# Athletic Field Surfaces in the Pacific Northwest:
## A Comparison of Synthetic and Natural Grass Fields.

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## ***Recommendations:***

| | |
|---|---|
| **Use infill (rubber and sand) synthetic surfaces where the location and usage requirements are appropriate.** | When considering an infill artificial surface installation these factors should be considered:<br>1) The volume of demand and types of anticipated use<br>2) The existing topography<br>3) The existing infrastructure (restrooms, parking, etc.)<br>4) The community support and potential impact (noise, parking, etc.)<br>5) Not all infill synthetic fields are made the same, they differ in quality, playability, and durability. |
| **Infill synthetic surface use is appropriate at the primary school level.** | New generation fields are not only for professional or university level athletics and should not just be considered a luxury item. In fact, they are essential given technological improvements, the Pacific Northwest climate and the surfaces proven cost effectiveness.<br>Initial installation costs for infill artificial surfaces are substantially higher than playable grass surfaces (~30%), but maintenance costs are substantially lower (95%). Field users currently pay a use fee that could be marginally increased to cover both maintenance and future surface replacement costs. |
| **Light infill synthetic fields for maximum usage and efficiency.** | A single infill artificial surface playfield with lights can accommodate the playable hours of **seven** regular grass fields. This capacity increase will help offset the demand on grass fields and other open space in local neighborhoods and permit more open space activities or non-traditional sporting activities (unofficial ultimate Frisbee, kite flying, etc.). Pooling of resources (e.g. 2 middle schools sharing a facility) should also be encouraged. |
| **To reduce environmental impact, use synthetic surfaces.** | Synthetic fields do not require water, fertilizer, or pesticide consumption nor gasoline consumption from mowing equipment. |
| **To reduce injury, convert existing Astroturf™ surfaces to infill surfaces.** | Injury rates between infill synthetic surfaces vs. playable grass are still being studied. However, there is strong evidence that infill synthetics are far superior to Astroturf™ type surfaces in reducing injury incidence. |
| **Anticipate resistance to change.** | Policy makers, facilities managers, and in some cases the sports' purists would prefer to see only natural grass fields. |
| **Use grass fields more responsibly and cost-effectively.** | 1) Increase shared maintenance agreements and volunteer labor<br>2) Implement responsible scheduling that limits over use<br>3) Define a clear separation of athletic fields from open space grassy areas used to host public festivals or event parking.<br>4) Review technological advances in grass seeds and planting options and expected uses surface types. |

## ***Introduction***

Historically, people have not considered installing artificial athletic surfaces in local community settings. Artificial surfaces were viewed as expensive, for professional organizations, or simply not comparable to grass for multipurpose use. Not surprising, grass remains the standard and preferred athletic field surface by the majority of users. The current structure of public organizations continues to be centered around the development, maintenance and scheduling of grass fields despite the moist Pacific Northwest climate and the inability of grass to support year round athletic use. Now faced with limited resources and an ever expanding user population, organizations and public entities are interested in finding ways to reduce costs and maximize athletic field capacity. Advances in synthetic field surface technology are enabling a paradigm shift in thinking about synthetic surfaces and their appropriate use for local community and regional facilities.

## ***Background***

The generations of synthetic surfaces:

*First Generation:* In 1965 Astroturf began installing synthetic surfaces in large NFL football stadiums. Most people still associate synthetic surfaces with "AstroTurf™" which was developed for professional sporting events where players are afforded extra protective equipment to cope with the "turf burn", and maintenance and replacements costs are borne by large corporate business. These fields were originally made from a raw polyurethane that was highly susceptible to elements especially ultraviolet rays and lacked durability. These expensive surfaces were replaced on average, every five years.

