CREVE COEUR GOLF COURSE

ANALYSIS OF GOLF COURSE EXISTING CONDITIONS FOR NEEDS ASSESSMENT

11400 OLDE CABIN ROAD
CREVE COEUR, MISSOURI 63141

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Cover Photo-Hole-Number 9

EXECUTIVE SUMMARY

Site Description

Property Name: Creve Coeur Golf Course

Property Location: 11400 Olde Cabin Road, Creve Coeur, Missouri

Approximately .7 of a mile east of U.S. Highway 270 and .4 of a mile south of Missouri 340 (Olive Boulevard).

Course Owner: City of Creve Coeur;

Current Target Market: The primary customer base or market for the Creve Coeur Golf Course originates from Creve Coeur and the surrounding suburbs of Saint Louis. Additionally, the course competes for tournament and outing play originating from the local and regional market area.

Site Description: The site encompasses a total of 53.8 acres, improved with the Creve Coeur Golf Course, Creve Coeur Indoor Ice Arena, Maintenance Building and supporting improvements:

- *Main Building Ice Arena, Meeting Rooms, Cart Storage, Golf Shop, Offices – Approximately 43,150 ft²;*
- *Maintenance Building – Approximately 6,000 ft².*

Golf Course Specifications:

Number of Holes:	9
Par:	35
Yardage:	3,050 yards
Number of Tees:	36
Course Type:	9-Hole
Practice Facilities:	Practice Green
Zoned:	Subject property is not zoned

Surrounding Property Uses: Surrounding zoning is designated Single Family Residential (east and south of subject property), Planned Office District (north of subject) and Core Business (directly west of subject property). See Addendum 1 - Zoning Map on page 31.

Topography: Level to slightly undulating;

Drainage: On course retention ponds;

Irrigation Water: Creve Coeur Golf Course irrigates the golf course with potable water purchased from Missouri American Water. Irrigation system operates off supplied water pressure without additional booster pumps.

In the executive summary my findings are broken into sections relating to:

- Renovations/Projects that improve **health** and **safety** for employees and patrons;
- Renovations/Projects that would save **labor and overall expense savings**;
- Renovations/Projects that would add to the **positive patron experience**;
- Renovations/Projects that will prove to have a positive impact on **overall ease of golf course maintenance**.

Many golf course features and equipment assets have been deferred from renewal and/or replacement on a needed basis over the years. In the pages to follow I will outline a strategy to renew these features and assets on a schedule that will begin to enhance the valuable golf course asset and patron experience that is the Creve Coeur Golf Course. See page 29, Project Timeline,

Renewing or replacing assets well after the useful life is most always more expensive than planning for renovation or renewal on a planned basis, prior to exceeding the assets complete normal life-expectancy.

Existing conditions are reported in pages 11 through 28 and organized by features and assets beginning with greens.

A map illustrating major projects and their location on the course is located in Addendum 2 – Project Map on page 32.

SAFETY

General safety of patrons and employees should be considered most important when considering any renovations or capital intense projects. The following safety items are based upon my observations and cannot be all inclusive during just five days of observation. However, these items should be considered important in comparison to other capital items that would save operating costs or add to golf playability, operation ease or expense savings or income enhancements.

BRIDGES

Photo 1 Equipment bridge between hole 5 and 6

Safety issues include maintenance service bridge at the maintenance facility, player/service bridge near #5 green and service bridge between holes number 6 and #5. These bridges lack proper decking, and/or superstructure and/or safety rails and should be repaired or replaced as soon as reasonably possible.

It may be advisable to consider prefabricated bridges that would conform to all applicable safety regulations for weight, railing height and needed width.

MAINTENANCE FACILITY

There are several issues that employee safety may be at risk:

- No emergency eye wash station;
- Turf chemical storage not locked.

These safety items should be addressed as soon as possible.

Maintenance Facility (continued)

Photo 2 Maintanance facility

Generally, the maintenance building and surrounding parking and yard area is very poorly suited for the performance of golf course maintenance. A site plan should be considered to arrange a proper building and a specific area to inventory, mix and load turf chemicals. If buildings were arranged with the back to play area a safe parking and yard area could be shielded by the structure. A separate building may be considered to house turf chemical application equipment and turf chemical inventory. Securing turf chemical inventory and spill containment should be considered high priority safety items. More information on maintenance building planning may be obtained by contacting McMahon Group at www.mcmahongroup.com.

Photo 2 illustrates the exterior of the maintenance building is of a wood frame and wood siding construction. Nearly all modern golf maintenace buildings constructed are cement masonery units (CMU) and steel.

Photo 3 shows the designated area for cleaning equipment and mixing turf chemicals. There is no spill containment should an unintended turf chemical release occur.

The under-roof facility is approximately 6,000 ft². Based on size of staff and equipment fleet the current size the building may undersized by as much as 4,000 ft².

Photo 3 Wash pad at maintenance facility

NUMBER 4 TEE

Photo 4 Retaining wall at 4 tee

Number 4 tee has a cement masonry unit (CMU) wall that is in jeopardy of failure, as shown in Photo 4. This retaining wall should be repaired or replaced as soon as possible.

It is imposable to know just how long or to what extent a failure will manifest itself. It's possible that a failure will be a gradual collapse or a catastrophic rapid collapse involving patrons and/or employees. As plainly illustrated by the red line visible in Photo 4, the retaining wall is leaning well past 90° (see Addendum 2 - Project Map, page 32).

TEE HARDSCAPES

As seemingly appropriate as these features look, the hardscapes at tees 5, 4, 6, 8 are potential hazards as well as maintenance struggles. Trip and fall accidents as well as where the hardscape ends and turf resumes have developed distinct wear areas.

Many courses I have been associated with have removed the hardscapes and have added turf back into the slope. The flow of foot traffic may necessitate barrier signage to distribute wear.

Photo 5 Worn tee top area on number 6 tee, from shade and foot traffic

NUMBER 1 TEE

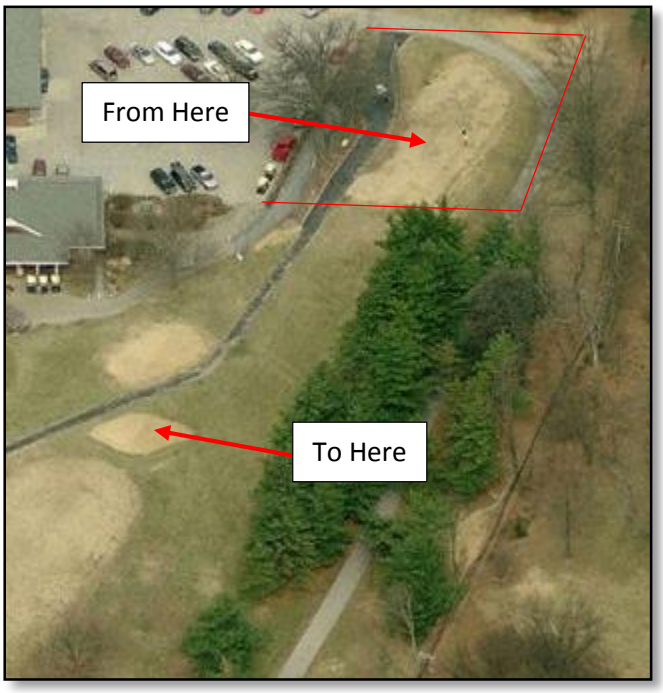


Photo 6 Move number 1 tee forward

Number 1 tee faces many issues; copious amounts of shade, increase foot traffic of players waiting to tee off, limited egress onto the tee and errant shots traveling right in close proximity to the practice green. An alternative would be to shorten the hole by moving the tee forward and slightly to the west.

By moving the tee forward by approximately 60 yards it could perhaps limit most dangerous errant shots, improve turf quality, enlarge the tee to better serve the patron and just marginally change the shot value into number 1 green.

Also, by moving the tee forward the City could then increase parking by nearly 11,000 square feet (approximately 25 additional parking spots) and make the number 1 tee visible from the golf shop window.

Number 1 hole will still play to a respectable 257 yards from the back tee as opposed to 317 currently. This yardage change would still preclude most golfers from driving this hole (see Addendum 2 - Project Map page 32).

LABOR AND OVERALL EXPENSE SAVINGS

IRRIGATION SYSTEM REPLACEMENT

Perhaps the most complex system at any golf course is the irrigation system. It's maze of pumps, wires, pipe and tubing must be extraordinarily dependable and efficient enough to apply water to turf in a reasonably timely and efficient manner.

The irrigation system at Creve Coeur Golf Course is well past its useful life. We have conducted an audit to quantify the poor distribution, performance, wasted labor time and wasted precious water. I would put this renovation on top of the list of replacements (see page 27 for evaluation of irrigation system).

POSITIVE PATRON EXPERIENCE

GOLF COURSE CART PATHS

In the years when petroleum was lower priced many golf courses elected to use asphalt as the product of choice for golf cart paths. Now, concrete is priced nearly equal with asphalt and is far superior in durability. The cart paths at Creve Coeur are in very poor repair. As the city begins to repair or replace paths the preferred material should be concrete. The path should be at least 6 feet wide along fairways and 7 feet wide around greens and tees. Areas around greens and tees may have curbing installed to curtail turf wear in these critical areas.

DRAINAGE REPAIRS

Mainline drainage may be installed on fairway areas intersecting holes 6 and 7. Once installed these mainlines could be tapped to add ancillary drainage to dry areas adjacent to these holes (see Addendum 2 - Project Map, Page 32).

SAND BUNKERS

The lack of sand bunkers is a topic that has been discussed. Currently Creve Coeur Golf Course does not have any sand bunkers. Before a decision is made to add any sand hazards the subject should be studied to include:

Design	Location
Initial Cost	Maintenance

These cost may be in excess of $12 per square foot for new sand bunker construction, maintenance cost may be upwards of $25 per season, per square foot. Any considerations for sand bunker construction should be made before irrigation system installation.

