University of California

Santa Barbara

Environmental Decision Making

in

Goleta Old Town Brownfields

A Group Project submitted in partial satisfaction of the requirements for the degree of Master's in Environmental Science and Management for the Donald Bren School of Environmental Science and Management

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Signature Page

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The Group Project is required of all students in the Master's of Environmental Science and Management (MESM) Program. It is a three-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Final Group Project Report is authored by MESM students and has been reviewed and approved by:

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Abstract

Brownfields are defined by the US Environmental Protection Agency as "abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination." Santa Barbara County was awarded a U.S. EPA Brownfields Assessment Demonstration Pilot grant in 1997 for revitalization of Goleta Old Town.

Environmental Decision-Making in Goleta Old Town Brownfields demonstrates the efficacy of a geographic information system (GIS) in driving the formulation and selection of goals for Brownfields redevelopment. The components of the project include an integrated GIS as a central mechanism to access, store, retrieve, and analyze data; a site characterization of the historical and physical context for the site; a site suitability methodology for ranking and proposing prioritizing land use options for redevelopment; and application of this methodology to selected sites. This methodology is made available for use by other Brownfield projects via a web-based workbook located at www.bren.ucsb.edu/oldtown.

Executive Summary

The U.S. Environmental Protection Agency defines a Brownfield as "abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination." The recycling of land and buildings in urban areas is critical to redirecting growth from the urban fringe to its core and curbing urban sprawl. In California, it is estimated that brownfields cover 300,000 to 600,000 acres, much of which is recyclable land close to urban centers (Morrison, 1996). EPA's Brownfields Economic Redevelopment Initiative provides funding up to $200,000 through 2-year Brownfields Assessment Demonstration Pilots. The Santa Barbara County Demonstration Pilot grant for the Goleta Old Town area is a component of the Goleta Revitalization Plan. The plan's mission is to make Old Town a sustainable and dynamic community center with a vital and diversified economy and an enhanced quality of life (Santa Barbara County, 1998).

Based on historic and current land uses, Santa Barbara County has 50 potential brownfields sites with known and suspected environmental contamination. Pilot Objectives include restoring the Goleta Old Town area as an economically vital social and cultural focus of the Goleta Valley community, creating effective development partnerships, implementing sustainable land uses, and encouraging diverse commerce and business.

Development of a geographically-based, dynamic information system, a GIS, that provides site-specific data for site assessment can be useful in purchasing or leasing industrial sites. GIS supports decision-making by providing an information baseline, serving as an archive for pertinent physical and planning data; allowing an easy view and manipulation of information; allowing an exploration of hypothetical situations; and serving as a planning tool to support decision-making.

The mission of the project is to demonstrate the efficacy of GIS in addressing Brownfields, to provide a comprehensive view of otherwise fragmented information, and to provide a tool for analysis. The GIS provides an information baseline for other analyses. The components to the project are the construction of a GIS, site characterization and assessment, human health risk assessment, and site suitability methodology and application.

The development of a fully integrated GIS for the project area serves to organize disparate data sources and provide a single mechanism to access, store, and retrieve data. Site characterization provides a historical and physical context to the selected sites, creating a comprehensive background on which to base further components of our study. An extensible, consistent and systematic site suitability approach is developed for supporting decision making in the context of brownfields redevelopment and demonstrated on selected Key Sites in the Goleta Old Town area.

Two analyses were run: the first used the existing setting, and the second incorporated the planned transportation infrastructure improvements, consisting of extending two roads running east-west, designed to increase access through the southern portion of the area. Resultant site suitability scores are on a scale ranging from high suitability to medium unsuitability, showing the overall suitability relative to the other potential land uses. Much of the area prohibits residential land uses due to the flight clear zone. The remaining parcels are predominantly unsuitable for residential land uses. Commercial land use shows a variation in suitability from low unsuitability to medium/high suitability. Industrial land use shows the highest suitability scores for the area. All parcels fall into the suitable range. Open space shows predominantly suitable scores with only one parcel in the unsuitable range.

Planned transportation infrastructure improvements for the Old Town area include extending Fowler Road and Ekwill Street to connect Fairview Avenue with State Route 217. For the analysis including infrastructure improvements residential land use shows a marginal increase in suitability scores, influenced by Ekwill Street to the north of the study area. Commercial land use shows an overall increase in suitability scores by one suitability class, industrial land use shows some increase in suitability scores in the northern parcels, and open space suitability shows little change in scores.

Background

What is a Brownfield?

The U.S. Environmental Protection Agency defines a Brownfield as "abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination."

The Importance of Brownfields

Brownfields are of national importance and relevant to the economic growth and development of cities, suburbs and rural areas. Brownfield sites can be both a resource and a liability. As a resource, they are usually well situated and served by existing infrastructure; as a liability, they may have environmental problems that constrain redevelopment. The recycling of land and buildings in urban areas is critical to redirecting growth from the urban fringe and curbing urban sprawl. However, lenders, investors, and developers fear that involvement with brownfields sites incur liability for cleaning up contamination they did not create and additional costs in order to comply with environmental regulations. Nonetheless recent changes in environmental regulation and public perceptions have led to renewed interest in brownfields redevelopment. (Grayson, 1995)

By current estimates there are 50,000 to 300,000 brownfields sites in the U.S., constituting an estimated 5 to 10 percent of America's urban land area. In California, the figure is estimated at 300,000 to 600,000 acres, much of which is recyclable land close to urban centers and serviced by roads, utilities, and public services (Morrison, 1996).

Addressing Brownfields

The study of brownfields is interdisciplinary, bringing together physical and natural science, public policy, economics, and law, incorporating innovative technologies and approaches.

Encouraging brownfields redevelopment requires overcoming obstacles unique to sites with actual or perceived contamination. These include liability risk, regulatory uncertainty, difficulty in finding financing, declining property values, local unemployment, and lack of informed community involvement in planning. Over the past few years, several states have tried different approaches to solve these issues, learned valuable lessons, and developed new tools and strategies that are now stimulating redevelopment, housing, and new jobs (US EPA Brownfields website, 1999)

EPA Brownfields Assessment Demonstration Pilot

EPA's Brownfields Economic Redevelopment Initiative is designed to encourage States, communities, and other stakeholders in economic redevelopment to work together to prevent, assess, safely clean up, and sustainably reuse brownfields. In this document Brownfields refers to EPA designated brownfields. Since the program was founded in 1995,

EPA has provided funding to 300 states, cities, towns, counties, and tribes for Brownfields Assessment Demonstration Pilots. The Pilots, each funded for up to $200,000 over two years, test redevelopment models, direct special efforts toward removing regulatory barriers without sacrificing protectiveness, and facilitate coordinated site assessment, environmental cleanup and redevelopment efforts at the federal, state, and local levels. Pilot funds are used to generate interest by bringing together community groups, investors, lenders, developers, and other affected parties to address the issues of cleaning up sites contaminated with hazardous substances and returning them to appropriate, productive use. The Pilots serve as vehicles to explore a series of models for states and localities struggling with such efforts. (US EPA Brownfields homepage, 1999)

EPA's Brownfields Initiative strategies include funding pilot programs and other research efforts, clarifying liability issues, entering into partnerships, conducting outreach activities, developing job training programs, and addressing environmental justice concerns. The four main components of the EPA's Brownfields program are summarized below.

Brownfields Assessment Demonstration Pilots

To date, EPA has awarded more than 300 Brownfields Assessment Demonstration Pilots that are funded through cooperative agreements of up to $200,000 each for a two-year period. The pilots are exploring innovative approaches to solving brownfields problems and providing a growing knowledge base to help direct the Brownfields Initiative. These pilots have been testing redevelopment models, directing efforts at removing regulatory barriers, and bringing together community groups, investors, lenders, developers, and other affected parties to address brownfields issues.

Clarification of Liability Issues

EPA is working with States and localities to clarify the liability of prospective purchasers, lenders, property owners, and others regarding their association with and activities at a site. EPA anticipates that these clear statements will alleviate concerns these parties may have and facilitate their involvement in cleanup and redevelopment.

Partnerships and Outreach

EPA is committed to building partnerships with States, cities, and community representatives to promote public participation and community involvement in Brownfields decision making. EPA will continue to work with other Federal agencies, on a national and local level, to ensure a coordinated Federal approach to the cleanup and redevelopment of brownfields.

Job Development and Training

Brownfields staff, local contacts, and community colleges have established local partnerships to foster workforce development through environmental education. This program

encourages recruiting students from disadvantaged communities, and trains local residents for jobs developed by Brownfields efforts.

Santa Barbara County Demonstration Pilot

Goleta is an unincorporated city in Santa Barbara County, California, located approximately eight miles west of the City of Santa Barbara (Map 1). In 1997 Santa Barbara County was awarded an EPA Brownfields Assessment Demonstration Pilot grant for the Goleta Old Town area. Old Town has served as an economic, social, and cultural focal point of the Goleta Valley since the early 1900s. During the 1950s and 1960s, military, industrial, and commercial businesses expanded in Old Town. Since that time, however, Goleta Old Town has experienced significant economic decline. To a large degree, economic redevelopment has been impeded by known and suspected environmental contamination. (US EPA SWEROSPS homepage, 1999)

The Goleta Old Town Brownfields Pilot is a component of the Goleta Revitalization Plan, which was adopted by the Board of Supervisors in 1998. The plan's mission is to make Old Town a sustainable and dynamic community center with a vital and diversified economy and an enhanced quality of life (Santa Barbara County, 1998).

Map 1: Location Map

Goleta Old Town Area

The Pilot area has a history of known contaminant releases. It includes both active remediation and closed remediated sites, as well as a number of properties that can be considered high risk for contamination based on historic or current land uses. The status of these sites range from being in litigation to establish responsibility, to assessment, monitoring and active remediation. Most sites still have free petroleum products in the groundwater, with delineation of plumes complete in some cases. Under current procedures contaminated sites could be closed in 4 to 10 years. Development could occur simultaneously with remediation and/or monitoring in certain cases. (Santa Barbara County, 1998)

The Pilot area is approximately 650 acres, with 200 property owners. The population is approximately 5,000, of which 44 percent are minority and 12 percent live below the poverty level. The area contains 1,847 residential units, and approximately 4.2 million square feet of commercial/industrial space much of which is vacant. The Old Town area also currently lacks a strong physical identity ("sense of place").

To a large degree, economic decline in the area is associated with a number of known and/or suspected contamination sites. The costs and risks associated with brownfields have historically impeded redevelopment in the area. Based on historic and current land uses, the county has identified approximately 50 potentially contaminated sites involving approximately 600 acres with known and suspected environmental contamination. A full evaluation of the contamination is needed before redevelopment of the area can fully proceed.

Pilot objectives include restoring the Old Town area as an economically vital social and cultural focus of the Goleta Valley community, creating effective development partnerships, implementing sustainable land uses, and encouraging diverse commerce and business (Santa Barbara County, 1997a).

Activities planned as part of this pilot include:

- Develop plans for site assessment, characterization, and future cleanup strategies through a private/public team approach
- Conduct target site assessments, including data compilation, technical interpretations, sampling, drilling, geophysical surveying, hydrogeological testing, and health and safety reviews
- Determine funding sources and mechanisms for future cleanups and revitalization
- Coordinate the revitalization interests of residents, property owners, businesses, lenders, educational institutions, governments, and other stakeholders

- Document remediation strategies, revitalization strategies, and Pilot progress, including measures of success

The Use of GIS in Addressing Brownfields

A geographical information system (GIS) is a computer system designed to allow users to collect, manage, and analyze large volumes of spatially referenced information. A GIS is used for solving complex research, planning and management problems. The major components of a GIS are: a user interface, system/database management capability, database creation/data-entry capacity, a spatial data manipulation and analysis package, and display generation function (Burroughs, 1998).