*Second Generation:* In the late 80's-early nineties second generation athletic surfaces were conceived on the notion that synthetics could be blended with natural grass to somehow capture the best attributes of both. An example of this surface is "Sportsgrass™", a natural grass playing surface grown into a layer of amended sand. The sand hosts polypropylene grass blades tufted into a woven backing. Theoretically, the grass roots would grow down through the synthetic blades and woven backing thereby preventing damage to the crown and root system with surface play. So, even if the surface grass is worn away, athletic play continues. Early complaints were that the surface was harder than grass; and later, heavy weight combined with cleated footwear caused damage to the synthetic underlying surface. This sustained damage decreased the field stability and hampered natural grass re-growth[1]. Although Sportgrass™ is still marketed and installed, it has clearly failed in the Pacific Northwest climate. High levels of moisture softened the crown and root systems making them even more susceptible to damage. In sum, the grass failed to grow through the surface.

*Third Generation:* The third generation of synthetics sought to replicate grass with UV ray resistant polyurethane carpets with fibers filled with either crushed rubber (Nexturf™, Astroplay™) or a combination of rubber and sand (FieldTurf™). The sand and rubber fill artificial surface most closely replicates natural grass in color, resistance, ball bounce, and in some cases, even scent, while far surpassing grass in terms of usability, lowered long term maintenance costs, and environmental safety[2].

## ***Cost and Capacity***

*Definitions:* **Optimal Grass:** Top grade installation and limited use to a maximum 15 football games per year or 1 other single sporting event per week. **Playable grass:** 5 events per week 36 weeks per year weather permitting. **Synthetic Surface:** In-fill surface with unlimited use even during inclement weather without damage to the field or compromising field stability.

Estimated "cost per playable hour" for the compared surfaces over the expected life of the synthetic surface (industry standard 10 years). Although infill synthetic surfaces are applicable to diamond fields, all estimates pertain to rectangular athletic fields and do not include land purchase costs. For an itemized installation process see Appendix C.

| Expense | Optimal Grass | Playable Grass | Grass Complex | In-fill Synthetic | Synthetic with lights |
|---|---|---|---|---|---|
| Installation, initial capital costs: | $800,000* | $500,000* | $75,000 | $1,000,000 | $1,200,000 |
| Labor/Maintenance | $80,000 | $37,000 | $11,000 | $5,000 | $5,500 |
| Equipment purchase/rental/maintenance | $3,000 | $3,000 | $3,000 | $1,000 | $1,200 |
| Crowning/topdressing/insecticides /fertilizers, etc. | $9,000 | $5,000 | $3,500 | $0 | $0 |
| Water | $4830 | $4830 | $0ω | $0 | $0 |
| Irrigation system repairs | $1,000 | $1,000 | $133 | $0 | $0 |
| Line Paint | $132 | $132 | $132 | $132 | $132 |
| Total Annual Maintenance Cost | $97,962 | $50,962 | $17,765 | $6,132 | $6,832 |
| Total Annual Maintenance Cost (10 years) | $979,620 | $509,620 | $177,650 | $61,320 | $68,320 |
| Total Cost (Installation, Capital, and 10-year Maintenance, No Land Costs) | $1,779,620 | $1,009,620 | $252,6500 | $1,061,320 | 1,268,320 |
| Number playable hours supported | 780 | 6,800 | 4,480 | 36,120 | 51,100** |
| Cost per playable hour | **$2,282/hour** | **$148/hour** | **$56.00/hour** | **$29/hour** | **$25/hour** |

* Cost for a natural grass field ranges from $300,000 to 1,000,000 for optimal grass depending on location. The 2 most recent grass rehabilitation projects performed by the Seattle Parks Department averaged 722,000 per field making this estimate conservative.

A useful size for a multipurpose field is 75,000 sq. ft., with subsurface costs conservatively estimated at $4.00/sq. ft. Turf cost is figured at $9.00/sq ft. 2.5% error margin included in total figure.

Grass maintenance begins at $30,000 (playable) and can go as high as $100,000/year. The practical estimate for maintenance of optimal grass was defined as $80,000/year.

Industry standard maintenance is $5,000/year, including the cost of a power sweeper pro-rated over 10 years.

Minimum of 1 inch of water per week, more during hot months. Field size, 93000 sf = 200,000 cu ft or 2000 units. Efficiency calculated at 85% add 300 units. Unit price $2.10 average estimated cost per unit over 10 years.

Ω Water rights available allowing water to be pumped from river for this example.

Temporary lining system for synthetic surfaces is similar to grass lining system. $11/per field monthly is employed here.