OVERALL EASE OF GOLF COURSE MAINTENANCE

EQUIPMENT INVENTORY

Equipment is an ongoing expense at all golf courses. The city should consider leasing high use machines such as greens and tee mowers. This is especially a good strategy for golf courses similar to Creve Coeur that does not employ a full time mechanic and no back-up machines are inventoried for these most critical routine duties.

A proper **minimum** list of equipment for a course similar to Creve Coeur Golf Course is illustrated in Table 1 with the current inventory.

Overall Ease of Golf Course Maintenance (continued)

Creve Coeur Golf Course Equipment Inventory Recommendations	
RECOMMENDED	**IN INVENTORY**
Greens - Triplex Mower (lease)	Greens - Triplex Mower (owned)
Tees - Triplex Mower (lease)	Tees - Triplex Mower (owned)
Fairway – Fiveplex Mower	Fairway – Fiveplex Mower
Rough – Triplex Rotary Trim Mower	**2 Rough – Rotary Trim Mower (Replacement Needed)**
Rough – Fiveplex Rotary Mower	Rough – Fiveplex Rotary Mower
Greens Roller	**Greens Roller (Replacment Needed)**
Turf Sprayer	Turf Sprayer
(2) Heavy Duty Utility Trucksters	**(2) Heavy Duty Utility Trucksters (One Replacment Needed)**
(4) Light Duty Utility Carts	**(2) Light Duty Utility Carts (Two Replacments Needed)**
Topdress Machine	Topdress Machine
Debris Blower (3 Point Hitch)	Debris Blower (3 Point Hitch)
Debris Blower (Tow-Behind Truckster)	**Not in Inventory**
Front Loader Tractor	Front Loader Tractor
Utility Tractor	Utility Tractor
Seed Planter (3 Point Hitch)	Seed Planter (3 Point Hitch)
Greens Aerifier	Greens Aerifier
Fairway Aerifier (3 Point Hitch)	Fairway Aerifier (3 Point Hitch)
Vertical Mower Attachments (For Triplex)	Vertical Mower Attachments (For Triplex)

Table 1 Equipment recommendations

Photo 7 Heavy duty utility truckster

Photo 8 Triplex tee mower

GOLF COURSE EXISTING CONDITIONS

The purpose of this study is to investigate current conditions, assess golf course maintenance equipment, golf course features and components that comprise the golf course assets specifically at Creve Coeur Golf Course. Feature valuations and irrigation systems are based on industry averages[1]. For equipment actual replacement costs from manufacturers and/or distributers have been used.

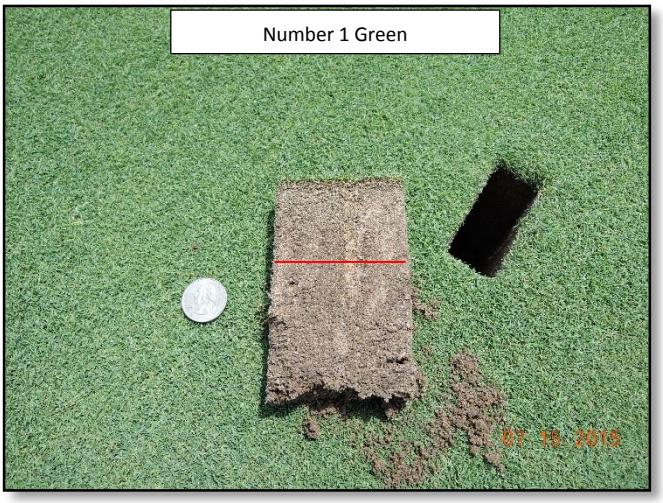
Upon arrival at the facility I was met by Golf Course Superintendent, Cory Gettemeier. Mr. Gettemeier and I began with discussing the history and operating characteristics of the golf course. After a brief run-down of the golf course history, an overview of Creve Coeur Golf Course's equipment fleet and a hole-by-hole tour of the golf course was begun.

Overall, the golf course appeared to be in very good condition. With above average rainfall during the beginning of the 2015 golf season, turf exhibited good color and density, with few exceptions.

Greens are a mixture of Annual Bluegrass (*Poa annua*) and Creeping Bentgrass (*Agrostis stolonifera*). Fairways and tees are a mixture of several Zoysia grass varieties (*Zoysia Japonica)* and varieties of Bermuda grass (*Cynodon dactylon)*.

[1] Golf Course Construction & Renovation Costing, Version 6, Golf Course Builders Association of America

GREENS



Number 1 green is typical of the majority of greens at Creve Coeur Golf Course. Illustrated in the Photo to the left the sand root zone extends just 3 inches below the turf canopy. Roots rarely extend into dissimilar textures in a green root-zone.

On #1 we can see the bright colored sand from past aerification and topdressing. The turf coverage is very good. No disease present, overall quality is very good.

This green, with proper corrective measures should preform reasonably well in the future. Continued aerification, vertical mowing and topdressing are recommended cultural practices. During the season spiking and venting may be needed to increase gas exchange in the lower root-zone. Thatch is controlled well with less than ½ inch visible.

Number 1 green is 26 years old.

Number 2 green is not typical with a sand profile well below 6 inches. Rooting on this green was deeper than most at greater than 4 inches. Although the sand profile extended below 6 inches we can still see the positive benefits and signs of proper aerification and sand topdressing. Turf cover was very good and disease free. Superintendent Gettemeier mentioned that #2 green dries much faster than the other greens most likely attributable to the large column of sand that comprises the root-zone and irrigation inefficiencies.

Number 2 green is 22 years old.

Greens (continued)

Number 3 green has a sand profile of at least 6 inches. The green is severely shaded by a number of oak and hickory trees to the south and east limiting the critical morning sunlight on the turf surface. The turf population is very good and the green appeared to be in very good condition with a root system depth of 1 to 2 inches.

It is highly recommended to remove and/or heavily prune the trees that are limiting sunlight to the #3 green. Also helpful would be to install an oscillating fan to improve air circulation to this particular green that is situated in an area that receives little air movement. A complete installation for an oscillating fan, purpose-built for green use would cost an estimated $8,500 installed.

As shown in the photo to the right, #3 green, nearly half of the green is receiving sunlight, this photo was taken at approximately 9:00 am. Early morning sunlight is most critical to golf green turf. Also, an unrestricted flow of air is of great importance to turf leaf drying and proper gas exchange in the turf leaf blade. For these reasons proper tree placement in the future and careful pruning and in some cases tree removal is essential in a good turf maintenance regime.

Number 3 green is 27 years old

Greens (continued)

Number 4 green has a root-zone comprised mostly of sand over heavy clay. The clay layer is at approximately at 3½ inches below the turf canopy. Rooting is restricted to the sand layer and especially the aerification holes with topdressing sand incorporated.

Turf population on #4 green was very good. Color was good with no disease or weeds present.

Limited hole-cup positions are available on this green, for this and perhaps additional parking options it may be practical to move this green forward by at least 15 yards with a less severe slope.

Number 4 green is 36 years old.

Number 5 green is sand above heavy clay. Rooting was slightly less deep than average at just 3 inches. On several spots I did notice a slight occurrence of blue-green algae. The algae is most common on greens that have poor drainage that retains water in the top layer of the root-zone for extended periods of time. Additional aerification and sand topdressing may alleviate this problem.

Although they do not infect grasses, blue-green algae is a significant pest. Algae have historically been thought of as secondary colonizers, meaning that they only fill-in areas where turf density has been reduced by some other problem. However, mounting evidence indicates that high levels of algae activity can directly cause thinning of putting green turf, possibly by production of toxins or competition for air, water, and nutrients. An aggressive algae management program can greatly increase the density and overall quality of putting greens during periods of warm and humid weather.

Take steps to correct algae problems with removal of shade and increased air circulation. Mow at the recommended height for each turfgrass species, and if possible, increase mowing heights in shady areas to compensate for the reduced light levels. Irrigation should be applied deeply and infrequently; apply sufficient water to wet the entire root zone, and then reapply as needed when the turf shows signs of wilt. Putting greens and other heavily trafficked areas must be cultivated (aerified, spiked or small diameter solid tines) regularly to maintain soil drainage and aeration.

Fungicide treatments may slow down the progression of algae. However, once a severe algae infestation has occurred, fungicide applications alone will not provide acceptable control. Additional steps must be taken to physically break-up the mat of algal growth so that the turf can recover.

Number 5 green is 30 years old.

Greens (continued)

Irrigation practices have a great effect on turf rooting. Deep, infrequent irrigation produced a greater number of roots, longer roots, a larger root surface, lower soil temperatures, less thatch, and generally higher water-soluble and total nonstructural carbohydrates than light, frequent irrigation. For these reasons it should be attempted to practice deep infrequent irrigation. It should be noted that this deep irrigation practice is best performed with an adequate irrigation system that will deliver water with a greater distribution uniformity that is being currently used at Creve Coeur Golf Course.

Aerification timing, diameter of tine and depth of tine is also a significant practice that will invoke deeper rooting.

Number 6 has a good profile of solid sand to a depth well over 7 inches. Although sand depth on 6 green is greater than most greens at Creve Coeur, roots are not growing significantly deeper in the root-zone as would be expected.

The front of the green remains wet even in dry conditions. An addition of a perimeter drain on the lower front may eliminate this problem; this work could be accomplished in house.

Number 6 green 24 years old.

Number 7 green has a deep sand root-zone with viable turf roots penetrating to 4 inches below the turf canopy. Blue-green algae is also present on 7 green to a small extent.

Number 7 green is 22 years old.

Greens (continued)

Number 8 green has a root-zone of sand over heavy clay. The sand depth is approximately 4 inches below the turf canopy. Rooting depth is slightly less than 3½ inches from the turf canopy. No weeds or disease was present during my visit.

Turf population and density is good. A severe shade issue is present on the east side of the green until approximately 10:00 am limiting critical morning light and turf drying.

Number 8 green is 37 years old.

Number 9 green consists of sand to a depth of more than 7 inches. Rooting extends to slightly below 4 inches. Turf population and density is very good. No weeds or disease was present during my visit.

There is severe slope to the green surface from north sloping down to south. This radical slope is rendering much of the green surface not acceptable for placing a hole-cup.