Development of a geographically-based, dynamic information system that provides site-specific data for site assessment can be useful to planning organizations, government agencies, community development organizations, and parties interested in purchasing or leasing sites. Use of a GIS should provide a significant time and cost savings to potential property purchasers with a simplification of the inquiry process involved in such an undertaking. By decreasing the cost of initial research and improving the line of communication between buyers and sellers, municipalities employing the system may have an advantage over other areas in redeveloping idle or under-used properties.

As a tool for decision-making in Old Town Goleta, GIS is useful in the following areas:

Information Baseline – GIS serves as an information baseline; an archive for pertinent physical and planning data from which further information can be derived or added. In addition, GIS allows a "snapshot" of the current state of the project area, including such thematic layers as vacant properties, existing infrastructure and development, and current land use and zoning. From this baseline users can track the revitalization efforts as they are implemented, and maintain an archive of "time slices" showing different stages of the project as the revitalization plan is carried out. This type of information framework allows an historical overview of the project to be produced, enabling an evaluation of the revitalization plan and its effectiveness within a single workspace. In this way GIS can serve as a framework for tracking and collecting long-term data over the revitalization project lifetime and as a tool assisting the evaluation of long-range planning efforts.

Ease of Representation – GIS allows manipulation and viewing of spatial information through the generation of maps and views from an underlying database. Viewing data spatially often permits new patterns and relations to be recognized in the data; these patterns and relations might otherwise remain unnoticed in traditional text-only formats such as spreadsheets or databases. With a GIS map views are readily produced making information exploration, representation and retrieval a straightforward task.

Perform "What if" Scenarios –GIS allows users to explore hypothetical situations in order to assess and evaluate the effects and potential outcomes of plans before the plans are implemented. Information centralization in the GIS provides a workspace for studies such as traffic and circulation impacts, economic forecasting, and the analysis of environmental

impacts of infrastructure improvements. Users can enact the proposed change within the GIS and model the impacts of the change on other variables within the project site. Much of the pertinent information that a decision-maker or planner needs to perform the "what if" analysis can be made available within a GIS. Although the GIS that we produced is not currently configured to provide direct implementation of some of the extensions mentioned here, the database could be enhanced to support such analysis.

GIS as a Planning Tool – GIS can be used as an effective planning tool to support decision-making. In a Brownfield redevelopment context a GIS can function as a tool to organize the variables of interest such as vacant properties, assessed value, improvement value, traffic circulation patterns, existing infrastructure, and various biophysical parameters. Once in place, this information can help target sites for redevelopment, target and prioritize sites for remediation, and perform analyses such as site suitability.

Objectives

Research Objective: How can a geographic information system (GIS) be used to drive the formulation and selection of goals for brownfields development?

Project Mission: To demonstrate the efficacy of GIS in addressing brownfields, to provide a comprehensive view of otherwise fragmented information, and to develop a tool for analysis.

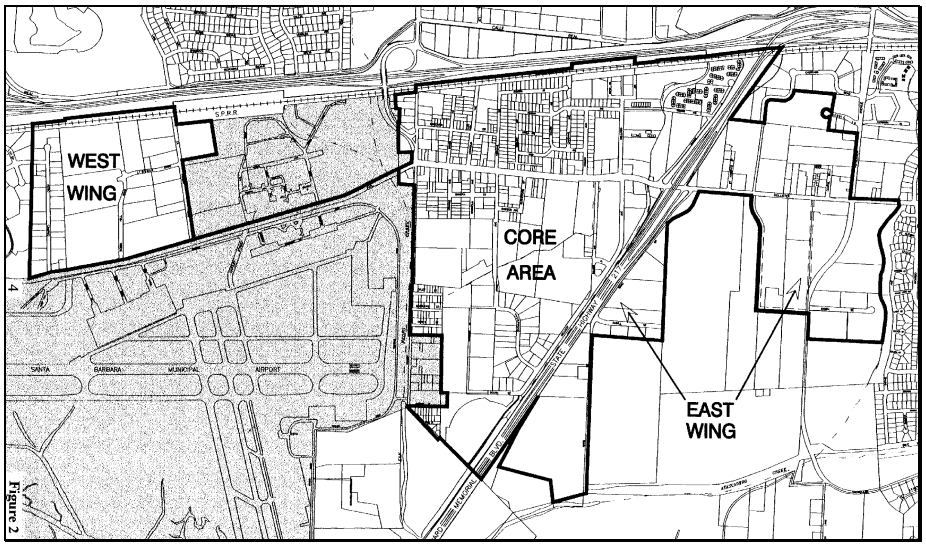
The components of the project are:

- Construction of a Geographic Information System
- Site characterization and assessment
- Human health risk assessment
- Site suitability methodology and application

Project Area

The Brownfield Pilot area consists of the Core area and East and West wings. The Core area is bounded by US 101 to the north, Fairview Avenue to the west, and Ward Memorial Boulevard (SR 217) to the east. The East Wing is contiguous with the core area and extends as far as Patterson Avenue. The West Wing is located north of Hollister and is not contiguous with the core area. Our project area is the core area. The Pilot area contains 16 Key Sites of parcels or groups of parcels to focus planning efforts. We selected four Key Sites in the southwestern portion of the project area in order to demonstrate our site suitability analysis methodology. (Map 2)

Map 2: Brownfield Pilot Area



Development of a Working "Brownfield" GIS

A principal goal of the project was to develop an integrated geographic information system for the project site. We organized disparate data sources and provide a single mechanism to access, store, and retrieve the data. The GIS that we developed is a functional tool, which will be given to Santa Barbara County for their utilization. From this central data repository information on land-use, zoning, demography, property ownership, regulation, physical features, and environmental contamination are collected and available to users.

Site Characterization and Assessment

Characterization and assessment of the EPA designated Brownfields in Old Town Goleta is focused on selected Key Sites. Site characterization provides a historical and physical context to our selected sites, creating a comprehensive background on which to base further components of our study. The selected Key Sites were characterized by investigating historical land-uses and by gathering information about the environmental characteristics of the site. We did not characterize the nature and extent of contamination, as the concentrations of contaminants sampled were below actionable levels. Although a quantitative analysis was not performed, we did examine the contaminant sampling results to better understand the contamination issues of our study area.

Human Health Risk Assessment

Understanding the risks associated with brownfields is an important component of decision making in brownfields redevelopment. Quantitative information on contamination and the associated human health risks helps in making informed decisions. However contaminant concentrations at sampled locations are predominantly below detectable levels and below the California Preliminary Remediation Goals and therefore do not warrant a risk assessment.

Site Suitability

We developed and demonstrated an extensible, consistent and systematic approach to decision making in the context of brownfields redevelopment, incorporating economic, environmental, and social factors. Using a decision framework, we identified parcel and site land-use characteristics to describe appropriate potential land uses. This framework is made available for use in other brownfield redevelopment projects via a web-based workbook.

Site suitability requires consideration and weighing of multiple site characteristics, incorporating both economic and environmental viewpoints. Site criteria therefore involve both economic development factors and environmental condition factors. The site criteria we used are a function of criteria identified as pertinent and obtainable data holdings. The methodology consists of seven steps, which identify, value, integrate and rank the criteria. The resulting index of suitability scores for each of the potential land uses for the parcels of interest is then integrated with the additional considerations to deliver a final recommendation.

Methods

Construction of the GIS Database for Goleta Old Town

The GIS was constructed over the course of approximately six months. We utilized our contacts with various members of the academic and local GIS community to identify and obtain the necessary data layers. The work started with a planning phase and then proceeded to the construction phase when the various sources were integrated. The intended users of the system are planners and decision-makers in local government, who can use the information to inform and support the process of community planning.

Planning Process

The GIS is designed to inventory, retrieve, store, and analyze geographic information for the Goleta Old Town Brownfield project area. As such, the GIS should include information providing a comprehensive view of site features. We began the planning process by compiling a list of data layers that would be essential in constructing a base geographic information system having the purpose of supporting decisions in the revitalization of Goleta Old Town. We collected data layers according to the following thematic categories:

- Parcel Base Map
- Planimetric Data (building footprints, transportation infrastructure)
- Aerial Photograph Background Base
- Land Use
- Zoning
- Census Demographics
- Contaminant Data
- Soils/Geology
- Groundwater Data
- Physiographic Features (vegetation cover, topographic and hydrographic features)
- Redevelopment Constraints (regulated sites, design constraints)

Data Providers

To help identify potential data providers we contacted known University and County data holders and attended the Santa Barbara County GIS Information and Database Partnership meeting, held in July 1999 and organized by Mark de la Garza. From this meeting we identified existing GIS coverages within Santa Barbara County and their respective holders. We found two major sources of data that provided most of the coverages for the GIS; the UCSB Geography Department and the Santa Barbara County Planning and Development Department. Some of this data was ready-to-use, but most of it required conversion or modification before it could be used. We obtained further data from: Watershed Environmental, a local consulting firm; Pacific Western Aerial Photography; the UCSB Map and Imagery Library; and the Alexandria Digital Library. Some data that we acquired is for our academic use only and will be excluded from dissemination.

GIS Database Design

Our choice of GIS platform was determined by convenience and compatibility with the County agencies' existing software. ArcView (ESRI, Redlands, CA) software was most accessible to us. Santa Barbara County Planning and Development, a major supplier of data to our project and an intended end user of the data, also uses ArcView. Moreover, we received several initial coverages in ArcView format, so we used this format throughout the project.

Santa Barbara County uses the California State Plane Zone V coordinate system, on the 1983 North American Datum (NAD), in units of feet, as its standard coordinate system for the Assessor's parcel base map. To ensure compatibility with the County's existing information systems we adopted this as our standard coordinate system.

Our project is based upon a parcel level view of the study area. We received an Assessor's parcel base map coverage from the UCSB Geography department. The Santa Barbara County Assessor's office has been in the process of creating a GIS parcel coverage base map since 1996 and the project continues to the present. The Assessor's office is currently not authorized to distribute the data and has not granted distribution rights to other agencies (Laurie Kurilla, pers. comm.), thus we were not able to use a complete version of the base map. The base map that we received covers the Goleta Old Town area, but is missing some fields in the associated attribute table. In addition, a metadata catalog is being compiled but is currently not available. We do not know the scale of the parcel base map nor the accuracy. We understand that the accuracy varies across the parcel base map, and is purported to be accurate to within several feet for many areas (Laurie Kurilla, pers. comm.).

The initial GIS data we received was from the Santa Barbara Country Model Project, directed by Keith Clarke of the UCSB Department of Geography. The data was in our standard projection and format and included the following coverage for Old Town Goleta:

- Assessor's parcel base map

- Zoning
- Land use
- TIGER (Topologically Integrated Geographic Encoding and Referencing) road files
- Census tract and blockgroup information
- Various planimetric data including roads, building footprints, elevation contours, and vegetation cover.

We later received additional planimetric data from the Santa Barbara County Planning and Development Department office on the 1927 North American Datum. These layers contained much of the information found in the Goleta Old Town Revitalization Plan (e.g. 100-year floodplain, flight clear and approach zones, master environmental assessment layers, planned infrastructure improvements, etc.). This data was delivered in AutoCAD (Autodesk, San Rafael, CA) format in a single layer with very little attribute data associated with it (the attribute data was mostly CAD text). A list of the base layers in the GIS can be found in Appendix A.

