new stadium's field in addition to his oversight of the teams' three grass practice fields.

The three root zone mixes tested were: (1) a USGA-specification sand stabilized with five pounds of polyurethene fibers and five pounds of polypropylene fibers per ton of growing media; (2) a blend of 80% USGA-specification sand with 10% Axis synthetic beads and 10%

"Worm Gold" organic material; and (3) USGA-specification sand with no additional amendments.

During the experiment, we periodically cut 12-inch square sections in the turf to measure root growth and observe the drainage system. We also conducted Clegg Impact Tests on both the mock-up fields and the adjacent practice fields to determine the general firmness of the various mixes as well as a variety of tests to measure moisture content and retention.

While each of the root mixes performed well, option #1 with its sand and stabilizer fibers proved to be the best. It most nearly matched the impact density of the existing practice fields and was the most effective at retaining moisture for root growth.

For the actual grass, the evaluation team chose Tifway 419. It was thick, green, and firm with a soft texture and deep root growth, and demonstrated superior ability to regenerate after divot damage.

Finally, although there was little visible difference in surface quality between the stolon and sod areas, the test sections planted with stolons provided stronger root growth. We therefore recommended a turf established with stolons, assuming a sufficient growing season in the spring and summer leading up to the stadium's opening.

In addition to demonstrating better root growth, we felt a grass field established with stolons would have less initial thatch, eliminate the chance of introducing a soil barrier layer between the sod and sand root-zone, and provide cost savings. If a sufficient growing season was not possible, sod could be used as an alternative.

For the underlying drainage mat, we selected the "Draincore 2" system by Airfield Systems, which was extremely efficient in collecting and discharging excess water and also provided excellent moisture control.

**Installation**

In mid-March of this year, the long-awaited installation began. First came the laying of a non-permeable plastic liner to provide a water-tight barrier and protect the structural steel in the tray from rusting.

Next was the placement of two one-inch layers of the drainage mat covered with a woven geotextile fabric, a permeable product that allows water to pass through into the drainage mat while holding sand from the rootzone mix in place. Then, the irrigation system, using a low-profile fitting configuration and Hunter "Ultra" sport sprinkler heads, was laid on top of the drainage mats.

The next step, in late April, was filling the mammoth tray with nearly five million tons of the sand and stabilizing fiber mix. The sand and fibers were mixed offsite and brought in by truck, unloaded and then scooped up by a front-end loader. The mixture was then placed on a long conveyor belt and spread uniformly across the tray.

In early May (and on schedule) the sprigging process began. The stolons used were derived from Tifway 419 sod, grown over 18 months in a medium consisting of a mixture of sand, clay and silt at the Evergreen Turf sod farm in southern Arizona. Installation of the stolons occurred within 12 hours of their harvest.

The sprigging, under the supervision of Valley Crest Contracting, was accomplished using a "hydro cannon" equipped with a fire hydrant-type hose shooting the stolons onto the sand base at a rate of 20 bushels per 1000 square feet.

The stolons were sliced and rolled into the surface by a lightweight disc machine and syringed to prevent drying and to bind them to the rootzone. Wood fiber mulch was added to the surface at a rate of 45 pounds per 1000 square feet.

It was time to water (and water and water) the field and watch the grass grow.

By late May, the grass was beginning to green. By mid-June, it was fully on its way to becoming an established field, and was given its first 740-foot test drive into the stadium, with eight more weeks of growing time before the Cardinals' first game.

We used that time to help in the fine-tuning of the field including fertilizing, rolling and topdressing, and working with the Cardinals to provide a field that will be durable and easy to maintain throughout 2006 and many seasons to come.

This has been CMX's most visible project because the field will be on national display for a Cardinals' Monday night game, the Tostitos Fiesta Bowl, and next year, when Cardinals Stadium will host Super Bowl XLII.

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