Ω Includes $14,500 in other maintenance expenses.

3 hours/week

10 hours per week 36 wks/year plus 20 hours per week 16 weeks/year (seasonal)

9 hours/day 36 wks/year plus 12 hours/day 16 weeks/year (daylight savings)

** 14 hours per day/365 days per year

See Appendix C for a breakdown of required maintenance.

Increase in playable hours includes highest demand scheduling block.

**NOTE:** The complete "cost" of grass is not adequately reflected in the table above. A single game played on natural grass in inclement weather can damage grass to an extent that requires

considerable rehabilitative expense (up to 18 months of rehabilitation). Another consideration is the required maturation period for the newly seeded grass to mature enough to support regular use (roughly 18 months of grass maturation time [3-5] or 648 hours of use for a playable grass field). This 18 month period totals 5,418 playable hours provided by a non-lit synthetic surface immediately following installation.

**Infill Surface Replacement Estimates:** The industry standard of 10 years for a synthetic in-fill surface leaves us with the question of how to finance the resurfacing of the field every ten years. The in-fill technology is so new, we can only estimate the cost of resurfacing at roughly 1/2 the initial cost (~$500,000). For a single field rented out at $30 per hour (estimated average King County area fee for full sized field with lights), ~$10/per hour could go towards the refinancing of the field in 10 years. If the field is primarily used during peak hours, a reasonable estimate of the billable hours over the 10 year period would be 23,100 hours (7 hours per day 3:00 PM to 10:00 PM, 330 days per year). In this instance, the peak hours could be billed at $40/hour, with roughly half (~$21.65) slated for surface replacement.

**Infill Surface Temporary Lining Estimates:** In cases where the synthetic field will be used for multiple purposes, there are two options for dealing with the field lines, 1) Use different colors for different sports, or 2) use a temporary lining system. Although the use of different colors has proven feasible, athletes and officials periodically get confused about touch lines, and the field is less esthetically pleasing. Therefore, the optimal option is the temporary lining system. A solvent based inverted marking chalk product is presented here. The paint comes in aerosol cans that meet Volatile Organic Compounds (VOC) regulations. The Aerosol cans are applied inverted using standard lining equipment (Spotter Hand Held Wand or a Wheeler Hand Held Wand) taking approximately 10 seconds per foot. Drying time is about 30 minutes (recommended 2 hours). Painted lines will last approximately 30 days and removed using cold water combined with light rubbing with stiff nylon brush (removal is fairly fast estimated at 30 seconds per linear foot). The paint is available in a variety of colors. MSDS and more detailed product description plus Volatile Organic Compounds (VOC) compliance regulations: www.sprayon.com www.krylonindustrial.com or www.msindustrial.com

Temporary Lining Paint Cost: *One can (17oz actual material in 20 oz can) covers approximately 120 linear feet of 4 inch wide line (7-8 cans per field). Estimated local vender cost $4.00/can ($30/field). Estimated bulk cost $1.75/can ($11/field).*

## ***Location***

Importance of existing topography: In isolated cases, facilities with installed synthetic athletic surfaces have converted back to grass turf. This occurs exclusively when the existing topography was not carefully considered in advance of the installation. In one case, a natural spring was discovered at the field location and the stability of the field was compromised. In addition to considerable added expense, the life of the surface could not be guaranteed. Estimates of added expense due to topography is beyond the scope of this document.

Importance of existing infrastructure: A comprehensive athletic facility plan must include complete review of existing infrastructure. Installation of an infill artificial surface by definition will increase public use thereby increasing the demand for related facilities such as restrooms, water

fountains, parking, maintenance equipment storage, etc.. To limit the required initial capital and garner community support, locations where this sort of infrastructure already exists should take priority over locations where there is no existing infrastructure. Since public schools have existing infrastructure, community support, and the highest user demand, public schools should be carefully scrutinized as the most optimal locations. Public Schools offer fairly even distribution throughout all geographically populated areas. Athletic fields with surfaces that permit virtually unlimited use with minimal maintenance costs disseminated throughout the entire region would absorb local demand and offset the regional demand on grass field complexes, reserving such complexes for tournament type events (Appendix B). There are currently 45 Public High schools and 53 public middle schools operating in King County, with all but 7 in need of improved playfields. It follows that parks departments should consider partnering with public schools to maximize the use of the infill synthetic surface and minimize expense and public resistance.

