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NATURAL ANOMALOUS COGNITION TARGETS: A FUZZY SET APPLICATION

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ABSTRACT: Fuzzy sets have previously been applied to photographic target stimuli. In this paper, we use the same technology to construct a set of natural sites in the San Francisco Bay area. We created a Universal Set of Elements containing 13 items which created five orthogonal categories: Buildings, Ponds, Towers, Gardens, and Bridges; 22 sites were identified and were independently coded by two volunteers. Thus, the fuzzy sets that represent these sites are a reasonable consensus of their content. This paper describes the construction process in detail, and the appendix shows each site and its associated fuzzy set.

Keywords: anomalous cognition, remote viewing, RV stimulus, RV targeting, target pool construction

A traditional set (called a crisp set) is simply a collection of items that share a common property. For example the set of cities that possess 1,000,000 people or more includes New York, New Delhi, London, and Hong Kong. However, a city that has a population of 999,999 (i.e., one person short of a million) is not a member of this set of cities by definition. Zadeh (1965) realized that this kind of reasoning is not the way people actually think about problems. In this example there is no real difference between a city of one million people and one that is one person short of that number. Like crisp sets, fuzzy sets are simply a collection of items that generally share a common property. Using fuzzy sets, it is possible to construct a set of "reasonably large cities." Here cities that differ by an insignificant number of people are still member of this set. In other words, fuzzy sets allow the quantification of the ambiguous.

This concept has broad appeal outside the application to psi research. Because, for example, experimental psychology and cognitive psychology are concerned with how people "think/feel" about various concepts, using fuzzy rather than crisp descriptions of the concepts is valuable (Sternberg, 2008).

Honorton (1975) may have been one of the first to encode pictorial information in a quantitative way. Honorton used 10 concepts from Van de Castle's dream research (Hall & Van de Castle, 1966; Van de Castle et al., 1972). Dream concepts included color, mythological characters, food, human artifacts, etc. These were turned into a binary system of characteristics either present or absent from a picture (usually a collage). For example, a colorful collage of superman sliding down a disembodied leg into a pile of bananas would have four of a possible 10 binary bits each with the value of one. For a variety of reasons this clever attempt was shortly abandoned, in part because of the lack of thematic content for any given collage and some of the 1,024 pictures in the set were a bit "racy" even for 1975 Brooklyn, New York. One of us (May) was present at Maimonides when this target pool was under construction. So much of this is first-hand recall. Then Jahn, Dunne, and Jahn (1980) advanced the free-response judging methodology by using a set of descripters for the target material. Later, however their free-response methodology was critiqued (Hansen, Utts, & Markwick, 1992), whereas the PEAR group offered a rebuttal (Dobyns, Dunne, Jahn, & Nelson, 1992).

May et al. (1990) first applied fuzzy sets for the analysis of anomalous cognition (then called remote viewing) data and photographic targets; however their first attempt was cumbersome and the universal set of elements (USE)—all possible elements that might describe any of the target photographs—contained 130 separate elements, thus making it difficult to encode any given photograph. By "universal" we mean only within the jargon of fuzzy sets; that is, this "universal" set of elements is only for the design of the fuzzy sets for the particular sites and responses. It cannot be applied to any other circumstance. So by definition, it is not a generalized concept. For example, a USE for sites in India would not apply to sites in the US, and a USE for sites in California would not work for sites in the Eastern half of the US.

Using a different photographic target pool May et al. (2012) reduced the USE down to a more manageable set of 24 elements.

Our first attempt to apply this technique to natural sites occurred as part of the Laboratories for Fundamental Research workshop hosted by the School of Management at GITAM University near Visakhapatnam, Andhra Pradesh, India in 2011. Over the course of an 8 week, 8 hours/day, 6 days/week intensive, we carried out a preliminary search of sites within one half hour drive of the university. As with any new approach there were numerous false starts both with site selection as well as the design of a proper USE. This part of India is on the coast, and it also has a number of high-tech industrial sites. Figure 1 shows a sample of some of the sites that were under consideration.

Figure 1. Sample outdoor sites near Visakhapatnam, India.