If green reconstruction is considered number 9 would be a good candidate based purely on the contour on slope of the green. Do to the greens significant slope cupping/flag stick positions are greatly limited. This may cause undo wear on the flattest areas of the green. Rebuilding this green to a flatter surface would have an impact on patron satisfaction and ease of maintenance.

Greens (continued)

The practice green is in generally good condition considering the amount of traffic it endures. Sand depth is greater than 7 inches. Root depth is slight greater than 4 inches below the turf canopy.

Similar to green number 6, the front low area suffers from a waterlogged condition, additional drainage tile may alleviate this problem.

No weeds or disease was present during my visit.

The practice green is 19 years old.

Greens at Creve Coeur Golf Course are all very serviceable for the foreseeable future with proper care. The issues demonstrated with morning sunlight and perhaps a more aggressive aerification regime and topdressing will only be beneficial in the short and long term. Deep tine aerification has been used successfully to "Breathe" new life into tired greens[2]. I would recommend deep tine aerification on greens along with a moderately high application of sand topdressing. Moderately heavy would be 100 tons of sand or 60 cubic yards for all 11 greens. This sand topdressing should be brushed into the deep tine channels as soon as possible as to not allow the channels to collapse. Often, with deep tineing additional brushing may be necessary after several days of settling.

Photo 9 Deep tine aerification on a golf green

2 Deep-Tine Aerification in Compacted Soil, Golf Course Maintenance, December 2003, E.A. Guertal, Ph.D.; C.L. Derrick; and J.N. Shaw, Ph.D.

Greens (continued)

Many superintendents sand topdress prior to aerification with a solid deep tine machine such as the one illustrated in Photo 9. The sand acts to cushion the tractor weight and tire tread. This operation can be contracted for approximately $800.00 per acre for greens.

The American Society of Golf Course Architects, several years ago published a guide to help golf course stakeholder's understand useful life estimates for golf course assets (Figure 1). While each golf course can be dramatically different these guidelines may be used as a general rule for asset replacements.

HOW LONG SHOULD PARTS OF THE GOLF COURSE LAST?

No two golf courses are alike except for one thing: deferring replacement of key items can lead to greater expense in the future, as well as a drop in conditioning and player enjoyment. The following information represents a realistic timeline for each item's longevity.

Component life spans can vary depending upon location of the golf course, quality of materials, original installation and past maintenance practices. The American Society of Golf Course Architects (ASGCA) encourages golf course leaders to work with an ASGCA member, superintendents and others to assess their course's components.

ITEM	YEARS
Greens (1)	15 – 30 years
Bunker Sand	5 – 7 years
Irrigation System	10 – 30 years
Irrigation Control System	*10 – 15 years*
Pump Station	*15 – 20 years*
Cart Paths – asphalt (2)	5 – 10 years (or longer)
Cart Paths – concrete	15 – 30 years (or longer)
Practice Range Tees	5 – 10 years
Tees	15 – 20 years
Corrugated Metal Pipes	15 – 30 years
Bunker Drainage Pipes (3)	5 – 10 years
Mulch	1 – 3 years
Grass (4)	Varies

NOTES: ***(1)*** *Several factors can weigh into the decision to replace greens: accumulation of layers on the surface of the original construction, the desire to convert to new grasses and response to changes in the game from an architectural standpoint (like the interaction between green speed and hole locations).* ***(2)*** *Assumes on-going maintenance beginning 1 - 2 years after installation.* ***(3)*** *Typically replaced because the sand is being changed – while the machinery is there to change sand, it's often a good time to replace the drainage pipes as well.* ***(4)*** *As new grasses enter the marketplace – for example, those that are more drought and disease tolerant — replanting may be appropriate, depending upon the site.*

Figure 1 American Society of Golf Course Architects list of golf course feature lifespans

USGA Method of Green Construction

The USGA construction method makes use of a common principle of water movement in soil - a perched water table. This principle is graphically illustrated in the time-lapse movie Water Movement in Soils, produced by Dr. Walter Gardner, at Washington State University, in 1957. This means that water resists flow from a fine-textured soil into a coarser material below it until the upper profile has become saturated and gravity overcomes the adhesive nature of water for soil and the cohesive force of water molecules. Thus, even a sandy surface mixture need not be droughty if there is an abrupt change in particle size between the root zone mixture and the drainage layers below. In effect, it made use of stratification (often called layering) for beneficial results.

If any greens are rebuilt at Creve Coeur Golf Course it is highly recommended that USGA construction methods be followed.

Greens (continued)

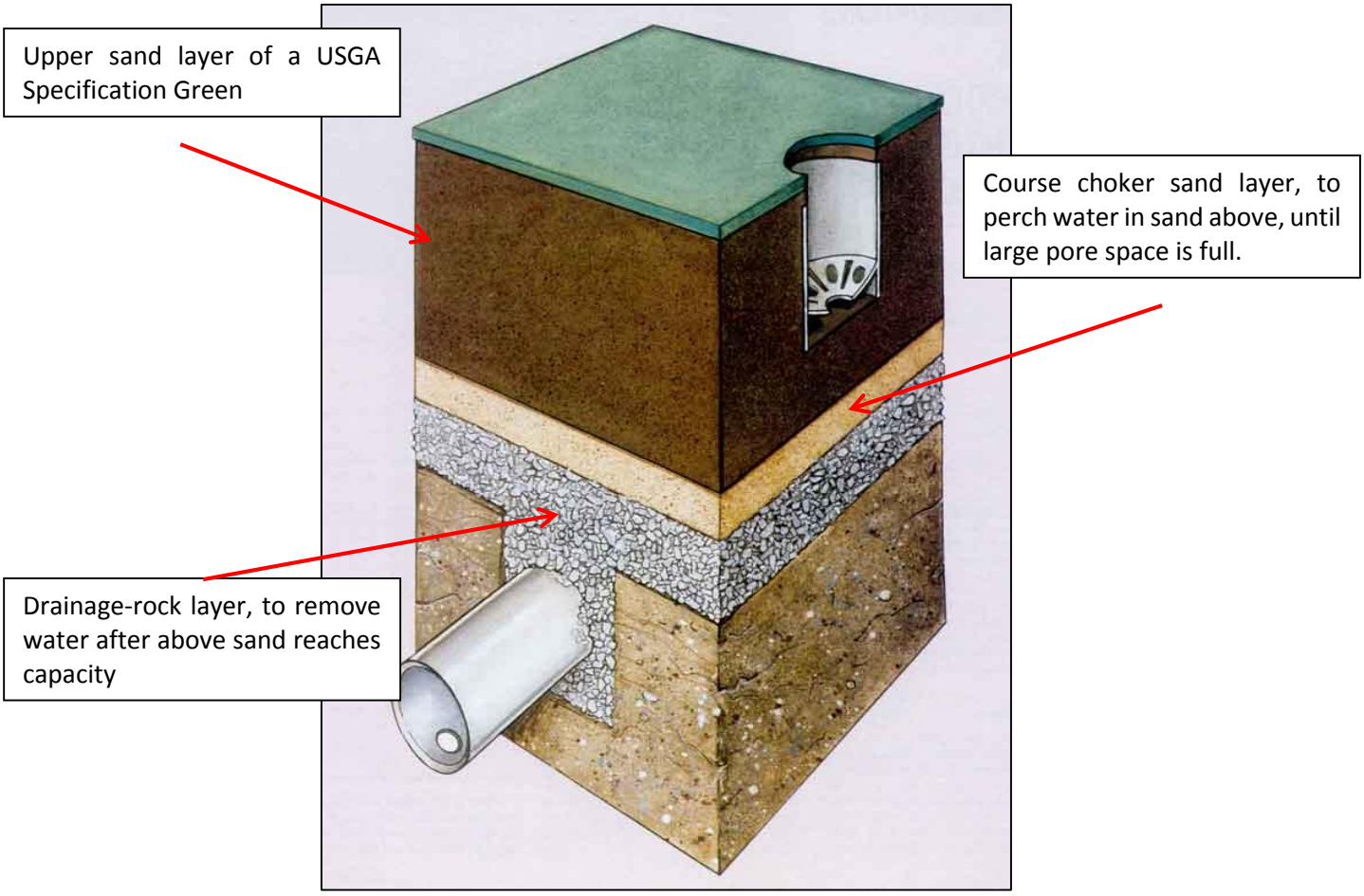


Figure 2 Typical USGA specification green profile

Figure 2 is a cutaway of a properly constructed USGA specification green. I believe this is such a critical subject to stakeholders in the golf business, I include this short explanation in each of my agronomic based reports.

Sand based constructed root-zones are living structures that change over time due to the presence of plants and microorganisms. These impacts include:

Negative changes in hydrological properties due to the development of water repellency and pore clogging;

- Organo-mineral complexes that impact nutrient retention;
- Fluxes in microbial community structure that impact nutrient cycling and plant performance;
- Build-up of debris and shifts in plant community structure at the root-zone surface;
- Mechanical reinforcement of root-zone soil by the enmeshment of particles by roots and fungi, as well as biological exudates that bind particles.

For these reasons aeration, vertical mowing, sand topdressing and other cultural practices are critical to long lived heathy USGA construction specification root-zones and most other green root-zones.

TEES

Number 1 tee is situated in a poor area of shade and traffic congestion. Wayward tee shots often end up far right, causing a dangerous situation on the practice green. Moving the tee forward may alleviate this problem and solve:

- Morning light on turf surface;
- Golf cart and player congestion;
- Additional parking area;
- Move tee 60 yards forward and slightly west.

Additionally, there is already a tee in this area.

Number 2 tee has just undergone a re-surfacing to Zoysia. The tee is large enough to sustain normal play for a par 3 golf-hole. Selective pruning or tree removal may be necessary to sustain turf growth on front ¼ of tee. Additionally, several applications of sand topdress is recommended to level and allow sod seams to "knit". The retaining wall is in good repair.

Number 3 tee is in good condition

Photo 10 retaining wall at 4 tee

Number 4 tee should be completely rebuilt as soon as possible. As mentioned earlier the retaining wall that surrounds the front of the lower level is beginning to lean well past 90°. If left un-repaired eventually the wall will succumb to waterlogged soil (hydraulic pressure) and to gravity and fail. Steps, and other hardscapes should be considered in the reconstruction project.

