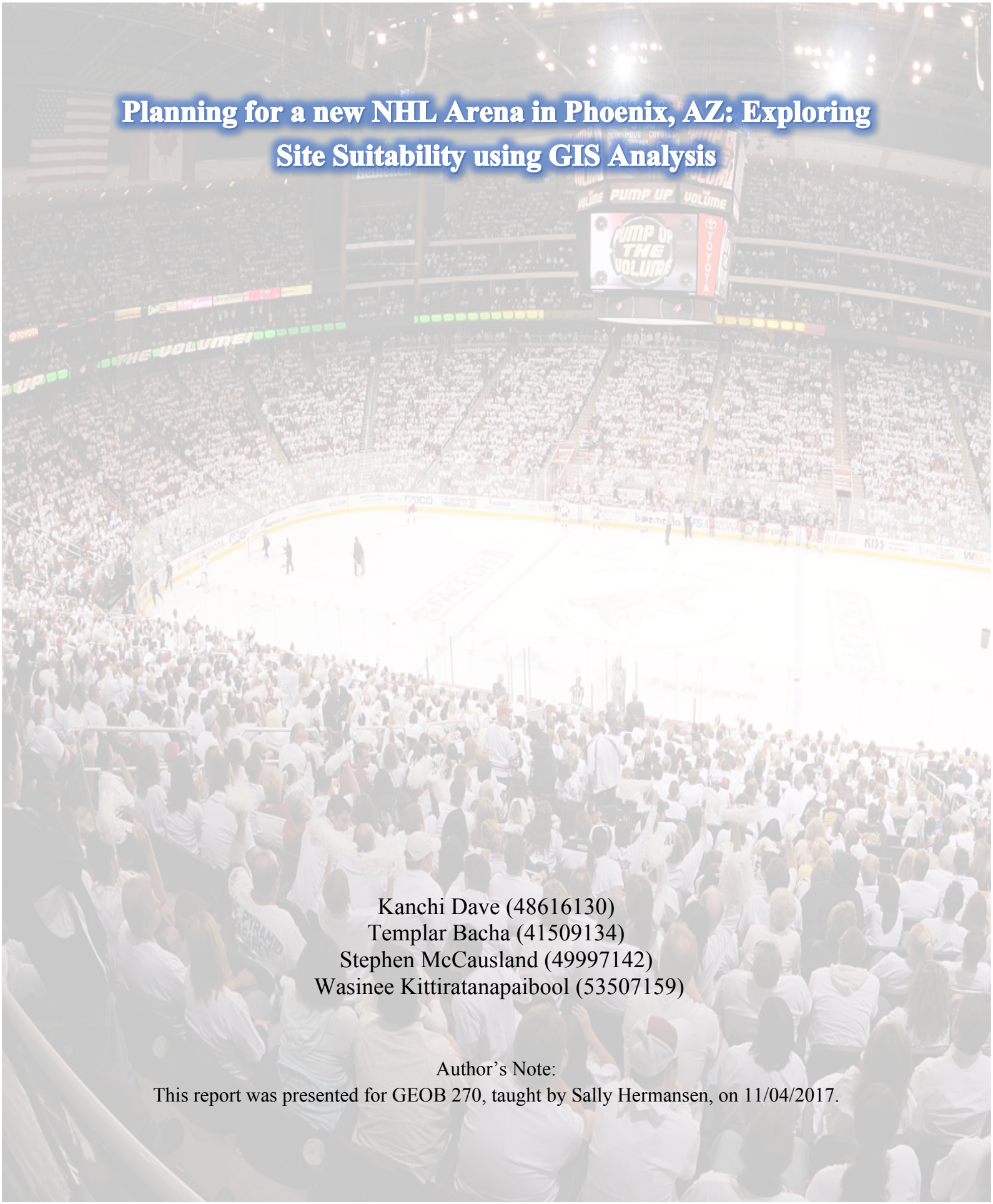

Planning for a new NHL Arena in Phoenix, AZ: Exploring Site Suitability using GIS Analysis