A high-resolution 1:12,000 scale color aerial photograph taken in January 1995 was obtained from the UCSB Map and Imagery Library, through permission from Pacific Western Aerial Surveys. The image was scanned in full color at 600 dots per inch, and later registered with the road layer using 12 road intersections as control points.

Conversion and Processing of the GIS Coverages

Data were converted from a variety of formats into the ArcView format standard that we adopted. Conversion consisted mostly of addressing incompatibilities between data, correcting linework, and subsetting and extracting information.

Modifications to the GIS Data

The Santa Barbara County Planning and Development dataset and the UCSB Geography Department datasets were referenced to two different datums. Normally this is easily fixed by converting the dataset to the desired datum. However after conversion of the Planning & Development dataset to the 1983 North American Datum, we still observed misalignment between the two parcel base maps. The parcel layer from the Geography Department was derived from the Santa Barbara County Assessor's parcel base map and was more accurate. The Planning & Development parcel map was digitized from a paper map of an older version of the Assessor's parcel base and was less accurate. All planimetric data that we received from the Planning and Development office was tied to this less accurate parcel base map.

When we overlaid the two parcel base maps on top of each other the positional difference was as much as 30 feet between the parcel maps, as measured in ArcView. The differences between the base maps are not consistent throughout the coverages. Uncorrected, the difference between base maps could affect the integrity of the data. For example, floodplain boundaries or noise contours, which are tied to the less accurate Planning and Development base map, might be mislocated and give false information. The floodplain polygon might intersect parcels that are not actually within the floodplain; noise contours could overlap into neighboring parcels. While our study does not require a high degree of positional precision from the data, we did strive to make the data as accurate as possible within the resources of our project.

To bring the datasets together, we created links between the coverages and mathematically transformed the Planning and Development coverage to the Assessor's parcel base using the Arc/INFO (ESRI, Redlands, CA) "ADJUST" command. We then extracted the layers of interest into polygons that could be used in ArcView.

Other modifications to the original data sources included:

- Adjusting the land use and zoning polygons so their boundaries matched the assessor's parcel base
- Merging multiple, separate coverages into continuous coverages (namely the 100-year floodplain)
- Resizing the digital elevation model, census and EPA data sets to the study area size
- Converting polyline (linear) features to polygon features

Many of the problems would have been difficult to correct completely, either in terms of time or the amount of information needed; therefore we corrected only those features that were directly within the Key Sites of our analysis.

The EPA regulated sites information came originally from a regional scale coverage and did not exactly coincide with our parcel base layer. We therefore attached the point locations to their corresponding address in the parcel attribute table when possible. The EPA Envirofacts Data Warehouse and Applications website (1999) was used as a reference to update this information. Not all parcels in the parcel base map contained street addresses. When this was the case we were not able to relate the EPA point data to a parcel polygon in the GIS directly. To attempt to verify the location of these "unknown" entries, we made a field investigation to the Old Town Brownfield site in order to locate the EPA site addresses on a hardcopy parcel map. Once these sites were located on the printed parcel map we entered the information into the correct parcel record in the GIS database.

Thematic Extension of the GIS

Extensions to our base GIS included updating the attribute tables of coverages, creating new layers, deriving further information from the base layers, and gathering our own information.

We also encoded spatial relationships into the parcel layer, to accommodate our site suitability calculation. Proximity intervals were defined for the riparian corridor and environmentally sensitive habitat, for access to public transportation, and for distance to the central business district according to the needs of our site suitability analysis. Intersection with the 100-year floodplain and adjacency to, or containment of, a leaking underground fuel tank (LUFT) were relationships that were explicitly coded in the GIS. Intersection with noise, and flight clear and approach zones were also entered. The flight clear zone is defined as the area under the approach slope of the primary runway end to the point where the approach slope is 50 feet above ground level; the flight approach zone is an extension of the flight clear zone (Santa Barbara County, 1998).

Intersection, adjacency, and containment were coded as binary values 0 or 1 in the GIS for ease of use in weighted sum calculations. Proximity was assigned numeric intervals with higher values for shorter distances (greater proximity), using a scale of 0 to 3.

Normalized "compatibility" scores were calculated by querying information about neighboring land uses and then assigning a score reflecting compatibility with those uses.

"Hot links" were added to some of the parcels; with ArcView it is possible to link external media such as photos, text or video to elements within the GIS. We took advantage of this capability by linking site photographs to selected parcels within our selected Key Sites. The user of the GIS can click on one of these parcels using the hot link tool, and the site photograph opens in a new window. In a Brownfields redevelopment context this could be used as part of a property marketing information tool.

A catalog of the layers included in the GIS and supporting documentation can be found in Appendix B.

Data Layers Not Included:

A number of potentially useful data layers were not included in the GIS due to difficulty in locating the data or the available information being impertinent to our project question or scale:

Soils: We were not able to find a soil coverage, either hardcopy or digital, that was compatible with the scale of the parcel base map. SSURGO (Soil Survey Geographic Data Base) soil maps from the United States Department of Agriculture Natural Resources Conservation Service became available midway through our project. The soil map and data used in the SSURGO product are prepared by soil scientists as part of the National Cooperative Soil Survey, and in general are the most detailed level of soil geographic data developed on a nationwide basis (SSURGO website, 2000). This data was available at a

1:24,000 scale and was deemed too coarse for our project purposes. Boring logs were available from contaminant sampling and could have been used as a basis for building a spatial distribution of soil type, but including this was outside the scope of our project.

Subsurface Geology: The only geologic data that was available was a Dibblee map of the area at 1:24,000 scale. Dibblee maps are geologic maps published for coastal southern California on U. S. Geological Survey 7.5-minute topographic bases. They include such geologic features as formation contacts, bedding attitudes, faults, anticlines, synclines, and drill hole locations (California Department of Conservation website). We obtained a Dibblee map for our site, which separated the project site into only two geologic classes. This information was too coarse for our project scale.

Groundwater Data: We obtained a text file of quarterly groundwater level measurements of the Goleta Old Town area from the Goleta Water District. This data was a collection of measurements going back eight decades. However, this data was very difficult to use because it was poorly documented, not in a consistent format, and often incomplete within a given year. We were not able to put it into a usable format.

Traffic Information: Information about the road network, traffic circulation, and level of service would allow a more comprehensive and detailed site characterization but this information was not available to this project in a readily useable format.

Historical Ownership: We obtained two historical property ownership maps from the Map and Imagery Library dating from 1933 and 1954. The 1933 map shows that Ohio Oil Company leased the southern portion of the Old Town project site. The map from 1954 shows that the same land was later subdivided and under different ownership. These maps were not incorporated in the GIS because there was not enough landmark information to register them accurately to the parcel base.

We also searched for Sanborn fire insurance maps for the project area. Fire insurance maps are large-scale maps (usual scale: 1 inch = 50 or 100 feet) designed to assist fire insurance agents in assessing risk from fire hazard and determining premiums. They typically show the size, shape, and construction details of buildings, as well as widths and names of streets, property boundaries, building uses, and house and block numbers. The Sanborn map collection consists of a uniform series of large-scale maps, dating from 1867 to the present and depicting the commercial, industrial, and residential sections of some twelve thousand cities and towns in the United States, Canada, and Mexico. Fire insurance maps are unique documents, offering richly detailed historical information about urban areas, and thus are quite useful for developing an historical site description (UC-Berkeley Sanborn Fire Insurance Map website). We searched through the Sanborn collection at the UCSB Map and Imagery Library but did not locate any fire insurance maps for our project area.

Floodway: A floodway is the area of a river or channel and adjacent floodplain that must remain unobstructed to discharge a 100-year flood event without increasing flood elevations more than one foot (Santa Barbara County, 1997). We did have partial information about the floodway designations for the creeks in our project area from detailed maps of the Key

Sites in the Old Town Goleta Revitalization Plan. While these maps provided some information about the location of the floodway, we did not have a definitive source that detailed an accurate, comprehensive view of the floodway outlines.

Sampled Contaminant Concentrations: Sub-surface sampling by Padre Associates, Inc. reported concentration levels much lower than expected. Only a single site showed actionable levels of contamination. Our original plan was to characterize the spatial distribution of contamination as well as could be supported by the data. The distribution of the sampling locations and the low amounts of contaminants reported prevented us from mapping contamination concentrations. A separate sampling of contaminants was performed by Tetra Tech, Inc. Results from this survey would expand the dataset and possibly support an exploratory spatial representation of site contamination. However, results from this sampling were unavailable to us within the time frame of our project. Tables 2 and 3 show contaminant concentration data.

Limitations of Data Layers:

It was beyond the scope of our project to provide up-to-date, consistent and accurate information for all GIS layers across the Old Town Brownfield Pilot area. Instead, we focused on providing base information for our project area and more specific and accurate information for our selected Key Sites. Therefore, the data contained in the GIS may not accurately reflect the current state of features within the project area. While the data is not uniformly accurate over the project area, it has been corrected and cleaned up for the area that contains our selected Key Sites.

The demographic information we have is from the 1990 Census. We had hoped to update the Census information with supplemental information that might be available through government agencies, such as estimates or projections for Census interim years. On-line information searches at the US Census Bureau, California Housing Authority and the Santa Barbara County Association of Governments websites did not turn up any usable information. General and economic county profiles were available for off-census years, but these were aggregated to county level statistics, and thus were not appropriate for our study.

Data Accuracy & Consistency

Due to the lack of any substantial supporting metadata it is not possible to make a systematic overview of the accuracy of our data. However, we can discuss inconsistencies in our data or areas where our dataset may be in error or uncertain. As mentioned previously, we extended our data sources to incorporate further information, when this information was available. Following is a discussion of known areas of inconsistency in the quality of our GIS data.

Building footprint adjustment. Building footprints often did not line up accurately with property lines because of misalignment of parcel base sources. A single building footprint often straddled two or more parcels. Footprint linework was adjusted only for parcels within the Key Sites of our study area, where detail in the Old Town Revitalization plan supported such

corrections. The high-resolution color aerial photograph was also used in adjusting the footprints.

Building type. The building footprint layer also contained the associated usage of the building (e.g. commercial, industrial, residential). This information was drawn from detailed Key Site maps in the Old Town Revitalization Plan and was not available for parcels outside of these Key Site areas. In some cases, the Old Town Revitalization Plan contained inconsistent information on building type. Key Site maps showed building type graphically and an appendix of parcel information cataloged building type in a tabular format. Where the information contradicted, we used the map as the authoritative source, as the map accorded with information available from the aerial photographs.

Land use for individual parcels. This information was drawn from detailed Key Site maps in the Old Town Revitalization Plan and was not available for non-Key Site parcels. For parcels in our selected Key Sites, this information was added as a field in the parcel attribute table. Land use information for all other parcels was obtained from maps which classified aggregate units of multiple parcels into a single land use category. Note that this classification was not on a parcel-by-parcel basis. This aggregate land use information was maintained as a separate layer in the GIS. Thus, the land use information in the GIS has a higher "granularity" for our selected Key Sites, as this information was obtained on a parcel by parcel basis, not from an aggregate classification.

There were a few cases when a large parcel contained a dual land use (e.g. Commercial and open space). When this occurred land use was assigned according to the dominant activity (in terms of area occupied) on the parcel.

Noise levels. While this information was available as a hardcopy map in the Old Town Revitalization Plan for a large portion of the Old Town area, it was a small-scale map (i.e. 1" on the map covered a large area on the ground) with imprecise linework (certain contours had line widths greater than individual parcel sizes). For our Key Sites, where more detailed maps of noise contours were available, we included delineation of the noise contours. In the GIS these noise contours are not included outside the area of our selected Key Sites.

