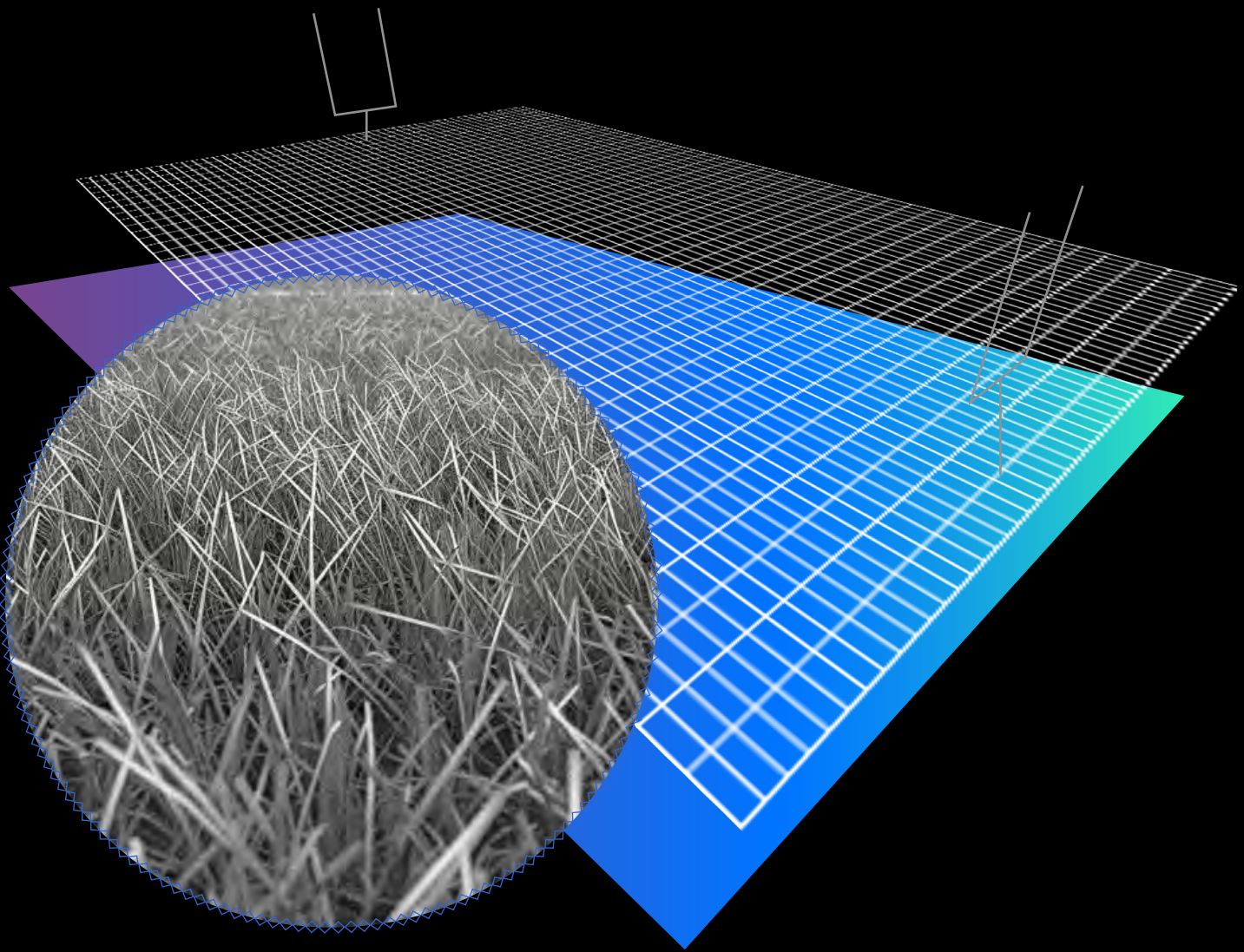
SURFACE BEST PRACTICES



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Playing surfaces for NFL use should be safe, playable, and aesthetically pleasant. This document provides best practices related to selection, implementation, and maintenance of playing surfaces for NFL use. This document was developed in a collaboration involving NFL and NFLPA playing surface experts, external industry professionals with expertise in stadium and field construction, and several NFL field managers who contributed with their specific expertise in NFL playing surfaces.

These recommendations are grounded in current knowledge, professional standards, and collective experience. However, they are provided for informational purposes only and do not constitute mandatory policy. Implementation of these practices remains at the discretion of the individuals involved in this area of work, who are encouraged to exercise their professional judgment in determining their applicability within their specific operational contexts. Mandatory policy related to playing surfaces is governed and developed by the Joint Field Surface Safety and Performance Committee (JFSSPC) and can be found in the NFL-NFLPA Mandatory Practices for Playing Surfaces. Additional operational requirements can be found in the NFL Game Operations manual.

This document is divided into four main sections: natural, synthetic, hybrid surfaces, and non-NFL events. Also included are appendices outlining recommendations related to request for proposals (Appendix A – RFP Template for NFL Fields), and sod growth and inspection for NFL use (Appendix B – Sod Farm Assessment Form).

The selection of any playing surface for NFL use should take into consideration the following aspects:

- **Player-surface interactions.** When possible, consider requesting information and data related to injury rates, mechanical testing, and player preference.
- **Climate.** For open stadiums, the climate plays a big role in the selection of the surface type. It is important to consider available surfaces (products, sod types, grass species), and available growing aids, when applicable.
- **Stadium type.** A feasibility study carried out by qualified professionals and experts will be useful in selecting the best surface for the stadium microenvironment.
- **Stadium usage and venue business model.** Stadiums shared by more than one team and/or sport can pose additional challenges towards maintaining natural grass for NFL play. Non-sporting events such as concerts, trade shows, fairs, etc. should also be discussed between the club and venue management teams when selecting a playing surface.

SECTION 1:
NATURAL GRASS

CHAPTER 1 - INTRODUCTION TO NATURAL GRASS

Natural grasses are living plants and require a suitable environment for their survival. The goal of an engineered turfgrass system is to create an environment suitable for healthy turfgrass yielding a safe, playable, and aesthetically pleasing playing surface.

American football is primarily played in the fall and winter seasons, leading to heavy wear on the playing surface, especially due to the size and strength of NFL athletes, hindering the surface's ability to recover from such heavy wear.

A natural grass playing surface comprises the turfgrass plants and their rootzone growing medium. When managed for fast and aggressive sporting activity, and marked with football-specific layouts and markings, it is referred to as an American football field. Natural grass fields require air, water, light, and nutrients to thrive. However, recent trends in stadium development and usage pose challenges to the growth of healthy grass. Stadium construction commonly limits natural sunlight and air movement, creating a microclimate at the field surface [Fig. 1].

The use of the field for other sports, such as soccer, or by multiple NFL/NCAA football teams can further stress the natural turfgrass, demanding excellent maintenance to meet NFL standards. Non-sporting events such as concerts, conventions, and monster trucks can also damage the playing surface and may require the grass to be replaced several times per year.

This section outlines best practices for maintaining natural grass surfaces for NFL use.

Fig 1. NFL stadium (natural grass) with partial roof/overhang

CHAPTER 2 - CONSIDERATIONS FOR CONSTRUCTION OF NATURAL GRASS FIELDS

An independent consultant/engineer with experience in the development of NFL fields should be engaged from the earliest stage of the design process. In cases where the contract is executed as a "design-build" by the contractor, it is recommended that external oversight be implemented. A comprehensive procedure for such a review is outlined in Appendix A – Template RFP for NFL Fields.

2.1 FIELD CONSTRUCTION PRINCIPLES

Field construction may require site-specific accommodations; however, many universal principles can be applied to any field, regardless of geographic location, facility type, or planned field usage.

This section outlines key principles that underpin the design and construction of a natural grass playing surface for NFL use.

2.1.1 SUBGRADE

The subgrade comprises the base layer of the constructed field profile [Fig. 2]. The subgrade should be compacted appropriately to ensure adequate load-bearing capacity. The achieved compaction should be verified using relevant standards (for example, Proctor maximum density; ASTM D698 and D1557). Required bearing capacities are site-specific and should be developed by the design team. It is important that all organic matter, muck, and organically decomposing matter are removed from the base to avoid future settlement. In some cases, a geotextile fabric can be used to help increase stability of the subgrade.

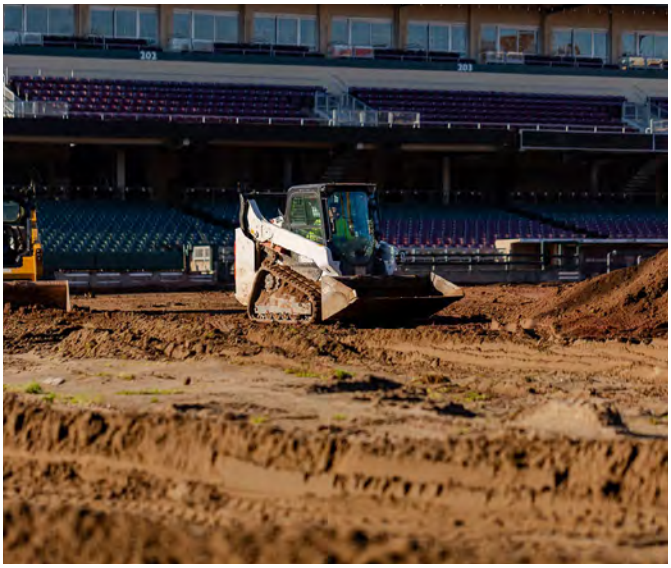


Fig 2. Field subbase construction

The subgrade should be graded to the exact slope and contour of the final finished grade profile. **Note that all natural grass fields should have at least 0.25% and at most 1% slope, to facilitate surface drainage, even if the rootzone is designed to be highly porous.** Care should be taken by contractors when travelling on the base to avoid rutting or otherwise compromising the grade. Final topographical surveys should be performed to verify compliance of the subgrade with the design.

2.2.2 DRAINAGE

The starting point for drainage system design is the outlet through which water exits the system. It may be necessary to model water flow and obtain certain permissions/permits to discharge water from a new field or stadium. Refer to local regulations for stormwater/drainage discharge.

The in-field drainage system usually comprises a combination of lateral pipes connecting to main pipes on the field's perimeter. These pipes must be installed with slope to promote water flow into the main outlet pipes. Other key design criteria include pipe depth, diameter, material, geometry, and orientation.

Regular corrugated pipes are installed within trenches which may be lined with geotextile membrane to prevent upward migration of fines. The trenches are filled with a specially-sized gravel (see 2.2.4 Rootzone construction). Flat-panel drainage pipe can also be used in place of perforated pipes [Fig. 3]. These flat panel drains are laid with the same principles as the pipe drains but do not require trench excavation. Ensure that the panels take advantage of the subgrade slope to move water. A key aspect of this system is ensuring that the flat panel drains connect correctly into the collector drains using purpose-designed junction connectors. It may also be required to increase the gravel layer's depth to provide additional clearance above these flat panel drains.

Fig 3. Drainage pipe in a lined trench

2.2.3 IRRIGATION SYSTEM

The irrigation system is generally installed at the same time as the drainage system. The pipework is installed at the lowest level of field construction. Irrigation system design and specification is a specialized area and should be performed by a qualified professional. The irrigation system is critical infrastructure for both the establishment and long-term maintenance of grass and can also play a vital role in gameday preparation. The irrigation system consists of the following components:

- Water source
- Pumps
- Control system
- Delivery pipework and valves
- Sprinkler heads

The water source for the irrigation should be tested and approved for turfgrass growth and management. Water chemistry should also be considered in the construction materials of the field and the facilitation of regular "flushing" should be considered if the water source is high in salts. If an alternative water source is not available, it may be necessary to install a means of in-situ water treatment such as reverse osmosis or acid injection.

The next component of the irrigation system is the pumping and control systems. If designing a new system, consider installing a second identical pump as a backup. This allows for full redundancy if one of the pumps malfunctions, which could damage or even kill the grass if water is not supplied during a drought.

The control system allows for the irrigation to run at pre-set times. Modern control systems allow irrigation to be precisely controlled, oftentimes from an off-site location via smartphone or other handheld device.

The pipework used within the field delivers water to the sprinkler heads. Most irrigation leaks are due to faulty connections at pipe joints. HDPE pipework is much less likely to malfunction than PVC pipework because it is more durable and flexible, and the joints are fused together rather than glued. The pipework should be buried to a sufficient depth which accounts for the climate, field maintenance, and future traffic loads.

Valves control the entry of water into the pipes. Consider installing all valves in a central, above-ground location [Fig 4]. This method incurs an upfront cost for additional pipe, but it will significantly extend the lifespan of the valves.

Fig 4. Aboveground irrigation valve room (top) and belowground irrigation valve box (bottom)

Irrigation heads distribute water across the field. The spacing should facilitate "head-to-head" coverage. This geometry allows for uniform water application, minimal water use, and a consistent turf response. Irrigation heads should be installed at the appropriate depth to prevent a tripping hazard. Valve boxes should be covered with synthetic turf or other anti-slip covering as outlined in the NFL Game Operations manual.

2.2.4 ROOTZONE CONSTRUCTION

Sand-based rootzones are preferred for construction of high performing sports fields [Fig. 5]. These rootzones provide rapid drainage and help prevent turfgrass decline due to compaction and excessive organic matter accumulation. The soil profile often comprises a ~12" layer of rootzone material over a gravel drainage layer. These sand-based rootzones often follow the United States Golf Association (USGA) specifications for construction of golf greens but could also be amended and/or modified to increase stability.

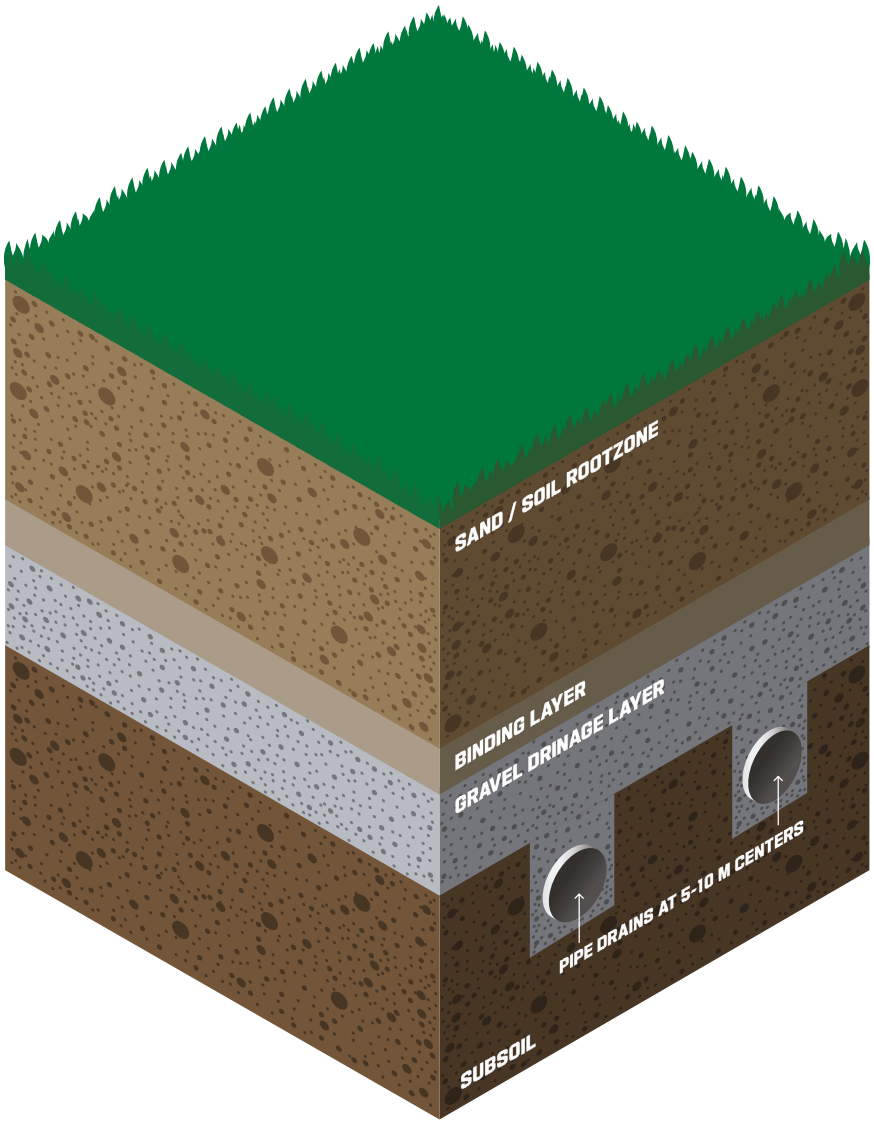


Fig 5. Suspended water table field profile

The selection of the gravel is based on a series of lab-based suitability tests and is also subject to matching or "bridging" with the upper sand layers. The depth of the gravel varies depending on design but generally ranges from 4-6". The gravel is spread over the subgrade and graded using laser-controlled equipment. If using flat-panel drainage, it may be necessary to increase the depth of gravel to accommodate the cleated tracks of heavy equipment and avoid damage to the underlying flat panel drains.

The rootzone is the soil layer serving as growth medium for the turfgrass plants [Fig. 6]. The rootzone should drain rapidly, provide adequate stability, and retain a healthy balance of air, water, and nutrients. The depth of this layer is generally 10-12". Rootzone soil is a highly engineered mixture of multiple bulk components. The mixture typically comprises sand plus one or more amendments; popular amendments include organic matter (e.g. peat, compost), and inorganic amendments (e.g. calcined clay, zeolite). The purpose of the amendment is to increase stability, water- and nutrient-holding capacity while retaining the desirable drainage properties of the sand.

Rootzone soil should be blended offsite using specialized equipment to yield a homogeneous mixture. Tilling soil amendments into the rootzone in situ should be avoided because it is difficult or impossible to achieve a homogeneous mixture.