The workshop did make progress with regard to developing a USE in that a cluster analysis showed promise with regard to creating categories of sites, buildings for example, that were orthogonal. Unfortunately, the workshop came to an end before we could complete the target pool construction and begin collecting anomalous cognition data.

A San Francisco Bay Area Natural-Site Target Pool

Before we embark on the target pool description, we provide a brief tutorial for the entropy concepts we use below. The concept of entropy arises from classical thermodynamics in physics. Although the mathematics of various theories rapidly becomes difficult, the conceptual framework is rather straightforward. One approach is to think of entropy as a measure of chaos or to the related idea of uncertainty. Ice, for example, has much lower entropy than does water. Why? Because the molecules of water in liquid form are bouncing around in a chaotic fashion; whereas in ice, these same molecules are all lined in an ordered array we call a crystal. Also in liquid water the position of a given molecule is very uncertain (i.e., high entropy); whereas in ice the position of a molecule is far more certain because it is trapped in a crystal and is not going anywhere. So when ice melts it undergoes a change of thermodynamic entropy, transitioning from ordered molecules of water (ice) to disordered molecules (water).

In the experiment described below, when liquid nitrogen becomes a gas, the molecules in the gas are far more disordered than they are in a liquid, and, thus they experience a change of entropy. We developed a natural site-target pool as part of a test of the hypothesis that changes of thermodynamic entropy at a natural target site will enhance the quality of the anomalous cognition of that site. In a future experiment, the change of entropy at the site will be tested by pouring 3 liters of liquid nitrogen (LN) at a randomly chosen site while an experimenter is located there.

When the very cold liquid nitrogen (-320.4 F^{o}), becomes a gas, that phase change results in a change of thermodynamic entropy. The sites were chosen, in part, to be relatively entropy neutral so that the entropy change associated with 3 liters of liquid-to-gaseous nitrogen would be substantially above any changes of entropy that might naturally be associated with a target site.

The LN condition will be true for half of the sessions, and for the remaining half there will be no LN poured at the site. The conditions will be counterbalanced across the six sessions.

Our previous work on entropy and its gradients (May, 2011; May, Spottiswoode, & James, 1994; May, Spottiswoode, & Faith, 2000) used computational Shannon entropy and its gradients of AC photographic target stimuli as the dependent variables. Thus, these parameters were intrinsic properties of the photographs. Here, however, we exercised great care to keep the *intrinsic* entropy and its gradients as qualitatively uniform across the natural sites as possible. For example, sites near power lines or substations, or sites for which the intrinsic entropy might be large and change, were all excluded. Thus, we are hopeful that the change of state of the liquid nitrogen will be larger than any other sources of entropic change. This, of course, is an empirical question to be addressed in the study.

Following the lead from the workshop in India, we first identified 31 candidate sites on which to develop a USE; however, we reduced these to 25 by inspection. The list was reduced further to 22 in that one site was adjacent to high-voltage transmission lines, another had limited hours when the site was available to the public, and access to a third was only through a prison school. As in earlier work, we computed the effective distance between each pair of sites as:

$$d_{j,\mathrm{k}} = 1 - \frac{\sum_{i=1}^{N} \min(\mu_{i,j}, \mu_{i,k})}{\sqrt{\sum_{i=1}^{N} \mu_{i,j} \times \sum_{i=1}^{N} \mu_{i,k}}},$$

where N is the number of elements in the USE (13 in this case), and the μ's are the fuzzy set membership values for the respective sites *j* and *k.* The distance is not a physical distance between two sites; rather, it is a conceptual distance based upon the universal set of elements. For example, a site with lots of man-made buildings and no trees is conceptually very far "away" from a park with nothing but trees.

The fraction part of Equation 1 ranges from zero to one, so that $d_{j,k}$ varies nearly continuously from one to zero, zero meaning the two targets are identical. One way to see that Equation 1 represents a "distance" measure in element space and thus adheres to a generalized version of the pythagorean theorem is to reduce the space to only two dimensions. So in Equation 1, we let *j* have the values 1 and 2 and likewise for *k.* Now we have a two-dimensional parameter space with only two points in the space. Clearly the distance between these two points in this restricted space satisfies the requirement for the pythagorean theorem. Because, in general, these pairwise $d_{j,k}$ are "distances" in element space, standard cluster analysis can show visually if pairs of targets are alike or not or if groups of targets are orthogonal to other groups. Please see Figure 4 below as an example of our new target pool of sites.