Community support and potential impact: Neighborhood relations are considered elsewhere in this report. However, we should note that a synthetic surface installation will substantially increase public access issues. By the same token, playfield improvements increase the quality of life on an individual basis and with careful planning will enhance communities by offering safe, affordable, and esthetically pleasing facilities.

Environmental Impact: The State Environmental Policy act requires that an Environmental Impact Statement (EIS) be reported and reviewed prior to the installation of either a grass or synthetic athletic surface. The EIS covers but is not limited to the following environmental elements:

1) Earth: Geology, soils, erosion, and topography
2) Air: Air quality and odors
3) Plants & animals: Threatened and endangered species, sensitive wildlife habitats
4) Energy and natural resources: Energy use, sources and efficiency; nonrenewable and renewable resources
5) Noise: Noise levels and attenuation, sensitive receptors
6) Land and Shoreline Use: Land use patterns and compatibility, relationship to plans and policies
7) Housing: Relationship to housing activities
8) Aesthetics: Views from adjacent and surrounding areas, views for park users
9) Light & Glare: potential conflicts with surrounding residents
10) Recreation: Compatibility with existing and planned uses.

An EIS is customized for each given location. In general, in-fill synthetic fields with sand and rubber in-fill use recycled materials including tires and recycled athletic shoes. The fiber itself is inert with no known impact environmentally. Sand or silica is a known human carcinogen in instances of long-term exposure [6], and industrial policy about the health concerns of sand have been widely considered [7, 8]. However, the impact of sand used in an in-fill athletic playfield or on a sand based grass field has not yet been researched. The rubber in-fill fields do not have a permeable backing, therefore the holes punched into the backing may permit rubber particles to transfer into the drainage system, however, no measured impact of these particles has yet been offered. Similar to interior carpet installation, an industrial grade glue is used to seal the synthetic

seams. The potential environmental impact of this glue has not been previously reported as it pertains to in-fill surface installation.

As opposed to artificial surfaces, a soil based or sand based grass field requires fertilization, pesticides, and disproportionate use of a limited natural resource, water. The measure of the environmental impact of grass versus the inert synthetic surface is measured by the potential impact to the earth, air, plants and animals. The environmental benefits of infill synthetic surfaces compared to grass are obvious and proven. A single infill synthetic field displaces 7 playable grass fields (1/7 of the land use), requires no water, no chemicals, minimal gas and diesel powered equipment, and most importantly offers a decisive diversion of labor and machinery to real habitat improvement projects.

## ***Quality***

### Not all Synthetic Fields are made the same:

The two main technical differences between the infill surfaces are

1) use of a patented permeable backing (as opposed to a mesh backing with holes punched into it), and
2) the use of sand mixed with rubber (as opposed to rubber alone). These differences between the technical aspects of the infill surfaces should be carefully considered when deciding on a vendor. However, other considerations should also be taken into account such as the following:
   - Recent successful installations: Note problems with Seattle School district field installations which include inadequate sub-surface preparation causing a non-level field, use of cheaper grade of glue that failed to hold and caused seams to break, etc..
   - The reality of surface maturation: In recent installations, the fiber came out of the surface where the holes were punched for drainage. For several weeks, users would leave the field covered with a "birds nest" of the fiber. This fiber also blew all over the area, increasing cleanup demands and irritating neighbors.
   - Vendor competition market: Compare the number of scheduled installations among competing vendors.

## *Injury Rates & Safety:*

Since artificial surfaces were introduced, several theories have been postulated comparing the rates of injury on grass vs. synthetics. Several national studies were conducted and found no significant differences in injury prevalence. With serious injuries defined as one causing a player to miss up to two subsequent games, a recent National Football League study concluded fewer serious injuries with the synthetic surfaces, though more frequent minor injuries (turf burn) were reported [9-11].