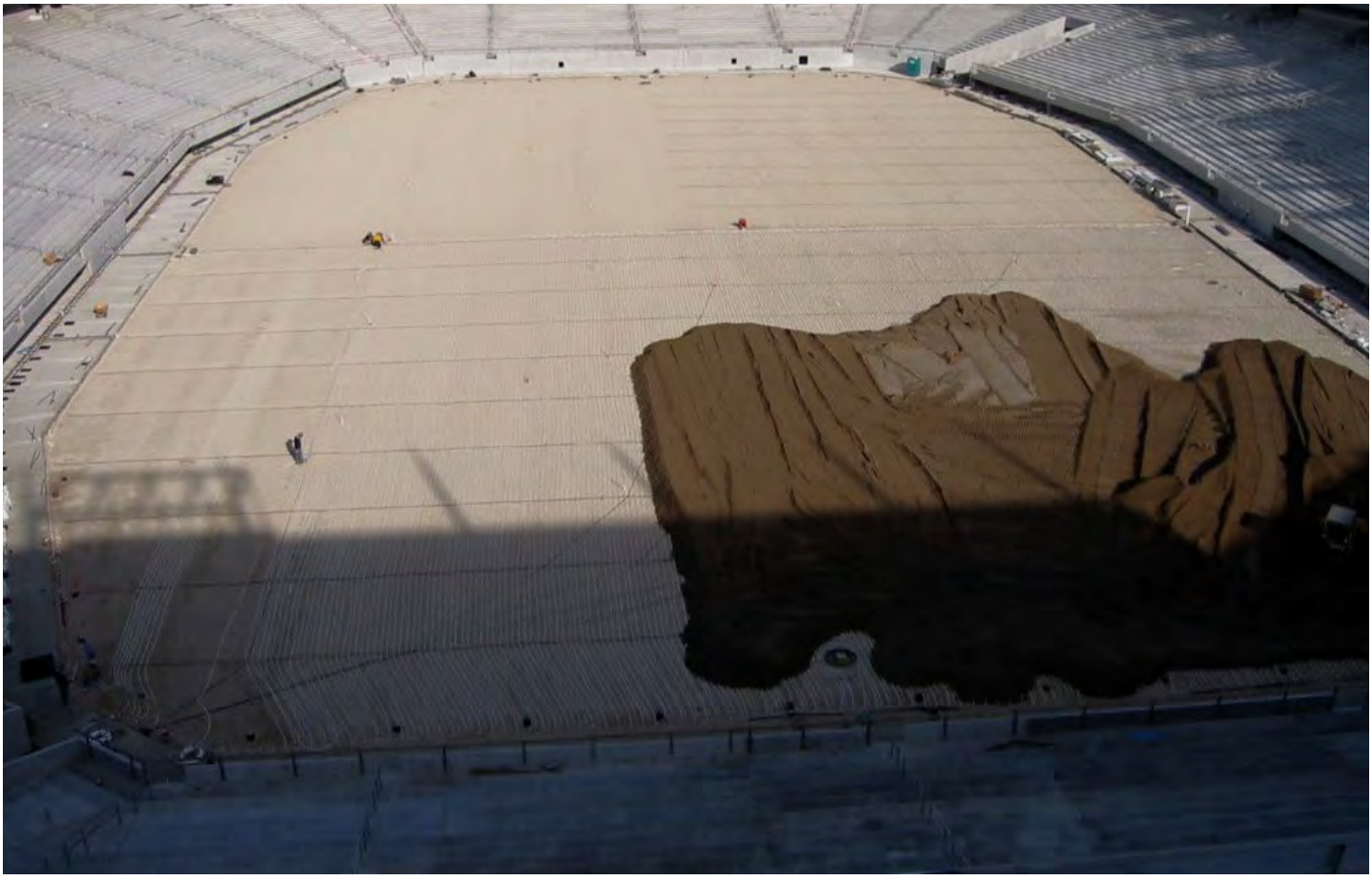


Fig 6. Rootzone installation

2.2.5 MATERIALS QUALITY AND TESTING PLANS

The selection and depth of rootzone material is a specialized area requiring laboratory analysis and calculations. Raw materials such as sands, rootzones and gravels can vary, and inconsistency in the construction materials is a common cause of field failure. A detailed materials testing plan needs to be in place at the design stage of the project. The material testing plan should clearly define the testing requirements (including any certifications if needed), frequency, and remediations available.
For guidelines on the assessment and acceptance process, refer to Appendix A - RFP Template for NFL Fields.

2.2.5 HEATING AND COOLING SYSTEMS

Late in the NFL season, heating of the rootzone may be required in cold climates to prevent the surface from freezing and becoming excessively hard. The most widely used heating systems are water or glycol based FIG. 7], although electric systems are also available. These water or glycol systems heat and circulate the liquid through a network of closely spaced pipes (generally 10-12" apart). These pipes are installed atop the subgrade. The radiant heat from the liquid raises the soil temperature, preventing the soil from freezing and in some cases enhancing turfgrass growth. The heating level is controlled via sensors and should consider rootzone depth, local climate, stadium microclimate, and peak demands on the system. It is also important that the heating system can run when the stadium experiences peak energy usage (e.g. gameday). Technology is evolving, allowing these systems to be used with air systems.

Fig 7. Placing rootzone over heating pipes

The principle of cooled liquid in the pipes can also be used as cooling systems in summer. This facilitates cooling of the rootzone to enhance the health of cool-season grasses throughout the year. The liquid is cooled in a chiller and a cooling effect is applied to the base of the rootzone, potentially reducing high-temperature stress on the grass.

The liquid in these systems can be either water or glycol/coolant based. If using a glycol, any leaks may cause turfgrass death. The system should be designed by an engineer with energy usage and the thermal conductivity properties of the rootzone, combined with the expected weather fully considered. Glycol systems are winterized with the glycol left in the pipes and the pumps circulating the liquid. Water based systems must be evacuated once temperatures drop to minimum levels to prevent bursting the pipes. Multiple heating zones can be configured to help improve uniformity and efficiency.

2.2.6 FORCED AIR VENTILATION, VACUUM SYSTEMS, AND SURFACE FANS

These systems are used to promote air circulation and to improve the functionality of heating and cooling systems. These systems can also accelerate drainage performance.

The drainage system (see 2.2.2 Drainage) comprises a series of large main pipes (up to 24" in diameter) running the length of the field [Fig. 8]. These pipes are connected to smaller manifold or lateral drains (generally 4-6" diameter). This network can be utilized to move air through the rootzone with the added possibility of heating or cooling the air. Air may be circulated on either vacuum or pressure mode. When the pressure is negative (suction/vacuum mode), the water collects in a centralized "air-water separator" and all the field drainage water is discharged via large pumps.

The air handling unit for such a system [Fig. 9] should be installed within the stadium, in a dedicated room capable of supplying power and ventilation requirements for such systems. Modern systems incorporate mobile-ready technology for controlling the air flow and temperature. Even if an electric electric/water/glycol system is installed beneath the drainage layer, a forced-air system improves the efficiency of the undersoil heating or cooling.

Fig 8. Typical air handling unit associated with forced air, ventilation and vacuum systems

Fig 9. Typical air handling unit

Surface fans can also be used on the perimeter of the field to assist in air movement and cooling [Fig. 10]. Air movement facilitates cooling of the turf and reduces the chance for turfgrass disease. Surface fans are usually placed on the edge of the field. Some fans also can mix a fine mist of water with the circulating air, adding to the cooling impact of the fan. An adequate supply of electricity (and water, if applicable) is important for these fans.

Fig 10. Surface fans to improve air movement within the stadium

CHAPTER 3 - SOD SELECTION FOR NFL

The intense usage of NFL fields eventually degrades the turfgrass and its morphological structures (roots, rhizomes, stolons). While a skilled grounds manager can prolong the life of a field, the loss of ground cover reduces surface stability and will eventually result in unplayable conditions. Poor footing, changes in impact attenuation (impact, deformation, restitution), and poor aesthetics could be symptoms of field decline. This reduction in surface stability can compromise player safety and performance. The grass surface may be replaced by removing the upper portion of the field and installing new sod [Fig. 11, 12]. This section outlines important considerations for sod replacement.

Fig 11. Sod harvesting on a sod farm

Fig 12. Re-sodding in a stadium

3.1 TURFGRASS SELECTION AND PERFORMANCE ASSESSMENT OF SOD OPTIONS

The quality of sod available for NFL use has improved markedly in recent years. The turfgrass producer/sod farm should ideally be selected at least 1 year prior to the expected harvest. The grass selection for sod production needs to consider (1) local climate (2) stadium microclimate (3) type and intensity of expected usage.

It is important to develop a relationship with the sod grower so they are willing to adapt their practices to the stadium requirements. The stadium needs to understand what the sod producer can and cannot produce.

Selection of the sod provider needs to consider experience, reputation, equipment and expertise, past performance, and cost. Basing the decision on cost alone is strongly discouraged, because not all suppliers can deliver an NFL-ready product. Refer to Appendix B – "Sod assessment form" for more information on how to track growth of sod intended for NFL use. Most importantly, the sod should have a rootzone that is compatible with the stadium or practice field rootzone, ensuring that a finer texture is not placed over a coarser one.

3.2 MONITORING AND MAINTENANCE OF SOD GROWN FOR NFL USE

It is important to have a monitoring system is in place while the sod is being prepared at the farm. This includes recording and sharing information with the stadium regarding mowing height and frequency, fertilizer applications, cultivation practices (e.g. topdressing, verticutting), and pest management (weeds, diseases, and insects). It is highly recommended that the field managers visit the farm several times during the season to assess the sod as it matures. Consult the "NFL Sod Inspection Checklist" (Appendix B) to document the sod properties. The sod grower should complete this form monthly to verify production milestones, with the field manager making periodic visits as an independent check. When feasible, consider making at least three visits during the production cycle – one at initial establishment, one several months prior to harvest, and one at the time of harvest.

Early and frequent dialogue between the field manager and sod grower is valuable so that problems can be handled collaboratively. Monitor the turf regularly for performance aspects such as tensile strength and grass density. If the sod is grown on plastic [Fig. 13], particular attention should be given to the compaction and evenness of the base on which the plastic is laid. Sod on plastic is usually established by transplanting a thin-cut sod to the plastic and building the profile through light and frequent topdressing.

Fig 13. Sod grown on plastic

At the time of transplant of the thin-cut sod assess turf health and thickness of cut of the planting stock. Minimize the amount of native soil being introduced with the sod. Evaluate the sand being used for production topdressing, with focus on textural compatibility with the stadium sand rootzone. The turf may mature faster than the desired harvest date which requires maintenance interventions such as scarification or fraze mowing. These practices should be decided collaboratively between the farm and field manager.

Attention should be paid to maintenance practices, particularly within 3 months prior to harvest. Maintenance intensity may be increased to match the level expected at the stadium after transplanting the sod. Potential adjustments include lower mowing heights, spoon-feeding fertilizers, introduction of plant growth regulators, and applying a final sand topdressing.

3.3 PRE-HARVEST CHECKS AND TESTING

Pre-harvest checks and testing should be carried out in advance of the harvesting event. When possible, request or commission testing for relevant metrics such as impact hardness and traction [Fig.14]. During the final sod assessment visit, verify turf health and vigor, canopy density, and absence of any pests (weeds diseases, or insects). Clearly mark any areas in the field where the sod is unacceptable for harvest, such as field edges, low-lying areas, etc.

A full and detailed logistics plan from the point of harvest to the point of installation needs to be developed. This will include the transport type (flat bed, refrigerated, curtain sider, etc.), the transport route, and delivery schedule. This allows the field manager to plan, ensuring that activity in the stadium is focused around getting the sod installed in the best condition possible. Treatment with fungicides and a growth regulator to reduce the risk of transport damage also takes place at this time. Agreed harvesting quality assurance tests to be carried out at harvest such as sod thickness and big roll sod length are also done at this time. See Appendix B.

Fig 14. Testing sod for NFL use before its harvest and transport to stadium

3.4 SOD HARVEST AND TRANSPORT

The thickness of harvested sod should be checked [Fig. 15] and once rolled up, sod should remain rolled for the shortest time possible, following a minimum shelf-life approach from harvest through transport to installation. Sod transport planning is a key risk item [Fig. 16]. It is not possible to entirely de-risk the operation of transporting sod over long distances and times, but proper planning and execution reduce the chance of failure. Sod should remain rolled for the shortest time possible, following a minimum shelf-life approach from harvest through transport to installation.

Fig 15. Flatbed sod transport

Depending on the sod type, distance to travel and ambient weather conditions, it may be necessary to use refrigerated transport for the sod [Fig.17]. The cooling temperature during transport should be, determined collaboratively by the sod producer and the field manager. Sod can still overheat in cooled transport and desiccation of sod edges can also occur. The best practice when harvesting sod, particularly for long haul transport, is to have the sod as dry as possible at harvest. However, strategies for minimizing each of these risks should be included in a plan provided by the sod producer and approved by the field manager.

Fig 16. Checking harvested sod thickness

Fig 17. Refrigerated sod transport

3.5 SOD INSTALLATION

The success of a field replacement is highly contingent on adequate preparation prior to laying the new sod. The existing field should be stripped to a consistent depth which usually corresponds to the specified thickness of the new sod. If the old field is removed to a greater depth, additional rootzone material should be added [Fig. 18]. Ideally this material would be thoroughly incorporated into the existing rootzone, but time and equipment availability will dictate this choice. Use caution around irrigation heads (the sod in these areas should be removed by hand). The disposal of the existing sod waste requires a well-formulated plan as the debris comprises several thousand cubic yards and must be hauled off site. Attention should be made to assure that the goal posts are still at the correct height.

The surface should be laser-graded to a tolerance of ±1/8". Consider having an accredited or licensed professional perform a laser scan of the finished surface to confirm conformance to slope and planarity specifications. After grading, verify complete operation of the irrigation system. Flooding the rootzone hastens compaction and assists with fine laser grading. Inspect each irrigation head to ensure it has been placed at the appropriate depth. The position of the top of the head should account for the sod thickness. Similarly, verify the elevations of any other fixed infrastructure (i.e. valve boxes, communication boxes, etc.). Apply any preplant fertilizers and amendments. Depending on the field manager's preference these materials may be lightly incorporated with a nail drag or drag mat.

Fig 18. Sod removal with specialized equipment

It is important to establish efficient means of unloading the sod from the truck and transporting it to the field. If forklifts are used to stage the rolls, they must be equipped with balloon flotation tires to avoid sinking or disrupting the surface grade. The sod should be handled carefully to avoid soil loss or stretching of the rolls. The sod should be transported to the installer which should in turn always be working on a freshly prepared surface, raked clean of footprints or tire tracks. The final preparation of the surface can use a combination of brooms, laser graders and rakes. The sod installation machine should install the turf so that minimum damage occurs to the rolls. Retaining tension on the turf as it is unrolled is very important. If the roll spins out too rapidly, soil can be displaced from the roll and leaving an uneven surface. Joining of seams is another important aspect of the installation. Seam joining should be completed by trained staff using the appropriate tools. If the turf rolls are covered or use plastic wrap, all waste must be removed and disposed appropriately [Fig. 19].

After it is unrolled, the sod should be secured against the adjacent pieces using a mechanical arm. This equipment ensures the seams are tight and the strips will not be displaced by athletes [Fig. 20]. Gaps between the sod strips can also desiccate the turf at the strip edges. The strips must not be compressed so much that turf damage occurs. Having dedicated "spotters" walk the seams as the rolls are installed improves quality assurance in this regard. Avoid driving on the new sod as much as possible. If driving is needed, use low round pressure tractors and sod layers.

Fig 19. Sod installation

Fig. 20. Post sod install joint pushing using specialist machine

Roll the sod immediately after laying, using a suitably sized roller [Fig. 21]. If laying equipment must run on the adjacent sod roll, protect the grass with plywood running boards. Check and adjust all sprinkler heads to proper height - 5/8" to 3/4" below the top of the sod; ensure heads are in the upright/plumb orientation. Irrigate the new sod rolls as soon as possible.

Walk all seams, filling with rootzone sand to ensure no gaps are present to conform to the requirements listed in the NFL-NFLPA Mandatory Practices for Playing Surfaces. Areas of concern (tears, thin soil, leaf burn, etc.) can be marked with flags or cones. It is wise to note any problem areas while the installation crew is still on site so they can make the repairs. If repairs are necessary, use sod pieces that are full width and no less than three feet long.

When possible, allow several days for the new sod to acclimate to the stadium environment before play commences. Additional rolling, watering, and fertilizing are standard practices to prepare for NFL play.

Fig 21. Rolling newly installed sod

Fig 22. Impact testing on new sod

3.6 POST INSTALLATION SURFACE TESTING AND COMMISSIONING

After installation on the field and before play, a series of tests should be carried out to commission the field and confirm it is safe for play [Fig. 22]. Refer to the NFL-NFLPA Mandatory Practices for Playing Surfaces. Other helpful tests are suggested in Appendix A – RFP Template for NFL Fields.

CHAPTER 4 - TURFGRASS MAINTENANCE

Modern field managers possess specialized skills to address the challenges associated with growing turfgrass in the stadium environment.
The principles of turfgrass management include mowing, fertilization, irrigation, cultivation (topdressing, rolling, verticutting, fraze-mowing, aerifying, etc.), and pest management (weeds, disease, and insect). Supplemental management tools such as plant growth regulators, supplemental lighting, wetting agents, soil heating, and vacuum ventilation can be also deployed to help achieve high-quality playing fields. It is critical that the field manager is resourced correctly to maintain the field from a materials, equipment [Fig. 23], and personnel perspective.

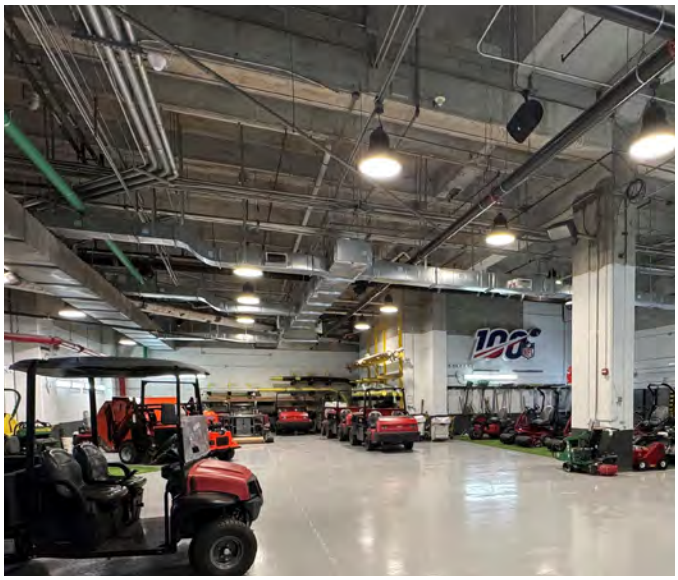


Fig 23. A well resourced field crew and modern equipment is essential

4.1 MANAGING TURFGRASS IN ADVERSE WEATHER

The fall/winter timing of the NFL season necessitates provisions for managing turf in adverse weather. This section describes actions which promote a high-quality playing surface in a variety of weather conditions. There are many types of field cover designs to aid in turfgrass growth in adverse weather.