Table 1 shows the USE that, by trial and error, ended up as the final set. It is important to note that these elements are site-specific and most likely would be completely different for another set of sites in the Bay Area or in any other location.

Table 1
Universal Set of Elements for the Natural Bay Area Sites

Buildings	Land/Water Interface	Roads/Paths
Bridges	Congested	Isolated
Repeat Motif	Prominent	Vegetation
Man Made	Natural	Geometry
	Towers	

Before we can apply Equation 1 using the USE shown in Table 1, the 22 sites must be coded into fuzzy sets. We asked two individuals to code all 22 sites against the USE shown in Table 1. The metric for coding was the degree to which each element "characterized" the site. This, of course, is a subjective assessment, but that is part of the reason for using fuzzy sets in the first place.

The rows and columns in Table 1 have no significance at all; they are just a convenient way to display the 13 elements of the universal set of elements. Each site will have varying amounts of these elements.

However, to reduce the impact of the subjectivity, we had identified a designated spot to stand at each site and where the coders will be instructed to focus attention. Figure 2A shows one example of where to stand from the instructions given to the coders. Figure 2B informs the coders where to fix their gaze.

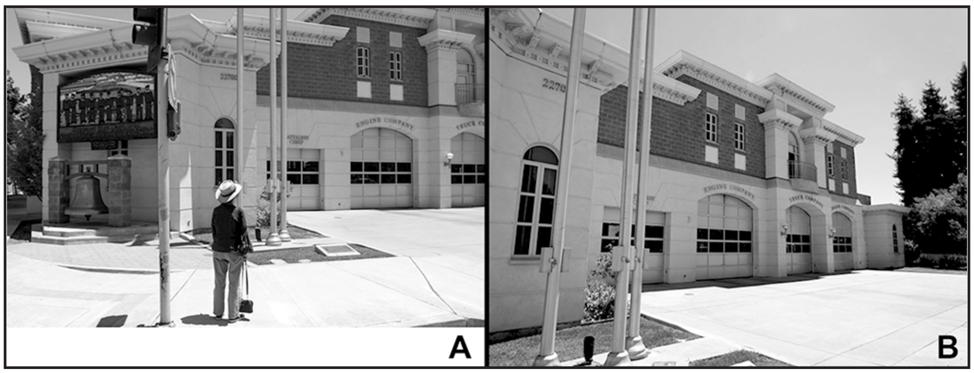

Figure 2. Where to stand (A) and where to focus gaze (B) for a building site.

The coding instructions also included driving instructions from known Bay Area landmarks and a description of how each of the elements in Table 1 should be interpreted.

The metric for the evaluation of each of the sites is *the degree to which each element characterizes the site.* This metric can range from zero (i.e., not there or is totally insignificant) to one (i.e., totally dominant as you view the site). The score is constrained to be in steps of 0.1. That is, the only acceptable values are: 0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0. The reason for this restriction is that over time we realized that the subjective difference between a score of 0.14 and 0.15, for example, was meaningless in this type of evaluation. The element descriptions follow:

1. **Buildings**: These can be of any size and shape.
2. **Land/Water Interface**: We are not concerned as to the type of the water. It could be a creek or a pond. The point is the degree to which water is "edged" in any way with land.
3. **Roads or Paths**: This element could be a major street in a downtown environment or a narrow dirt path in the hills.
4. **Bridges**: This element can be of any size and shape as long as it spans something such as a road, creek, or canyon.
5. **Congested**: By congested we mean full of a number of visually different things locally associated with the site. The element could be embedded in an otherwise isolated environment.
6. **Isolated**: By isolated we mean the site (congested or not) is generally standalone. For example a complex building with lots of structure variations and landscaping, but all by itself in a large open space, would be consider isolated.
7. **Repeat Motif**: Mostly this element means exactly repeated, usually man-made, repeating patterns. Examples include a fence with a series of posts, a series of light fixtures evenly spaced, or seats in a football stadium. Natural repeating features, including rows of evenly spaced trees in a row or carefully manicured fields with rows of things growing, also qualify.
8. **Prominent**: This element should get high marks if there is something that really catches one's attention at the site and masks almost everything else that is there.
9. **Vegetation**: Although there may be growing vegetation at nearly all locations, sometimes the vege-