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Abstract

In 2013, under new ownership and after 4 years of bankruptcy, the Arizona Coyotes (a National Hockey League franchise) settled a 5-year, $15 million deal with the City of Glendale to play at Gila River Arena. However, after considerable losses, largely due to mismanagement, low demand, and an infeasible location for their fanbase, the Coyotes have turned elsewhere in the Greater Phoenix Area to build an arena. In February 2017, after an attempted negotiation to locate an arena site beside Arizona State University's athletic facilities in Tempe, AZ, a deal with the university fell through, leaving owner Anthony Leblanc looking for new locations. On March 7th, NHL Commissioner Gary Bettman threatened to withdraw the team from Arizona if a location outside of Glendale is not found, stating that "the Coyotes cannot and will not remain in Glendale" (Traikos, March 8th). Using spatial data from the OpenStreetMap Data Extracts, City of Phoenix Open Data, ArcGIS Open data, and Arizona Library GIS portal, this GIS location analysis evaluates the best site for a new NHL arena in the Phoenix city proper using proximity, extraction, selection analysis, visual inspection and weighted overlay techniques. It evaluates site suitability according to walkability, driveability, natural hazards, zoning regulations, parcel size, and multifunctionality. The results outline three optimal locations for an arena, of which one was chosen as the best location.

Project Description, Study Area, Data

The purpose of our project is to seek out a pertinent parcel of land within the City of Phoenix which the Arizona Coyotes would be able to build a new hockey arena. To determine suitability of a site, two separate analyses are needed: The first of these analyses is the determination of an appropriate location with respect to the NHL Team Coyotes preferences, whereas the second analysis involved notation of areas which were compatible with UEFA stadium guideline. In order to calculate a suitability index, we implemented a weighted overlay. In doing so, the weighted overlay worked on the premise that layers which possessed desired traits would be given a value of 1, whereas layers which were incongruous will be denoted a value of 0. The formulation of a new site for the arena of the Arizona Coyotes was based on the limits of Phoenix proper. Moreover, considerations were given to the Tempe Town Center land parcel that the Coyotes planned on locating their new arena (NHL.com, 2016): located on Rio Salado Parkway and McClintock Drive in Tempe, a suburb of Phoenix, the proposed site was calculated on Google Earth to have an area of 5.491 million square feet. Google Earth was used for lack of City data from Tempe. In order to comprehensively measure areas of suitability and areas which were deemed unsuitable, prerequisite values were allocated to specific variables of importance. These variables were:

- Natural hazards susceptibility of the region
- Walkability
- Drivability
- Zoning
- Parcel size
- Multifunctionality

Data was gathered from multiple sources which included: OpenStreetMap Data Extracts, City of Phoenix Open Data, ArcGIS Open data, Arizona Library GIS portal. As well for consideration of project topics such as arena guidelines, FEMA 100 year floods, walkability and distance to stadiums information was retrieved respectively from UEFA, transit research, and the deadspin stadium convenience survey.

Methodology of Analysis

Through a combination of urban planning and stadium building protocol a comprehensive criteria was created and ranked based on its importance (Table 1). Table 1 shows a breakdown which analysis methods were used to narrow down on suitable areas. For details on analysis steps followed, see flowchart in Appendix C.

Criteria	**Method**
Natural hazards susceptibility of region: Site should not be in areas susceptible to prominent natural hazards (in case of Phoenix, flooding)	Weighted Overlay
Walkability: convenient to walk to from public transport	Weighted Overlay
Drivability: convenient to drive to from highway interchanges. This reduces substantial traffic flows on arterial roadway and increases the arenas architectural aesthetics visibility	Weighted Overlay
Zoning: the site should fall within a commercial or light industrial area	Select by Attribute
Parcel Size: size greater than 5.491 million sq. ft	Select by Attribute
Multifunctionality: the sites should be close to hospitals, to tend to potential player injuries, close to public parking, to convenience drivers, and far from recreation centres, so that the multipurpose stadium could serve as a rec centre for its neighboring community.	Visual Inspection

Table 1- Criteria used for finding suitable sites and the analysis methods used

Step 1: Weighted overlay of walkability, drivability and flood zone layers to find suitable areas.