Number 5 tee is in good condition. The hardscape east is functioning well and looks attractive. As mentioned earlier in this report hardscapes on the course should be kept at a minimum.

Number 6 tee could be moved 50 feet east to eliminate shade from trees as well as give more of a buffer form approach shots to 5 green. Turf quality is poor from traffic and shade. By slightly elevating the tee and moving the tee east the angle to the fairway on 6 would also be improved.

Number 7 tee is in good condition. However, the bridge that crosses the water feature directly in from of the tee has a railing that may affect the tee shot. It may be possible to lower the railing slightly to eliminate the tee shot interference.

Number 8 tee is thin in the area where the steps end. The hardscape on this tee may be removed and replaced with just a turf slope leading to the tee surface.

Number 9 tee is large enough and in reasonably good condition. The back positions do not give the player a view of the target and may be considered a waste of resources to maintain.

Tees (continued)

Tees as a whole are in reasonably good condition. It should be noted that any turf will survive much better if given proper light, especially morning sunlight[3]. However, even tees in perfect condition will occasionally need to be resurfaced due to wear and unevenness over time. Also of note, as with any highly maintained turf aerification will improve turf population and density overtime.

FAIRWAYS

Number 1 fairway was found to be in reasonably good condition.

Number 2 fairway consists of a small area directly in front of the green. This small landing area is in good condition.

Photo 11 Fairway number 4, arrow denotes Goosegrass filling voids

Numbers 3, 4 and 5 fairways have several areas of Bermuda grass encroaching on the Zoysia. Additionally, the soil seems to be very compacted and signs of annual grassy weeds have emerged[4]. Goosegrass (*Eleusine indica*) can be particularly difficult to control when soils are compacted. Aerification on these fairways as well as all other fairways may be a remedy for poor turf performance and difficult to control annual grassy weeds.

Deep-tine aerification relieves soil compaction at lower levels than typical aerification. The tines fracture the soil creating channels through the root-zone allowing oxygen, water and nutrients to penetrate deep into the soil profile. Deep-tine aerification may penetrate the soil up to 16" below the turf canopy. Contractors will perform deep tine aerification on fairways for approximately $300 per acre. This operation will most certainly improve grassy weed control and turf quality.

While it's true that the root system usually stops where the aeration tine stops, if aerification reaches 16 inches below the turf canopy, the root system will support a very healthy stand of turf. With a deeper root system from deep tine aerification, irrigation intervals can be lengthened, fertilizer applications last longer, and more oxygen is introduced into the soil.

[3] Addressing Shade Issues, http://usga.org Shade Issues, Pat Gross, director, USGA Southwest Region, May, 2011
[4] Getting a Grip on Goose Grass, Superintendent , January 2015, Pages 59-60, John Fech

Fairways (continued)

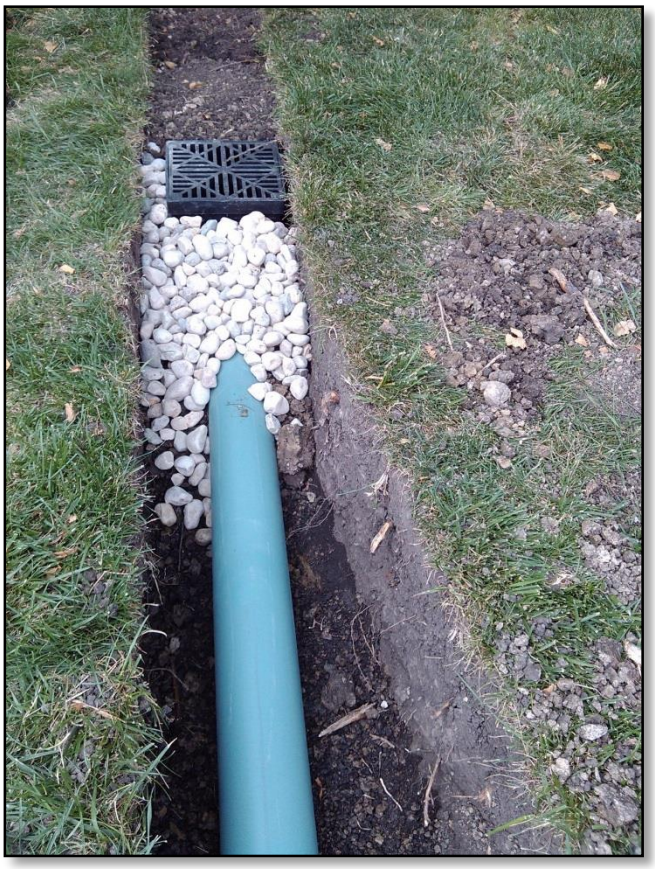


Photo 12 Solid PVC drainage pipe

Number 6 fairway has a very serious wet area just short of the water feature. It is apparent that some type of drainage work is needed to elevate the problem. If drainage is installed, a solid PVC pipe may be used with drain grate perforated risers to grade. Budget $16.00 per foot for 8 inch drainage (refer to page 32, Addendum 2 - Project Map for locations).

Photo 13 ADS type perforated pipe

Number 7 fairway is in relatively good condition with the exception of several voids and perhaps the addition of drainage in the two swale areas, adjacent to number 6 fairway.

Number 8 fairway is in excellent condition. The fairway was observed to be weed free and the turf population was excellent with Zoysia dominating the surface. Aerification would ensure the fairway remains in very good condition. Full sun is available all day as well as good natural drainage.

Number 9 fairway/approach is in good condition.

CART PATHS

Photo 14 Deteriorating paths near 9 green

Cart paths are generally well past their useful life. Many of the paths are severely fragmented and/or the asphalt is cracked or broken. It would be wise to budget for replacement with concrete. Concrete cart paths are close to the cost of asphalt and have a much longer life. Budget $7.50 per ft². The average par 4-hole at Creve Coeur would cost approximately $75,000 to install concrete cart paths 7 feet wide at greens and tees and 6 feet wide along fairways and other areas on golf holes.

BRIDGES

Bridge on number 3 is in good condition with the exception of the railing may need to be built to higher strength standard to withstand a more substantial vehicular impact.

Bridge on number 4 is more of a culver pipe than a true bridge, although some sort of guardrail may be desirable.

Bridges (continued)

Photo 15 Equipment bridge at number 5

Bridge on number 5 is in very poor repair and should be placed out of service and repaired. Guardrails will not support a mis-step by pedestrian, broken or split lumber is present which could easily cause a trip and fall.
Maintenance bridge from 5 to 6 is in poor repair. The bridge has no guardrail and deck boards are beginning to split. This bridge should be repaired as soon as possible.
Bridge on number 6 is only 5 years old and is in very good condition.

Bridge on number 7 is only 5 years old and is very good condition. Both prefabricated steel bridges with wood decking should be maintained. The wood decking should be sealed at least every three years or as needed. This bridge does have a railing that is in elevation higher than the tee and may be lowered to accommodate players tee shots.

The bridge on 9 is more of a culvert pipe than a bridge.

The equipment bridge at maintenance/dump area is sinking and should be completely replaced as soon as practical. This bridge has no guardrails.

See Major Project Timelines, page 29, for cost and recommended schedule of project, see page 32, Addendum 2 – Project Map for locations.

PRACTICE AREAS

Photo 16 Computerized Golf Simulator

Currently there is no practice area except for the practice putting green that exists at Creve Coeur Golf Course. However, with indoor space available, many fine golf simulators are currently on the market. A word of caution, cheap golf simulators will not stand-up to the rigors of commercial play. If the city chooses to purchase a golf simulator be certain it will be reliable and perform to a high standard.

EQUIPMENT

On the following page (Page 26) is listed the complete inventory of golf maintenance equipment. These pieces are listed to help guide management to the relative usable life that remains and the amount of replacement funds necessary to keep the inventory in good condition.

Some items may last longer and some may not last as long as estimated, these estimates are based on industry averages for a like golf course.

EQUIPMENT – INVENTORY AUGUST, 2015

Creve Coeur Golf Course

Cory Gettemeier, Golf Course Superintendent

Owned Equipment Inventory

# of Units	People Movers / Utility Cars	Year Purchased	Original Unit Cost	Condition 1-5 (1Poor-5Excellent)	Unit Cost for New Replacement	Replacement Cost	Useful Life Remaining	Replacement Year	Comments
2	Club Car Carry-All Turf 2	2014	$ 3,578	4	$ 4,700.00	$ 9,400	6	2021	
1	Toro Workman 3300D (2005)	2008	$ 9,500	3	$ 19,000.00	$ 19,000	3	2018	
1	Toro Workman MD	2012	$ 4,900	2	$ 19,000.00	$ 19,000	4	2019	
1	Cushman Truckster	1997	$ 11,200	1	$ 25,000.00	$ 25,000	1	Replace or Salvage	
1	Cushman Truckster	2001	$ 9,304	1	$ 25,000.00	$ 25,000	1	Replace or Salvage	

# of Units	Tractors / Trucks	Year Purchased	Original Unit Cost	Condition 1-5 (1Poor-5Excellent)	Unit Cost for New Replacement	Replacement Cost	Useful Life Remaining	Replacement Year	Comments
1	Dodge Ram Pick-Up Truck (2003)	2008	$ 5,500	3	$ 30,000	$ 30,000	3	2018	
1	Chevy 1 Ton	1990	$ 16,686	1	$ 40,000	$ 40,000	1	Replace or Salvage	
1	John Deere 5200	1995	$ 13,959	3	$ 28,000	$ 28,000	12	2027	
1	Ford 2820 Tractor	1996	$ 14,172	3	$ 35,000	$ 35,000	6	2021	
1	John Deere 240 Skid Steer	1995	$ -	3	$ 38,000	$ 38,000	10	2025	Transfer from another city department
1	Chevy ¾ Ton	2003	-	2	$ 35,000	$ 35,000	5	2020	Transfer from another city department