tation is characteristic of the site. For example, a park would be mostly vegetation, but so too a big building with fancy landscaping might get high marks. But a large overpass with a few bushes would get relatively low marks.

10. **Man-made**: Many of the sites are man-made but some more than others. Thus, this element is scored with regard to one's subjective assessment as to how critical the manmadeness is with regard to the overall site.
11. **Natural**: It may be tempting to score this element equivalent to vegetation; however, there are a number of examples that are natural that may not contain much vegetation at all. An example is an interesting rock formation in the desert. In the proposed experiment, this element is a way of assessing the degree to which "natural" is characteristic of the site.
12. **Geometry**: By geometry we generally mean shapes that are not regular and linear. Swoops, curves, and round shapes are what we are thinking of here.
13. **Towers**: Towers differ from buildings. They are generally tall and have a specific purpose.

In developing the USE, two of us (May and Hawley) together coded each site. This exercise turned out to be quite instructive, because we approached the problem from the perspective of making sure that the group of 22 targets grouped into orthogonal categories. The categories were: Gardens, Ponds, Buildings, Towers, and Bridges. We required that each category be as different from all the others as possible, so judging packs could be constructed by choosing one site from each of the five categories.

We merged the two independent coders' results with our original results. As we had found out in a group coding of our photographic targets, we agreed on most of the assessments (May et al., 2012). We provide black-and-white photographs of all 22 sites together with their consensus coding in the Appendix.

Figure 3A shows a church target taken from the designated location, and Figure 3B shows the coding for this site by the three independent coders.

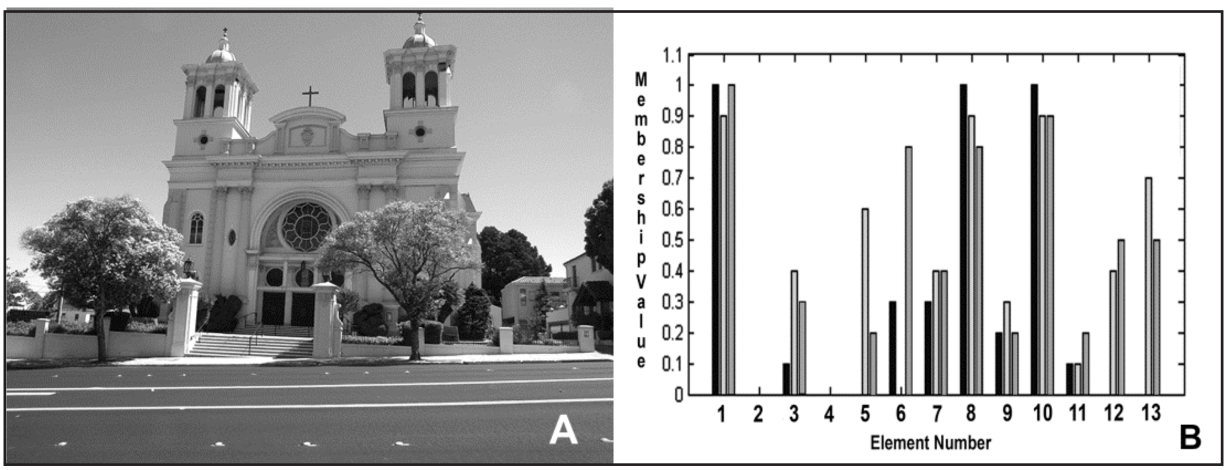

Figure 3. The element numbers correspond to the elements shown above. The black bars correspond to the original coding; the open and grey bars correspond to the independent codings.