4.1.2 SNOW COVERS

Field covering during snow and frost is an excellent way to improve the efficiency of an undersoil heating system if installed [Fig. 24].
A covered field will retain heat and can stimulate grass growth and recovery under the cover while outside temperatures remain below freezing. Managing grass in these conditions is a challenge and while heating and covering the fields is possible, this procedure raises other challenges such as moisture and condensation beneath the covers.
In such conditions, the use of fungicides can help prevent disease and maintain turfgrass quality.

Fig 24. Checking the condition of a field in freezing conditions under a snow cover

4.1.3 GERMINATION COVERS

These are generally covers which allow light and air through but improve heat retention and create a micro-environment for grass growth at the surface level of the soil [Fig. 25]. They require considerable labor to deploy and must be removed to perform field maintenance.

Fig 25. Germination covers allow grass to grow and establish while in place, accelerating growth conditions

4.1.4 RAIN COVERS

Rain covers can be deployed over an entire field to prevent rain or snow from falling on the field [Fig. 26]. It is important that the rain cover system sheds water to a suitable drain on the edge of the field. Refer to the **NFL Football Game Operations manual** for guidance on covering a field prior to forecasted rain.

Fig 26. Field covered

4.1.5 SUSPENDED TENT COVERS

These types of covers form a suspended tent over the field, allowing for limited maintenance under the cover [Fig. 27]. The area under the cover can be heated by above-ground heaters and/or utilizing the sub-surface heating systems. These types of cover ensure that the grass area is not impacted by frost or snow, but moisture management is challenging for their success because air exchange is limited, and high humidity can develop beneath the cover. These covers are only generally used for short periods of time (5-7 days).

Fig 27. Suspended tent style field cover. View from the stands (top) and from inside the cover (bottom)

4.2 MANAGEMENT FOR COLD WEATHER CONDITIONS

Field covering during snow and frost is an excellent way to improve the efficiency of an undersoil heating system if installed. A covered field will retain heat and can stimulate grass growth and recovery under the cover while outside temperatures remain below freezing. Managing grass in these conditions is a challenge and while heating and covering the fields is possible, this procedure raises other challenges such as moisture and condensation beneath the covers.

Management of natural turfgrass in cold weather conditions relies heavily on the technology and tools available as well as the experience of the field manager. Undersoil heating systems and covers are generally necessary if managing a stadium where the temperatures drop below freezing during the NFL season. Forward planning and pre management of the surface is critical. Supplemental light can be used to stimulate grass activity later into the season. When done effectively, supplemental lighting results in stronger rooting and more plant reserves available when freezing cold weather approaches. Though the effectiveness of this technique varies greatly by grass species.

It is important to have a well-draining surface for snow melt and improve air movement within the grass canopy. Light sand topdressing in the fall also improves prevents surface moisture and decomposition at the canopy when covered. Pre-treatment of the field with fungicide is standard practice as the microenvironment created under the covers with heat and moisture is ideal for fungus development. Green pigments can be applied to help preserve green color even as the grass enters dormancy.

The selection of rootzone heat temperature is based on the desired outcome. If grass recovery, growth and germination are required, heating levels can be increased to create an incubator effect on the field. The resulting growth will however be soft and lush and can easily shear off. If the aim is to keep the surface frost free, it may be an option to keep the grass under the cover just above freezing with snow removal planned nearer to events.

4.2.1 SNOW REMOVAL

Attempting to continuously melt snow for long periods of time with the undersoil heating system is not recommended. Keeping the rootzone at very warm temperatures while the grass is covered or snowbound may cause grass vigor to reduce and rooting to reduce. It can be possible to combine the use of undersoil heating and covers, however, experience suggests that this works better for hybrid grass than for natural turfgrass.

Freezing temperatures can also mean that simple operations such as fungicide or pigment application can be hindered and the use of warm water or even misting backpacks can be used on localized outbreaks of disease.

If a snow cover is in place, snow melt can be used in conjunction with the undersoil heating system to remove the snow [Fig. 28]. Undersoil heating systems are not designed to melt large depths of snow and removing the snow by plowing, shoveling, or other method may also be required. If the grass below the snow is not frozen, it is preferred to remove snow to the sides of the field and remove it with trucks rather than attempting to melt it in situ. The field manager is best-suited to decide whether to plow and what equipment to use.

Fig 28. Snow removal panoramic view (left) and snowplow detail (right)

Water generated from melting snow must be quickly removed from the field. If the drainage system fails to evacuate water from the surface (either via surface or internal drainage), the surface could freeze the following night, resulting in unplayable conditions and severe damage to the turfgrass.

Trafficking frozen grass will also damage or kill it. During cold conditions, every effort should be made to keep the surface as dry as possible and minimize traffic. Younger, immature grass under the covers is especially susceptible to frost damage [Fig. 29].

Fig 29. Typical grass desiccation from the thawing and freezing of snowmelt on a field

4.3 CULTURAL PRACTICES

Cultural practices refer to the operations carried out to 'cultivate' healthy turfgrass. These practices promote turfgrass density, growth and recovery and improve rootzone conditions. Such operations are generally carried out less frequently than mowing or fertilizing but are equally important. Ideally, cultural practices are performed under conditions dictated by the turfgrass natural growth cycles, but in practice the decisions to carry out these procedures are heavily influenced by event load and weather conditions. Operations such as solid tine aeration will improve air and water movement through the rootzone but may also reduce the firmness of the field [Fig. 30]. The resulting loss in surface stability needs to be balanced against the agronomic benefits of this operation. Sand topdressing is also an important cultural practice. caution should be taken regarding the selection of a sand that is compatible with the existing rootzone, and that the application rate doesn't disrupt in-season playability. Topdressing aims are two-folded. In the short-term, it lessons surface algal formation and other moisture related issues in cold stadium growing environments.

Fig 30. Regular shallow aeration is an important cultural practice

In the long-term, sand topdressing dilutes excessive organic matter build-up, which can be detrimental to the soil physical properties (e.g. compromise drainage) of the field. Enough sand is required to achieve the desired outcome, but too much sand can be difficult to work into the surface and may negatively impact performance and aesthetics of the field. In a similar way, scarifiers and rakes may be used to thin out the grass canopy and allow light and air to the smaller, younger plants, but this process must be carefully monitored to avoid excessive disruption.

When more plant material must be removed, operations such as the fraze mow can be carried out [Fig. 31]. The use of this aggressive technique is usually limited to the off-season because additional time is required for the grass to recover. Fraze mowing describes the use of a counter rotating spiral drum removing grass plant vegetation and surface, but leaving the growing point of the grass plant intact. Fraze mowing is particularly effective in the management of warm season bermudagrass, when combined with aeration and topdressing. The operation can improve the performance of surfaces. The amount of time required for the recovery of the grass post fraze mowing is determined by the severity of the operation and the growing conditions. Four to six weeks are considered sufficient for mature warm-season grasses while cool-season grasses can take up to 6-8 weeks to recover in ideal growing conditions. Fraze mowing is also a necessary practice to remove organic matter buildup on hybrid carpet or ybrid stitched fields, because regular sand topdressing can no longer be done.

Fig 31. Fraze mow on stadium surface (left);
note the small amount of plant material left on the surface (right)

The same machinery used for fraze mowing can be set to operate deeper and remove the entirety of the turfgrass vegetation [Fig.32]. This is common practice during in-season sod installations. Ideally, when anticipating a full surface removal in the off season, the grass is treated with a total herbicide and allowed to desiccate before surface removal. This allows a cleaner surface removal and less carryover of problem grasses or weeds. The recovery of these surfaces will be achieved by seeding or sodding in the case of cool-season grasses and sprigging or sodding in the case of warm-season grasses. Again, timelines need to be considered, not just for the operation carried out but the recovery time for the field performance to be achieved. Post renovation, the use of technology such as undersoil heating, covers and lights can accelerate growth and shorten the windows involved in recovery.

Fig 32. Total surface removal

4.4 SUPPLEMENTAL LIGHTING

Supplemental lighting can be a valuable management tool, especially for cool-season grasses. The lighting systems, now widely available, provide additional heat and light to fields which are grown in shady stadiums and cold climates [Fig.33]. Due to physiological differences between the grass types, supplemental lighting is more effective for cool-season grasses relative to warm-season grasses. Comprehensive shade studies done by experts in this field should be carried out to determine whether supplemental lighting is a feasible option for a particular field.

There are two main lighting types on the market. The older type consists standard high-pressure sodium (HPS) lights which provide both light and heat to the grass. The heat from the HPS lights are not always wanted or needed, but can be a helpful under colder climate conditionsHPS lights, while still used, are being fazed our for newer technologies. Light-emitting diodes (LEDs) are the newer technology for grow lights, and often chosen for both warm and cool-season grasses. Separate heating elements can be placed on the same rig if desired, since LED lights do not emit as much heat as HPS lights. The LED provide a better grow light spectrum which makes them more suited for both cool and warm-season grasses. They are also less costly to run. These lighting systems are often mounted on gantries that roll onto the field. The coverage area depends on the number of gantries and lights available. Maneuvering the gantries through the field to achieve full coverage should also be taken into consideration as it adds extra wear on the playing surface.

Supplemental light rigs are bulky and take larges amount of storage space when not in use. It is very important to consider the storage requirements for lighting systems at an early stage to ensure that the lights can be stored safely. The manufacturers will provide storage and transport dimensions. The provision of plugs and energy supply on the field is also a consideration to be discussed with the supplier.

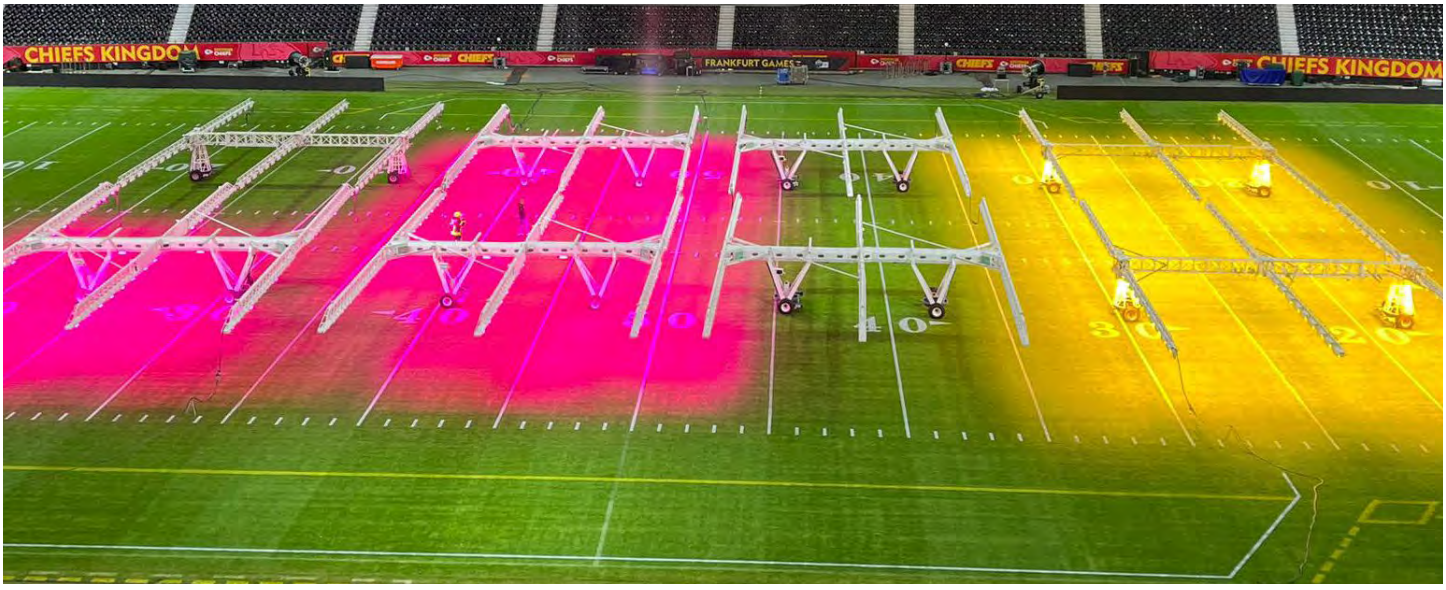


Fig 33. Supplemental growth lights. LED type (pink) and HPS type (yellow)

CHAPTER 5 - CONSIDERATIONS FOR REMEDIATION AND/OR FIELD REPLACEMENT IN SEASON (RE-SOD)

The following are the key factors which need to be considered for mid-season re-sodding operations. For game and practice field resodding during the NFL playing season, refer to the **NFL-NFLPA Mandatory Practices for Playing Surfaces** and/or consult a Football Operations representative for clarification on the requirements.

5.1 STADIUM FIELDS

NFL stadium fields are subject to severe wear and tear during competition. The degradation of the grass cover necessitates frequent resodding. Mandated policy for resodding is available in documents referenced throughout this Best Practices. This section provides additional guidance for making the decision to re-sod.

In-season resodding requires careful advance planning because the available time window between field events (whether an NFL game or other) is often very short. Resodding is often scheduled months in advance because of the time required to produce the sod and schedule contractors. In other words, resodding should be planned without advance knowledge of what the surface conditions will be at the time of resodding. However, experienced field managers can accurately anticipate when the field will require replacement based on the event and NFL schedules.

If a re-sod is not already planned, the field manager can use surface performance indicators such as impact characteristics, traction/shear resistance, and percent ground cover to determine when the sod should be replaced.

5.2 PRACTICE FIELDS

On practice fields, wear can be dispersed over a larger area by rotating drills and periodically closing a portion of a field. The field manager can devote special care to worn areas to promote recovery. Occasional resodding of practice fields may still be required but this is a more flexible operation as these surfaces are not typically used for destructive non-football events.

SECTION 2: HYBRID GRASS FIELDS

CHAPTER 6 - INTRODUCTION TO HYBRID GRASS FIELDS

Hybrid grass, sometimes referred to as reinforced grass fields, was developed in Europe in the early 1990's and became very popular globally, particularly for use in soccer. Reinforcement of natural grass consists of introducing synthetic components, usually fibers, to a stand of natural grass. Hybrid grass systems offer artificial stability to the surface and subsequently less reliance on anchoring by the grass roots and stems. Some hybrid systems can also enhance field aesthetics, providing a green appearance to the field even if little or no natural grass is present. The aim of any hybrid system is to offer a stable, playable surface under reduced grass density conditions. In modern stadia where maintaining grass density can be difficult due to challenging conditions, the use of hybrid reinforcement technology combined with other technology such as supplementary lights and good management practices can help maintain higher levels of consistency over longer periods of time and increased use

The use of hybrid reinforcement is more common on cool season grasses, as the morphology and growth habit of these tend to be vertical, allowing the fibers to protrude and remain vertical. Additionally, cool-season grasses used in sports turf do not have an aggressive rhizomatous and/or stoloniferous growth habit, allowing the roots to grow more easily through the carpet.

It is important to note that the performance of a hybrid grass system relies on characteristics of both natural grass and synthetic turf. Selecting a hybrid type should account for design attributes of the synthetic turf and the morphological and physiological characteristics of the natural grass. Ultimately, the goal is to have a synergistic combination of synthetic fibers with healthy natural grass hybridized in a way that can be maintained effectively throughout the life cycle of the surface.

In general terms, the construction of a hybrid grass field is analogous to that of natural grass fields. Subsurface infrastructure, materials and installation procedures adhere to the same principles outlined in section 2.0.

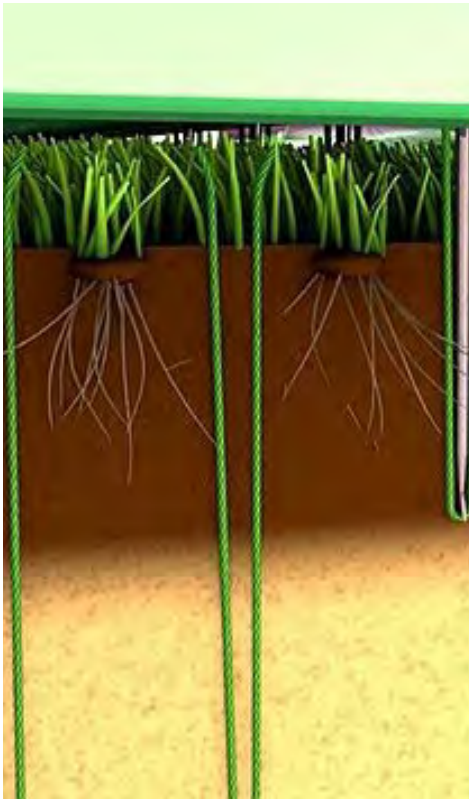
CHAPTER 7 - TYPES OF HYBRID GRASS

There are two main types of hybrid grass surfaces. One consists of introducing synthetic fibers to a natural grass sward by stitching synthetic fibers into the field. Hence, those systems are commonly referred to as stitched hybrids. The other type of hybrid grass, commonly referred to as carpet hybrid, consists of planting and growing natural grass into an open-backed synthetic turf carpet.

7.1. STITCHED HYBRID

In stitched hybrid turf systems, synthetic fibers are injected vertically into the playing field using specialized machinery [Fig. 35]. Historically, the monofilament fibers are pushed into the soil on 3/4" x 3/4" spacing, 6"-7" deep and have 3/4"-1" of fiber exposed above the rootzone surface. Today, fiber spacing, stitching depth and fiber bundling/ply can be individually selected Strong research evidence should guide the stitching parameters. Fibers can be stitched into prepared rootzone material and followed by seeding, or into an existing grass sward [Fig. 36].