Walkability layer: The average walking speed of a human is approximately 5 km/h. Using the BC Transit study, 5 minutes is the appropriate time limit to walk from transit stops to pedestrian destinations. From this, it was calculated that a 400m buffer from a public transit stop is the ideal convenient walking distance. Bus stops and light rail stops were extracted and applied with a 400 m buffer. The resultant layer was converted to raster and reclassified to show a value of 1 in buffer zones and 0 in the rest.

Natural hazards susceptibility: Using the Arc open data, a feature class of the 100 year FEMA flood was found: only data for city of Phoenix was extracted. The resultant layer was converted to raster and reclassified to show a value of 1 in safe zones and 0 in the rest.

Vehicular access: Due to inability to find standard arena distance from freeway exits and entrances, we chose a buffer distance of 1 kilometre (0.6 mile) by observing that the majority of successful American sports arenas are located within this radius. *(This is a source of error as a multi-buffer would have been more suitable. See Error and Uncertainty).* Freeways within the city limits were identified and extracted and the interchanges digitized. A buffer of 1km was applied for all interchanges with primary roadways. The resultant layer was converted to raster and reclassified to show a value of 1 in buffer zones and 0 in the rest.

Using weighted overlay, only areas which fell within walking buffer, driving buffer and outside floodplain were extracted to form a new layer.

Step 2: In suitable areas from step 1, find parcels with area > 5.491 million sq ft and within commercial and light industrial zoning sites.

Zoning: Based upon UEFA stadium building recommendations, site search were limited to sites which conformed to their areas preferred (commercial and light industrial zones) and areas to avoid (residential, historical sites and parks). So commercial and light industrial zones were selected to form a new layer from which historical areas were erased out. Parcels falling in those zones were extracted to a new layer. The resultant layer was clipped to only include parcels within areas suitable from step1.

Parcel Size: footprint of the Tempe Town Center was 5.491 million sq. ft. From the resulting parcels of the zoning analysis, only parcels with an area greater than 5.491 million sq. ft. were selected.

Step 3: From suitable parcels in step 2, choose top 3 parcels that would best serve community as a multifunctional arena.

Multifunctionality: This is the last criteria to explain the choice of top 3 suitable arena sites. The sites closer to existing parking lots, hospitals and far away from recreation centres were

given preference so as to not over service the surrounding community. Satellite imagery is used to give an idea of the land use in the area.

Results & Discussion

Our project was, as mentioned in the previous section, comprised of three major steps. These steps were (a) the weighted overlay in order to determine initial potential sites, (b) attribute selection which resulted in land parcels within the preferred area, and (c) a visual analysis to determine suitability based on proximity to key facilities.

The weighted overlay (see Map 1) gave us preliminary area alternatives from which we could apply our subsequent selections on. In doing so, the members had agreed upon specific criteria to determine the final location from. The criteria was as follows: any location which was within walking distance from public transport, convenient driving distance from freeways, and, lastly, outside of the flood zones in Phoenix. Our definitions for walkability and drivability can be found in the methodology section.

For the next step, the aim was to expand upon the initial areas found within the first, and then locate appropriate city owned land parcels within the aforementioned locations. The main focus of our analysis for this step was done via performing the select by attribute command. Map 2 shows land parcels within the favored area which was well complied with zoning designations of either commercial or light industrial. Furthermore, all of the preceding locations were required to have an area greater than 5.491 million square feet. Any parcels above 5.491 million square feet, that fell within either the flood-free, the drivable or the walkable zone, were identified as the second best locations (in blue on Map 2). While the best sites for the arena construction were the parcels that had an area above 5.491 million square feet and were located within the flood-free, the walkable and the drivable zones (i.e. qualified with all the criteria) as shown in pink in Map 2. However, as many of the second best locations include scattered parcels, those parcels were discarded as they were deemed incompatible to our criteria. As a result, we were able to create visual representations of all the favourable parcels and then place them into four zones (Map 2). This allowed further discussion based on proximity of the location to hospitals and parking lots, whilst maintaining a considerable distance from recreation centers.