Element 1 is Buildings, and there is complete agreement among the coders that buildings characterize this site. However, the independent coders were in agreement with each other but not with the original coder with regard to how roads characterized the site. The original coder did not feel that Geometry (12) and Towers (13) characterized the site. This is an example of a coding bias by the original team, in that they did not see the more general meaning of the elements as they "forced" their coding to make the Towers category of sites more orthogonal to the Buildings category.

Figure 4 shows the result of a cluster analysis based upon a consensus of all three coders.

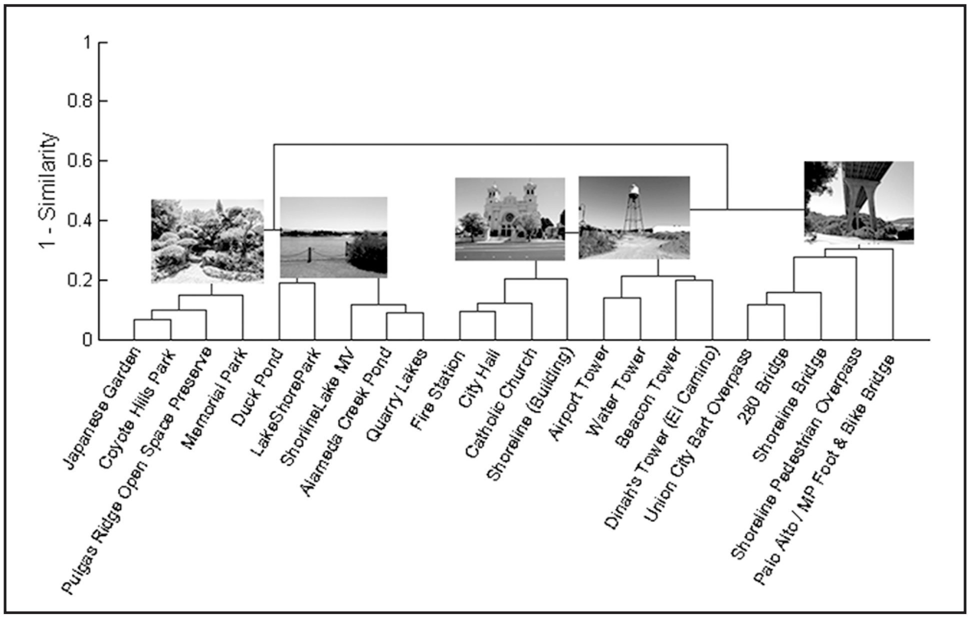

Figure 4. The thumbnails indicate the categories Gardens, Ponds, Buildings, Towers, and Bridges. The more similar sites are to one another, the closer they pack toward zero. So the four Building sites, for example are all quite similar to one another, but the group is significantly different from, say, the Bridges sites.

Three categories (Parks, Building, and Towers) each have four sites and the remaining categories each have five. However, the probability of selecting a category from which the intended site will be chosen is .2 regardless of how many sites are in that category.

Site Selection in the Future Experiment

Following the practice we used for selecting target photographs in the past (May et al., 2000), we first randomly generated a category number in the inclusive interval of 1 to 5. Then depending upon which category is selected, we randomly generated a site number either between 1 and 4 inclusively or between 1 and 5 inclusively. Note that three categories, Gardens, Buildings, and Towers, each have only four sites. Decoy sites for judging were chosen from the remaining four categories in a similar way.

Discussion

The method described here to identify a number of natural sites for an anomalous cognition experiment is quite general, although it is also region dependent. That is, desert communities will be characterized by a different kind of site than, say, the Pacific Northwest.

There is, of course, a problem using natural sites—seasonal changes. In winter they look totally different than in summer, and in California ponds that had water in them in the spring are dry in the fall. The best way to attend to this problem is to create season-dependent target sites.