Fig 35. Hybrid stitching machine



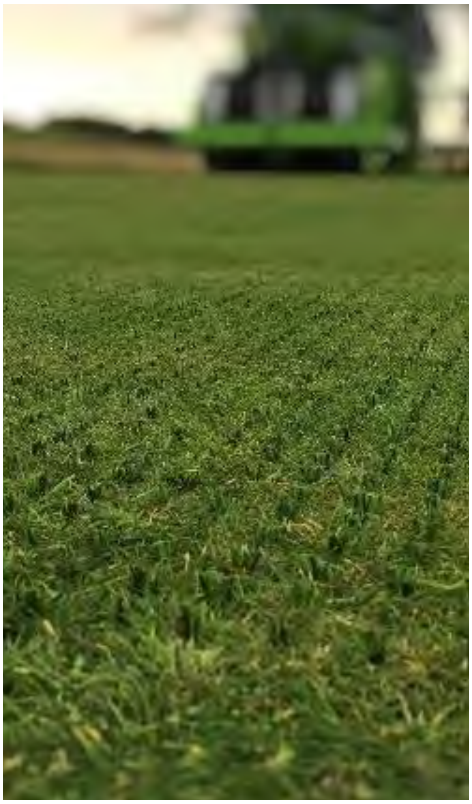


Fig 36. Hybrid stitched concept (left), hybrid stitching pre grass (middle) and hybrid stitching in established grass (right)

7.1.1 ADVANTAGES OF STITCHED HYBRID

- Longest record of performance (circa 20 years of references)
- Provides a more consistent and uniform playing surface than natural grass; particularly, as wear patterns increase across a field.
- Easier to renovate than carpet systems
- Can be installed into existing fields where stability issues are occurring, retaining the existing grass
- Provides a green shine/tinge to the pitch when grass density is lost
- There are options for shallow stitching that can be implemented at the sod farm and enable easier field replacement.

7.1.2 DISADVANTAGES OF STITCHED HYBRID

- Annual renovation required, consisting of complete removal or grass and organic matter. This requires substantial downtime for recovery of the grass sward.
- Increased (sometimes excessive) firmness and traction loads compared to an equivalent natural grass surface. The magnitude of change in surface properties depends on the stitching pattern/ density and the grass species.
- Changes to maintenance practices may need to take place to maintain compliance with the NFL's testing standards.
- Specialized machines needed for installation resulting in challenges with logistics, and timing.
- When renovating/replacing a traditional stitched hybrid rootzone, a significant depth of rootzone must be removed (up to 9 inches).
- If the grass cover becomes degraded and aesthetically unacceptable during the season, overseeding is the only option. In such an emergency, the last resort would be to lay sod on top of the existing surface. This practice is strongly discouraged as it presents many challenges.
- Limited end of life solutions for hybrid fields, depending on the region and local regulations. Disposal/landfilling is expensive and environmentally unfriendly.

7.2 HYBRID CARPET SYSTEMS

This involves establishing natural turfgrass in an open-backed synthetic turf carpet, specifically designed to facilitate natural grass plants growing through the carpet. Ideally the grass roots penetrate the backing of the carpet, and the grass shoots and tillers grow amongst the fibers. The synthetic fibers can share the canopy with the grass blades, or they can be buried underneath the natural grass canopy. These types of systems are often established in a sod farm, harvested, and transplanted to the intended playing field. They can also be established and grown in-situ. Hybrid carpet systems have recently regained popularity since their introduction in the 1990s, due to their potential to offer a more streamlined and quicker resurfacing option during the playing season [Fig. 37].

Carpet hybrid grass systems can have substantially different characteristics than pure natural grass. In these systems, surface attributes of interest (impact hardness, restitution, traction, etc.) are highly reliant on the design attributes of the synthetic turf carpet rather than on the grass. Special attention should be given to the vetting and selection of the appropriate carpet hybrid product. For example, these systems often provide a higher level of stability, which may result in excessive hardness and traction loads. There are several options for hybrid carpet systems, and fiber density and backing porosity can vary greatly.

Fig 37. Hybrid grass concept (left), sand filling and installation (middle) and harvested rolled hybrid carpet grass (right)

7.2.1 ADVANTAGES OF HYBRID CARPET SYSTEM

- It can be either grown in a sod farm and transplanted or installed and grown in-situ.
- No specialized machinery required for installation. Uses traditional synthetic turf installation machinery.
- Provides a green shine/tinge to the pitch when grass density is lost.
- Removal depth is limited to the thickness of the carpet system (whereas the stitched systems must be removed to the full fiber stitching depth).

7.2.2 DISADVANTAGES OF CARPET HYBRID

- Hybrid carpet backing systems are often not open enough to promote appropriate turfgrass rooting.
- Hybrid carpet systems often have too much fiber, which can altersurface properties such as hardness and traction.
- Annual renovation is required each year with total grass and organic matter removal. This requires downtime for recovery of the grass.
- The synthetic carpet needs to be deep enough and be filled deeply enough with rootzone medium to prevent damage to the carpet backing during renovations.
- Potential for excessive hardness and traction loads, which may affect player safety and performance.
- Limited end of life solutions often involves removal of carpet and separation of carpet, grass, and sand material. This process is expensive, environmentally unfriendly, and still requires disposal of the carpet portion.

CHAPTER 8 - CARPET HYBRID GRASS SOD GROWTH, HARVEST, AND TRANSPLANTING.

If carpet hybrid grass is being grown in a turf nursery for future harvest, it is important that the following points are noted:

- When grown in a sod farm, the hybrid carpet turf is generally placed on a 1-inch blinding layer consisting of clean sand material. This layer allows the blade of the harvester to cut under the carpet backing for a smooth, separated finish [Fig. 38].
- Hybrid carpets can be grown for sod both conventionally and over plastic.
- Synthetic turf fiber trapping during establishment is a common issue and requires intensive level of maintenance through diligent addition of sand and brushing/grooming.
- The level of sand infill in the carpet system should be consistent throughout to avoid issues matching the desired grade and planarity.

Fig 38. Installation of hybrid carpet at sod farm

- Verify that the sand infill is not falling through the carpet upon harvesting, which will result in an uneven field.
- Check the preparation of harvested sod for transport. Moisture, wrapping and transport type can have an impact on keeping the rolls intact.
- Check the age of the sod and the level of thatch on the surface. Hybrid carpet sod with high levels of thatch and maturity will divot heavily and require more aggressive maintenance.
- Ensure installation of hybrid grass sod by an experienced staff. Although the process is similar to installing natural grass sod, differences in installation methods, tools, and expertise must be accounted for.

CHAPTER 9 - HYBRIDIZATION WITH WARM-SEASON GRASSES

Hybrid grass reinforcement was first introduced in Europe as a solution for unstable rootzones. European fields mostly use cool season grasses due to climate conditions. Therefore, the birth and evolution of hybrid grass systems is centered around cool-season grasses. As a result, the use of warm-season grasses in a hybrid configuration is less popular and less tested. A key challenge presented by hybridization of warm-season grasses is related to its aggressive growth habit that results in dense morphological structures below and sometimes above the soil preventing a synergistic environment between the synthetic fibers and the grass canopy.

Challenges related to hybridization of warm-season grasses include:

- More difficult to establish and maintain compared to cool-season grasses due to its vegetative growth.
- Warm-season natural grasses' aggressive growth is more prone to thatch development, which needs to be managed more intensively and removed more frequently through cultural practices.
- Synthetic fibers may be pushed over by the lateral growth habit of warm-season grass, becoming buried into the canopy if not maintained properly.
- Restriction to cultural practices such as sand topdressing to control organic matter

Lastly, warm-season natural grasses tend to offer adequate stability without any synthetic reinforcement, due to their aggressive morphological structure. Mechanical testing of surface parameters (traction, impact, restitution, etc.) before deciding is strongly recommended.

CHAPTER 10 - HYBRID GRASS SYSTEMS, VENDOR SELECTION, AND IMPLICATIONS FOR RE-SODDING

Conventional stitched hybrid systems do not facilitate resodding due to their stitching depth up to 9" into the rootzone. When resodded, the rootzone needs to be removed to the full stitching depth. This greatly limits resodding as a recurring maintenance practice to reestablish an adequate playing surface, especially during the season or in the case of a non-sporting event (i.e. concert). Shallow stitching (2.5 – 4in) is a recent capability and provides an alternative option for easier removal and resodding. Detailed discussions with the stadium management team should take place when considering a stitched hybrid to ensure that the surface choice does not negatively affect a stadium's business model.

Hybrid carpet and shallow stitched (2.5 in) systems do facilitate resodding as they can be established off site (i.e. at the sod farm), harvested, and transplanted to a stadium field [Fig. 39]. When choosing a carpet-style hybrid, special attention should be paid to the synthetic component/product and the maturity of the grass canopy, ensuring that the hybrid sod is harvestable and offers good surface attributes resulting from both the synthetic turf and natural grass components. As these systems are not popular in the NFL, extra vetting is recommended including testing, sod inspection visits at the sod farm, discussions with the vendor, and, when possible, establishment of small-scale areas to gain familiarity with this type of system.

Fig 39. Hybrid turf being installed

With many synthetic turf manufacturers now offering hybrid grass products, there has been a large influx of new products, particularly in the carpet hybrid sector. There has been limited independently verifiable research associated with the performance characteristics of hybrid turf and its suitability for NFL play. It is critical that the products proposed are fully assessed and tested before being used in the NFL.

It is also very important that the playing characteristics are fully understood from a safety perspective, particularly how the players' cleats interact with carpet systems. The vendor references and experiences should be assessed in detail and clarifications should be sought regarding the performance of the product. It is also critical to carry out a full evaluation of the implications of the installation and make sure that the benefits and drawbacks of the system chosen tie in with the stadium use and activity.

CHAPTER 11 - MANAGEMENT, MAINTENANCE, AND RENOVATION OF HYBRID GRASS SYSTEMS

The management of hybrid grass systems should be adjusted from natural grass maintenance practices to accommodate for the peculiarities of the hybrid grass system. It should take into consideration general agronomy, field management experience, player preference and feedback, and testing of relevant metrics related to player outcomes. The practices below are similar to natural grass in section 4 but may have to be modified to be effective in a hybrid grass pitch.

11.1 AERATION

Aeration, commonly done on natural grass, is also performed on hybrid grass systems, especially for permanently stitched grass, with the goal of reducing surface compaction and improving agronomical aspects. Aeration is often done with solid tines (8-10 mm), and to a 3" to 4" depth. Though hollow tines can be used, it requires larger diameter tines that may cause more surface disruption and potentially damage the stitched fibers. On carpet hybrid systems, aeration with solid tines may be done, although damage to the carpet backing may to occur. Since carpet hybrids are usually not a permanent installation and are frequently resodded, the decision to solid tine aerate should consider potential damage to the carpet backing and time between aeration and the next resodding event.

11.2 HYBRID GRASS HYGIENE MANAGEMENT

Spring raking, brushing, and grooming provide several benefits, including the removal of decaying leaf litter and damaged grass plants, as well as helping lift and stand up of the synthetic fibers. The resulting debris is then removed with a sweeper or suction mower.

11.3 MOWING

If reel mowers are used, stiff bristle brush attachments before/after the cutting reel are recommended to help stand up the fiber. Removal of grass clippings is strongly recommended, contributing to proper hygiene management. Finally, Rotary mowers can be used as a follow up to help with grass clipping and other debris collection. [Fig. 40].

Fig 40. Clean up suction mowing and general surface hygiene is very important

11.3 SAND TOPDRESSING

Sand topdressing "dustings" on hybrid grass fields can be helpful in preventing organic matter build up. It is critical not to bury the fiber in sand topdressing. If sand topdressing is over applied, the surface may become unstable and shear.

If heavier sand topdressing takes place, fraze mowing in the off season is typically required to remove the excessive sand and re-expose the fibers to their initial reveal.

11.4 ANNUAL RENOVATIONS

The long-term performance of hybrid turf (both stitched and carpet) is highly dependent on annual renovation. This involves removing the grass canopy and organic matter from the field with a stripping machine, leaving the synthetic fibers exposed. The intensity and number of passes of the machine is generally determined on site [Fig. 41]. The goal is to "gouge" out the grass plants and organic matter without impacting the synthetic fiber and/or the carpet backing (when present in a carpet system). Using incorrect machinery use in renovations is detrimental to the hybrid fiber and can cause unnecessary fibrillation or total removal of the fiber.

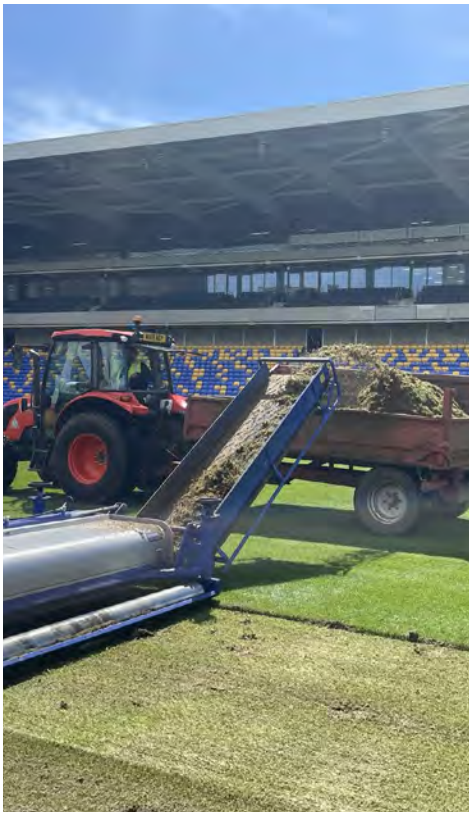


Fig 41. Sand topdressing before seeding (left), fibers left upstanding (middle) and vegetation removal during renovation (right)

The surface stripping is generally followed by raking of the fibers, which are erected vertically. The depth of raking and types of rakes used is dependent on the hybrid system used. Powered rakes have also been adopted recently.

Following raking, the surface is usually aerated and lightly topdressed with sand. The sand is brushed and dragged to smooth the surface and the grass stand is re-seeded. In Europe, perennial ryegrass is generally used with hybrid fields for its rapid germination. In the USA, perennial ryegrass is mostly used as overseeding into bermudagrass, leaving Kentucky bluegrass as the cool-season grass of choice. This is a slower grass to germinate and establish than perennial ryegrass.

11.5 LOCALIZED REPAIRS

When using stitched hybrid grass systems, it is common to repair localized areas by hand stitching if stitching has been removed by renovations [Fig. 42]. This is a slow and labor-intensive process. Localized repair of carpet hybrid systems involves removal of the sodded area. The sod has to be cut out of place with a mechanical saw or removed in an entire roll and replaced. Generally for carpet hybrid systems, localized repairs should take place in field sections (i.e. the full width of the field back to the edge of the field).

Fig 42. Hand stitching repair of hybrid stitched grass

11.6 EMERGENCY RE SODDING OF HYBRID STITCHED FIELDS

In circumstances where hybrid stitched fields require resodding it may not be possible to remove the stitched component of the field in the short term. Though not recommended, sod has, in the past, been laid over a declining hybrid field. In the event of a resod over a hybrid field, consider the following:

- Full removal of the existing grass, ensuring that synthetic turf fibers are exposed and clean of material (debris, grass, organic matter, soil, etc.). Note that conditions beyond the control of the staff may impact execution in these circumstances (winter, snow, etc.).
- With the surface stripped of all grass and organic matter, the surface should be graded when possible, or at a minimum dragged and raked to improve levels.
- Sand topdressing and deep solid tine aeration should be used to fill the standing fibers as much as possible. This will prevent them from lying flat on installation of the sod
- Placement and installation of the sod on the sand layer and roll into place.
- Make sure the goal posts are still at the proper height.

When resodding stitched hybrid fields, the advantages of the hybrid reinforcement are lost, and the reinforcement becomes a hindrance to management and performance.

11.7 USE OF TECHNOLOGY WITH HYBRID FIELDS

The use of technology such as forced air vacuum, undersoil heating, ventilation systems, grow blankets and supplementary lights are all commonplace in the management of hybrid grass fields. These are all detailed in the natural grass section.

SECTION 3:
SYNTHETIC TURF

CHAPTER 12 - INTRODUCTION TO SYNTHETIC TURF

The use of synthetic turf has grown in recent years due to improvements in synthetic turf design, increased field usage for sporting and non-sporting events, and maturation of the industry to support synthetic turf manufacturing and installation. Once relegated to uses related to indoor venues and harsh climates, synthetic turf is now used in a wide range of locations, climate conditions, and levels of competition. Currently in the NFL, roughly half of the gameday stadiums have synthetic turf surfaces, and most practice facilities have at least one synthetic turf field or training area.

Since its invention in the mid-1960s, synthetic turf has evolved significantly. The original, 1st generation synthetic turf consisted of a carpet of short nylon fibers glued to concrete or asphalt, with a cushion layer in-between. These surfaces were abrasive, hard, and did not replicate the cleat-surface interaction of natural grass. The 2nd generation of synthetic turf appeared in the 1970s, replacing the abrasive nylon fibers with polypropylene. Sand infill was also introduced to the short carpet fibers to better mimic natural grass. That style of synthetic turf endured for nearly 3 decades, despite its low popularity amongst players. The next breakthrough in design resulted in 3rd generation synthetic turf in the early 2000s containing soft polyethylene fibers and crumb rubber infill from recycled tires. Significantly longer carpet fibers, and a heavier infill composition consisting of sand mixed with crumb rubber improved many athlete-surface interactions. In many ways, this is still the foundational design for current synthetic turf fields, with a few modifications. Due to the increased fiber length, cushion layers were abandoned for the better part of the decade. In the early 2010s, many new cushion underlayment products re-entered the market as a solution to battle long-term compaction and increased field hardness of synthetic turf. The 4th and present generation of synthetic turf consists of the same long and soft polyethylene fibers infilled with alternative infills, such as organic materials, rather than crumb rubber. Available organic infill materials include cork, coconut husks, shredded wood, walnut shells, among others. Organic infills are less elastic than crumb rubber, so the former usually require a cushion layer underneath the turf to provide shock absorption.