Zoning. Zoning designations, like general land use classifications, came in the form of large units containing multiple parcel polygons. We attached this zoning information to individual parcel polygons by performing an intersection operation in ArcView. However, because of the misalignment between data sources described earlier, there was some error and some polygons could possibly have ended up with the wrong zoning attribute. This problem was addressed by using the zoning map and detailed Key Site maps to correct parcel attributes within our selected Key Sites (Santa Barbara County, 1998). We could not correct other parcels because of the small-scale nature and lack of parcel boundary information on the zoning map.

Table 1 lists the general data categories that comprise the GIS and the status of the collection; Appendix B contains more complete documentation.

Metadata

Metadata is information about the format and content of a dataset that can be read and utilized by appropriate tools and human users (Sheth and Klas, 1998). Metadata may include information such as publisher/author, provenance, age, format, structure, quality of data, contact information, and keywords for indexing and searching. Metadata provides information about how data was collected, derived, or processed. This information improves integration and sharing of GIS layers between agencies and users, and helps describe data quality so users can be aware of limitations bounding the use of a dataset.

Only two coverages that we received were accompanied with metadata other than file format and projection information. This lack of metadata has restricted our assessment as to the lineage, timeliness, and accuracy of the data sets that we have acquired. The nature of the information included in our GIS, such as property ownership and current land use, exemplifies the need for metadata to allow updating and quality assurance of time-sensitive data.

Table 1: GIS Layers for Goleta Old Town Brownfield

Layer	Available?	Acquired?	Ready For Use?	Date
B/W Digital Orthophoto Quarter Quad	Y	Y	Y	?
High Resolution Color Aerial Photograph	Y	Y	Y	1995
B/W Aerial photograph background base (time series)	Y	Y	Y	1943-1997
100-year floodplain	Y	Y	Y	c. early 1990s
Census data/demographics	Y	Y	Y	1990
Derived Layer - Heritage District			Y	-
Derived Layer - Key Sites			Y	-
Derived Layer - Site Suitability			Y	-
Digital Elevation Model			Y	1999
Elevation contours	Y	Y	Y	c. early 1990s
EPA Listings	Y	Y	Y	CERCLIS, RCRIS 1999; TRI 1995
Groundwater Basin	Y	Y	N	?
Historic Ownership (hardcopy only)	Y	Y	Y	1933, 1954
Hydrographic features (surface)	Y	Y	Y	c. 1998
Land Use	Y	Y	Y	c.1998
Land Use Overlay Designations - Various	Y	Y	Y	c. 1998
Master Environmental Assessment-Various	Y	Y	Y	c. 1998
Parcel base map	Y	Y	Y	c. 1999
Planimetric – (Building, vegetation footprints)	Y	Y	Y	?
Planned Infrastructure Improvements – Public	Y	Y	Y	c. 1998
Soils	N	N	N	-
Subsurface groundwater	Y	Y	N	?
Subsurface soil/geology	Y	Y	N	?
TIGER Road Layers	Y	Y	Y	?
Zoning	Y	Y	Y	c. 1998
Zoning Overlay Designations	Y	Y	Y	c. 1998

Outreach

In order to maintain an understanding of the current issues in brownfields redevelopment, keep up-to-date with other projects, and provide information about the progress of our project to our stakeholders, we provided an outreach component.

Over the course of our project we maintained a project web page, served by the UCSB Bren School, which includes our project synopsis and periodic updates. The project synopsis was also made available via a handout which we distributed at various meetings (Appendix C).

We attended the Santa Barbara County GIS Information and Database Partnership Program meeting, hosted by Mark de la Garza of Watershed Environmental, at the UCSB campus in July 1999. The purpose of the program was to identify current GIS data holdings for Santa Barbara County, with the goal of facilitating integration and sharing of existing information. In attendance were many representatives from local agencies holding GIS data. From the information shared at this meeting we identified datasets that were relevant to our project and established contact with the data holders. The meeting was effective in acquainting local GIS stakeholders with our project and in helping us understand what data was available locally.

We held two meetings to provide project information to, and receive feedback from, external project stakeholders. The first meeting was held in the project planning phase (Spring 1999), and the second during project implementation (Fall 1999). Stakeholders attending included Santa Barbara County Planning and Development Department, UCSB faculty and doctoral candidates, non-profit entities such as the Santa Barbara County Economic Community Project, and Padre Associates, Inc. environmental consultants.

In December 1999 we attended the U.S. EPA National Brownfields Conference in Dallas, Texas. This gave us the opportunity to survey the current approaches and technologies in addressing the issues of this project. We hosted a roundtable discussion session in which we presented our project and received feedback from attendees. A full copy of the report of our attendance at this conference can be found in Appendix D. We received financial assistance from University of California Toxic Substances Research & Teaching Program, Coastal Components in order to attend the EPA conference. As recipients of this funding, we attended the Annual Research Symposium of the UC Toxic Substances Research & Teaching Program and presented a poster.

A web-based workbook is one of the project deliverables and it provides general guidelines, examples, and pointers to information sources for brownfields redevelopment. This workbook provides a generalization of the methodology we developed for Goleta Old Town that can be used in other projects. The workbook is made available through http://www.bren.ucsb.edu/oldtown/.

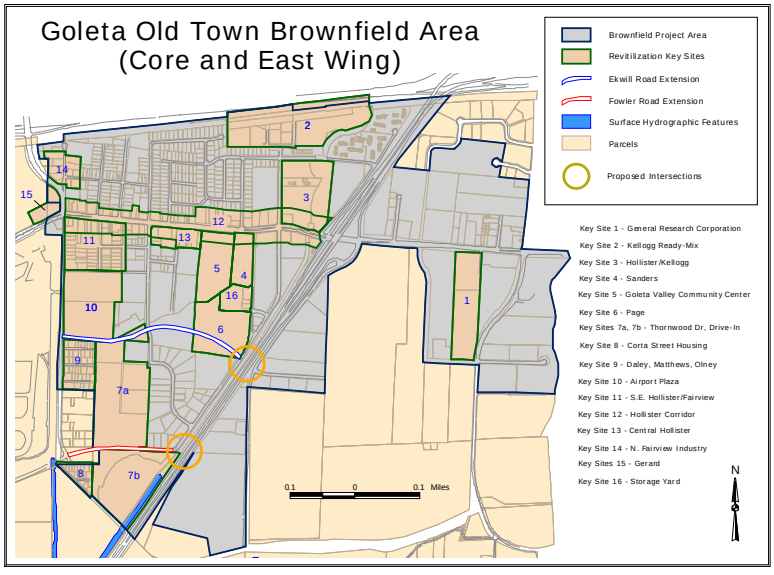
Site Characterization and Assessment

We performed a site characterization and assessment of the project area in order to understand the physical and historical characteristics of the area and to support informed decision making. The pertinent information we gathered was incorporated into the GIS database. Additional information layers were identified as important to the decision-making process, however they were either unavailable to us or their inclusion was outside the scope of this project.

Site location and size

The Goleta Old Town Revitalization Plan area is located in the Goleta Valley, just west of Santa Barbara, California (approximately 90 miles west of Los Angeles). The core area is bounded on the north by Highway 101, on the west by Fairview Avenue, on the south by Goleta Slough and to the east by SR 217 (see Map 3). The Plan also includes areas to the east and west of the core area known as the East and West Wings.. The Brownfields Assessment Demonstration Pilot covers the same area as the Revitalization Plan but is focused predominantly on the core area. Nearby features of interest include the Santa Barbara Municipal Airport, the University of California, Santa Barbara, the Pacific Ocean, the Goleta Slough and Goleta Beach Park. The Pilot area is approximately 650 acres with 200 property owners. The Core Area contains 303 acres and includes mixed land uses, including commercial, professional, light and general industrial, single family homes, apartment buildings, and mobile home parks. (Santa Barbara County, 1997). Our selected Key Sites 7a, 7b, 8 and 9 cover approximately 55 acres and contain 70 parcels.

Map 3: Old Town Goleta



Site topography

Goleta Old Town is located in the broad, flat alluvial plain of the Goleta Valley (Santa Barbara County, 1997). This alluvial plain slopes into the Goleta Slough, south of the Project area. The site is at an elevation of 10 to 30 feet above mean sea level.

Physical features and natural habitat

Physical features of importance near the project area include the Los Padres National Forest, the Pacific Ocean, and Goleta Slough.

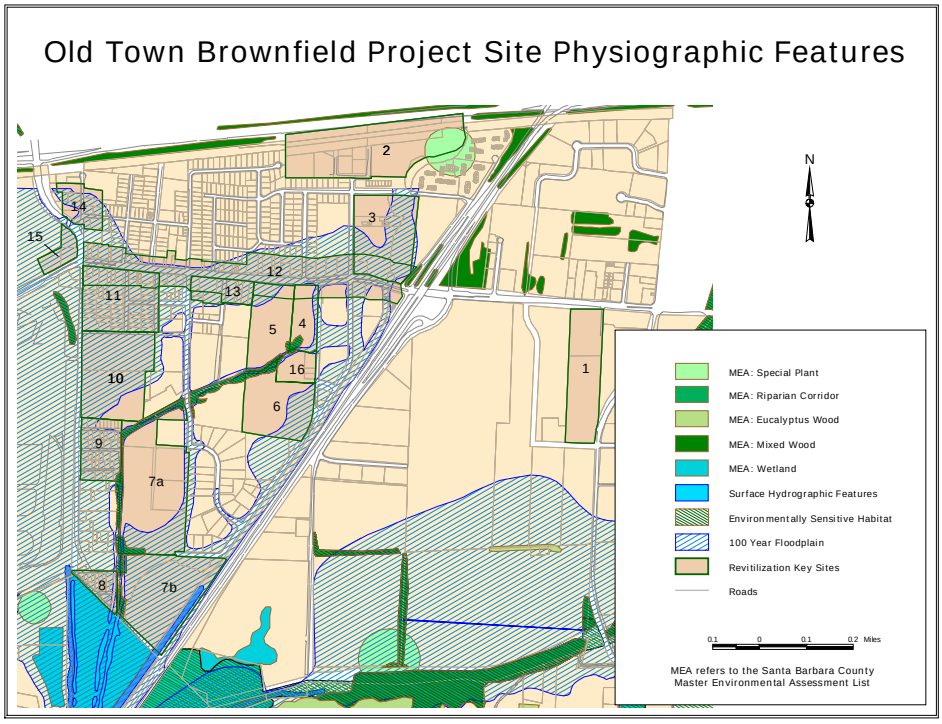
The Goleta Slough is 360 acres located to the south of the Project area. The Goleta Slough has relatively flat topography, attributed to the floodwaters originating from local mountain watersheds, sediment transport and deposition, and tidal influences through the Slough. The Slough is designated an Environmentally Sensitive Habitat (ESH) and as Rare and Endangered Species Habitat in the Local Coastal Plan (Santa Barbara County, 1980). Environmentally Sensitive Habitat is "any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments." (Santa Barbara County, 1994)

Tidal and freshwater habitats support the light-footed clapper rail, Belding's Savannah sparrow, the brown pelican, and occasionally the California least tern and peregrine falcon (Santa Barbara County, 1997). The Master Environmental Assessment layer is a collection of data on flora and fauna from scientific studies and biological assessments (Matt Dobberteen, pers. comm.).