Zone 1: Located in northeastern Phoenix in the Desert Ridge neighbourhood, zone 1 has two conceivable locations within its boundary. Moreover, one of these locations is considered to

be a top 3 site location, whereas the other location is on the shortlist. As noted by the legend, pink polygons are the most favorable sites, and in turn, blue polygons are shortlisted. The location of the pink parcel is favorable as it is adjacent to a hospital and has abundant preexisting parking at the site. The blue parcel is less favorable, though still a strong site based upon the criteria. The shortcomings of the blue site are in its distance from the hospital and public transport, but it does have a large amount of pre-existing parking. Shared between both these sites is that they are 3km from the rec center, therefore making it a null factor among the two parcels.

Zone 2: Located in the middle of northern Phoenix, zone two as well has two potential sites. Furthermore, similarly to zone 1, this area consist of both a favorable and a shortlisted parcel. Using satellite imagery, however, it was determined that the blue parcel was an airport. Though we still marked this as a potential site, it was done with full recognition that due to cost and importance of an airport it would most likely be naive to consider its potential as an arena. However, the pink site proved to be a redeeming factor of this zone, as it was a large open parcel far from any existing recreation centers. Zone 2 in its entirety was in many senses bipolar to our criteria. Though it showed great promise in the location of the hospital (4km), it as well had a scarce amount of appropriate parking lots, and had three recreation centers.

Zone 3: Located in southwestern Phoenix, this zone was most chosen for its meeting of criteria and as well separation from the sprawl of Phoenix. The disparity between this zone and the other 3 gave us many considerations when discussing the overall landscape. As can be seen in Map 2, there are two sites. The blue site is located in an area which is far more rural, as can be noted by the satellite imagery which shows surrounding farmland. As well, it is further away from a main highway. The pink parcel in turn is located in a much more favorable location when considering highways and thus transportation. Though it unfortunately is near, howbeit not included in the 100 year flood zone. The entireness of zone 3 only includes two recreation centers, although this can be contrasted to its lack of suitable parking and as well absence of a hospital.

Zone 4: The most unfavorable of all the zones, this region was chosen more for a comparison of potential location than realistic site consideration. Though three zones did meet certain aspects of the criteria, they were all only considered as shortlisted sites. Of the zones displayed, one is located on a preexisting hospital, whereas the other two are part of an airport. Though this does attest to our criteria as providing suitable sites for important locations, neither a hospital nor an airport is feasible to be purchased or developed for the purpose of building of a sports arena.

The pink parcels mentioned above are our top 3 parcels, for ease of understanding, these parcels are named Plot A, Plot B and Plot C, respectively (Map 3). The most suitable plot on which to build the Coyotes' NHL arena is discussed below.

Plot A: Determined to be the best option, we were able to definitively conclude that its close proximity to public transport, freeway interchanges and distance from flood zones, all allowed for it to be the discernibly superior option. Furthermore, the site sits close to a hospital, has 8 hundred thousand sq. ft. of pre-existing parking lots on site and the locale is serviced by only one other recreation center. The importance of only one other recreation center is that in turn it would as well support the community, which we deemed to be an overall influential factor. The one drawback that must be addressed is 15km from the city core. It is uncertain as to whether this is negative. Without data on the location of the fan base this may prove to be either a negative, positive or a null inquiry.

Plot B: The decision to rank this plot second was based on the accessibility of public transport and its location outside of the flood zone. Moreover, based upon satellite imagery it appeared that Plot B was largely undeveloped, implying that any demolition-related costs could be reduced. The proximity of a hospital was a large benefit to this site. However, the overall location of Plot B within Zone 2 meant that it was already in a locale which was serviced by three recreation centers. In addition there was a large scarcity of parking lots close to the site.