The use of synthetic turf in the NFL should take into consideration the following aspects:

- Player safety, performance, and preferences. One of the most important aspects when considering using synthetic turf in the NFL is related to player-surface interactions. When possible, consider requesting information and data related to injury rates, mechanical testing, and player preference. While no single surface construction can entirely prevent injury or optimize player performance, current NFL research continues to evolve and support opportunities for player health and safety improvements.

- Climate – synthetic turf is an alternative to natural grass in harsh environments which preclude optimal grass growth, although it is important to consider the advancements and newest technologies available to aid natural grass growth such as heating, drainage, and lighting systems, etc., before deciding.

- Stadium type – synthetic turf is often installed in enclosed domes or other stadiums whose structure limits natural sunlight and air flow.

- Stadium usage and venue business model – stadiums shared by more than one team and/or sport can pose challenges toward maintaining natural grass for NFL play. Non-sporting events such as concerts, trade shows, fairs, etc. should also be discussed between the club and venue management teams when selecting a playing surface.

CHAPTER 13 - COMPONENTS OF A SYNTHETIC TURF FIELD SYSTEM

Currently, there are many synthetic turf products, infill types, underlayments, and installation methods available in North America. An abundance of options can be an advantage to buyers, but it can also be overwhelming and confusing. This section outlines some helpful steps when considering a new synthetic turf installation for NFL use.

First, it is important to understand the basic composition of synthetic turf systems, as brand name or make/model for the intended system is insufficient to comprehensively describe a synthetic turf field.

Synthetic turf systems are composed of a grass-like textile fabric (e.g. turf carpet), granular infill inserted into the spaces between the artificial grass fibers, and occasionally a cushion underlayment directly underneath the turf carpet [Fig. 43]. Those components are constructed over a prepared sub-base layer. Listed below are key attributes of each synthetic turf system constituent:

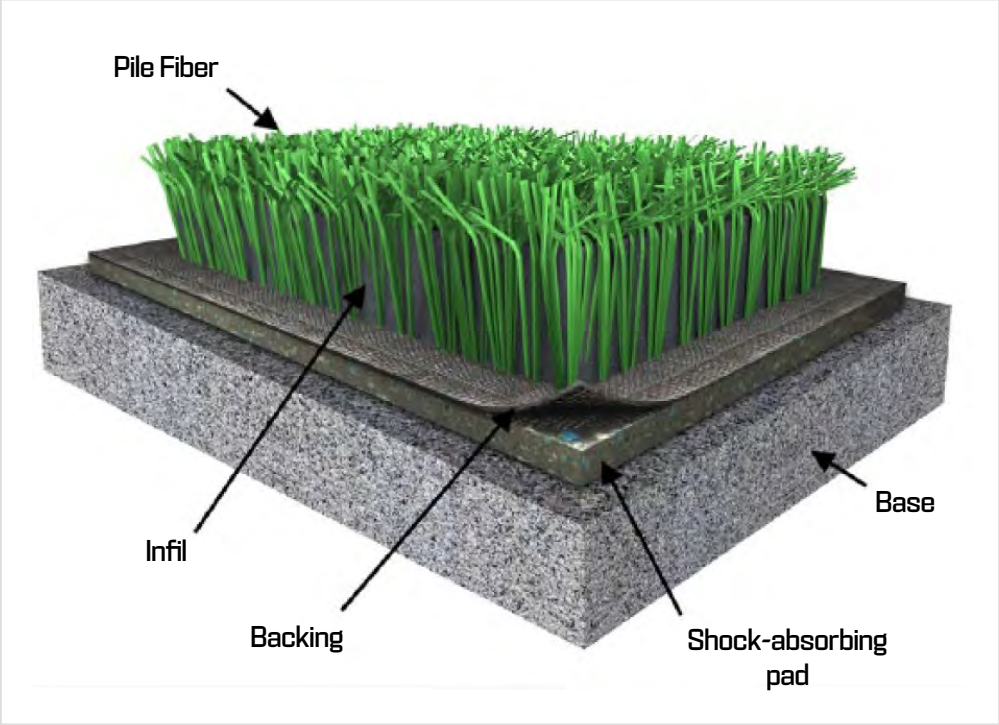
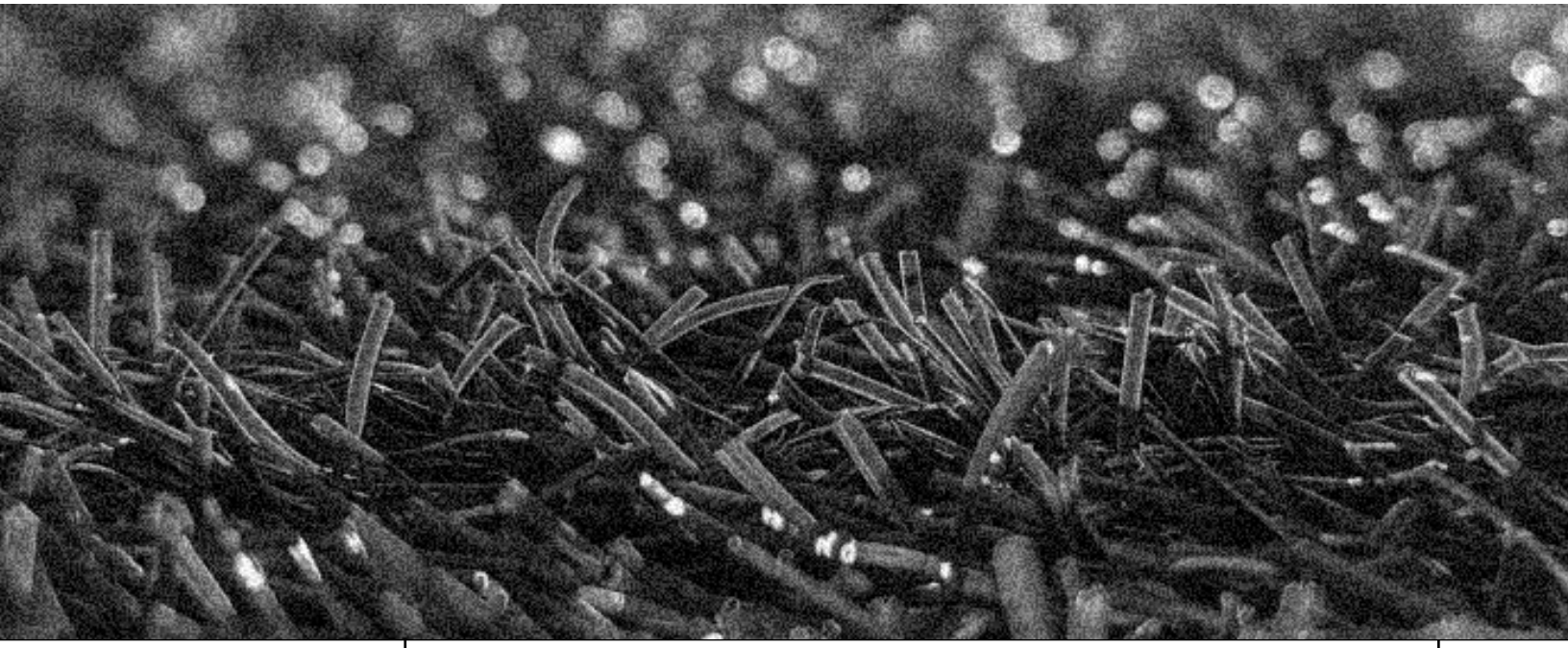


Fig 43. Architecture of a 3rd-generation synthetic turf system *(source: Jastifer et al. 2019)*

13.1 SUB-BASE

The sub-base forms the base of the field and is critical to the integrity, performance and playing attributes of the field. The sub-base is a constructed layer underneath the turf system with some site-specific features including grade and slope, presence/absence of drainage, and type of material to be constructed from. Though sub-base design tends to be site specific, there are 3 common types of sub-base used for synthetic turf fields.

- **Concrete:** Usually chosen for indoors stadiums, a concrete sub-base is a robust, non-compliant surface. This method of construction is permanent, necessitating substantial construction to be modified or removed. The advantages of the concrete sub-base are the ability to withstand heavy loads such as in heavy load bearing events. Disadvantages of this type include lack of drainage, which may affect paint removal, and potential for increased surface hardness depending on the turf system installed over it.
- **Porous Asphalt:** Almost as robust as concrete, porous asphalt is sometimes chosen for its robustness withstanding heavy loads, and it's drainage capabilities. Another advantage of this type of sub-base beyond built-in drainage, is the flexibility in the method of construction. For example, in the process of pouring asphalt, crumb rubber can be added to this layer, effectively turning it into an elastic layer with shock absorption properties.
- **Aggregate:** this method utilizes gravel of different gradation and shape to build up a drainage volume underneath the field. This method is widely used in lower levels of competition such as college, high schools, and municipalities. The key to an aggregate sub-base is to achieve stability through compaction and interlocking of the gravel particles, while maintaining drainage properties. The result is a stable enough layer for playing and everyday use, but care should be taken not to overload this type of system, which could cause ruts, planarity, and other issues.



13.2 TURF CARPET

The turf carpet "backing" is installed with fibers which sit erect and retain the infill. There are a number of technical factors associated with fiber types:

- **Fiber type:** monofilament fibers, slit-film fibers, and texturized "thatch" fibers may be used exclusively or combined [Fig. 47]. The fiber type influences aspects such as confinement of the particulate infill, field aesthetics, and field maintenance.
- **Fiber pile:** length of each fiber bundle from the backing of the carpet to the tip of the fiber. Fiber pile influences the amount of infill that can be dispersed into the carpet. Longer fiber piles will require more infill.
- **Fiber density:** commonly called "face weight", it represents how dense or sparse the turf carpet is. Generally, denser carpets increase infill confinement, which can alter the athlete to surface interaction. Fiber density is influenced by fiber type, pile (height from the carpet backing), stitch rate (linear distance between each stitch), and gauge (distance between the fiber rows).

Fig. 44. Types of main synthetic turf fibers (left) and texturized "thatch fiber" added to a main fiber (right)

13.3 INFILL

The infill material is a granulated material dispersed between the artificial grass fibers of a synthetic turf carpet, intended to provide a medium for athlete-surface interaction. The infill can be of a variety of materials, and can be dispersed into the turf carpet as a single material, or as a combination of multiple materials. Crumb rubber is the most commonly used infill material, although many options are currently available. The infill material can also have different functions related to the game. For example, from a structural standpoint, the infill material holds the artificial grass fibers upstanding, which is desirable. From a performance standpoint, the infill material provides a layer for the cleats to engage with the playing surface so athletes can generate enough traction to perform athletic maneuvers. From a safety perspective, the infill and fiber interaction can contribute to tunable field attributes such as shock absorption, energy return, and prevent excessive traction loads from developing. Consider the following aspects when choosing an infill:

- **Infill material:** the most common infill material is recycled tires which are ground-up into "crumb" rubber, or a mixture of crumb rubber and sand. However, other choices are available. To cite a few: thermoplastic elastomers (TPE), Ethylene Propylene Diene Monomer (EPDM), and organic materials such as cork, coconut husks, walnut shells, or shredded wood may all be used exclusively or mixed with sand and/or other particulates [Fig. 48].

- **Infill ratio:** ratio of each infill present in a synthetic turf carpet on a weight or volume basis. Most infill is measured, sold, and installed in weight units (e.g. lbs./sq.ft.).

- **Infill layering:** installation method for the infill mix: pre-mixed, layered (e.g. sand at the bottom and rubber at the top) or stratified (alternating layers of different infill materials.

Fig. 45 Examples of granulate infills commonly used as fillers in synthetic turf

13.4 CUSHION UNDERLAYMENT (OPTIONAL)

Cushion underlayment's are not always used in synthetic turf. The primary intent of a cushion layer underneath the turf is to provide shock attenuating properties to the turf, especially when the infill material type and/or quantity is insufficient to appropriately attenuate forces applied to the playing field. Certain shock pads can also contribute to other attributes such as increased drainage, and/or improved planarity [Fig. 46].

- **Elastic layer (e-layer):** bonded rubber shock pad that is placed between the sub-base and the turf carpet. Can be provided in rolls, squares, or it can be poured on site in a process similar to paving a road.
- **Shock-pad:** shock absorbent layer/product between the sub-base and the turf carpet, consisting of several materials of different stiffness, thickness, and elasticity. It can also be provided as rolls, squares, or other puzzle-like geometric shapes.
- **Drainage tiles:** rigid and partially void 3-dimensional structures intended mainly for creating extra porous volume under the turf to facilitate drainage. Some tiles may also claim shock absorption properties.

Fig. 46. Common types of synthetic turf underlayments: elastic layers poured on-site (left), shock-pad (center), and drainage tiles (right)

When choosing synthetic turf for NFL use, extra diligence should be taken to ensure the surface will be sufficient to fulfill all intended needs at its home venue. There are peculiar aspects to some NFL game venues that should be considered:

- **Shared stadium/venue:** when shared with other teams and/or other sports, extra requirements may have to be met. For example, changing field markings, team logos and colors, or even changing from American football to, for example, soccer, require extra steps to prepare and maintain the field surfaces. In addition to the field markings, sports requirements for size, surface type, and surrounding areas and benches may be different and should be accounted for during planning for synthetic turf selection and installation.

- **Non-sporting events and usage:** to their advanced infrastructure and high seating capacity, NFL stadiums often host non-sporting events (concerts, trade shows, tours, corporate events, etc.), which disrupt the field surface. The decision-making process when choosing a surface for NFL use should account for the additional efforts to convert the surface between NFL and non-NFL events. Some examples include protection, sanitization, decompaction, and grooming of the field. Ensure that the synthetic turf selected can withstand the desired use at the intended venue while passing the gameday requirements listed in the *NFL-NFLPA Mandatory Practices for Playing Surfaces*.

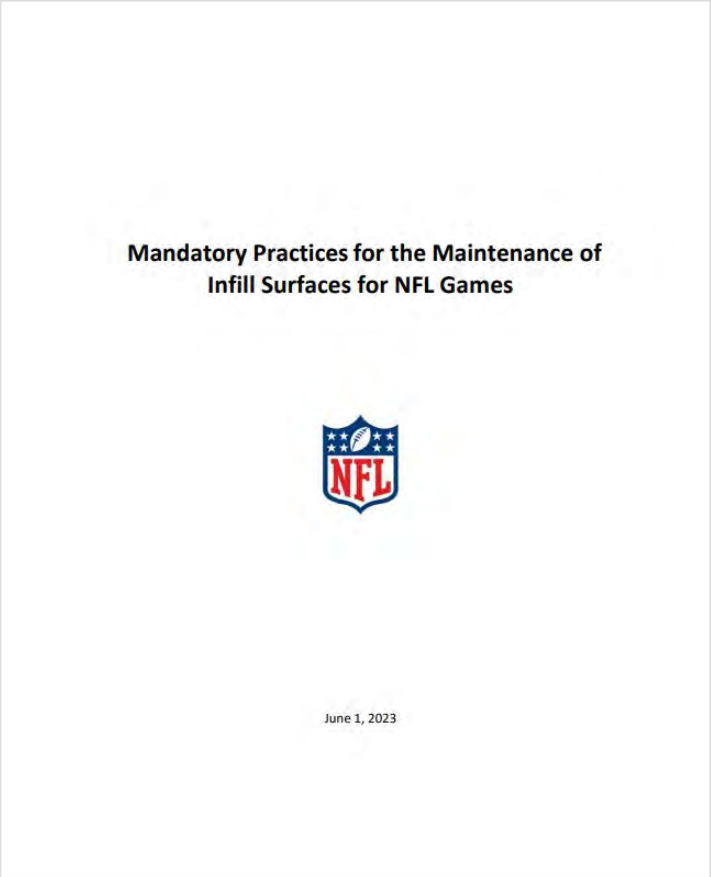


Fig. 47. Mandatory Practices for the Maintenance of Infill Surfaces for NFL Games

Several industry resources are available to support synthetic turf education and selection, however, they may be focused on other sports (i.e. soccer) or may not consider the peculiarities of the NFL use case. Inquire from the manufacturer about product specifications, system components, warranty and services/support, detailed installation plans, and references for clubs who have already installed their products. Also request additional information from the supplier about how the surface specifications and maintenance requirements relate to NFL use.

Consider requesting and gathering all additional information available to support the decision-making process for synthetic turf selection for NFL use. Consult with League representatives to request pertinent information beyond what is provided by the surface suppliers. It is also recommended that after initial evaluation of available product options, clubs and venues request plot mock-ups to be installed at their preferred site by each contending supplier/product. This process allows for extra vetting and validation of the intended surfaces through club staff feedback, player feedback, and mechanical testing (where possible). If testing of the mock-up surfaces is desired, allow a minimum of 6 months for coordination, execution, testing, and reporting. For more information on synthetic turf selection, please refer to Appendix A – Template RFP for NFL Fields. These steps should help mitigate the risks of an unknown outcome related to a field surface choice.

CHAPTER 14 - SYNTHETIC TURF INSTALLATION

Installation of synthetic turf is a complex and labor-intensive procedure and therefore, it should be done by specialized and qualified personnel. Installing turf fields includes handling of bulky materials (turf rolls and super-sacks of infill), panel alignment, cutting and glueing of inlays for designs and color, joining of seams for adjacent panels, and dispersion/conditioning of infill materials. If underlayment is used, it adds another layer of complexity to the process, sometimes even requiring construction techniques in the case of elastic layers. Ultimately, installation methods should be agreed upon between the club and venue to ensure product meets expected performance at completion and handoff.

14.1 CHOOSING A CONTRACTOR

Turf contractor qualifications:

- The turf contractor should be knowledgeable in the manufacturing of the turf and experienced in the installation of the specified type of synthetic infilled turf system, including all materials, sundries, and installation equipment and techniques.
- It is recommended that the turf contractor has a minimum of three (3) NFL stadium football fields in use for games or practices for at least 3 seasons with similar turf carpet, infill system, backing and seaming method as is being proposed for the project.
- The turf contractor should provide the club with a letter on the company letterhead certifying that the field will meet the expected installation quality, ideally matching the performance test results (when available) during the screening process. Details on seaming methods, infill ratios and layering, brushing, and grooming should be set forth in this document. Pertinent tests intended for installation QC should also be listed.
- The letter should also clearly state ownership of tasks and responsibilities between the manufacturer, installer, and any other involved parties, related to field aspects before and after the handoff to the club or venue.
- The turf contractor should verify that the installer, whether in-house or independent third-party, is certified by the manufacturer to install the synthetic turf specified for this project.