The Goleta Slough watershed habitat is predominantly emergent wetland (saltmarsh). Other habitat types include mudflats; creek and channels, dominated by ditch-grass and pondweed; riverine (riparian) habitat, dominated by tules and cattails, and palustrine (vernal wetlands) habitat dominated by herbaceous vegetation, including bulrushes, cattails and pickleweed. Coastal live oak and poison oak dominate the bordering bluffs. Grasses and weedy herbs have colonized disturbed areas. (Santa Barbara County, 1997)

Three creeks intersect the project area, San Jose, Old San Jose, and San Pedro Creeks. They provide aquatic and riparian habitat for many locally and regionally important plant and animal species. Native vegetation includes arroyo willow, western sycamore, coast live oaks, cattail, and german ivy. Animal species include the coast range newt, California red-legged frog, southern steelhead, Cooper's hawk, Least Bell's vireo, and the yellow warbler (Santa Barbara County, 1997). Natural features information included in the analysis consists of the riparian corridor, wetland, environmentally sensitive habitat and surface hydrographic features (Map 4).

Map 4: Natural and Ecological Features



Soil characteristics

There are three principal soil associations in the Goleta Valley. Goleta-Elder-Agueda is level to moderately sloping, consisting of well-drained sandy loams, loams, and silty clay loams on floodplains and alluvial fans. Camarillo-Aquents is nearly level, with poorly drained fine sandy loams on low floodplain and tidal flats. Milpitas-Positas-Conception consists of nearly level to steep, moderately well drained fine sandy loam on terraces (Santa Barbara County, 1997).

Potential hazards include liquefaction and compressible/expansive soils. Liquefaction is the loss of strength in a saturated, loose soil due to seismic shaking. Compressible soils occur in fine-grained organic-rich sediments deposited in marshy areas. Loading or filling compressible soils can result in settlement. Expansive soils repeatedly shrink and swell causing structural problems (Santa Barbara County, 1997).

Regional geology

The project area is located in the southern portion of the Goleta Valley and was probably once connected to the Goleta Slough. The present valley floor consists of a mature floodplain and a tidal slough (Santa Barbara County, 1996). The underlying geology of the

project area consists of poorly lithified, relatively young sedimentary deposits of alluvium and older alluvium.

The project site is in a seismically active region. Four major active faults affecting the Goleta Valley are the San Andreas, Santa Ynez, Big Pine, and Nacimiento. The Mesa, San Jose, More Ranch and Goleta faults lie near the Project area and are considered active or potentially active, according to the Santa Barbara County Seismic Safety and Safety Elements (Santa Barbara County, 1991).

Hydrogeology

Regional groundwater flow in the project area is towards the south-southeast. Depth to groundwater ranges from 5 to 20 feet and varies seasonally. Monitoring wells dug during 1999 by Padre Associates, Inc. encountered groundwater between 8 and 16 feet. The shallow groundwater in the area is typically poor quality with high total dissolved solids and is generally not used for domestic or agricultural purposes. (Padre Phase II, 1999)

Surrounding land uses

The project area has mixed land uses. The Core Area contains 303 acres and includes commercial, professional, light and general industrial, single family homes, apartment buildings, and mobile home parks (Santa Barbara County, 1997). The Local Coastal Plans of both the City and County of Santa Barbara designate Goleta Slough as Open Space and Environmentally Sensitive Habitat. The area surrounding the Goleta Slough is designated as an Ecological Reserve (Santa Barbara County, 1996). Wetland areas outside the Ecological Reserve have designations including industrial, utility, residential, planned development, agriculture, open space and park/recreation. The land use zoning designations and land use classifications are data included in the analyses.

Historically, it is estimated that Native American peoples began inhabiting the area some 9,000 years ago. Early European explorers used the Goleta Slough embayment as an anchorage for large ships until the 1860's. The severe winter storms of 1861/62 filled the embayment with sediment. Agricultural development in the slough began in the 1870's and the following decades saw the construction of berms, dikes, and roads to further facilitate agricultural development. In 1928 a landing strip was established in the northeastern portion of the slough, which was expanded in 1942-43 for the Marine Corps Air Station, now the Municipal Airport (Santa Barbara County, 1998).

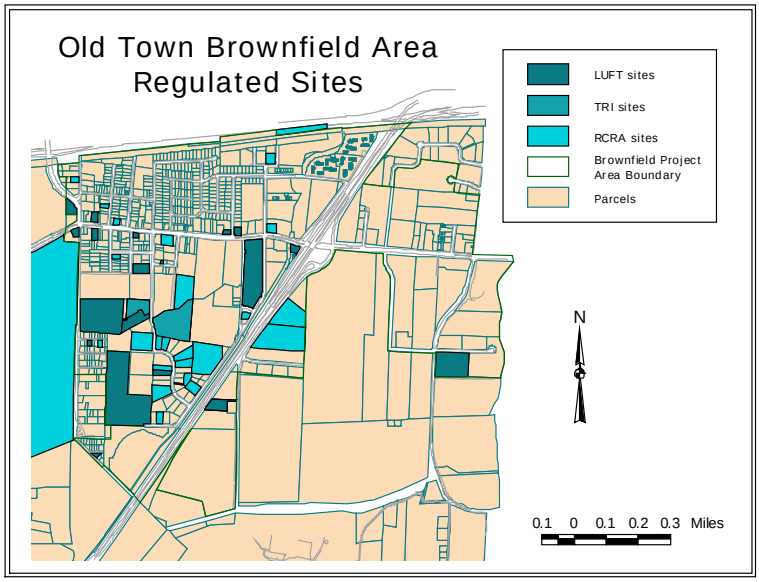
Contaminant Information

An important part of site characterization is to summarize what is known about the actual contamination at a site (as opposed to uncertain or perceived contamination). Information about contaminants was obtained from county records of Leaking Underground Fuel Tanks (LUFTs) and remediation sites, and from the soil and groundwater sampling performed within the study area for total petroleum hydrocarbons (TPH), volatile organic compounds (VOC) and metals.

The project area has a history of known contaminant releases that are either under remediation or recently closed. Currently the area contains 11 open LUFT, 9 closed LUFT, 3 open site mitigation units (SMU) and 5 closed SMU sites in the core area (See Map 5). Contaminants encountered at these sites include gasoline, diesel fuels, waste oils, chlorinated solvents, and metals. In addition there are many facilities operating "high risk" activities in the area. Activities considered high risk include: auto repair and painting, heavy equipment storage, dry cleaners, vehicle fleet maintenance, service station, machine shops and auto salvage yards.

We also investigated facilities that operate in the core area. Information on facilities in the area that handle hazardous chemicals, or emit them, into the air, water or soil, is listed with the EPA. Listings of facilities under the Toxic Release Inventory (TRI), the Resource Conservation and Recovery Information System (RCRIS) and the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) are all available from the EPA under the Emergency Planning and Community Right to Know Act (EPCRA). TRI contains information on all facilities permitted to emit chemicals into the air, water or soil. RCRIS contains information on facilities that handle regulated chemicals and CERCLIS contains information on sites listed in the National Priorities List (NPL). The NPL is a list required by CERCLA of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States (Section 105(a)(8)(B) of CERCLA). There are a total of 3 facilities listed under TRI, 31 facilities listed under RCRIS and no sites listed on the NPL in the project area. Sites in the project area are regulated by the Santa Barbara County Protection Services Division (SBCPSD) and the South Coast Regional Water Quality Control Board (SCRWQCB) in the case of groundwater contamination.

Map 5: Regulated Sites



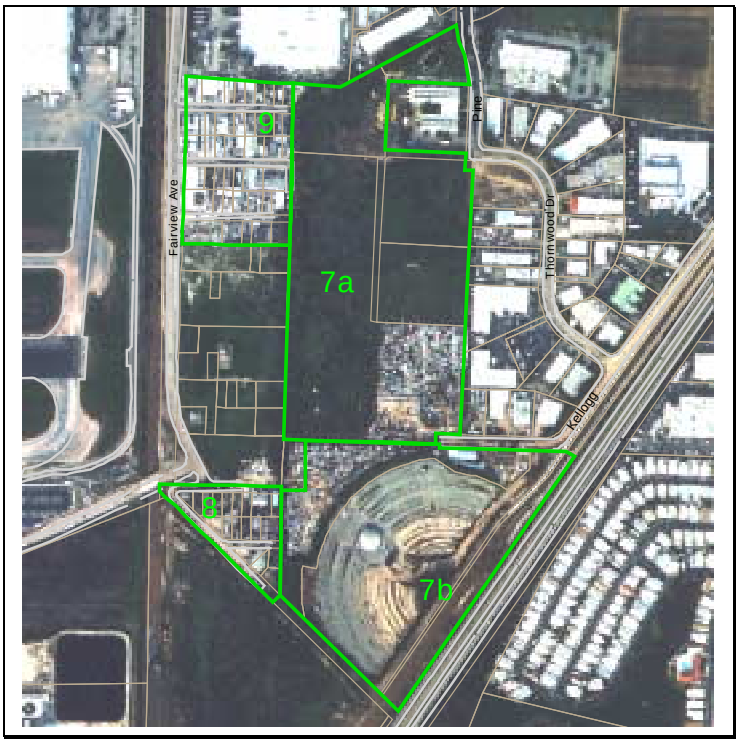
Key Sites

The Goleta Old Town Revitalization Plan selected 16 “Key Sites”, or redevelopment units, in order to focus planning efforts on parcels with high potential for new development and/or a need for redevelopment (Santa Barbara County, 1998). We selected four (7a, 7b, 8 and 9) of the 16 Key Sites in the south portion of the project area in order to demonstrate our site suitability methodology (See Map 6). We selected these Key Sites based on the presence of contaminant sampling locations in the area; the planned transportation infrastructure improvements; and the greater flexibility of land use options for the southern area in comparison to the Hollister corridor. In addition, Santa Barbara County has set the following development standard which groups these Key Sites for a "gateway development" for the airport.

> Development Standard KS 7A-9: To the extent feasible, site plans for Sites 7a, 7b, 8 and 9 shall be coordinated in order to provide the most appealing gateway development. Such coordination shall include design, scale, architectural style, and color of development. (Santa Barbara County, 1998)

For the parcels in our selected Key Sites we collected information on historical land uses from: aerial photographs; plans already identified by the county for these sites; and detailed contamination information. We performed a site visit and obtained photographs of the area.

Map 6: Selected Key Sites

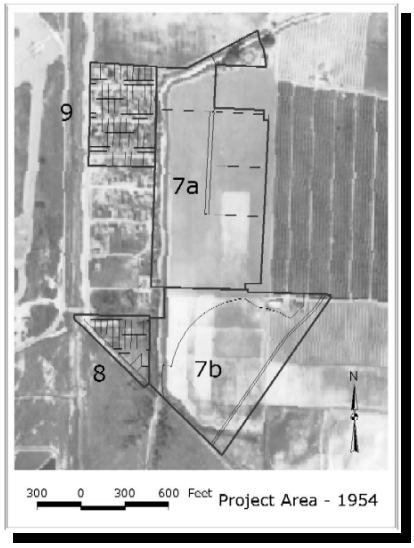


Historical Overview of Selected Key Sites from Aerial Photographs

We incorporated aerial photographs spanning the years 1943 to 1997 into the GIS. We used these to determine changes in land uses for the selected Key Sites (KS) for these years. Comparison of time-series aerial photographs is much easier in a GIS environment, where photos from the two dates can be laid on top of each other and viewed in succession. This allows the analyst to notice small changes between images that might be overlooked in a manual comparison.