# of Units	Greens Mowers	Year Purchased	Original Unit Cost	Condition 1-5 (1Poor-5Excellent)	Unit Cost for New Replacement	Replacement Cost	Useful Life Remaining	Replacement Year	Comments
1	John Deere 2500 E	2014	$ 30,349	4	$ 31,000	$ 31,000	9	2024	
1	Toro GreensMaster 1000	2005	$ 5,783	3	$ 6,000	$ 6,000	2	2017	
1	Toro GreensMaster 1000 (2002)	2007	$ 1,955	3	$ 6,000	$ 6,000	2	2017	

# of Units	Tee Mowers	Year Purchased	Original Unit Cost	Condition 1-5 (1Poor-5Excellent)	Unit Cost for New Replacement	Replacement Cost	Useful Life Remaining	Replacement Year	Comments
1	Toro GreensMaster 3100 (2000)	2007	$ 10,000	4	$ 23,000	$ 23,000	2	2017	
1	Jacobsen Greens King IV	1995	$ 14,000	2	$ 28,000	$ 28,000	1	Replace or Salvage	

# of Units	Fairway Mowers	Year Purchased	Original Unit Cost	Condition 1-5 (1Poor-5Excellent)	Unit Cost for New Replacement	Replacement Cost	Useful Life Remaining	Replacement Year	Comments
1	Jacobsen LF 3400	2007	$ 15,350	1	$ 30,000	$ 30,000	1	Replace or Salvage	

# of Units	Rough Mowers	Year Purchased	Original Unit Cost	Condition 1-5 (1Poor-5Excellent)	Unit Cost for New Replacement	Replacement Cost	Useful Life Remaining	Replacement Year	Comments
1	Toro GroundsMaster 4500-D (2010)	2013	$ 33,500	3	$ 55,000	$ 55,000	3	2018	
2	Kubota F 2560	2003	$ -	2	$ 16,500	$ 33,000	1	Replace or Salvage	Transfer from another city department

# of Units	Other Equipment	Year Purchased	Original Unit Cost	Condition 1-5 (1Poor-5Excellent)	Unit Cost for New Replacement	Replacement Cost	Useful Life Remaining	Replacement Year	Comments
1	Salsco Roller	2011	$ 7,500	2	$ 8,000	$ 8,000	1	Replace or Salvage	
1	Toro ProCore 648	2010	$ 19,471	4	$ 27,000	$ 27,000	10	2025	
1	Toro Aerothatch Seeder	2005	$ 5,932	4	$ 6,500	$ 6,500	10	2025	
1	Lely Fertilizer Spreader	1993		3	$ 4,000	$ 4,000	5	2020	
1	Turfco Sod Cutter	1992		1	$ 5,500	$ 5,500	1	Replace or Salvage	
1	Toro 686 Aerifier	1989	$ 3,200	1	$ 12,000	$ 12,000	1	Replace or Salvage	May be less expensive to contract fairway aerification
1	Jacobsen Walkbehind Seeder	1994	$ 4,675	3	$ 7,500	$ 7,500	10	2025	
1	Toro 2613 Blower	1998		4	$ 5,500	$ 5,500	15	2030	
1	Toro Propass 200	2010	$ 11,834	3	$ 15,000	$ 15,000	12	2027	
1	Toro Spray Pro 200 Gallon w/ Workman	2004	$ 15,491	3	$ 40,000	$ 40,000	5	2020	

# of Units	Shop Equipment	Year Purchased	Original Unit Cost	Condition 1-5 (1Poor-5Excellent)	Unit Cost for New Replacement	Replacement Cost	Useful Life Remaining	Replacement Year	Comments
1	Foley Bed Knife Grinder (1992)	2008	$ 2,000	2	$ 20,000	$ 20,000	1	Replace or Salvage	May be less expensive to contract sharpening
1	Foley 600 Reel Grinder	2008	$ 4,300	3	$ 25,000	$ 25,000	1	Replace or Salvage	May be less expensive to contract sharpening

IRRIGATION SYSTEM

Distribution Uniformity or DU in irrigation is a measure of how uniformly water is applied to the area being irrigated, expressed as a percentage. The distribution uniformity is often calculated when performing an irrigation audit, such as we performed on the 4 greens at Creve Coeur Golf Course.

The most common measure of DU is the Low Quarter DU (DU_{LQ}), which is a measure of the average of the lowest quarter of samples, divided by the average of all samples. The higher the DU_{LQ}, the better the performance of the system. If all samples are equal, the DU_{LQ} is 100%. If a proportion of the area greater than 25% receives zero application the DU will be 0%.

According to the Irrigation Association's Certified Golf Irrigation Auditor manual, rotary sprinkler DU_{LQ} is listed in 3 categories, with 80% considered excellent (achievable), 70% good (expected), and 55% or less considered poor. It stands to reason that the lower the DU_{LQ} the longer the irrigation head or heads have to run to achieve uniformity at the worst area of coverage (watering to the driest area).

Photo 17 Irrigation audit on 4 green with catchments

[5]These are the results from an irrigation audit performed by me on greens #1, 2, 4 and 5.

Irrigation Audit			
Golf Green	DU_{LQ}	Inches Per Hour	PSI at Sprinkler
1	65%	0.85	40
2	53%	0.76	27
4	33%	0.59	34.5
5	74%	0.89	45.5

Table 2 Irrigation Audit

The current irrigation system at Creve Coeur Golf Course is technology from the 1960's. All of the golf sprinklers at Creve Coeur Golf Course are held closed by spring and hydraulic pressure from the active system pressure. If this hydraulic pressure falls below static pressure in the pipe these sprinklers will activate. This hydraulic tubing runs from each control satellite box to the sprinklers in the field. After time these systems become weak and begin to weep pressure from these tubes and sprinklers begin to leak slowly at first then control is often lost completely. Most modern day irrigation systems are comprised of electrically controlled solenoids.

5 Irrigation Audit performed by Certified Golf Irrigation Auditor, Michael D. Vogt, Candidate #58853, in accordance with the Irrigation Association's prescribed guidelines

Irrigation System (continued)

These modern systems have replaced the long runs of tubing with copper wires conducting a 24 volt signal to operate the solenoids opening the sprinkler to pressure. These electric systems have a much improved reliability and have an instantaneous operation of the sprinkler.

Irrigation head pressure was observed at well below operating parameters for the model of sprinkler. Recommended pressure at the sprinkler head should be at least 50 PSI for proper water distribution. As shown in Table 2, none of the pressure samples reached the minimum recommended pressure.

It is recommended that a new irrigation system be installed immediately after management is satisfied with correcting all deficiencies with regards to safety and health. Based on a drawing from the local Toro dealer an estimate to replace irrigation for all turf areas will be $480,000. It is highly advisable to have an irrigation designer work with Superintendent Gettemeier to hydraulically balance the system and produce documents for bid and installation. These irrigation designers will work for the city of Creve Coeur, they do not have an allegiance to any brand of irrigation equipment or products. By using an Irrigation Design Consultant it is my opinion the final project will be superior.

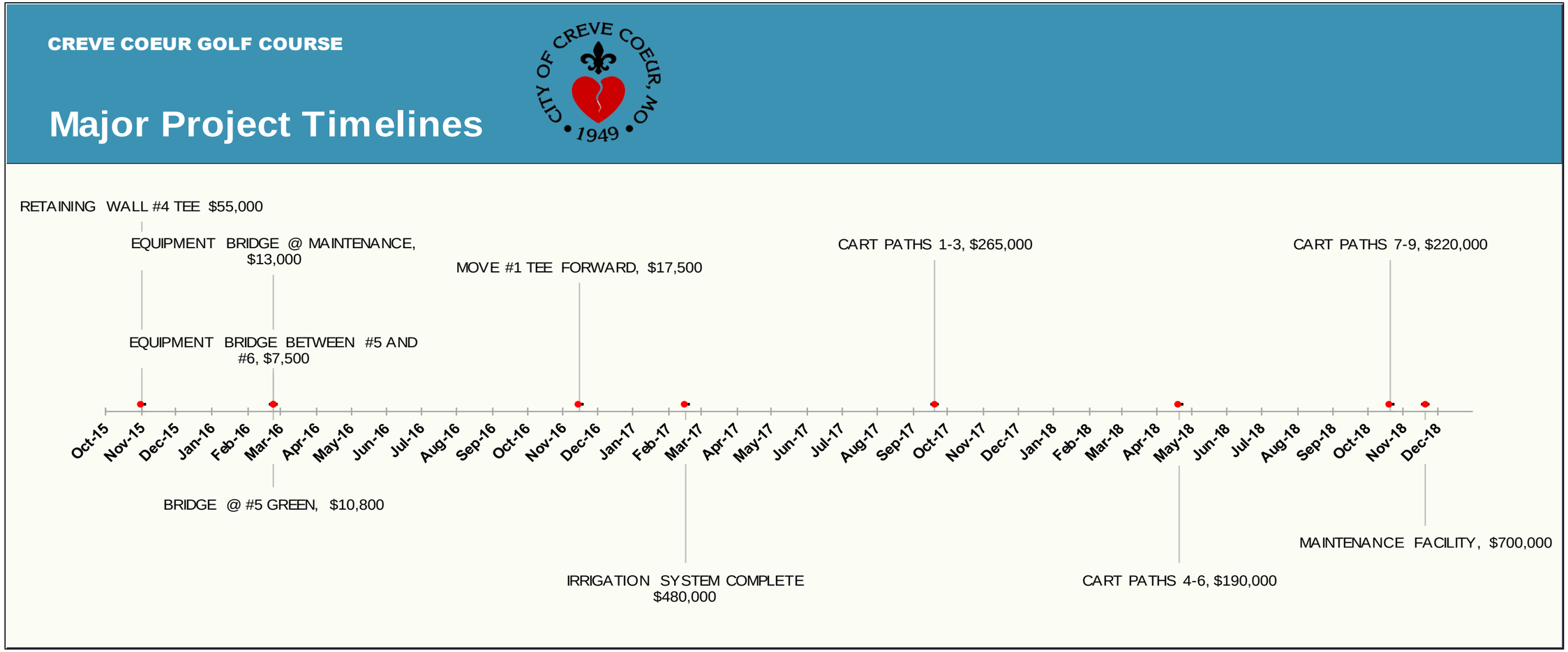
EC Design Group, Ltd.
PO Box 65036
West Des Moines, IA 50265
Phone: (515) 225-6365

OR

Jeffrey L. Bruce & Company
1907 Swift Street, Suite 204
North Kansas City, Missouri 64116
Phone: (816) 842-8999

WATER FEATURES

The main water feature at Creve Coeur Golf Course is the storm water impoundment on holes 5, 6, 7 and 9. This area accounts for 48,983 ft². The water feature on hole-5 is in need of a silt removal program. It is my understanding the city has already secured plans to renovate the far south number 5 water feature. This renovation should include retaining walls, weir system, silt removal, and bridge structure from 5 fairway to 5 green.