Plot C: Though Plot C was our third choice, it lacked many of the qualities of the previously described locations. Positives of this site were its location to public transport and

major highways. Additionally, from satellite imagery, Plot C is largely undeveloped. Related to this underdevelopment was its location far away from many key city functions, though this could be remedied through its access to the highway. From a negative perspective, this site had parts existing in the 100-year flood zone. This would affect both the overall structure of the building and the insurance associated to a building in a flood zone, most likely increasing costs due to both. Moreover, the surrounding area was already serviced by two recreation centers, and lacked any hospital and significant parking lots within the boundary.

In conclusion, it can be stated that the most preferred option was Plot A. This was due to the locations adherence to our criteria, most notably as it was the only site which was successfully adjacent to a hospital, far from any recreation centers, had substantial parking was was greater than 5.491 million square feet, and was both in a zone of accepted walkability and drivability.

Error & Uncertainty

The project's visible error and uncertainty can be observed through several factors in the analysis and map-making process:

- *The inability to find the cost data for land values.* Cost of the land parcel is, among others, a highly weighted criterion in standard site analyses, and would crucially apply to the Coyotes' case because of the limited budget for their new arena. In other words, while the franchise's new arena has to be located on a suitable size of land at the minimum cost, this project cannot take such key analysis into account since no public data for the land assessment was made available.

- *The credibility of the acquired data* was considered as the primary factor for the uncertainty to any performed analysis at the fundamental level. There was an absence of metadata from many base layers, and the inaccuracy of certain layers to their real-world location. While the lack of metadata raised the question of data incompetence, there was no better alternative source to obtain these data. The layer inaccuracy was most evident in the land parcel layer where individually scattered parcels were treated as a singular entity in the attribute table. It not only affected the course of the analysis, but also caused considerable delay to the work progress from thoroughly reviewing each concluded results to identify any consequential error.

- *The visual inspection* could weaken the validity of the result since there is no established principle to guarantee the result consistency. Such method of analysis was based heavily on subjectivity in determining the proximity of the potential arena location to the existing public facilities: hospitals, recreational centers and parking spaces.

- *Determining a distance to buffer* from a selected feature class challenging, due to the lack of general protocol in determining the appropriate proximity away from, or toward, a facility. This unavailability resulted in buffered distances from a rational personal judgment, instead of a standard regulation (400 m for walking, 1 km for driving).

- *The interchange layer* was a set of digitized points where the freeway and the roadway intersected, but for some interchanges, they did not intersect and on/off ramps were placed in different spots. This could cause good arena locations to fall outside of the 1000 metre buffer zone.

- The analysis did not consider that *multiple land parcels can be purchased* by the Coyotes, the city, or other private firms to plan for the arena. One built in assumption in our analysis was that the arena would be built on a single land parcel.

- Lastly, *determining the target parcel size* involved error, largely because the measurement tool on Google Earth is an inaccurate method of surveying land. Moreover, upon completing the analysis, it was determined that the site measured was in fact different than the location provided on the article from the source NHL website. That proposed site yielded a result of roughly 103,000 square feet, a much smaller parcel size than used in the analysis. Proceeding with the same analysis with this figure used for the parcel location would have yielded very different results.

In summary, the cause behind the project's error and uncertainty were largely of technical issues as the pre-deficit of the acquired data, the absence of crucial pieces of information (metadata and the standard proximity), and various unexpected encounters, including misinterpretation of the actual location.

Further Research & Recommendations

For further site analysis in Phoenix for a new arena location, more research is needed to reduce error and uncertainty. Firstly, standardized buffering distances and arena footprints will greatly decrease inaccuracy surrounding parcel sizing and walkability/drivability criteria. Although the arena is still in the preliminary planning stages, a square foot estimate or accurate seating capacity ratio would be needed to accurately find a range for parcel sizes. Second, better quality data is needed to develop more important criteria in site suitability analysis. Cost data is fundamental for determining budgeting, while other criteria such as local ecosystem impact, proximity to the Coyotes' fanbase, and population density are worth pursuing for a more rigid analysis that better identifies areas within the city limit that may be more suitable. Official interchange data is needed to provide a more accurate buffering distance from major freeways. Third, once a site is definitively chosen, a community consultation must be undertaken to examine noise levels, line of sight, neighbourhood traffic increase, and light pollution among other factors that will likely affect the closest residential areas. Lastly, more complicated statistical analyses must be mobilized to account for arena proximity to and distance from desirable/undesirable features like hospitals and recreational centres, as well as ensuring that the arena is covered by the city's fire zone, a criteria that fell outside the scope of our analysis.