1943: The entire area is, in general, open and undeveloped (with the possible exception of KS 9, although the resolution of the aerial photograph does not show enough detail to determine the land use). The only major road in the area is Fairview Avenue, Thornwood Drive and SR 217 are not in place at this time. The San Jose Creek appears much wider than present and water is visible in the channel. There appears to be a broad channel and possibly a wetland area near the southeast of KS 8. In addition, a stream channel runs south from the northwest corner of KS 8. Much of the broader Old Town area appears to be in agricultural use.

1954: Noticeable changes include the conversion of parcels in the western portion of the study area to new land uses. It also looks as if the airport has undergone significant improvements, indicated by the clearer demarcation of runways. The area near KS 7b appears to have been converted from open space to agricultural uses and it appears the stream channel to the east of KS 7b has been filled in. San Jose Creek still appears as an open stream channel. The area around KS 8 shows some modification. The stream channel to the southeast of KS 8 appears to be smaller than in 1943. There is also more agricultural development near the coast, human modification of streams and wetland areas (i.e. east of the present-day SR 217) and increased development along the Hollister Corridor.



1967: SR 217 and Thornwood Drive have been constructed. The concrete channel for the redirected San Jose Creek is visible parallel to SR 217 and San Jose Creek appears as a dry channel. The creek also appears to have more riparian vegetation than before. Parcels in KS 7b have been converted to a drive-in theater. KS 8 and 9 appear to be developed to their present-day use. Several businesses are visible along Thornwood Drive and KS 7b appears to be divided into the sections that currently exist. It looks as if an unpaved road is in place connecting Kellogg to Fairview Avenue. The post office building in KS 10 has been constructed. The mobile home park along Pine Ave (just NE of the top right parcel in KS 7a) has been constructed. The stream channel near the southeastern portion of KS 8 appears to have gone dry with the diversion of waters to the concrete channel of the storm drainage. However, the stream to the west of KS 8 is much wider and similar to its present-day state. There is residential development to the north of Hollister Avenue, converted from agricultural land. There is increased development in the south central Hollister Avenue area. Extensive modifications to the Goleta Slough area occurred with the construction of the SR 217 interchange.

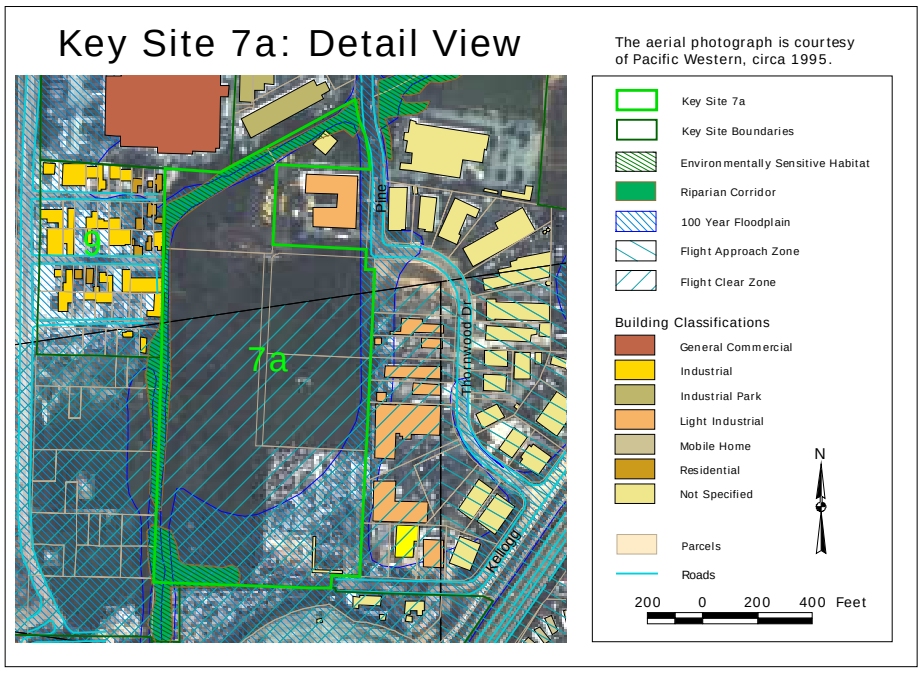
1976: The time period from 1967 to 1976 shows the greatest change between time periods and this is the first photograph where the site appears similar to its current state. There is increased development along the Thornwood corridor and the mobile home park to the east of KS 7b is in place (along with the lagoon), and the area around the Thornwood corridor is built up with new businesses. KS 7a seems to have some modifications to it, with a few unpaved roads running through it. The riparian corridor is more thickly vegetated than in the previous photo. KS 7b supports more vegetation along SR 217 and between its two sub-parcels. The configuration of the airport runways has changed and a new airport building has gone up along Fairview Avenue. The area along the southeastern border of KS 8 now appears in contrast with the surrounding land, perhaps because the wetland area has increased. The physical structure of this area

shows some change. Ekwill Street (just east of SR 217) is in place, along with several buildings, on lots which used to be agricultural land. There appears to be extensive modifications to the eastern core Old Town area and to the airport.

1986: The auto salvage yards are now visible in the southeast corner KS 7a and behind the drive-in theater in KS 7b. KS 7a has more unpaved roads, leading to the auto salvage yard area. The area north of KS 7a and east of KS 10 is developed. The wetland area south of KS 8 appears to have reverted to a more open, untended state (i.e. more vegetation, lack of human modifications). Riparian vegetation is a bit sparser than in 1976. There has been much development in the open areas just north of KS 7a and east of KS 10 as well as development of agricultural land north of Hollister and east of SR 217. A few more buildings have also gone up along the Thornwood corridor. Also apparent is development of the open space just north of the large mobile home park alongside SR 217.

1997: The riparian vegetation is much thicker than in the 1986 photograph. There is a different kind of crop in the agricultural area just east of the mobile home park, southeast of KS 7b. The agricultural area in KS 6 is also planted with different crops. There have been some changes to the water treatment facility site southwest of the study area. There is now a structure in KS 7a, just north of the auto salvage operation in the southeastern corner. This auto salvage area appears to have at least doubled in size.

Map 7: Key Site 7a



This 26.1 acre site is comprised of 5 parcels. The site has few structures and is vacant except for the Santa Barbara Auto Salvage yard in the southeast corner. Development constraints for this site include the flight clear zone over the southern 17 acres, the ESH, which extends for 2200 feet along the northern and western boundaries, and the coastal zone over the entire site. The southern 450 feet fall within the 100-year floodplain.

Revitalization plans for this site include proposed rezoning for the northern 9 acres, in order to accommodate 216,000 SF (square feet) of research park space, with joint use parking within the flight clear zone. The southern 17 acres could accommodate 80,300 SF of service industrial under existing zoning.

The planned transportation infrastructure improvements would provide improved road access to the site with Ekwill Street along the northern boundary of the site and Fowler Road along the southern boundary

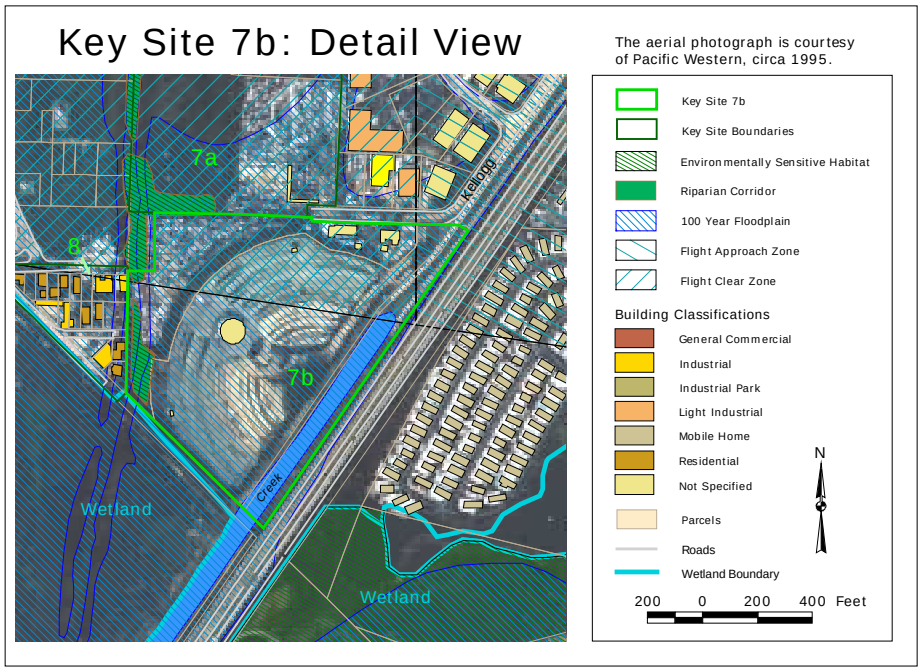
Aesthetic resources include the Old San Jose Creek, which provides a natural scenic backdrop to the site's western property boundary (Santa Barbara County, 1997, Santa Barbara County, 1998).

There is a closed LUFT site at the Santa Barbara Auto Salvage facility. The site recorded highest soil concentrations of 46mg/kg for TPH , 11 mg/kg for lead, and 36 mg/kg for chromium. The site was closed by SBCPSD on 8/10/93 (Padre Phase II, 1999).

The aerial photographs show the site as undeveloped in 1943, except for a single structure. The surrounding area is undeveloped and consists of wetlands. There is little change in the 1954 photograph, except for a short dead-end road (Placencia) and some modifications to the wetland area to the south of the site. By 1967 most of the site is developed and the old San Jose stream channel appears dry. There are few changes between 1967 and 1976. In 1986 the auto salvage yard to the east of the site can be seen. Again there are few changes visible between 1986 and 1997.

Key Site 7b

Map 8: Key Site 7b



This 16-acre site consists of 2 parcels. The site is mostly unused as the drive-in movie theatre is no longer operational except for occasional swap meets. There is one small structure remaining from the drive-in. In addition there is a 4-acre auto salvage yard on the site.

Development constraints on this site include the flight clear zone over 230 to 350 feet of the northern portion of the site and the ESH, which extends 150 feet along the riparian corridor

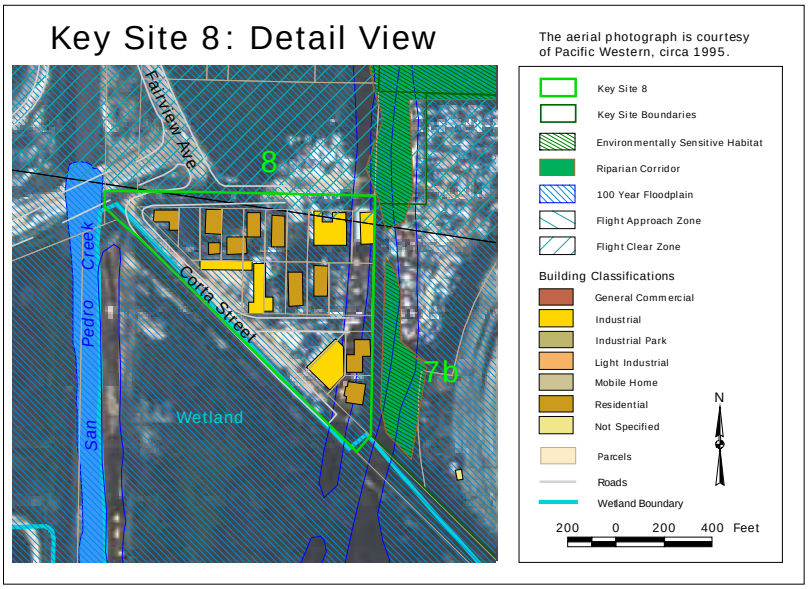
at the northwest corner. There is a 700-foot segment of the Old San Jose Creek extending along the western boundary, and the entire site falls within the 100-year floodplain and within the Coastal Zone.