Unofficial studies do indicate lower rates of injury on synthetic fields, which is often attributed to the even, all weather playing surface. For example, for college football at the University of Nebraska, the Cornhuskers went from 40 injuries in 1998 to an injury-free season in 1999 following an infill synthetic surface installation [12]. Similarly, at Amarillo ISD, after two years, 76 football games and over 100 soccer matches, no significant injuries of any kind were reported. Finally the 1998-99 NCAA Injury Surveillance System reported lower injury rates on artificial turf than on grass for men's football and soccer [13].

Since a combination of factors contribute to injury incidence such as surface hardness, slope, weather conditions, foreign materials (glass) shoe type, equipment quality, position played, player conditioning, and coaching styles, it is almost impossible to attribute injuries or lack thereof to the playing surface. A methodologically sound research study comparing injury incidence must take place for valid results.

Most athletic administrators agree that artificial surfaces do not result in more injuries, but offer increased opportunities for practice and play [14]. The opportunity to practice prior to matches reduced the likelihood of injury. In sum, the predicable quality of the playing surface might decrease injury rates more than the type of playing surface.

The history of injury prevalence and comparisons between grass and synthetic surfaces has been primarily focused on professional level Astroturf compared to professional level grass. Studies indicate that injury frequency is greatly reduced when comparing an infill synthetic surface to the older Astroturf™ type surface [14, 15].

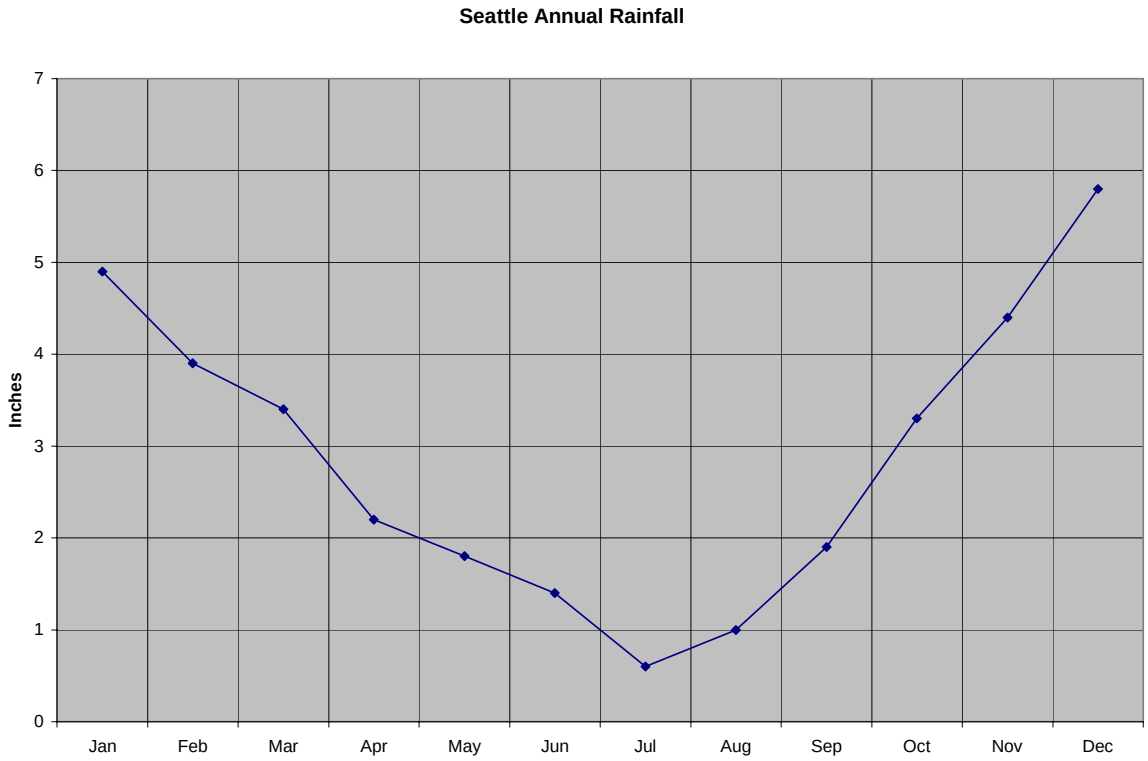
## ***Resistance to Change and Other Obstacles***