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Abstracts in Other Language

Spanish

OBJETIVOS DE COGNICIÓN NATURAL ANÓMALA:
UNA APLICACIÓN DE CONJUNTO DIFUSO (FUZZY SET)

RESUMEN: Se han aplicado previamente conjuntos difusos a estímulos fotográficos. En este trabajo, usamos la misma tecnología para construir un juego de sitios naturales en el área de la bahía de San Francisco. Creamos un Conjunto Universal de Elementos con 13 reactivos con cinco categorías ortogonales: Construcciones, Estanques, Torres, Jardines y Puentes. Dos voluntarios identificaron y codificaron 22 sitios de forma independiente. Por lo tanto, los grupos difusos que representan a estos sitios son un consenso razonable de su contenido. Este artículo describe el proceso de construcción en detalle y el apéndice muestra cada sitio y su conjunto difuso asociado.

French

CIBLES NATURELLES POUR LA COGNITION ANOMALE :
UNE APPLICATION DES SOUS-ENSEMBLES FLOUS

RESUME : Les sous-ensembles flous ont préalablement été appliqués à des stimuli cibles photographiques. Dans cet article, nous utilisons la même technologie pour construire un ensemble de sites naturels de la baie de San Francisco. Nous avons créé un Lot universel d'éléments contenant 13 items qui s'articulent selon cinq catégories orthogonales : immeubles, étangs, tours, jardins et ponts. 22 sites furent identifiés et indépendamment codés par deux participants. Ainsi, les sous-ensembles flous qui représentent ces sites sont le fruit d'un consensus raisonnable à propos de leur contenu. Cet article décrit en détails le processus de construction, et l'annexe montre chaque site et son sous-ensemble flou associé.

German

NATÜRLICHE ZIELOBJEKTE ZUR ANOMALEN KOGNITION: EINE FUZZY-MENGEANWENDUNG

ZUSAMMENFASSUNG: Fuzzy-Mengen wurden bereits auf photographisches Zielmaterial angewendet. In diesem Artikel verwenden wir die gleiche Technologie, um einen Satz natürlicher Örtlichkeiten in der Gegend um die San Francisco Bay zu konstruieren. Wir entwickelten einen Universellen Satz an Elementen, der 13 Items enthielt, die fünf orthogonale Kategorien bildeten: Gebäude, Gewässer, Türme, Gärten und Brücken. 22 Örtlichkeiten wurden ausgewählt und unabhängig von zwei Freiwilligen eingestuft. Die Fuzzy-Mengen, die diese Örtlichkeiten repräsentieren, stellen inhaltlich einen annehmbaren Konsens dar. Dieser Artikel beschreibt detailliert den Konstruktionsprozess, und der Anhang zeigt jede Örtlichkeit mit der dazugehörigen Fuzzy-Menge.

Appendix

The 22 Bay Area natural sites and associated consensus coding. Sites 6, 13, and 18 are missing.

JAPANESE GARDEN – 1

ID	Name	Value
3	Roads / Paths	.3
6	Isolated	.5
9	Vegetation	.9
10	Man Made	.1
11	Natural	1

FIRE STATION – 2

ID	Name	Value
1	Buildings	1
3	Roads / Paths	.3
5	Congested	.2
6	Isolated	.2
7	Repeat Motif	.5
8	Prominent	.8
9	Vegetation	.2
10	Man Made	1
11	Natural	.1

CITY HALL – 3

ID	Name	Value
1	Buildings	1
3	Roads / Paths	.1
6	Isolated	.4
7	Repeat Motif	.5
8	Prominent	.8
9	Vegetation	.2
10	Man Made	.9
11	Natural	.2

CHURCH – 4

ID	Name	Value
1	Buildings	1
3	Roads / Paths	.2
5	Congested	.1
6	Isolated	.4
7	Repeat Motif	.4
8	Prominent	.9
9	Vegetation	.2
10	Man Made	.9
11	Natural	.1
12	Geometry	.3
13	Towers	.2

BART OVERPASS – 5

ID	Name	Value
3	Roads / Paths	.4
4	Bridges	1
6	Isolated	.6
7	Repeat Motif	.6
8	Prominent	.8
9	Vegetation	.5
10	Man Made	.8
11	Natural	.3
12	Geometry	.3
13	Towers	.3