Plans for this site include grading and fill to raise the site above the floodplain and rezoning of the southern 10 acres for proposed new development of a service industrial area and research park. Construction of the Fowler Road extension would provide enhanced circulation and access to SR 217 and Fairview Avenue. This site is highly visible from SR 217 and is part of the planned "gateway" from the airport so there is encouragement for future development to include adequate screening and landscaping (Santa Barbara County, 1997, Santa Barbara County, 1998).

The aerial photographs show that the area was undeveloped in 1943, with agricultural uses and wetland areas surrounding the site. Several streams converge to the south of the site. The site is unconnected to the road network except for a single road to the west. By 1954 the land has been converted to agricultural use and there has been straightening of the stream channels. The drive-in is first visible in the 1967 photograph, along with SR 217 and the channelized San Jose Creek. There are a few structures present in the northeast portion of the site. By 1976 there is increased development to the north of the site along Thornwood Drive and there are some changes to the wetland to the south. In the 1986 photograph it appears that the drive-in is no longer in use and there is an auto salvage yard in the northwest corner of the site. There appears to be very little change between the 1986 and 1997 photographs.

Key Site 8

Map 9: Key Site 8



This 2.07 acre site has 5,300 SF of industrial space and 15 non-conforming residences that are considered incompatible with the area.

The airport clear zone extends over the northern portion of the site, contributing to high noise values (70 to 75 decibels) over most of the site. The entire site falls within the 100-year floodplain and within the Coastal Zone.

Plans for this site include grading and fill to raise the site above the floodplain and correction of the existing flooding and drainage problems. Rezoning of the site would allow for 25,000 SF of service industrial space, probably for services associated with the airport. This would require demolition of the 15 residences and construction of replacement housing elsewhere in Goleta Old Town.

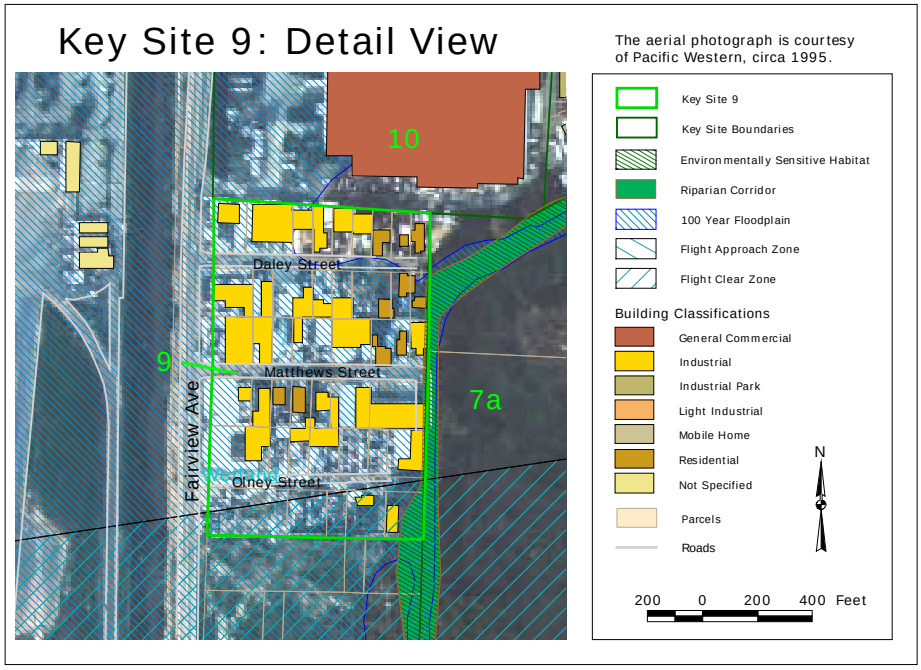
Aesthetic resources include a 500 foot section of Old San Jose Creek that forms the eastern boundary of the site; however, the riparian corridor is somewhat degraded. Goleta Slough forms the southern boundary to the site (Santa Barbara County, 1997, Santa Barbara County, 1998).

There is an open LUFT site at the Hertz facility at 5919 Corta Street resulting from a release of gasoline from a leaking underground fuel tank. The site contamination has highest recorded soil concentrations of 70 mg/kg for TPH (gasoline), 0.48 mg/kg for benzene, 1.7 mg/kg for toluene, 0.5 mg/kg for ethylbenzene, 1.7 mg/kg for xylenes, and 10mg/kg for lead. Highest groundwater concentrations recorded are 61.6µg/l for benzene and 1300 µg/l for MTBE, a gasoline additive. Groundwater is encountered 3 feet below ground surface with a gradient to south. (Padre Associates, Inc., 1999)

The aerial photographs show the site as undeveloped in 1943, except for a single structure. The surrounding area is undeveloped land and wetland areas. There is little change in the 1954 photograph, except for a short dead-end road (Placencia) and some modifications to the wetland area to the south of the site. By 1967 most of the site is developed and the old San Jose stream channel appears dry. There are few changes between 1967 and 1976. In 1986 the auto salvage yard to the east of the site can be seen. Again there are few changes visible between 1986 and 1997.

Key Site 9

Map 10: Key Site 9



This 6.39 acre site has 53,100SF of industrial space and 11 non-conforming residences that are considered incompatible with the area.

Constraints on this site include the airport flight clear zone, which extends over 0.7 acres of the southern portion of the site, contributing to high noise values (65 to 70 decibels). The 100-year floodplain covers almost the entire site except for the northeast corner, and the entire site falls within the Coastal Zone.

Infrastructure improvements planned for this area include the Ekwill Street extension, that would run along the northern boundary of the site, and potential paving of the streets within the site as well as improved lighting, parking and flood control.

Aesthetic resources include the 50-foot wide ESH corridor of the Old San Jose Creek, which extends 750 feet along the eastern boundary of the site, however the riparian corridor is somewhat degraded. (Santa Barbara County, 1997, Santa Barbara County, 1998)

There is a closed LUFT site at 5965 Daley Street operated by Anderson Bros. Auto Body and Paint from release of waste oil. The site recorded highest soil concentrations of 200 mg/kg for TPH (waste oil). The site was closed by SPCPSD, as the soil contamination is

limited to the LUFT location. In addition there is a RCRA hazardous chemical handler at 5915 Daley Street (Padre Associates, Inc., 1999 and EPA Envirofacts website). There are 2 open LUFT cases on neighboring parcels at 500 S Fairview and 505 Pine (UPS).

The 1943 aerial photograph shows that the area was partially developed with unpaved roads in place by this time. Old San Jose Creek is visible with open water and sparse vegetation and the surrounding land is mostly undeveloped. The 1954 photograph shows some development to the south of the site but little other change is visible. By 1967 the creek is dry and the development to the south of the site is no longer there. Key Site 10 to the north is now developed. In the 1976 photograph there is little change on the site other than increased vegetation along the Old San Jose Creek channel. There appears to be modifications to the airport runways that may have altered the flight zones. The site appears much the same in the 1986 and 1997 photographs, with only visible change increased vegetation along the Old San Jose Creek channel the.

Human Health Risk

Risk is the likelihood that individuals or a population will incur an increased incidence of effects such as injury, disease, or death. A risk assessment estimates how much damage or injury can be expected from exposures to a given agent and whether these consequences would affect decisions on future redevelopment options (Resources for the Future, 1998).

A critical element in decision making in brownfields redevelopment is an understanding of the risks involved. Lack of information about risks leads to market stagnation as perceived risks affect property transfer. Market exit (site transition) transactions do not take place because buyers are uncertain about the impact that potential environmental liabilities could have on a site's value. Firms that would like to exit the market, either because the owner would like to retire or the business is no longer competitive, do not do so. Firm owners are unable to tap into the corporate equity they have spent years building. Businesses need to measure and control their environmental risks so that lenders can accurately estimate their risk exposure on a loan. Quantifying risk is a necessary precondition for potentially contaminated assets to regain their "liquidity". Site information allows liabilities to be priced, controlled, and factored into lenders' calculations about whether to offer financing. Information also enables potential purchasers to more accurately assess site value (Improving access to capital, EPA, 1998).

In examining risk in the Goleta Old Town Brownfields area we used data from the soil and groundwater sampling performed by Padre Associates for Santa Barbara County. Additional sampling was performed by Tetra Tech, Inc. however this information was unavailable to us within the timeframe of our project.

The results from the sampling data can be seen in Tables 2 &3. Comparing the values obtained from the sampling to the EPA Region 9 Preliminary Remediation Goals (PRGs), we can see that almost all levels in the soil are below the PRGs. PRGs provide guidance that can be used to screen pollutants in environmental media, trigger further investigation and provide initial clean up goals (US EPA Region 9 website, 1999). The only chemical above

the PRGs is arsenic. Groundwater contamination showed only one significant result of 630µg/l at B20-HP.

We intended to perform a risk assessment using the data obtained from the sampling. However given the low values obtained from the contaminant sampling and the lateness in receiving this data, this was beyond scope of our project. However, had we performed a risk assessment our method would have followed the procedure outlined by the American Society for Testing and Materials (ASTM) provisional guide for Risk Based Corrective Action (ASTM, 1999).

Table 2: Summary of Soil Sample VOC and TPH Analytical Results

Compound mg/kg	CA PRG Industrial	CA PRG Residential	SB 153	SB 163	SB 173	SB 193	SB 2010	SB 2015
Benzene	1.50	0.67	0.0051	-	-	-	-	-
Ethylbenzene	230	230	0.015	-	-	-	-	-
Napthalene	190	56	0.017	0.013	-	-	-	-
1,2,4 trimethylbenzene	5.70	5.70	0.029	0.016	0.01	-	-	-
1,3,5 trimethylbenzene	70	21	0.0077	-	-	-	-	-
Total xylenes	210	210	0.072	32	-	-	-	0.021
MTBE	No PRG	No PRG	-	-	-	-	1.6	0.18
TPH Gasoline	No PRG	No PRG	-	-	-	0.61	0.51	-
TPH Diesel	No PRG	No PRG	-	-	-	-	-	-

"-" indicates below quantifiable limits.
All measurements are in mg/kg
Source: Padre Associates, 1999, and US EPA Region 9 website.