Despite the obvious benefits of installing synthetic surfaces[16], there are three main potential obstacles; 1) lack of capital for initial installation, 2) community reluctance or active opposition due to perceived increases in noise, traffic, light glare, etc. and 3) user resistance due to outdated or misinformation about the infill synthetic surfaces. There are credible arguments for either side of each obstacle. Although the ASPYRE Commission asserts that where possible, synthetic in-fill (with sand and rubber mix) athletic surfaces should be utilized, it also recognizes the potential for resistance and leaves task of arguing each point up to the existing public process.

### ***When Grass is the Best Option:***

Responsible scheduling and use policies: Current scheduling policies of the various governing entities in King County often prioritize users by age, prior use, and affiliated sport or activity. Discrimination among sports that have mid-winter seasons, adult athletes, or larger organizations is pervasive. In cases where grass fields are the only available facilities, scheduling policies must include limits on larger user groups to not only preserve the grass fields that are available, but also to permit access for non-mainstream or adult users.

Ways to Reduce Maintenance Cost of Grass Fields: Grass fields pose a considerable maintenance challenge[4, 5, 17-20]. The rainy Northwest weather is the first obstacle that must be addressed. Note the wide variability of average monthly rainfall in the chart below. Wet fields are easily turned to muck and mud if normal play is allowed on them. Clear, unambiguous opening and closing of fields to prevent field destruction is essential. If a Spring season is desired, then opening should occur at the earliest in the early part of April. For a normal fall soccer season, it is recommended that fields close stay open no later than October and remain closed 7 months of the year from November thru May. This allows time for recovery and rehabilitation of fields before the summer and fall seasons begin. In general, for any grass field it is best to pick two seasons for play and to not try to schedule a field for three seasons and 9 months of play. Doing so will almost guarantee fields that are over-used to the extent that they are mud holes at the end of the year with little grass remaining[21].




***Reference [22]**

Effective preservation of grass athletic fields must also include a clear separation between open space grassy areas used to host public festivals or provide overflow parking and expensive grass athletic fields with already limited capacity. For example, the City of Seattle spent over 1.4 million dollars to rehabilitate two grass fields in the past 5 years. Following the 18 month grass maturation period, the city awarded permits for community festivals on the newly rehabilitated grass fields. These festivals damaged the grass pores, compacted the fields, and festival tent stakes damaged the new drainage systems. Although subsequent repair (at additional expense) has aided field recovery at both locations, the quality and durability of these two fields has been permanently compromised.

## Water

Another area of significant cost is water. Water rates vary with each municipality, but a conservative estimate for an adequate irrigation regimen is a cost of $4830 per year simply for the water used to irrigate a normal grass field (See Cost and Capacity)[23]. In some areas, fields have been developed on flat valley lands with water rights to adjacent rivers. In such cases the water that is pumped is free. In the normal case, where water must be purchased, a decision must be made about the level of use during the summer. If the fields are seldom used or closed for the summer (as with some school fields) then water costs can be significantly reduced.

## Centralized vs. distributed grass fields:

Another consideration in maintaining fields is the cost of centralized versus distributed maintenance, and similarly, the cost of single-field maintenance versus multi-field maintenance. In the table below, we consider mowing of a set of 10 fields located at 10 different locations each 30min from a central maintenance facility. In contrast, compare that to the cost of mowing 10 fields at one location. And because centralized maintenance also allows for use of larger, more efficient machinery such as 16 foot and 22 foot mowers instead of 6 foot mowers, let's assume that each distributed field takes one hour to mow, and each centralized field takes only 30min:

| | Distributed Fields (10) | Central Field Complex |
|---|---|---|
| **Load up** | 15 minutes | 0 |
| **Drive to Site** | 30 minutes | 0 |
| **Unload** | 15 minutes | 0 |
| **Mow** | 60 minutes | 30 minutes |
| **Load up** | 15 minutes | 0 |
| **Drive Home** | 30 minutes | 0 |
| **Unload** | 15 minutes | 0 |
| | 180m = 2.67 hr | 1/2 hr |
| **Cost (@$27.5/hr)** | $73.43 | $13.75 |
| **70 mowings** | $5140 | $963 |
| **10 fields** | $51,400 | $9,630 |

A centralized grass facility has significant economies of scale. In this example of mowing alone, a distributed grass fields configuration increases cost by over 5 times.