Refer to Appendix A - Template RFP for NFL fields, for more specific guidance on vetting of synthetic turf manufacturers and installers.

14.2 QUALITY ASSURANCE RECOMMENDATIONS

Before turf manufacturing begins, a representative from the club or venue should visit the manufacturing factory to understand the manufacturing process and evaluate the facility. During manufacturing of the synthetic turf and prior to its shipment to the job site, the synthetic turf rolls should be randomly sampled and tested by an accredited, independent laboratory. The laboratory will certify the product meets all specifications cited in the bid/RFP documents and manufacturer's submittals. Consider testing a random sample for at least every 20,000 sq.ft. of manufactured turf [Fig. 48].

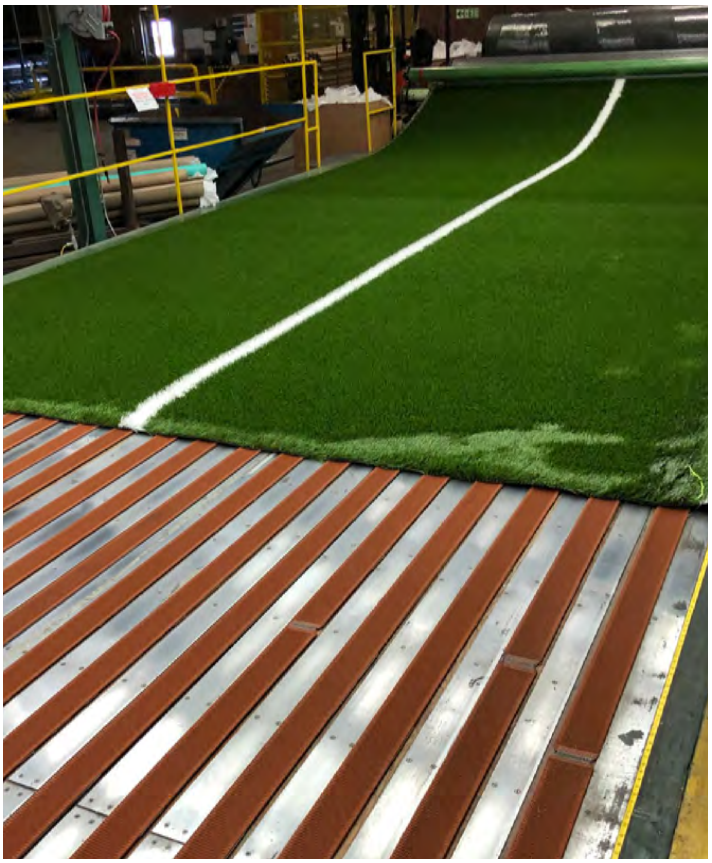


Fig. 48. Example of turf manufacturing defect.

Infill materials should be submitted to an accredited testing laboratory for particle size, bulk density analysis and certification that the product(s) meets all specifications cited in the bid/RFP documents and the manufacturer's submittals.

Manufactured pads should also be submitted to an accredited testing laboratory for pertinent testing and verification as requested in the bid.

Once a synthetic turf surface and its components have been selected, focus should be on the appropriate installation and verification of its intended performance.

14.3 FIELD INSTALLATION - QUALITY ASSURANCE/ QUALITY CONTROL (QA/QC)

Because several parties are involved in the installation of a synthetic field, it is recommended that a single party is responsible for verifying the quality of the installed surface. Typically, the turf in is the party responsible staller, but it could be done by another party designated by the stadium/ operations team. Regardless of who effectively installs the field, stakeholders involved should include representatives from the club, the venue, the League, and the turf manufacturer.

14.4 BELOW IS A LIST OF RECOMMENDED QA/QC TASKS DURING FIELD INSTALLATION:

- **Incoming materials: verification of conformance of incoming materials as specified in the bid and compliance with warranties [Fig.49].**
  - Turf product specifications, including field markings in conformance with NFL standards.
  - Infill specifications and bulk amounts delivered to match desired ratio.
  - Underlayment/pad specifications as described in the bid and product sheet.

Fig. 49. Panel layout and alignment (left), inlaying field markings (center), and infill spreading (right)

- **Field layout and panel joining**
  - Verification of field integrity and dimensions to conform to NFL regulations.
  - Verification of carpet quality for manufacturing issues, color pallet matching, and line straightness.
  - Verification of seaming technique, sundries, and seam quality.
- **Field Inlays (if present)**
  - Verify method for inlaying (water-jet prefabricated kits vs. on site cutting to shape).
  - Verify equipment and tools for inlaying.
  - Verify placement and straightness.
  - Verify glueing method (glue chemistry, cure, and edge match to the turf).

- **Infill process**
    - Verify equipment for infill distribution, brushing, and grooming
    - Verify the plan for infill distribution (layering or mixing, speed, pace, distribution consistency)
    - Perform and record infill depth amounts installed and infill checks along the way
    - Consider installing 1-2 mm over the target infill depth, as compaction is likely to occur.

CHAPTER 15 - GENERAL MAINTENANCE OF SYNTHETIC TURF

Once installed, synthetic turf fields require maintenance for optimal performance. Frequent maintenance items include grooming, painting and paint removal, and walkthrough inspections for repairs, seams, and box covers. Less frequent maintenance examples are washing and sanitization, post-event reconditioning such as raking, and turf replacement for convertible areas. The field manager is the most appropriate resource to develop a field maintenance plan in collaboration with the stadium venue.

15.1 FIELD INSPECTION AND SMALL REPAIRS

Synthetic turf fields require maintenance to maximize player safety and performance. As soon as the surface is installed, regular surveillance and monitoring of field conditions is recommended to inform maintenance practices, remediations, and field repairs. It is important to familiarize yourself with the educational materials provided by the surface supplier. Information related to surface specifications, maintenance recommendations, repair instructions, and service & warrant should be readily available. Although not specific to the NFL use case, and therefore insufficient at times, the supplier-provided recommendations are the best starting point to inform surface actions. It is important to refer to these documentation, as different surface providers may have different recommendations for surface maintenance and remediations, and performing a procedure outside of the recommended surface-specific scope may void the product's warranty. It is also suggested that you consult with your representative from the surface supplier to discuss and validate any procedures intended for the field. Almost all suppliers agree that the first step in synthetic turf maintenance is to thoroughly inspect the surface area frequently. Inspections should include the following items:

- **General aspects of surface:** fiber condition (color, integrity, reveal above infill), infill depth and planarity, attachment points along corners and transitions to other surfaces. Contact the surface supplier in case of a problem.

- **Seams:** "Walk the seams" to assess for any gaps or breakages. Pull on random seam areas to ensure adherence between adjacent panels. Small seam repairs are sometimes done by the field and stadium staff. If that is the case, ensure you have received appropriate safety and operational training from the surface supplier, and that you have all materials needed to perform the repair (seam tape, glue, sewing thread, tools, etc.) [Fig. 50].

Fig. 50. Glued (left), sewn seams (center), and tripping hazard due to seam failure (right)

- **Inlays:** assess adherence of the glued turf pieces to the adjacent/surrounding turf. Assess fiber condition and compare it to the rest of the field. Assess the level of inlays to ensure it is level with the rest of the surface. When not leveled, infill may deposit around the edges of the inlays resulting in a trip hazard and displeasing aesthetics.

- **Painted areas:** when present, assess paint accumulation and infill agglomeration in painted areas. If excessive, consider raking or replacing infill in such areas [Fig. 51].

Fig 51. Example of excess paint applied to the turf (left) and paint build-up inside the turf (right)

- **Irrigation valves and other boxes:** assess all box covers to ensure they have non-slip turf (and infill) cover and that they are leveled with the rest of the field [Fig. 52].

- **Water puddles:** if noticeable water pooling/ accumulation is noticed, contact the surface supplier immediately, as that may be a drainage issue related to sub grade, sub-base, or underlayment, which is beyond the scope of the turf carpet and infill

Fig. 52. Synthetic turf installed over and adhered to box cover

15.2 SYNTHETIC TURF FIELD SURFACE CLEAN UP AND SANITIZATION

Synthetic turf surfaces require periodic cleaning and sanitization. Various techniques may be deployed, including hand-picking of debris, mechanical grooming, and magnetic sweeping. Sanitization treatments such as topical applications and/or ultraviolet treatment can also be used, although synthetic turf is not recognized as a significant source of Methicillin-Resistant Staphylococcus aures (MRSA). infections by the Centers for Disease Control and Prevention (CDC). For instructions on how to clean and sanitize your surface, please refer to the maintenance manuals provided by the surface supplier. For clean-up following a non-sporting event, please refer to the event load section.

15.3 GROOMING AND CONDITIONING

Grooming is one of the most common maintenance practices in synthetic turf. Grooming is a general term that refers to the use of equipment to drag, brush, or rake the surface [Fig. 53]. Objectives of grooming include redistributing the infill to establish planarity, reconditioning fibers by standing them up, and alleviating infill compaction. The choice of grooming technique depends on how much disturbance is caused and depends on the type of equipment used. Light grooming consists of brushing the field with static brushes or dragging an abrasive mat on top of the field. Heavier brushing consists of using dynamic brushes (for example, rotary brushes). Raking is one the most intrusive grooming procedures, and utilizes a series of metal fingers or tines, which penetrate the infill and redistribute the infill particles in a looser configuration. Understanding of the field conditions, history, and usage are helpful when choosing a grooming procedure. Objective data is also a valuable tool to determine what type of grooming procedure to undertake. For example, impact hardness testing may provide insight into how aggressively to groom, which will help determine the equipment and setup.

Fig. 53. Grooming methods: aggressive rotary brush (top), static brushes and spring tines (bottom)

15.4 CONVERTIBLE TURF AREAS

When a synthetic turf field surface is shared by more than one NFL team or more than one sport, "convertible" areas of the field surface may be present. Convertible turf areas are designed to be easily replaced by another turf piece [Fig. 54]. For example, a stadium may swap the endzones or logos between team A and team B. In this scenario, the synthetic turf is removed entirely, with infill remaining in the turf carpet. The following items should be considered for convertible synthetic turf areas:

- **Attachment method:** convertible turf pieces need to be firmly secured at the seams to prevent a trip hazard. Although "hook-and-loop" is conventionally used for this intent, this option should be thoroughly discussed and vetted with the surface supplier.
- **Size of the convertible areas:** fully nstalled synthetic turf may be very heavy. The larger the convertible piece, the more labor will be required to perform the conversion.

Fig. 54. Convertible synthetic turf area

- **Dimensional stability:** convertible turf pieces have the potential to stretch from repeated swapping operations. To avoid changes in the original dimensions of the field, extra scrutiny should be placed on accurately measuring all convertible pieces during installation. This process increases the task time and requires a higher skill level from the installers. When stretched, convertible pieces also require precise manual trimming.
- **Wear pattern differences:** as the field ages, convertible pieces will not experience as much wear as the permanent portions of the field because they spend time out of use. Differential wear can affect the field's uniformity and compromise safety, performance, and aesthetics.
- **Installation procedure:** any turf conversion, full or partial, requires specific know-how in turf installation. This includes trained labor, materials, sundries, specialized tools, and equipment needs. Turf conversions should be planned before the season starts.
- **Storage space:** extra storage should be planned for the extra turf pieces when not in use. If the pieces are stored off-site, extra time will be required to stage them before the changeover.

15.5 PAINTING AND PAINT REMOVAL

An NFL field requires many field markings for gameplay including yard lines hashmark, sidelines solid border around the field, and other markings [Fig. 55]. Additionally, clubs will brand the field with team colors and logos. Field Managers should reference the official NFL Game Operations manual for all required field markings, specific measurements and allowable locations for logos and team branding.

Consider surface type and specific field marking needs when choosing equipment and accessories.

A successful painting event requires many site-specific decisions. Factors to consider when planning purchases and painting events include weather, application equipment; timing and frequency required for adequate visibility on game day, removal requirements (of non-NFL-event markings prior to NFL game day or of NFL field markings post-NFL game day, and facility schedule (i.e. available window for paint application, drying, and/or removal).

Natural grass differs from synthetic turf in that paint will eventually be mowed off as the grass blades grow. Additionally, most chemical solvents used to remove paint from synthetic turf are toxic to natural grass. Consult paint vendors for recommendations on removable paint for natural grass applications.

Fig. 57. Adding infill to low areas (left); example of objective testing to inform remediations (right)

15.6 EXTREME AND ADVERSE WEATHER CONDITIONS

The NFL is mainly a fall/winter sport, and adverse weather becomes more common late in the season. Game day preparation should include precautions for extreme cold and snow/rain/ice. Heating systems for synthetic turf fields should be considered for outdoor fields which experience atmospheric temperatures below 32°F. For a complete list of compliance requirements related to adverse weather, please refer to the policy described in the *NFL Mandatory Practices for Infill Turf*. Listed below are some strategies that should be considered for management of synthetic turf fields in the NFL.

- Field heating systems are intended to keep the field surface from freezing. Both above- and below-ground heating systems are available. Below-ground systems are installed several inches below the playing surface as part of the field construction and installation. The below-ground heating sources may be electric, glycol, or geothermal. It is important to consult with heating system suppliers to evaluate feasibility and the best fit for the intended use case. Above-ground heating systems are intended to heat the air directly above the field surface while a tarp or cover traps the warm air. Consult with field cover providers before selecting an appropriate cover for this application. Above-ground heating systems can only provide temporary warming. Once the field covers are removed, the warm trapped air dissipates into the atmosphere and the field quickly returns to the ambient temperature.

- Field covering to aid in snow removal and prevent rainfall saturation [Fig. 59]: Consider having at least one extra tarp on hand in case of damage to one of the field tarps. In case of damage, tarp tape can also be used to mitigate small tears. When tarping a field, make sure to secure the tarps in place with weights or anchors on top of the tarp around the perimeter and the seams. Do not use stakes to secure tarps on synthetic turf, as synthetic turf damage is likely to occur. Also ensure that your tarp anchors are tall enough to be seen during snow plowing. Shipping pallets, sandbags, and utility vehicles (such as golf carts) are often used to secure the tarps on synthetic turf.

- Snow plowing and removal [Fig. 56]: the use of appropriate equipment fitted with a rubber base is recommended. In the absence of dedicated plowing equipment, a tractor-pulled snow box can be helpful. In any case, leave a small gap between the snowplow blade and the surface to prevent direct contact with the field, which can lead to infill disruption (in the case of plowing directly over the field) or tarp damage (if field is covered). When snowplowing in preparation for a game, make sure to push all snow behind the yellow media line for removal. Once the playing field is clear, the snow behind the yellow medial lines can be taken off the field and put into mason dumps for removal from the stadium area. Snow may accumulate sometimes when the field is uncovered, for example, when the tarp is removed prior to a game and snowfall continues. In those cases, when possible, use a static drag mat to remove any accumulated snow. Rotary-brushing may also be used with caution, as brushing too aggressively may disrupt infill depth and levels. An underground heating system should also be used in these situations if possible.

Fig 56. Field tarp cover in place (top) and snow plowing off field (bottom)

CHAPTER 16 - REMEDIATION OF SYNTHETIC TURF

When remediating synthetic turf, planned actions should align with the surface supplier's recommendations regardless of the level of disruption. If standard procedures are deemed insufficient for field remediation, then it is suggested to develop a plan in alignment with the surface supplier to prevent voiding of the turf warranty. Usually, suppliers or surface contractors will offer services that are beyond the scope of the turf's "user manual". A non-sanctioned procedure should only be used as a last resort, and not before verifying that the novel intended remediation will not void the product's warranty. Ideally, the intended procedure would be agreed upon between surface supplier and stadium staff.

The venue should also consider the level of skill and equipment required to perform the intended remediation. Surface suppliers and service providers are better suited to perform advanced remediations due to specific know-how, experience and equipment needed.

Finally, objective testing can help determine when a field may require maintenance or remediation [Fig. 60]. When tested regularly, field performance patterns can be identified and help provide insight for when intervention is necessary. Failure of synthetic turf reconditioning procedures to restore desired field performance may indicate that the field has aged beyond restoration. Consult with available resources to assess the health of the field (League resources, turf suppliers, and service providers). Consider field replacement under these circumstances.

Lastly, should catastrophic issues take place on the field surface, immediately consult an NFL representative from Football Operations. A plan can then be formulated in agreement with the surface supplier and other experts as needed.

Fig. 60. Biomechanical testing for impact (left) and traction (right)

CHAPTER 17 - SUGGESTED EQUIPMENT FOR MAINTENANCE OF SYNTHETIC TURF FIELDS

The following is a suggested equipment list to maintain and prepare synthetic fields:

- Drag Broom/Brush
- Drag Mat/Surface Drag
- Spring Tines
- Topdresser
- Motorized sweeper
- Gear Driven/Towable Sweeper
- Towable magnet bar
- Drivable power broom (rotary brush)
- Vibrating double-drum roller (max 2.5 ton)
- Towable turbine and backpack blowers
- Paint sprayers and any tips necessary
- Paint remover and extractor
- Boom sprayer
- Utility vehicle capable of towing 2,500 lb.
- Forklift with articulating arm and pneumatic turf tires

CHAPTER 18 - SYNTHETIC TURF FIELD REPLACEMENT CONSIDERATIONS

Synthetic turf field surfaces should be periodically replaced after normal wear and tear. Most suppliers recommend replacing the field upon expiration of its warranty (usually 8 years), but many NFL venues replace their fields much sooner. This is likely due to the increased demands on synthetic turf fields in the NFL posed by large athletes and heavy field usage. Replacing a turf field is a significant disruption to the venue and should consider both the condition of the surface and logistical hurdles such as NFL scheduling, event scheduling, and supply chain/supplier availability. Finally, ongoing surveillance and testing are useful in identifying the end of a field's useful life.