CREVE COEUR GOLF COURSE
Major Project Timelines
CITY OF CREVE COEUR, MO
1949
RETAINING WALL #4 TEE $55,000
EQUIPMENT BRIDGE @ MAINTENANCE, $13,000
EQUIPMENT BRIDGE BETWEEN #5 AND #6, $7,500
BRIDGE @ #5 GREEN, $10,800
MOVE #1 TEE FORWARD, $17,500
IRRIGATION SYSTEM COMPLETE $480,000
CART PATHS 1-3, $265,000
CART PATHS 4-6, $190,000
CART PATHS 7-9, $220,000
MAINTENANCE FACILITY, $700,000
Oct-15
Nov-15
Dec-15
Jan-16
Feb-16
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Apr-16
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Dec-18

CONCLUSION

Creve Coeur Golf Course is maintained in fine fashion. Aside from immediate safety issues the critical question to ask will these improvements increase revenues or even pay for themselves overtime. The answer is almost always no, large capital investments most certainly will not ever amortize in the current climate of golf participation. The question should be this: If committed to golf at this location, and if the community desires a full spectrum of recreation does the golf course fill this citizen desire?

Municipal Golf Courses as well as parks provide intrinsic environmental, aesthetic, and recreation benefits to our cities. They are also a source of positive economic benefits. They enhance property values, increase municipal revenue, bring in homebuyers and workers, and attract high quality businesses and retirees.

At the bottom line, parks and golf courses are a good financial investment for a community. Understanding the economic impacts of golf courses can help decision makers better evaluate the creation and maintenance of municipal golf courses. Business and property tax revenues are difficult to quantify as well as pride in community and what the municipality has to offer.

It is vital to the future condition, playability and health of the golf course to renew assets as they become aged to the useful life. Many golf course decision makers postpone renewing assets until the asset becomes no longer functional – it has been my experience that costs and patron satisfaction can be negatively affected in many of these cases.

Addendum 3 is a report from the International Sports Turf Research Center. This report reiterates the need to increase core aerification and sand topdressing to remediate heavy soil in the root-zone areas on greens. With judicious aerification, Creve Coeur Golf Course will be able to virtually rebuild green root-zones from the top down. Again, more on this subject is available on pages 12 – 19 and the Addendum 3 beginning on page 33.

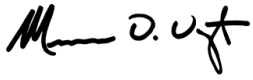
Another matter of management that should be considered is a written standard of golf course maintenace, whereby the stakeholders and management all understand what the cost are relative to level of acceptable maintenance standards.

My thanks to the staff members at Creve Coeur Golf Course for their complete cooperation and help during my visit; you should be proud of the work you accomplish at this outstanding course. Also, my hats off to Superintendent Gettemeier and Manager Tim Brinks for accomplishing many forward thinking programs that places Creve Coeur Golf Course in the position they enjoy today.

It will be the City of Creve Coeur's ultimate responsibility to act as it feels is proper to execute any recommendations or make decisions in its own best interest.

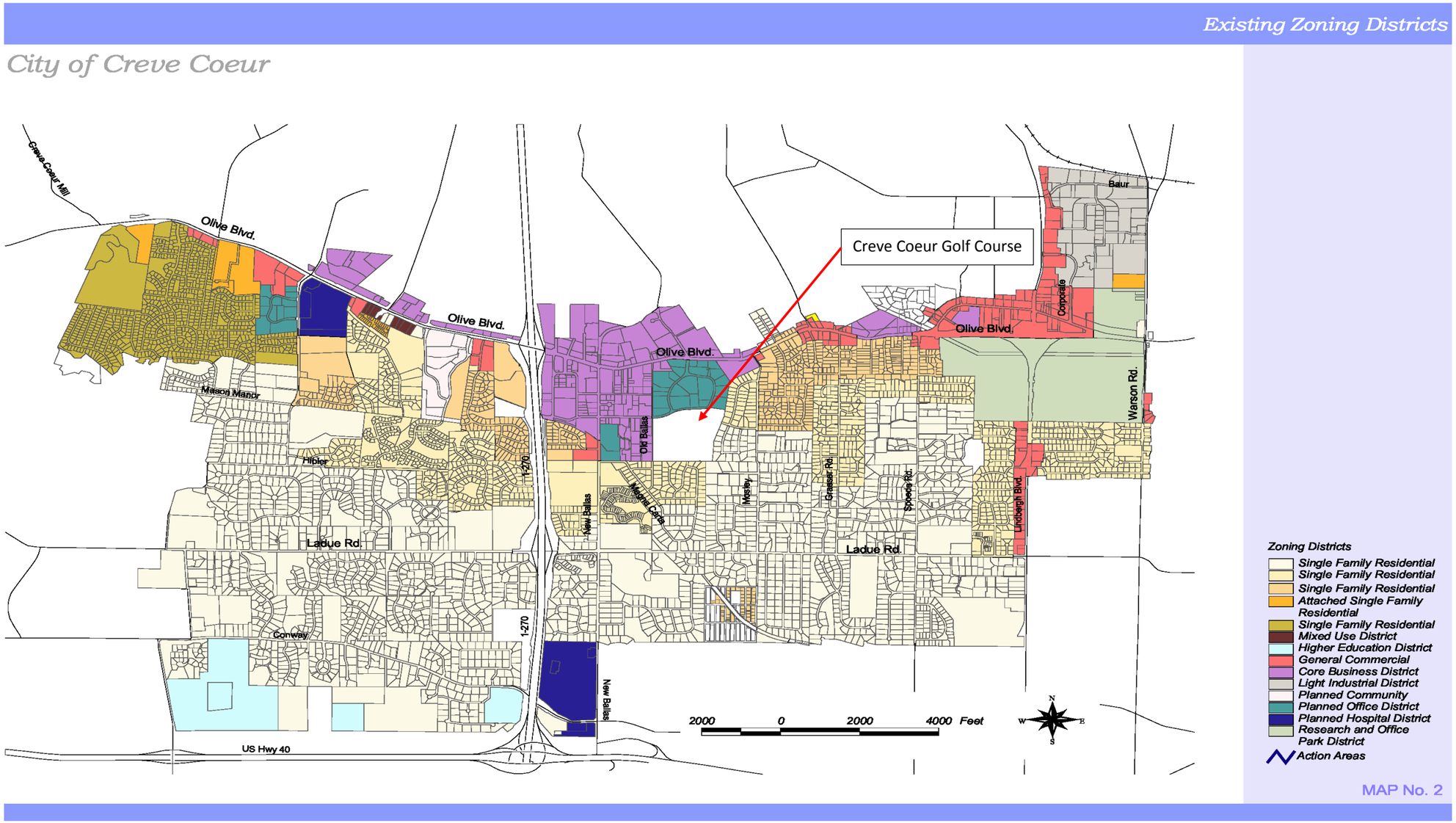
Please feel free to contact me at your convenience with any question or comments.

Respectfully Submitted,



Michael D. Vogt, CGCS, CGIA, LLC

ADDENDUM 1 - CITY OF CREVE COEUR ZONING MAP



ADDENDUM 2 - PROJECT MAP

YOUR
ISTRC SYSTEM™
REPORT

CREVE COEUR
GOLF COURSE

August 11, 2015
Greens 3, 5, 6 & 7
Lab ID: 15070041

Presented To:

Mr. Cory Gettemeier, GCS

11372 Strang Line Road
Lenexa, KS 66215

Phone: 800-362-8873
Phone: 913-829-8873
Fax: 913-829-4013
E-Mail: office@istrc.com
Website: www.istrc.com

August 11, 2015

Mr. Cory Gettemeier, GCS
CREVE COEUR GOLF COURSE
300 N. Ballas
Creve Coeur, MO 63141

re: Lab ID: 15070041; ISTRC SYSTEM™ BenchMarking of undisturbed core samples from Green #3 [back left]; Green #5 [back center]; Green #6 [back center] and Green #7. **ISTRC Rep:** Mr. Bob Brandt.

Dear Cory;

We have completed the ISTRC SYSTEM™ BenchMarking of the undisturbed core samples taken from Greens 3, 5, 6 & 7. The test results are attached and the time lapse photos are included. The section references in this report are to our **ISTRC's Guidebook**.

I. BACKGROUND
(per Information Supplied to ISTRC)

Creve Coeur Golf Course is a nine hole facility that supports play seven days a week on greens that were constructed out of varying material over different periods of time. This is the first testing performed on the greens so there are no comparisons included within the report. We will utilize USGA style green guidelines in the tables to better illustrate how the profiles are performing despite Green #s 3 & 5 resembling profiles closer to native soil greens. The primary objective for testing is to establish an initial benchmark as a basis for monitoring the aging of the root zone and evaluating the impact of the past & current cultural practices.

Table 1 is used to incorporate your evaluation of the tested green's turf quality and micro-environment (growing conditions). As a general rule, turf quality is a function of the interrelationship between the physical properties of the root zone and the green's micro-environment. Our research has found that it is possible to compensate for poor growing conditions by manipulating the physical properties of the root zone. Conversely, it is possible to compensate for poor physical properties with an excellent micro-environment. See, Section IV, D – *The Green's Micro-Environment* – at page 15.