### Labor Cost

One challenging problem for many parks and schools is their inability to effectively manage their field labor cost. Labor agreements restrict activities of members to narrow sets of tasks, set pay rates high relative to non-union field maintenance rates, and protect current and future union jobs from replacement with non-union workers. These are fairly typical and understandable restrictions for union work. Unfortunately, rather than pay these rather high costs, schools and parks have chosen simply to staff maintenance of fields at schools and parks at inadequate rates. The current King County Parks crisis is an obvious result of such staffing and thinking.

Fortunately, several ready sources of additional labor exist that could complement union labor and improve the amount of maintenance and quality of maintenance by an order of magnitude:

- volunteers,
- professional landscaping crews,
- student labor, and
- work-release crews.

The most straight-forward method for maintaining many grass fields is to contract with the many professional landscaping crews in the King County area. Competitive bidding would assure a reasonable price for maintenance of many of these fields that could complement general school and park maintenance.

Another obvious source of field maintenance labor is students who need part-time jobs. With decent supervision and training, good jobs for students that complement their work at school can be created with little trouble.

A third type of labor that might be used is the work-release work crew. Such crews allow work-release candidates to work under supervision to earn money to compensate victims, and to pay for the cost of their incarceration and rehabilitation.

The final source of complementary labor is the volunteer user group. These are sport-specific groups who have a burning desire to raise field quality to a level that would otherwise be cost prohibitive. Such groups are often more than willing to provide labor, equipment, funding, and management to fields if they can in return receive priority use of a facility for limited times during a season.

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## *Appendix A. Surface Comparison*

| Surface Type | Brief Description | General Drawbacks | Guaranteed Lifespan |
|---|---|---|---|
| In-Fill sand & rubber | Polyethylene and polypropylene blended 2½ inch fibers with a patented permeable backing that permits 62 inches of water per hour to pass through. In-filled with a sand (specialized silica that limits compaction) and cryogenic rubber (recycled tires and tennis shoes) that is frozen before it's broken for spherical shape (no sharp edges), no floating and no dust. Sand adds stability (ballast, or holds turf down) and mortar (binds filling together) with improved drainage and no known effect to durability. Surface plays perfectly in adverse weather conditions featuring excellent traction and low abrasion. | To support festivals, food, or fireworks (unclear pill burn rate) would require some administrative oversight.<br><br>UV rays break down the surface and it must be replaced every ten years (large capital).<br><br>Too expensive for classic park uses, open space, unscheduled use and not cost effective without lights and unlimited use agreements between public and residents (QUEEN ANNE BOWL CASE). | 8 years |
| In-Fill rubber only | Hydrophilic Nylon 6.6 fiber with a layer of texturized nylon fibers at the base of the pile that enmeshes the loose rubber. Holes are punched into the backing for drainage. In-filled with rubber pieces only. Ballast improved by fiberglass backing. Surface plays perfectly in adverse weather conditions featuring excellent traction and low abrasion. | Cannot support festivals or food due to limited drainage. Cannot support fireworks (unclear pill burn rate) same as above.<br>UV rays break down the surface and it must be replaced every ten years (large capital).<br>Too expensive for classic park uses, open space, unscheduled use and not cost effective without lights and unlimited use agreements between public and residents<br>(QUEEN ANNE BOWL CASE).<br>No patent for the blend of sand (silica) with rubber translates to the following limitations: Seam problems and turf instability (no ballast), loose filling, floating rubber, exaggerated ball bounce and over soft surface. | 8 years |
| Grass synthetic mix | Polypropylene grass blades tufted into a woven backing embedded on sand with grass growing through the backing. | Hard surface. High rates of turf burn. Struggling concept since damage to synthetic underlying surface hampered natural grass re-growth. Requires maintenance similar to a grass field, but with specialized equipment. | 3 years |
| Sand/rubber Only | A mix of sand and rubber is applied over an existing drainage system. | Esthetics, drainage, high maintenance, rubber floats into drainage system, sand blows into area residents. Extremely hard surface without regular maintenance. Requires repeated lining and tilling prior to every use. High rates of drainage system problems | N/A |
| AstroTurf® | Knitted nylon 6.6 fabric with special UV resistant formulation and diamond cross section fiber shape to boost resistance to sunlight, and airborne pollution, and enhance foot traction while reducing skin abrasions. Smooth and consistent playing surface. | Esthetics. Unnatural ball bounce or movement (no grass blade resistance), highly susceptible to sunlight and moisture. Requires more frequent replacement. | 6 years |
| Grass | Sand based grass field with drainage and irrigation systems. Since sand base fields are designed to drain efficiently, they do require more irrigation in summer, and several annual applications of fertilizer (no nutrients in sand). | Poor durability. High maintenance. Once spores are crushed the grass does not grow the same without complete rehabilitation. Requires several applications of fertilizers and chemicals for management of pests annually. Requires millions of gallons of water for irrigation purposes since turf grasses need at least 1 inch of water per week, more during hot months. | Seasonal, unlimited if properly maintained |