The replacement of an old synthetic turf field is an equally rigorous exercise as the procurement of a new synthetic field. Removal and disposal of turf and other materials, decisions about whether to reuse certain constituents in the system, and planning for smooth operational execution are demanding tasks. For more information, please refer to the QA/QC content and Appendix A – RFP Template for NFL Fields. Listed below are a few items to consider:

Sustainable options for used turf removed from the surface need to be considered including

- **Reuse:** depending on the condition, synthetic turf can be reused in applications with lower demands (i.e. recreational areas, municipal fields, youth, or church fields). Please consider donating the turf if it is deemed sufficient for the intended use. If reusing the shock pad or infill for the new incoming field is a consideration, the individual components should be tested before they are deemed suitable for reuse. It is very challenging to achieve a prescribed infill ratio by re-using old infill. Suggested analyses for old components include:
    - **Infill:** particle-size and bulk density
    - **Pad:** shock absorption and recovery properties; dimensional stability
    - **E-layer:** Shock absorption and recovery properties.
- **Recycling:** Ask the surface supplier about recycling. A take-back program for turf and turf components may be available. Consider the program's specifics and end-of-life solutions before deciding. Recycling strategies could also be considered as part of the product selection process for a turf field in the case that the manufacturer have a recycling strategy already in place and can guarantee an end-of-life solution.

SECTION 4:
NON-NFL EVENTS

CHAPTER 19 - NON-NFL EVENTS

It is commonplace for NFL game venues to be shared between more than one NFL team, or with other teams in different leagues and sports [Fig. 61]. As examples, NFL venues may also be used by a collegiate football team, or a professional soccer team. NFL stadiums commonly host high-profile collegiate football games as neutral sites. Early and frequent communication between the parties is recommended to allow for effective scheduling and execution of field tasks (conversions, painting, etc.). Careful planning is required when there is limited time between the event and the next NFL game. In certain situations, consider painting for the next game before the next event takes place and the field is covered/protected. Also develop a plan for staging of material and infrastructure (stages, sound relay towers, etc.) needed for the event which consumes a substantial amount of space. Staging may occur inside or outside the stadium. Verify the size and duration of storage space required with the stadium staff as staging and storage could impact daily operations. When staging outside the stadium, ensure any local requirements (permits, traffic, zoning, etc.) are met.

Events may be classified into the following groups:

- **Non-heavy load bearing:** light pedestrian or vehicle traffic; no field protection deployed.
- **Heavy load-bearing:** requires protective covering. Examples include concerts, monster trucks, ice hockey, etc.
- **Non-NFL sporting events:** playing field is utilized for other sports (soccer, cricket, tennis, baseball); may require alterations of field markings or conversion of the surface to a different type.

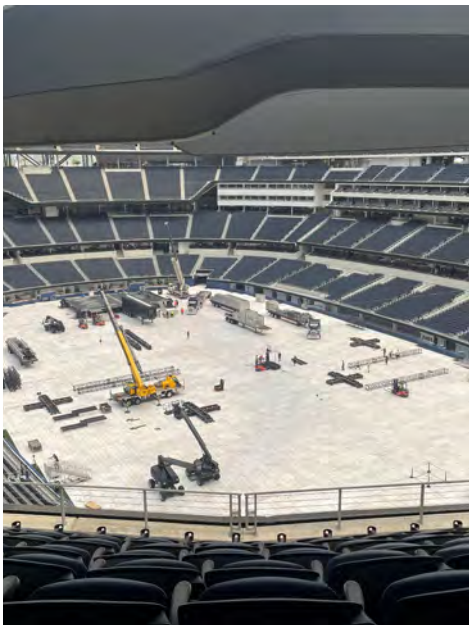
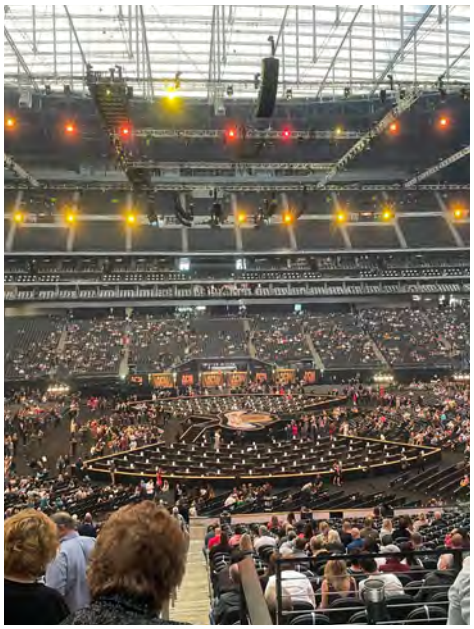




Fig 58. Field setup for heavy load bearing event (left); On-field event load (center), event setup without protective flooring (right)

Depending on the category of event, it may be possible for the grass to survive the event. Specific management practices geared toward protecting the turf may include pre-treatment with fungicides and/or plant growth regulators and adjusted nutrient management. In other cases, the club/venue may commit prior to the event to replacing the field so there is no need to protect the health of the grass.

Light pedestrian traffic sometimes can be held without any protective covering to the surface. It is the stadium staff's responsibility to use their best judgment, information, and data to determine if and which protective flooring is necessary. For smaller events, non-drivable protective flooring should be considered due to its lighter weight and ease of handling [Fig 59]. Pedestrian flooring can support foot traffic and light vehicles such as golf carts. Under no circumstance should forklifts, trucks, or other wheeled vehicles be driven on pedestrian flooring; the tiles may crack, and the playing surface will be damaged.

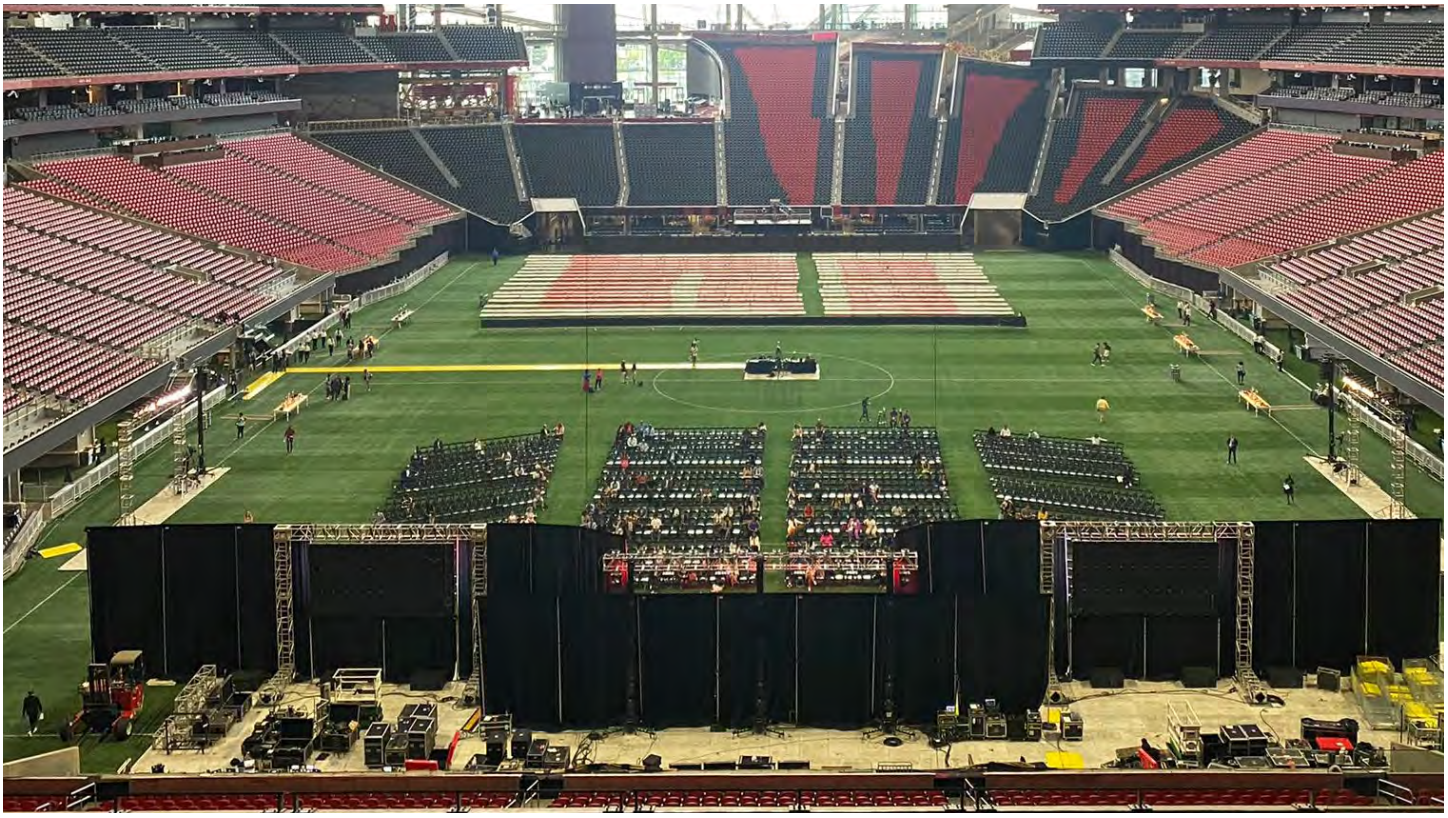


Fig 59. Pedestrian protective covering for short periods of time may allow concerts to take place without damaging the field

It is recommended that for large non-sporting events, also referred to as heavy load bearing, the field surface is covered with protective flooring to distribute the pressure evenly and prevent surface damage. Even when the sod is scheduled to be replaced, the flooring will protect the integrity of the surface grade and subsurface infrastructure (drainage pipes, irrigation system, moisture sensors, etc.). The flooring will also prevent equipment from sinking into the soil and becoming stuck on the field.

Types of protective field covers include geotextile fabrics, 3-dimensional mats, and rigid flooring/decking. Rigid flooring can be further split into drivable and non-drivable. Use drivable rigid flooring on areas expected to have large structures built, and where heavy equipment is expected to move around on the field surface (large semi-trucks, cranes, dump-trucks, etc.). Driving should be done carefully on the surface, even when fully covered. Avoid repetitive driving over the same area as much as possible, and absolutely avoid making sharp turns. For events including imported soil (monster truck, rodeo, motocross, etc.), pay extra attention to the method of flooring/protection used and the reconditioning of the field after the event's conclusion. Cover all field drains with a geotextile fabric to prevent accumulation of soil and debris. Depending on the event type, also consider adding an extra layer between the field and the protective flooring for extra protection. For example, 3-dimensional geotextile mats may be used under large load bearing structures such as stages to prevent excessive compression from excessive loads. It is also suggested that a geotextile fabric or plastic sheeting is placed directly over the playing surface and under the protective floor to help prevent small debris from falling onto the playing surface.

Other sporting events are sometimes hosted by NFL venues. Soccer is the most common due to its growing popularity in the United States [Fig. 60]. Soccer dimensions differ from those in American football, which may necessitate sodding of track areas and removal of end zone goal posts. Other sporting events including baseball, cricket, tennis, and even Formula 1 have also been hosted. Each non-NFL sporting event will have different playing surface requirements and should be handled on a case-by-case basis. The field manager should play an integral role in developing the plan for returning the field to NFL conditions.

Fig 60. Soccer on NFL field

After a non-sporting event, additional measures should be taken to clean and sanitize the field. If protective flooring was deployed, blow, pick-up, and remove all trash and debris before removing the flooring. Once all protective covering has been removed, the next step is removal of any debris that may have slipped through the coverings and onto the field surface, particularly metal debris. Walk the entire field to collect any large debris and use a tow-behind magnet to pick up small metal debris which may not be visible. Inspect the field thoroughly after nonsporting events before allowing for NFL play.

19.1 ADDITIONAL NOTES FOR NONSPORTING EVENTS ON SYNTHETIC FIELDS

Generally, the protective covering and procedures used in natural turf mentioned in section 8.0 are also applicable to synthetic turf fields. Additionally, the popularity of soccer has recently grown in North America, and NFL stadiums have become regular hosts for a variety of high-profile matches and tournaments. Some matches take place on the synthetic turf field, which only requires a conversion from American football field markings to soccer markings. However, in some scenarios, temporary natural grass surfaces are installed over the synthetic turf field. Under those circumstances, it is recommended that precautions like those for a concert be taken related to covering/protecting the synthetic turf field. When possible, use geotextile fabric or plastic sheeting above the synthetic turf to prevent soil and grass debris from falling into the synthetic turf. Also, consider using rigid protective flooring beneath the sod, as natural grass installed directly over synthetic turf may yield an excessively soft surface.

After a non-sporting event, additional measures should be taken to clean and sanitize the field. If protective flooring was deployed, blow, pick-up, and remove all trash and debris before removing the flooring. When possible, clean the flooring before removing it from the playing surfaces by sweeping, blowing, or power washing. If power washing, make sure that local drainage and storm-water requirements are met. Dedicated systems for washing/cleaning protective flooring are also available. If using a dedicated cleaning system, make sure to pick up all debris from the surface before removal of the flooring. Once all protective covering has been removed, the next step is removal of any debris that may have slipped through the coverings and onto the field surface, particularly metal debris. Walk the entire field to collect any large debris and use a tow-behind magnet to pick up small metal debris which may not be visible.

INTRODUCTION

The purpose of this document is to assist you in properly planning and delivering your surface project. There are many technical and practical challenges during a field installation or replacement.

The National Football League (NFL) and the NFL Players Association (NFLPA) have set forth general guidelines to aid with playing surface construction and establishment to serve as a resource to clubs and venues.

In some instances, these guidelines may be redundant and consistent with current practices and policies. In any event, the goal is to provide consistency within the league and facilitate satisfactory project delivery.

PROJECT PLANNING AND COMMUNICATION

Proper planning is important to the successful delivery of any new surface project. During this phase the program and scope are defined, which will be further developed during the design phase. This may include a narrative of the proposed improvements, basic sketches or drawings, or a detailed design report. This phase also includes an initial evaluation of specific systems which may be included in the project; this can range from surface type options, suppliers, and auxiliary field systems (i.e. vacuum ventilation and hydronic heating systems).

The design phase consists of the development of the plans and specifications which serve as the blueprints for the construction phase, often referred to as contract or construction documents. These documents are also submitted to the local jurisdiction for permitting when applicable.

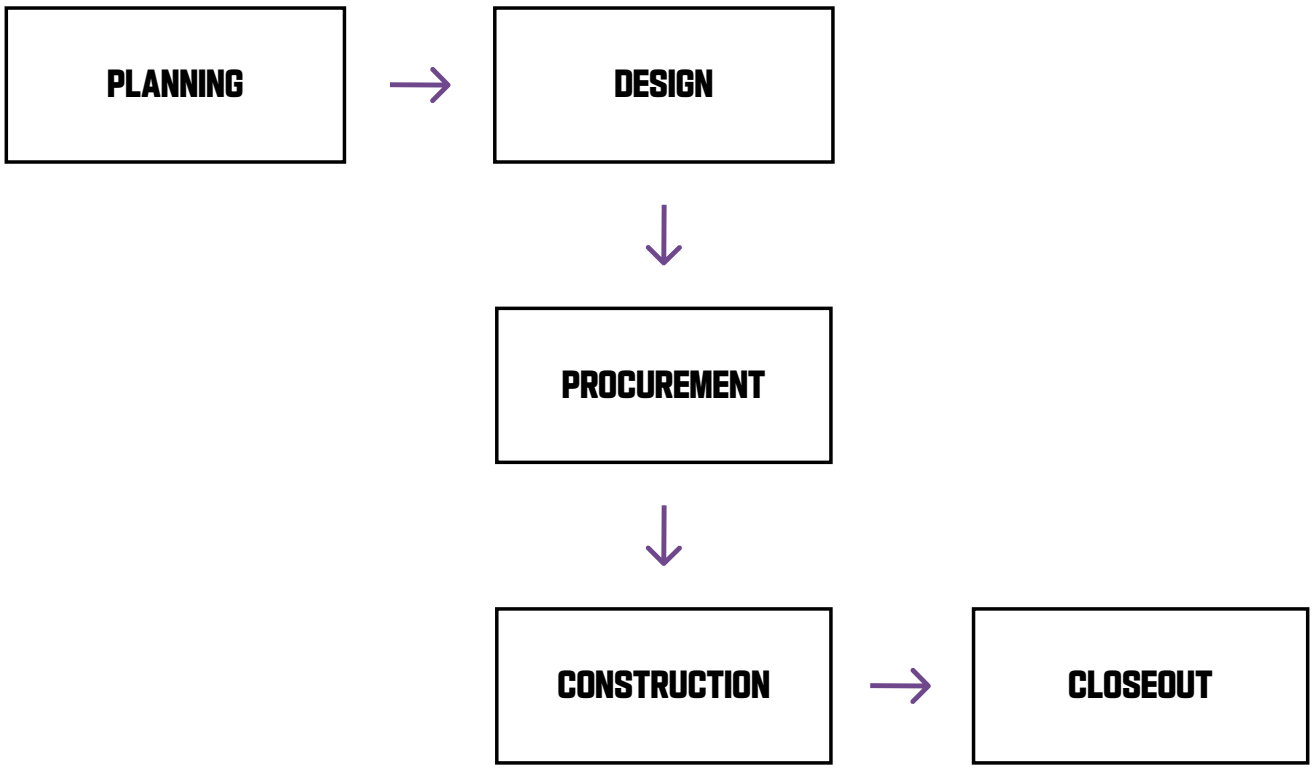
Procurement begins once the design phase is completed. It may require securing necessary permits and sharing them with contractors or vendors for bidding. This phase will also cover all contracts and contract requirements.

Most projects, except for the small renovations, require a permit. Confirming project specific needs for permitting may fall under the stadium manager or design professional. Additionally, the contractor may need to be included as needed for any necessary inspections.

The **permitting process** can be long and arduous, it is important to understand this process and include ample time in the project schedule. Failure to obtain a permit can pose significant fines and delays, building inspectors have the authority to halt construction if the necessary permits are not obtained.