Table 1. Scale: 1 [bad] – 5 [moderate] – 10 [excellent]

	Turf Quality (Current)	Air Movement	Direct Sunlight	Comments
Green #3	6	6	5	
Green #5	6	8	9	
Green #6	8	8	9	
Green #7	6	8	8	

II. DISCUSSION OF LAB RESULTS

The laboratory data can be found in its entirety at the end of this report. There are two sets of data. The first set of data consists of the physical evaluation, the evaluation of the root systems, and the measurement of the organic matter by layer.

The second set of data contains the textural & particle size analysis. The textural analysis measures the percentage of gravel, sand, silt and clay comprising the soil. The particle size distribution analyzes the size distribution of the sand.

We have also attached an aerification displacement chart at the end of the report. We designed the displacement chart to calculate the percentage of surface area that is removed from the green with various size tines and spacing. We have found that the chart is an excellent reference to evaluate the effectiveness of your program.

On the following pages we will discuss the current test results. Included with the discussion are selected time lapse photos of the root zone, our Target Table with the greens' physical properties, and an inch-by-inch analysis of the Textural & Sand Particle Size Distribution. Tables 2 & 3 compare the current test results to our recommended target range for well-drained, sand-based greens.

The time lapse photos included on the following pages were taken to monitor the drying process of your greens and to provide visual confirmation of the tested physical properties. We have found the photos are an excellent indicator of layering and/or variations in water holding properties throughout the profile.

Green #3

Green #5

These two samples represent some of the first greens that were constructed and the blend resembles more of a soil based material. The combination of organic build-up and compaction are discouraging any ability to breathe or drain that might promote consistency on the surface. These greens in particular are in need of hollow tine aerifications to displace the heavy amounts of organic matter in the upper 3 inches. Also, a critical component of the program is to continue to involve venting in between the larger tine procedures to encourage breathability through the surface. The profile must have a means of drying out.

Table 2. ISTRC Target Ranges

	Green #3	**Green #5**	Well-Drained Greens (1st tier Sample)
Infiltration Rate [In/hr]	1.27	0.00	At least 6
Air Porosity [Non-Capillary]	7.80%	9.26%	~20%
Water Porosity [Capillary]	39.02%	33.78%	15% to 25%
Bulk Density [g/cc]	1.47	1.51	1.35 to 1.45
Water Holding	26.53%	22.43%	10% to 20%
Organic Content: 0-1”	2.93%	3.40%	1.5% to 2.5%
Organic Content: 1-2”	2.82%	2.18%	1.0% to 2.0%
Organic Content: 2-3”	2.69%	1.36%	0.5% to 2.0%
Organic Content: 3-4”	0.16%	0.71%	0.5% to 1.5%
Root Mass	3/8 in.	3/8 in.	at least ½ in.
Feeder Roots	Less than 3 in.	Less than 3 in.	at least 3 ½ in. –med. density

Green #6

Green #7

You can immediately recognize the differences between these two greens and the previous two when looking at the infiltration ability. The increase in air porosities and the organic build-up being confined to the top two inches are contributing factors to the more balanced profiles that should behave more like mature sand based greens. Even though the styles and ages are different, the recommendations are the same; the plants require oxygen and the ability to dry out from excessive water holding.

Table 3. ISTRC Target Ranges

	Green #6	**Green #7**	Well-Drained Greens (1st tier Sample)
Infiltration Rate [In/hr]	11.54	8.08	At least 6
Air Porosity [Non-Capillary]	15.34%	11.11%	~20%
Water Porosity [Capillary]	26.10%	32.57%	15% to 25%
Bulk Density [g/cc]	1.42	1.44	1.35 to 1.45
Water Holding	18.35%	22.67%	10% to 20%
Organic Content: 0-1”	3.21%	3.44%	1.5% to 2.5%
Organic Content: 1-2”	2.89%	2.10%	1.0% to 2.0%
Organic Content: 2-3”	0.58%	0.55%	0.5% to 2.0%
Organic Content: 3-4”	0.01%	0.14%	0.5% to 1.5%
Root Mass	3/8 in.	3/8 in.	at least ½ in.
Feeder Roots	4 ½ in. Sparse	Less than 3 in.	at least 3 ½ in. –med. density

Particle Distribution

		Textural Analysis				Sand Particle Size Distribution						
		Sand	Silt	Clay	Gravel	Very Coarse	Coarse	Medium	Medium	Med/Fine	Fine	Very Fine
	USDA (mm)	.05 to 2.00	.002 to .05	<.002	2.00	1.00	0.50	0.25	0.18	0.15	0.10	0.05
	U.S. Sieve (mesh)	270 to 18	(Pan)	(Pan)	10	18	35	60	80	100	140	270
	SAMPLE NAME					% Retained on Sieve						
Green #3's 1st tier	.25 - 1.0 in.	96.67	1.42	1.91	0.00	3.22	32.53	45.50	10.95	2.50	1.40	0.57
	1.0 - 2.0 in.	95.33	1.65	3.02	0.00	4.10	21.67	47.63	14.30	4.03	2.30	1.30
	2.0 - 3.0 in.	90.81	6.60	1.94	0.65	5.88	23.35	41.53	11.95	4.22	1.85	2.03
	3.0 - 4.0 in.	92.53	4.77	1.40	1.30	2.95	26.33	38.93	16.70	3.30	1.47	2.85
Green #5's 1st tier	.25 - 1.0 in.	96.23	2.62	1.15	0.00	3.40	34.47	44.40	9.70	2.18	1.23	0.85
	1.0 - 2.0 in.	90.17	5.84	3.99	0.00	3.57	21.27	47.63	10.67	2.47	1.53	3.03
	2.0 - 3.0 in.	91.11	7.10	1.79	0.00	2.45	16.77	45.40	10.03	2.90	2.63	10.93
	3.0 - 4.0 in.	96.81	2.35	0.84	0.00	0.77	12.53	39.10	16.73	2.53	3.05	22.10
Green #6's 1st tier	.25 - 1.0 in.	96.33	2.00	1.67	0.00	2.47	29.43	48.85	10.73	2.67	1.65	0.53
	1.0 - 2.0 in.	95.39	2.35	1.96	0.30	3.35	21.70	48.32	13.57	4.45	2.85	1.15
	2.0 - 3.0 in.	94.85	1.95	1.63	1.57	6.08	24.55	39.53	13.87	5.27	4.08	1.47
	3.0 - 4.0 in.	94.83	1.99	1.65	1.53	7.57	25.33	36.47	14.88	5.25	4.13	1.20
Green #7's 1st tier	.25 - 1.0 in.	97.75	1.23	1.02	0.00	2.30	28.47	45.85	12.95	4.03	3.05	1.10
	1.0 - 2.0 in.	97.51	1.36	1.13	0.00	2.73	23.43	42.27	15.03	6.20	5.97	1.88
	2.0 - 3.0 in.	94.65	1.81	3.19	0.35	0.95	25.03	31.52	19.47	12.95	1.33	3.40
	3.0 - 4.0 in.	97.27	1.11	1.45	0.17	0.95	17.35	29.35	19.55	13.35	13.57	3.15

	89 to 100	5 Max.	3 Max.	3 Max.	10 Max.	At least 60		20 Max.	5 Max.
specifications		10 Max. w/ Fine & V.F.		10 Max.					10 Max. w/Silt & Clay
es	89 to 100	5 Max.	3 Max.	3 Max.	10 Max.	15 to 25	40+	10 to 15	20 - #80	5 Max.
		10 Max. w/ Fine & V.F.		10 Max.		65 to 85 Optimum			10 Max. w/Silt & Clay

Above is the inch-by-inch analysis (upper 4") of the Textural & Sand Particle Size Distribution for Green #3's 1st tier, Green #5's 1st tier, Green #6's 1st tier and Green #7's 1st tier. A complete inch-by-inch analysis for all the tested greens is also attached to the end of the report. The lower box contains the USGA specifications & ISTRC Guidelines - the upper set is the USGA specifications and the lower set is the expanded guidelines from ISTRC.

The particle distribution is difficult to analyze due to the fact that the way they were constructed forces us to use common sense while still utilizing the USGA guidelines to a limit. The distributions do not meet USGA specifications due to several erratic spikes in fines and Silt and Clay readings; however the top inch of each green does meet USGA specifications which indicates the recent topdressing programs are using an appropriate topdressing sand that should be proper for both light dustings as well as regular aerification fills. With different construction times using different blends, we cannot expect the profiles to represent one uniformed mix. The goal is to amend all the profiles effectively with consistency using a USGA style sand.

III. SUMMARY

A general discussion on Maintenance Practices is contained in Section V of **The ISTRC Guidebook**. We encourage you to reference the Guidebook for a wide range of topics relating to the root zone, environmental factors, and maintenance.

It's difficult to orchestrate a program to effectively manage two or more different styles of greens that were constructed at different times. That said; the main idea is to create balance and promote breathability with hollow tine aerifications and venting to discourage any moisture related diseases and to establish deep root structures for sustainable health. One cultural program can be implemented to effectively manage the different styles by taking the more aggressive approach in controlling the organic production.

We are recommending that no less than 20% surface material be removed each season by hollow tine aerifications to control and diminish the current water properties and transfer them back into air porosities. This can be achieved following a traditional spring and fall schedule, but will more than likely require a third application to utilize smaller tines to lessen the heal time associated with aerifications. Regardless of the schedule, the important goal to keep in mind is to lessen the organic matter that is prevalent in all the greens we tested in the top 2 to 3 inches.

In our discussion, the use of a solid tine procedure was discussed and what the good and bad effects of this application could be. True, the application will serve as a venting tool without sacrificing any revenue due to disruption during that time. However, with the elevated amounts of organic being reported, it's our advice to first lessen the cumulative organic percentages with hollow tine applications and then possibly implement a solid tine application towards the end of a season when monitoring has validated that the organic has been controlled.

The current program is utilizing venting techniques every other week and we couldn't agree more with this philosophy. The majority of water holding is taking place near the surface and in between the larger tine applications; the greens need help in the form of venting past the heavy organic matter and compaction.