It has been noted that arena building trends, especially in Canada with Calgary's "CalgaryNEXT" arena and event centre, arenas are being planned for multifunctionality, sustainability, transit- and pedestrian-oriented development, and residential build-up (CalgaryNEXT). Though Phoenix is not an overtly dense city, and is vehicle rather than transit-oriented currently, these are considerations that must be taken into account for the arena's location, given Phoenix's vision for a "carbon neutral city" by 2050 (City of Phoenix, 2017). Once more light rail and bus infrastructure is developed, it may encourage site selection to be weighted more towards walkable/bikeable areas and zones serviced by transit. However, NHL Commissioner Gary Bettman prefers the arena decision to be made sooner rather than later, and thus waiting for sustainable development to occur may not be within the Coyotes' best interests.

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Appendix B: Figures and Maps

Criteria for a Stadium

1: Most important, 5: least important

Criteria	Kanchi	Wasinee	Stephen	Templar
Contribute to local public + city wide community : size of stadium and how multipurpose the stadium can be.	5	4	3	4
The structure and spatial definition of the present and potential future street and public space system: Walkability, proximity to transport, proximity to highways/major roads.	2	2	2	1
The role of a stadium in visually marking an important corner on a major arterial route into and from the central city: Should be on a major road or close to a major highway	5	4	4	4
The physical character of existing buildings and structures in the adjacent area: Commercial areas to avoid inconvenience to residential areas. Need medium to small sized buildings around it. (zoning restriction) Open land preferable.	4	1	2	5
Size: should approximate the Arizona Coyotes' current arena, the Gila River Arena, and the planned Tempe Town Center site for square footage reference.	3	4	2	3
Stable land: Avoid Natural hazard prone areas- flooding plains	1	2	2	1

Figure B1- Group members' vote on the order of priority towards properties of the stadium

Name of data layer	Source	Uses	Entity Type	Data Model	Attributes
Zoning	City of Phoenix	Locate site within a commercial or light industrial land use zone	Polygon	Vector	Zone area, Year enacted, Zoning code, General Zone Classification, Date Approved
Historical Areas	City of Phoenix	Ensure site is not within a historical area	Polygon	Vector	
City Parcels	City of Phoenix	Find a suitable city parcel for locating an arena	Polygon	Vector	Addresses, Area, Zip Code, PIN
Light Rail Stops	City of Phoenix	Determine walkability	Point	Vector	Stop Location
Bus Stops	City of Phoenix	Determine walkability	Point	Vector	Stop ID/Description
OSM Arizona Roads	OpenStreetMap	Locate freeway interchanges with primary roadways	Line	Vector	Road Type, Road Name, Max. Speed Limit, Code
FEMA_100-Year_ Flood_ Z-ne	ArcGIS Online-Owner: lindsay.withers	Ensure site is not within floodplain	Polygon	Vector	Shape Area, Flood Zone
City Boundary	City of Phoenix	Clip all layers to city limits	Polygon	Vector	Shape Length/Area
ArcGIS Satellite Imagery	ArcGIS Online	Visual inspection of site use	Image	Raster	N/A
Hospitals	City of Phoenix	Determine if site is close to hospital	Point	Vector	Hospital Name, Address
Recreation Centres	City of Phoenix	Determine if site is close to recreation centre	Point	Vector	Address, Website, Access and Status
Parking	OpenStreetMap	Determine if site is close to pre-existing parking	Polygon	Vector	Multilevel/Single Level, Address

Figure B2 - Metadata Summary