MEMORIAL PARK – 7

ID	Name	Value
3	Roads / Paths	.4
6	Isolated	.6
9	Vegetation	.5
11	Natural	.3

AIRPORT TOWER – 8

ID	Name	Value
1	Buildings	.5
3	Roads / Paths	.2
6	Isolated	.8
7	Repeat Motif	.5
8	Prominent	.9
9	Vegetation	.2
10	Man Made	.9
11	Natural	.2
12	Geometry	.2
13	Towers	1

WATER TOWER – 9

ID	Name	Value
1	Buildings	.3
3	Roads / Paths	.3
5	Congested	.1
6	Isolated	.5
7	Repeat Motif	.4
8	Prominent	.9
9	Vegetation	.1
10	Man Made	1
11	Natural	.1
12	Geometry	.4
13	Towers	1

SHORELINE BUILDING - 10

ID	Name	Value
1	Buildings	.9
2	Land/Water Int.	.2
3	Roads / Paths	.3
6	Isolated	.8
7	Repeat Motif	.6
8	Prominent	.6
9	Vegetation	.3
10	Man Made	.8
11	Natural	.3

PEDESTRIAN OVERPASS – 11

ID	Name	Value
3	Roads / Paths	.3
4	Bridges	.9
5	Congested	.4
6	Isolated	.2
7	Repeat Motif	.7
8	Prominent	.8
9	Vegetation	.1
10	Man Made	.8
11	Natural	.1

BEACON TOWER - 12

ID	Name	Value
3	Roads / Paths	.2
7	Repeat Motif	.7
8	Prominent	.6
9	Vegetation	.6
10	Man Made	.9
11	Natural	.3
12	Geometry	.3
13	Towers	1

I-280 BRIDGE - 14

ID	Name	Value
3	Roads / Paths	.5
4	Bridges	.1
6	Isolated	.6
7	Repeat Motif	.6
8	Prominent	.9
9	Vegetation	.5
10	Man Made	.8
11	Natural	.3
12	Geometry	.1
13	Towers	.1

PA/MP Foot Bridge - 15

ID	Name	Value
4	Bridges	.9
5	Congested	.1
6	Isolated	.5
7	Repeat Motif	.5
9	Vegetation	.7
10	Man Made	.7
11	Natural	.5

Duck Pond - 16

ID	Name	Value
2	Land/Water Int.	.9
3	Roads / Paths	.2
6	Isolated	.4
7	Repeat Motif	.2
9	Vegetation	.5
10	Man Made	.4
11	Natural	.8

Shoreline Lake - 17

ID	Name	Value
2	Land/Water Int.	.9
3	Roads / Paths	.2
6	Isolated	.7
9	Vegetation	.7
10	Man Made	.2
11	Natural	.8

Dinah's Tower – 19

ID	Name	Value
3	Roads / Paths	.5
5	Congested	.5
6	Isolated	.2
7	Repeat Motif	.7
8	Prominent	.8
9	Vegetation	.5
10	Man Made	.8
11	Natural	.2
12	Geometry	.4
13	Towers	1

SHORELINE BRIDGE - 20

ID	Name	Value
2	Land/Water Int.	.2
3	Roads/Paths	.6
4	Bridges	1
6	Isolated	.8
7	Repeat Motif	.7
9	Vegetation	.6
10	Man Made	.6
11	Natural	.4
12	Geometry	.2

ALAMEDA CREEK POND - 21

ID	Name	Value
2	Land/Water Int.	.9
6	Isolated	.9
9	Vegetation	.8
11	Natural	1

COYOTE HILLS PARK - 22

ID	Name	Value
3	Roads / Paths	.3
6	Isolated	.8
9	Vegetation	.9
10	Manmade	.1
11	Natural	.9

QUARRY LAKES - 23

ID	Name	Value
2	Land/Water Int.	.9
6	Isolated	.8
9	Vegetation	.5
11	Natural	.8

LAKESHORE PARK - 24

ID	Name	Value
1	Buildings	.5
2	Land/Water Int.	.9
6	Isolated	.2
9	Vegetation	.4
10	Manmade	.5
11	Natural	1

PULGAS RIDGE OPEN SPACE PRESERVE – 25

ID	Name	Value
3	Roads / Paths	.5
6	Isolated	.8
9	Vegetation	.8
11	Natural	1