While we need to encourage balance beneath the surface, it's no surprise that Green #3 is one of the more problematic greens and it also possesses one of the more pocketed microenvironments. The plant needs oxygen and sunlight! Especially in greens that are prone to holding moisture, we need to do everything we can to encourage proper evaporation and air flow to limit the problems associated with excessive moisture. If pruning or the removal of trees isn't possible, then we highly recommend the use of portable or permanent fans to artificially create air flow for the green's surface. We often times compare wet profiles with flooded basements; the first thing you do is open up windows, put on fans and remove the water as quickly as possible before it becomes anaerobic. Greens' profiles are no different in that we need to provide the ability to dry out and achieve balance so we have the control in managing the moisture levels and to fine tune the greens as we see fit to suit playability and climate changes.

The current testing has established an initial benchmark of your greens. We recommend that you continue to monitor your greens with regular testing. The information derived from regular testing will allow you to monitor the aging process of the greens, evaluate the effectiveness of the current cultural practices, modify the program based on hard data, make adjustments to the program to meet the individual needs of specific greens, and detect problems before they affect the health of the greens.

If you have any questions or need any additional information we encourage you to give us a call. We are always available to answer questions and discuss ideas with you. Our service is not confined to analyzing undisturbed cores. We do not charge for telephone calls and we encourage our client superintendents to use us as a resource.

Sincerely,

I.S.T.R.C.

by: Eric J. Doherty

Eric J. Doherty, President

encl.: ISTRC's Guidebook

I.S.T.R.C. Form: Physical Evaluation
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I.S.T.R.C.

"International Sports Turf Research Center, Inc."

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The I.S.T.R.C. System™

Company: CREVE COEUR GOLF COURSE
Name: Mr. Cory Gettemeier, GCS
Address: 300 N. Ballas
City, ST, Zip Creve Coeur, MO 63141

Account No. 3146000
Date 21-Jul-15
Facility Creve Coeur G.C.
ISTRC Rep. Bob Brandt

Physical Evaluation

ISTRC SYSTEM™ Core Analysis

LAB ID NO.	SAMPLE NAME	Infiltration Rate in/hr.	40 cm Water Holding %	Bulk Density g/cc	Solids %	Porosity: Total Porosity %	Porosity: Capillary [Water Pores] %	Porosity: Non-Capillary [Air Pores] %
15070041-G03	Green #3, Back Left	1.27	26.53	1.47	53.18	46.82	39.02	7.80
	Organic [ISTRC Walkley/Black] .25 to 1 in.	**2.93%**				**Root Mass:**	**3/8 in.**	
	Organic [ISTRC Walkley/Black] 1 to 2 in.	**2.82%**				**Feeders:**	**Less than 3 in.**	
	Organic [ISTRC Walkley/Black] 2 to 3 in.	**2.69%**						
	Organic [ISTRC Walkley/Black] 3 to 4 in.	**0.16%**						
15070041-G05	Green #5, Back Center	0.00	22.43	1.51	56.96	43.04	33.78	9.26
	Organic [ISTRC Walkley/Black] .25 to 1 in.	**3.40%**				**Root Mass:**	**3/8 in.**	
	Organic [ISTRC Walkley/Black] 1 to 2 in.	**2.18%**				**Feeders:**	**Less than 3 in.**	
	Organic [ISTRC Walkley/Black] 2 to 3 in.	**1.36%**						
	Organic [ISTRC Walkley/Black] 3 to 4 in.	**0.71%**						
15070041-G06	Green #6, Back Center	11.54	18.35	1.42	58.56	41.44	26.10	15.34
	Organic [ISTRC Walkley/Black] .25 to 1 in.	**3.21%**				**Root Mass:**	**3/8 in.**	
	Organic [ISTRC Walkley/Black] 1 to 2 in.	**2.89%**				**Feeders:**	**4 1/2 in. Sparse**	
	Organic [ISTRC Walkley/Black] 2 to 3 in.	**0.58%**						
	Organic [ISTRC Walkley/Black] 3 to 4 in.	**0.01%**						
15070041-G07	Green #7	8.08	22.67	1.44	56.32	43.68	32.57	11.11
	Organic [ISTRC Walkley/Black] .25 to 1 in.	**3.44%**				**Root Mass:**	**3/8 in.**	
	Organic [ISTRC Walkley/Black] 1 to 2 in.	**2.10%**				**Feeders:**	**Less than 3 in.**	
	Organic [ISTRC Walkley/Black] 2 to 3 in.	**0.55%**						
	Organic [ISTRC Walkley/Black] 3 to 4 in.	**0.14%**						
	USGA Sample Range [Root Zone Mix]	at least 6	10 to 20	1.4 to 1.7	45 to 65	35 to 55	15 to 25	15 to 30

Reviewed by: _____

I.S.T.R.C. Form: Textural Analysis
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Account No. 3146000
Date 21-Jul-15
Facility Creve Coeur G.C.
ISTRC Rep. Bob Brandt

		Textural Analysis				Sand Particle Size Distribution						
		Sand	**Silt**	**Clay**	**Gravel**	**Very Coarse**	**Coarse**	**Medium**	**Medium**	**Med/Fine**	**Fine**	**Very Fine**
	USDA (mm)	**.05 to 2.00**	**.002 to .05**	**<.002**	**2.00**	**1.00**	**0.50**	**0.25**	**0.18**	**0.15**	**0.10**	**0.05**
	U.S. Sieve (mesh)	**270 to 18**	**(Pan)**	**(Pan)**	**10**	**18**	**35**	**60**	**80**	**100**	**140**	**270**
LAB ID NO.	**SAMPLE NAME**					**% Retained on Sieve**						
15070041-G03	.25 - 1.0 in.	96.67	1.42	1.91	0.00	3.22	32.53	45.50	10.95	2.50	1.40	0.57
Green #3	1.0 - 2.0 in.	95.33	1.65	3.02	0.00	4.10	21.67	47.63	14.30	4.03	2.30	1.30
1st Tier	2.0 - 3.0 in.	90.81	6.60	1.94	0.65	5.88	23.35	41.53	11.95	4.22	1.85	2.03
Back Left	3.0 - 4.0 in.	92.53	4.77	1.40	1.30	2.95	26.33	38.93	16.70	3.30	1.47	2.85
15070041-G05	.25 - 1.0 in.	96.23	2.62	1.15	0.00	3.40	34.47	44.40	9.70	2.18	1.23	0.85
Green #5	1.0 - 2.0 in.	90.17	5.84	3.99	0.00	3.57	21.27	47.63	10.67	2.47	1.53	3.03
1st Tier	2.0 - 3.0 in.	91.11	7.10	1.79	0.00	2.45	16.77	45.40	10.03	2.90	2.63	10.93
Back Center	3.0 - 4.0 in.	96.81	2.35	0.84	0.00	0.77	12.53	39.10	16.73	2.53	3.05	22.10
15070041-G06	.25 - 1.0 in.	96.33	2.00	1.67	0.00	2.47	29.43	48.85	10.73	2.67	1.65	0.53
Green #6	1.0 - 2.0 in.	95.39	2.35	1.96	0.30	3.35	21.70	48.32	13.57	4.45	2.85	1.15
1st Tier	2.0 - 3.0 in.	94.85	1.95	1.63	1.57	6.08	24.55	39.53	13.87	5.27	4.08	1.47
Back Center	3.0 - 4.0 in.	94.83	1.99	1.65	1.53	7.57	25.33	36.47	14.88	5.25	4.13	1.20
15070041-G07	.25 - 1.0 in.	97.75	1.23	1.02	0.00	2.30	28.47	45.85	12.95	4.03	3.05	1.10
Green #7	1.0 - 2.0 in.	97.51	1.36	1.13	0.00	2.73	23.43	42.27	15.03	6.20	5.97	1.88
1st Tier	2.0 - 3.0 in.	94.65	1.81	3.19	0.35	0.95	25.03	31.52	19.47	12.95	1.33	3.40
	3.0 - 4.0 in.	97.27	1.11	1.45	0.17	0.95	17.35	29.35	19.55	13.35	13.57	3.15
USGA		89 to 100	5 Max.	3 Max.	3 Max.	10 Max.	At least 60		20 Max.		5 Max.	
Recommended Specifications			10 Max. w/ Fine & V.F.		10 Max.						10 Max. w/Silt & Clay	
ISTRC Guidelines		**89 to 100**	**5 Max.**	**3 Max.**	**3 Max.**	**10 Max.**	**15 to 25**	**40+**	**10 to 15**	**20 - #80**	**5 Max.**	
			10 Max. w/ Fine & V.F.		**10 Max.**		**65 to 85 Optimum**				**10 Max. w/Silt & Clay**	

Reviewed by: EJD

ISTRC

International Sports Turf Research Center

Aerification Displacement Chart

Tine Size	1.25” x 1.25” Centers	1.5” x 1.5” Centers	2.0” x 2.0” Centers	2.5” x 2.5” Centers	5” x 5” Centers
¼” Hollow Tines	3.14%	2.18%	1.23%	0.79%	
3/8” Hollow Tines	7.07%	4.91%	2.76%	1.77%	
½” Hollow Tines	12.57%	8.73%	4.91%	3.14%	
5/8” Hollow Tines		13.64%	7.67%	4.91%	
5/8” Hollow Vertidrain					1.23%
¾” Hollow Tines				7.07%	1.77%
¾” Hollow Vertidrain					1.77%
1” Hollow Tines					3.14%
1” Hollow Vertidrain					3.14%
7/8” Drill & Fill (7” Ctrs)					1.23%
Graden Verticutter (15 Blades @ 1” Spacings)	1mm Blade 3.93%	2mm Blade 7.87%	3mm Blade 11.81%		

Note: 1/4" Quadtines remove as much material as Regular 1/2" Hollow Tines
3/8” minimum for ease of topdressing fill if replacement of material is required
For double aerification make two passes at approx. 37° (slightly less than 45°) to minimize overlap

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For Additional Information Please Call:

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-End of Report-

Michael D. Vogt

Digitally signed by Michael D. Vogt
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Date: 2015.08.27 14:10:41 -05'00'