## *Appendix B. Breakdown of Installation Procedures*

| | Natural Grass: (Cell-System, Sand Based) | Synthetic In-Fill Turf |
|---|---|---|
| **Initial Capital** | 1. Excavate existing site, install new drainage and irrigation systems, install sand fill and grow grass (seed/sod)<br>2. Provide necessary equipment to maintain and operate the system.<br>3. Cost for contractor to maintain field during initial growth period. | 1. Excavation, paving, drainage and installation of synthetic turf.<br>2. Operating equipment required - vacuum sweeper, line striper, painting templates. |
| **Future Capital** | 1. Periodic equipment replacement - can be handled by periodic purchase or as an annualized cost on a depreciated basis.<br>2. Periodic replacement of irrigation and drainage piping, equipment, etc.<br>3. Periodic replacement of field tarps. | 1. Field replacement is done by determining the useful service life interval. Sub-base repairs or rework should be minimal at the time of replacement. "Old" turf may have resale, salvage value.<br>2. Operating maintenance equipment replacement either per capital cost or per annualized depreciation. |
| **Annualized Operating Materials** | 1. Water, fertilizer, fungicides/pesticides, other chemicals/lime, striping paint/vegetable dyes, fuel/oil/etc. to operate equipment, seed and or re-sod materials. | 1. Fuels to operate equipment. |
| **Labor** | 2. For application of materials, related functions plus mowing, aerating, divot replacement, area sod replacement, reseeding etc. | 2. For periodic field cleaning and operating sweep machine, temporary line painting or touch-up painting. |
| **Equipment** | 3. Rental equipment may be needed such as: portable cranes to remove goal posts, aeration, spreaders, sod cutting equipment, etc. | 3. Equipment may be required to rent for specialized operations. |

## *Appendix C. Estimated Maintenance Requirements.*

| Maintenance Component | Playable Grass | In-fill synthetic |
|---|---|---|
| **Labor** | Mowing and clipping removal (est. 70 times/year).<br><br>Periodic topdressing, coring, over seeding, and thatch removal.<br><br>Spot surface repair as required.<br><br>Irrigation system monitoring, maintenance and repair. | Drag Broom-Annually<br><br>Rake –Twice annually to loosen sand rubber mix. |
| **Lining** | One hour lining per use | Same |
| **Fertilizer/Pesticides** | 6 annual applications (~750 lbs.) | None |
| **Irrigation system** | Required | None |
| **Water** | 1.2 Million gallons annually if irrigation system exists | None |
| **Drainage System** | Slope grade or monitoring 18 inch PCV piping | Monitoring 18 inch PCV piping |
| **Sand** | 40,000 tons annually for sand based field | None after initial installation |
| **Equipment** | Tractor/mowing<br>Spreader<br>Aerator | Tractor and Drag Broom for annual maintenance. |
| **Recovery, maturation period** | Up to 18 months | None |