The **construction phase** starts once contracts are signed. The scope may include a basic synthetic turf resurface, a full field renovation, or new field construction.

The **commissioning and closeout phase** occurs at the conclusion of the construction phase. It entails programming systems such as irrigation, heating, or vacuum & ventilation. It also includes grow-in of natural grass or settling in of the synthetic turf infill. It is the time when warranties are enacted, as-built drawings produced, and operation & maintenance manuals are turned over.



LEAGUE COMMUNICATION

Direct communication with the NFL creates a mutually beneficial relationship and aids in preventing potential challenges, setbacks, and roadblocks. The following communication roadmap has been set forth to create consistency and allows the NFL to provide reasonable support during the design and construction of your project.

The NFL recommends notification and general understanding of your project. This should not be misconstrued as technical review or conformance, though in some instances the NFL may be able to share technical knowledge that is relevant to your project. It is important that the completed project meets the NFL-NFLPA's published requirements for field performance and safety.

Clubs and venues undertaking surface establishment, construction, and/or renovation should consider voluntary communication of the key milestones such as timelines, design choices, and commissioning plan with a representative from Football Operations for awareness and help, if needed.

PROFESSIONAL SERVICES

Most organizations retain consultants to provide professional services through the design and construction of their project. It is recommended that consultants are hired as they help to ensure quality, schedule, and costs are maintained throughout the duration of the project. They also provide an independent viewpoint of both products and systems, which is important in the decision-making process.

When evaluating members of your consulting team it is important to confirm their qualifications. To obtain the most value from your professionals it is critical that they are proficient in the scope of your project and have completed other high-profile projects similar in scope to yours. It is preferred they have successfully completed similar NFL projects, though NCAA, MLS, or MLB projects are also noteworthy and should be considered in your evaluation.

Evaluating and hiring an experienced consulting team can help ensure a successful project.

DESIGN PROFESSIONAL

Engineers and landscape architects tend to represent the majority of playing field specific design professionals, though architects, structural, and electrical engineers may be warranted depending on the scope of your project. They are a key part of your team and will provide the planning, design, and construction oversight of your project. During your evaluation process, confirm the professional has the proper licenses, generally a "professional engineer" or "landscape architect" license in the state in which the work is performed.

AGRONOMIST

An experienced agronomist is critical for the success of natural grass projects. They can work with you and your design professionals to evaluate turf cultivars, rootzone mix designs, and also provide the necessary laboratory material testing. They should also have experience performing these services for similar high-profile projects. It is beneficial if the agronomist has a testing laboratory or a relationship with a laboratory. These laboratories can provide the necessary data needed to properly evaluate and maintain quality control during your project.

COST ESTIMATOR

Cost is an important part of any project, often a design professional provides this service. However, in other instances, especially for large, multi-faceted projects, it may be advantageous to hire a professional cost estimator. It is important to confirm the project team members have experience estimating your specific project type and understand the local market conditions.

PRECONSTRUCTION SERVICES

A contractor may be able to assist in the preconstruction phase of the project. These services generally include cost estimates for the proposed design, production of a detailed construction schedule, and in some instances procuring long lead items such as sod, sand, and mechanical equipment. They often work in tandem with other design professionals. Confirm that they have the appropriate professional licenses or certifications to perform their services in your state.

INSURANCE

Insuring the project is essential to safeguard the investment. All professionals involved should carry adequate insurance. The club and venue are best suited to decide on the appropriate insurance coverage for the project.

Vendors should have appropriate insurance and licensing; this should be confirmed prior to engaging in a contract or agreement. A third party insured warranty may be valuable, especially in situations where manufacturer warranties extend 10 – 20 years. An insured warranty typically covers warranty claims in the event the vendor is out of business, rejects your claim, or is unable to meet the terms of their warranty.

VENDORS

Multiple vendors will be involved with your project in some capacity. Maintaining a working relationship with vendors can be mutually beneficial. The club or venue is responsible for properly qualifying vendors and their materials, products, and services. The project design professional should be able to assist in these evaluations.

EXPERIENCE AND QUALIFICATIONS

There are a wide range of vendors such as synthetic turf manufacturers, material providers, sod suppliers, and special systems suppliers. It is important to utilize reputable vendors that are accustomed to supplying goods and services for professional venues. It is also important to consider the following when evaluating these vendors:

- Years in business and business stability
- Experience in professional and collegiate venues (elite sports)
- Research & Development departments, especially for synthetic turf vendors
- Industry reputation
- Local or regional warranty and technical support
- Manufacturing locations (domestic or foreign)

Vendors are very good at providing estimates and pricing for their goods and services. However, if their system is part of a larger project or other entities are needed for procurement and installation of their system, then use caution. Prices vary throughout the country and a price in one location may not be the price in another, additionally there could be components outside the vendor's understanding that can significantly impact your project budget.

SYNTHETIC TURF MANUFACTURERS

Many of the reputable manufacturers have research and development departments and interface NFL stakeholders to some capacity. While knowledge about a turf system can be gained from a supplier, no single manufacturer has a comprehensive understanding of the needs for a playing surface in the NFL environment. Furthermore, available quality standards are insufficient, and procurement could be confounded with sponsorship and marketing agreements. Therefore, it is suggested that the vetting and procurement of a new synthetic turf field leverages as much impartial, objective data as possible. Leveraging an experienced consulting team can be helpful.

There is tremendous variability in the manufacturing process, and it is important that the construction documents are well defined including product and installation tolerances enforced by a formal quality control program. These tolerances include both product and construction/installation components. Many playing field products do not adhere to a governing body that sets and maintains quality control standards, and it is up to the club and/or venue to define and enforce these. A design professional is an excellent resource in developing these documents.

NATURAL GRASS CULTIVARS AND SOD GROWERS

There are a handful of domestic research laboratories that focus on turfgrass science. These university backed laboratories tend to develop sports specific cultivars which are then licensed to sod growers. The reputable sod growers are well known and provide sod for many professional sports teams throughout the United States. It is advised to utilize the experience of a design professional, agronomist, and other qualified professionals to evaluate and select a cultivar for your stadium or practice venue. Regular visits to the farm itself are always a good idea to confirm quality is being maintained. It is not uncommon to request documentation from the sod farm such as maintenance practices, soil test results, and records for disease or infestation.

SPECIAL SYSTEMS

These systems, which may include grow lights, heating systems, and vacuum and ventilation systems to name a few have become common in stadiums and practice facilities alike. The number of vendors in this area is often limited, and there may be only one or two reputable vendors for each system. Vendors may be domestic or located overseas; it is important to understand if their systems are applicable to your situation.

The design professional and other members on the project team are the best resources to evaluate the benefits and drawbacks of each system. Engaging the vendors themselves is also worthwhile but limits you to a single perspective. It is important to understand the full picture including construction cost, operation cost, and maintenance requirements. For example, the cost for a new or upgraded power supply (electric or gas) may add significant cost and complexity to your project.

PROCUREMENT

REQUEST FOR PROPOSAL/BID SOLICITATION

In soliciting vendors, professional services, or contractors a Request for Proposal (RFP) or bid solicitation is generally the best means to accomplish this task. An RFP is typically used to solicit professional services and vendors, while a bid solicitation is designed for contractors. For the sake of this document, an RFP and bid solicitation are one in the same. They are similar with a few differences as outlined in this section.

The RFP provides detailed documentation of the project requirements and creates a competitive bidding environment. Your organization may have its own RFP template, though the following information should be considered in the development of this document.

A comprehensive, detailed RFP including its supporting documents will provide you with the most control of the project's cost, schedule, and quality. Ambiguity creates confusion and misaligned expectations, resulting in higher cost, schedule delays, and less quality. The following represents key sections which should be incorporated into an RFP.

INTRODUCTION

The introduction is a brief section outlining the contracting entity along with an overview of the project type such as:

- product/material solicitation
- professional services solicitation
- construction contractor bid

It is beneficial to include a summary of the scope of the project, the full description will be included in the Scope of Work section. Disclose any stakeholders who may be involved with the project and their role (ie management groups, municipalities, etc). List the project manager's information and the purchasing manager, if applicable.

It is also worthwhile providing a brief background of the project such as venue size, age, and use (ie sporting and non-sporting events).

SCOPE OF WORK

This section outlines the scope of work to which the bidder will be responding.
There are generally six project types, though there may be others that are not listed:

- New Natural Grass Field
- New Synthetic Turf Field
- Grass to Synthetic Conversion
- Synthetic to Grass Conversion
- Resurface of existing Synthetic Turf
- Renovation of Existing Natural Grass
- Other

Each of these project types may also incorporate special systems such as heating, vacuum & ventilation, and/or grow lights.

EXTENT OF WORK

A description of the extent of work is described here, specifically what portions of the facility will be impacted. Is this just the field or will other portions of the stadium/facility be impacted. This is generally produced by the design professional.

QUALIFICATIONS

All licenses and experience requirements should be listed. This may include contractors or design professional licenses, contractor license type and bonding, and insurance requirements. The purchasing department generally has minimum standards, and it is important to list these requirements.

Any experience requirements such as similar work experience, capacity to meet your project schedule, their project team resumes, etc. are listed in this section. It is not uncommon for you to request that they provide two or three references, especially if these references are among your peers.

PERMITS

It is advisable to clarify who is responsible for obtaining permits. It is often the responsibility of the design professional to submit for permits and the contractor to obtain "pull" the permits.

PREPROPOSAL AND PREBID MEETING

If you would like to hold a preproposal (design professional RFP) or a prebid meeting (contractor bid solicitation) then state whether it will be held virtually or onsite. State the time and date of the meeting and if there are any special circumstances to consider such as site access, etc. State whether the meeting is mandatory or optional.

INTERVIEWS

If you plan to interview respondents, or a shortlist or portion thereof, list this requirement in the RFP. It is advisable to confirm whether the interview will be in person or held virtually. Providing an anticipated interview date or a range of dates is helpful to the respondent. Prior to the interview you may want to provide the respondent with questions to which you would like them to respond. The following is a typical list of interview questions:

1. **Experience, especially as it relates to the scope of your project.**
2. **Project team members including their role and experience.**
3. **Project approach** generally includes a plan of how they would approach the challenges of your project. This may include how they would overcome limited egress to your site, handling complex special systems, etc.
4. **Project schedule** request that they provide a detailed project schedule which conforms to the milestones you listed.
5. **Quality control** all respondents should have a quality control program, whether it be a vendors manufacturing and installation program, a design professionals document control, or a contractors construction tolerances.
6. **Cost control** provides them with the opportunity to present how they handle change orders, cost overruns, and value engineering.

SCHEDULE

Outlining the schedule expectations is important for the success of your project. At a minimum, state the design or construction start date and completion date, as well as any other important dates which may impact the ability to complete the project. It is not uncommon to have an event scheduled during the construction process, the contractor needs to understand the requirements of this event and in what condition the field should be temporarily left to accommodate the event.

BID FORM AND COST PROPOSAL

It is advantageous to require your contractor to itemize their lump sum bid. The itemized bid provides a line item for each major scope of work, this allows you to better understand your project cost. It also allows more clarity during the contractor's monthly invoice as the contractor will invoice against each scope of work. This is not possible in a single lump sum bid. Design professionals are accustomed to producing a bid form for inclusion in the RFP.

You may require your design professional to provide a scope and fee proposal. Their proposal will outline the specific scope they are going to provide and the associated fee. It will also include any exclusions or assumptions they make. When evaluating multiple design professionals, it is important to confirm that their scopes are consistent and they are in line with your project requirements.

AWARD

State if the selection and award are based solely on price, a combination of price and experience, or other means. If you are procuring through a public jurisdiction your options may be limited.

STAGING, STORAGE, AND ACCESS

This section is reserved for contractor bid solicitations. Most if not all projects will require staging, storage, and access during construction. It is best to define these within the RFP as opposed to having the contractors make a guess.

Contractors will require a staging area, generally a secure area where they are able to store tools and equipment, sometimes this will include a construction office (either a temporary building or office in your venue). Material storage is also important and is sometimes combined with the staging area. If your project utilizes hazardous materials, it may limit the areas where these items can be stored. Materials such as synthetic turf, pipe, tubing, and mechanical equipment can take up a large footprint. Additionally, if you plan to blend materials, such as rootzone mixes, onsite then the impacts of this operation are to be considered.

Most facilities have some access limitations, whether it be access to the staging/storage areas or to the field itself. The size of truck can be limited, especially for field access if vomitories are limited in number and size. Additionally, if the local jurisdiction requires haul permits, typical in urban environments, this requirement should be disclosed.

SECURITY

This section is reserved for contractor bid solicitations. Any specific security requirements should be disclosed in this section. Contractors may utilize full-time, part-time, and non-associated staff such as delivery drivers. Obtaining some form of security clearance is typical of most stadiums and some training facilities. This would include requirements for background checks, photo identification, and other policies that the workforce would need to comply. If your facility has a security policy, it is best to attach this to the RFP.

CONTRACT DOCUMENTS

This section is reserved for contractor bid solicitations. All plans and specifications are to be included in the proposal. This covers the technical components of the project. A product/material solicitation such as a synthetic turf resurfacing project may have the contract documents incorporated into the RFP itself, otherwise they are included as an attachment.

WARRANTY

This section is reserved for contractor bid solicitations. All warranty requirements should be outlined in the RFP. Construction warranties tend to last 1 year, while specific products may have a longer warranty. For example, the drainage system and stone base for a synthetic turf field may be warrantied for 1 year, though the turf itself will be warrantied for much longer.

At the conclusion of the project, it is important to obtain warranty declarations, consisting of the construction warranty and individual product warranties.

MISCELLANEOUS

The club or venue may have other documents which can be included in an appendix or the body of the RFP. Check with your purchasing department, security manager, and stadium manager to confirm if these documents exist. They may consist of Labor Requirements, Venue Provisions and Requirements, Insurance Requirements, Safety and Operation Procedures, etc.

CONTRACT

All engagements should be formalized with a contract, it is advantageous to attach a copy of your contract to the RFP. If you organization does not have a contract one may be obtained through appropriate legal counsel or through the American Institute of Architects (AIA).

CLOSING

These guidelines were developed to provide a broad overview of the process of planning, designing and implementing a project. We hope it proves to be a valuable resource for NFL club field managers. We value your communication and look forward to any assistance we may provide on your next project.

RELEVANT TEST STANDARDS FOR SYNTHETIC TURF:

The standards below are also compiled in ASTM F1551-09 (Standard Test Methods for Comprehensive Characterization of Synthetic Turf Playing Surfaces and Materials).

Pile fibers:

- **D792** – specific gravity
- **D2256** – break strength and elongation
- **D3218** – yarn thickness

Fabric:

- **D1335** – tuft bind
- **D4491** – permeability
- **D5034** – grab tear strength
- **D5823** – pile height
- **D5848** – pile weight, total weight
- **E648** – flammability

Infill:

- **ASTM F3640-23** - Standard Test Method for Full Depth Field Sampling of In-situ Synthetic Turf Infills Materials.

The pad should be tested as specified in the bid. Recommended tests include shock attenuation, dimensional stability under normal and extreme conditions (frozen, wet, hot, etc.)

RELEVANT TEST STANDARDS FOR NATURAL GRASS:

- **D698,** Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
- **D1557,** Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))
- **F1632-03** Standard Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Rootzone Mixes
- **F1647-02a** Standard Test Methods for Organic Matter Content of Putting Green and Sports Turf Root Zone Mixes
- **F1815-06** Standard Test Methods for Saturated Hydraulic Conductivity, Water Retention, Porosity, and Bulk Density of Putting Green and Sports Turf Root Zones
- **F2396-04**, Standard Guide for Construction of High Performance Sand-Based Rootzones for Sports Fields

SOD PRODUCTION REPORT

OVERVIEW OF TURFGRASS MANAGEMENT IN PREPARATION FOR NFL RESODDING

REPORT DATE: _____ **SOD ESTABLISHMENT/PLANTING DATE:** _____

SOD FARM: _____

INSPECTOR: _____

INSPECTOR AFFILIATION: _____

GRASS SPECIES: _____

GROWN ON PLASTIC: YES ☐ NO ☐

[IF GROWN ON PLASTIC]:

ORIGINAL PROFILE THICKNESS FROM THIN-CUT SOD: _____

SAND PARTICLE-SIZE ANALYSIS - ATTACH. _____

TARGET HARVEST/INSTALL DATES: _____ **TO:** _____

CURRENT SOD THICKNESS: _____ **TARGET SOD THICKNESS:** _____

CURRENT HEIGHT OF CUT: _____ **OVERSEEDED (Y/N):** YES ☐ NO ☐

OVERSEEDING SPECIES: _____

OVERSEEDING RATE (LB/1,000 F2) _____

HARVEST/TRANSPORT/INSTALL PARAMETERS:

DISTANCE FROM FARM TO INSTALLATION SITE (MI): _____

ROLL SIZE/SQUARE FOOTAGE: _____

TRUCKING MODE (FLATBED, TARPED, BOX, REFRIGERATED): _____

SOD ASSESSMENT SCORECARD

PARAMETER	POOR	FAIR	GOOD	EXCELLENT
COLOR				
DENSITY				
OVERALL QUALITY				
TENSILE STRENGTH				
ROOT DENSITY				
WEEDS/DISEASE				

NOTES/COMMENTS ON EXISTING CONDITION:

IMAGES OF CURRENT CONDITION

(PLEASE INCLUDE IMAGES HERE OR ATTACHED TO EMAIL)

MAINTENANCE SCHEDULE NOTES

DATE: _____

	LAST 7 DAYS	NEXT 7 DAYS	NEXT 30 DAYS	NEXT 90 DAYS
MOWING				
IRRIGATION				
FERTILIZING (GRANULAR)				
FERTILIZER (LIQUID)				
PESTICIDE				
AERATION				
VERTICUTTING				
TOPDRESSING				
SEEDING				

NOTES:

NEXT WEEK MAINTENANCE SCHEDULE

DATE: _____

	MON	TUE	WED	THU	FRI	SAT	SUN
MOWING							
IRRIGATION							
FERTILIZING (GRANULAR)							
FERTILIZER (LIQUID)							
PESTICIDE							
AERATION							
VERTICUTTING							
TOPDRESSING							
SEEDING							

NOTES:

THANK YOU