Risk characterization enables developers to use Risk Based Corrective Action (RBCA), which allows greater flexibility in dealing with contaminated properties than traditional standard based approaches. The formal definition of RBCA:

> "A streamlined approach in which exposure and risk assessment practices are integrated with traditional components of the corrective action process to ensure that appropriate and cost-effective remedies are selected, and that limited resources are properly allocated." (US EPA website, 1999)

The goals of a RBCA process are:

- Protection of human health and environment
- Practical and cost-effective application of risk-based decision-making
- Consistent and technically-defensible administrative process

Table 3: Summary of Soil Sample Metals Results

Metal Mg/Kg	CA PRG Industrial	CA PRG Residential	SB46	SB412	SB56	SB512	SB69	SB612	SB133	SB143A	SB143B	SB153	SB163	SB173
Arsenic	2.70	0.39	4.5	7.7	2.9	1.5	3.4	1.5	1.4	2.3	2	1.8	1.9	2.2
Barium	100,000	5,400	56	41	26	79	83	79	54	64	37	38	54	67
Chromium	450	210	17	17		15	16	15	9.2	21	-	-	12	16
Cobalt	100,000	4,700	-	-	-	-	-	-	-	12	-	-	10	13
Copper	76,000	2,900	-	10	-	-	11	-	-	-	-	-	-	-
Lead	1,000	400	110	34	3.4	16	23	16	13	17	8	3.6	4.6	6.2
Nickel	41,000	1,600	20	16	12	21	20	21	10	28	-	11	15	17
Selenium	10,000	390	-	1.8	-	-	-	-	-	-	-	-	-	-
Thallium	180	7	-	2.4	-	-	-	-	-	-	-	-	-	-
Vanadium	14,000	550	22	20	10	22	7.5	22	16	35	16	19	26	32
Zinc	100,000	23,000	23	34	13	30	34	30	24	40	24	23	26	36
			SB183	SB193	SB203	SB2010	SB2015	SB2110	SB234	SB238A	SB238B	SB244	SB248	
Arsenic	2.70	0.39	2	2.4	1.8	0.72	2.3	1.2	1.8	1.6	1.6	1.7	1.5	
Barium	100,000	5,400	41	100	33	68	38	68	42	130	37	71	16	
Chromium	450	210	-	16	-	10	10	13	13	16	-	16	-	
Cobalt	100,000	4,700	-	12	-	-	-	-	10	15	-	-	-	
Copper	76,000	2,900	-	-	-	-	-	-	-	11	-	11	-	
Lead	1,000	400	3.6	7.2	3.1	3.2	4.8	2.1	5.8	6.4	8.1	13	2.8	
Nickel	41,000	1,600	-	34	-	13	11	17	13	22		17	-	
Selenium	10,000	390	-	-	-	-	-	-	-	-	-	-	-	
Thallium	180	7	-	-	-	-	-	-	-	-	-	-	-	
Vanadium	14,000	550	21	32	19	21	24	13	25	34	16	31	13	
Zinc	100,000	23,000	21	46	17	21	24	21	28	38	24	44	11	

"-" indicates below quantifiable levels
Source: Padre Associates, Inc,, 1999 and US EPA Regions 9 website, 1999
all measurements are in mg/kg

Site Suitability

Suitability models evaluate the ability of lands to accommodate various uses. They may include evaluation of natural, political, economic and cultural conditions. Judgments are based on knowledge of local objectives and interests, established policies, economic conditions, environmental conditions, and good development practices. (McHarg, 1969)

Site suitability analysis is done for one land use at a time. Types of land use are expressed through a hierarchical classification system in which more general classes are divided into increasing levels of detail. Generally, a California County General Plan defines the broadest categories of land use designations. The associated County Zoning Code provides more specific classes to facilitate implementation of the General Plan. The first level general designations such as residential, commercial, industrial, as defined in Santa Barbara County General Plan and the Goleta Community Plan (Appendix E) are appropriate for our broad level of analysis.

Site suitability analysis entails overlaying maps of physical and non-physical attributes, such as soil type, distance from a highway, or zoning class, to calculate a suitability index which is expressed on a single scale. An early procedure for land suitability analysis relied upon overlaying hand-drawn, transparent maps on which the intensity or importance of a particular factor was shown in shades of gray (McHarg, 1969). When the maps are overlaid with this technique the darkest areas show the most suitable sites. This overlay approach can be emulated using a GIS, which enables evaluation of larger numbers of layers, with better visual representations. A limitation to the use of overlays for suitability analyses is that it essentially uses addition of factors. Additionally, the results do not communicate how the individual factors contributed to the overall score.

An alternative method is a weighted scores approach. This involves selecting factors relevant to assessing the suitability for the land use being considered, assigning weights of relative importance, and computing the sum of scores into a composite score. This approach better facilitates modifying criteria and weights for evaluating different scenarios, and performing sensitivity analyses.

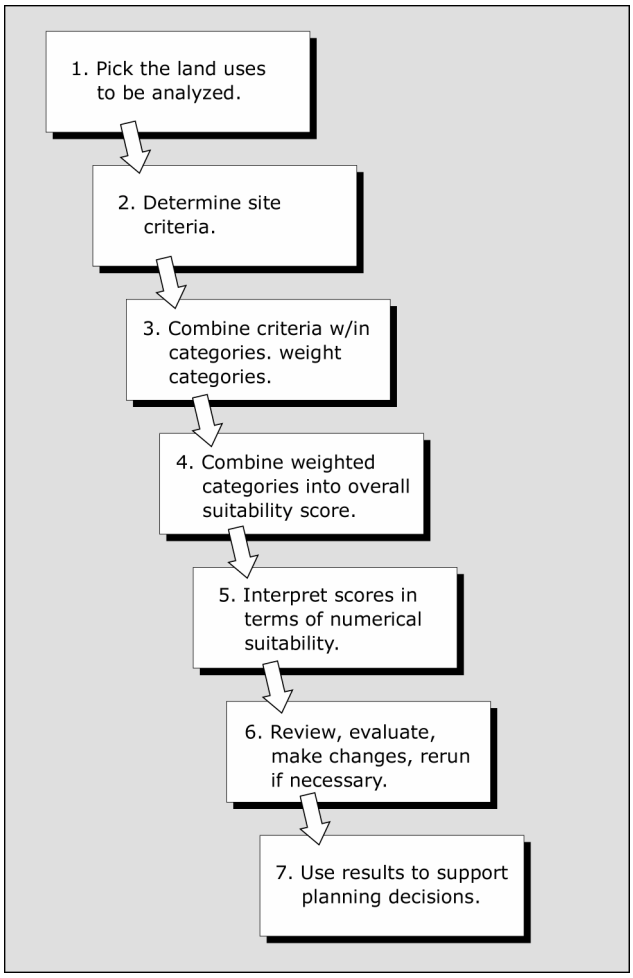
We performed a hybrid McHargian GIS overlay and weighted scores analysis to demonstrate a sample scenario. We based our criteria on McHarg's Site Suitability Model for determining appropriate and desirable land uses (Hanna, 1998). We also incorporated Kaiser's (1995) procedure for conducting a land suitability analysis which includes valuing the criteria within each category and then weighting the categories. Drawing from these two procedures, we followed a seven step procedure outlined in Figure 1. The procedure consisted of the following steps:

1. Pick the land uses to be analyzed

2. Determine the site criteria that establish or detract from suitability for that particular use and assign values to the criteria

3. Combine criteria values within categories and weight the categories
4. Combine the weighted categories into an overall suitability score
5. Interpret numerical scores in terms of suitability
6. Evaluate the results and make refinements
7. Incorporate additional considerations for final recommendations

Figure 1: Site Suitability Analysis Flow Chart



Using GIS, parcels are described by their physical attributes. The contributions of these attributes to the suitability of a site are determined relative to each other as well as relative to the different land uses. The general categories of site information are weighted according to

their contribution to site redevelopment potential. Final scores for each parcel are attained, describing suitability for each of the land uses. The decision tree describing these criteria and the weights is depicted in Figure 2.

We arrived at the values for the criteria and weights for categories by integrating our own knowledge with input from Matt Dobberteen, a planner with Santa Barbara County Planning and Development Department. He was able to give us perspective on the specific goals for revitalization of the Old Town Goleta area.

1. Pick the land uses to be analyzed

   We selected the major urban land use designations identified in the Santa Barbara County General Plan (1992) (Appendix E) for our analysis: residential, commercial, industrial, open space and public facilities. The methodology we have developed can be adapted to perform suitability analyses for more specific land uses, for example various housing densities or different types of industrial uses. Our current data corpus could be supplemented by more comprehensive data layers and at a more specific level of detail. This level of analysis is currently outside of our project scope, but could be implemented using the database structure and methodology described in this report. A suitability analysis for the land use designation of "public facilities" would require the level of detail described above, as the different types of public facilities (schools, hospitals, churches, communications/utilities infrastructure, transportation infrastructure) are too diverse to analyze at the general level. For this reason, we eliminated this land use category from our analysis. We used four land uses in our analyses:

   - Residential: single and multi-family dwellings
   - Commercial: general retail, professional services and offices and mixed-use
   - Industrial: light industry, warehousing, industrial and research parks
   - Open space: parks, recreation, ecological preserves and wetlands

   We did not consider non-urban land classes such as agriculture, forest or barren land, as this was not applicable to Goleta Old Town.

2. Determine Site Criteria

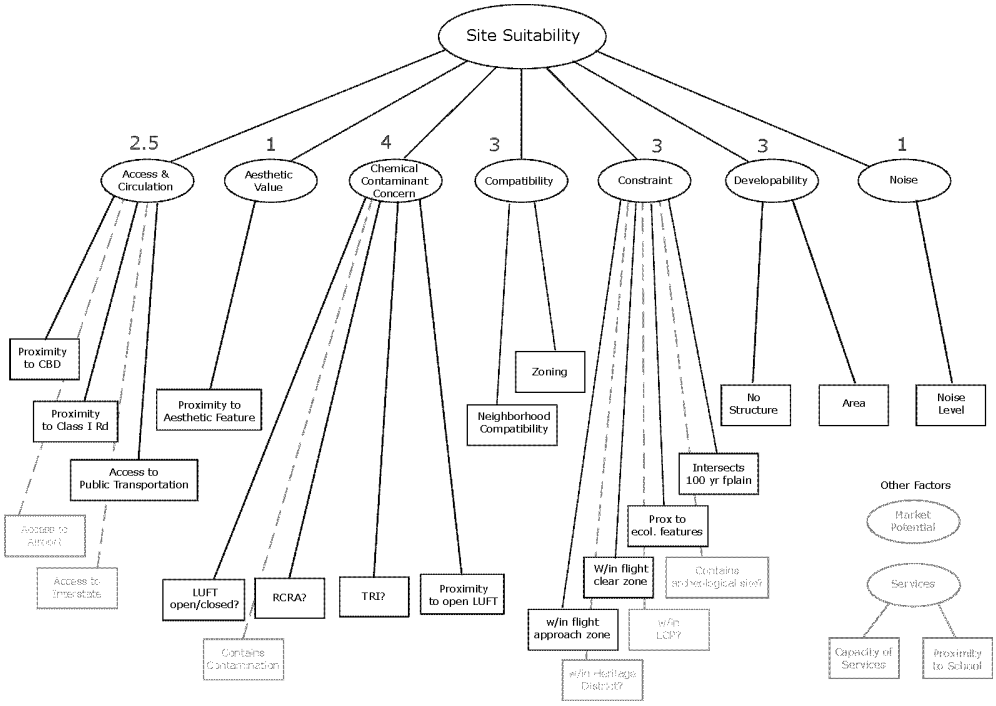
   We identified the influencing criteria that either supported or detracted from the selected land uses. Similar criteria were grouped into categories. These categories are shown (with weights) as the top level in the decision tree of Figure 2. In the diagram categories are shown as ovals and criteria are shown as rectangles. Criteria that were included in our study are shown as black outlined boxes connecting to ovals by a solid black line. Criteria or categories that were not included in our

analysis are shown in gray outline, with dashed line connectors. The levels in the site suitability hierarchy reflect the stages in our analysis: criteria values were aggregated into category scores, category scores were weighted and summed for a final site suitability score.

Some categories that we identified as important included criteria that were not a factor in our selected Key Sites or contained criteria for which we did not have data. These were not included in our analysis. There were also categories (e.g. market potential, services) that were omitted from our analysis because of incompleteness of our data. We include them here for completeness.

The criteria factors were encoded as numeric values in the attribute table of the parcels theme through various spatial select-by-theme functions including "within a distance of", and "intersects with".

Figure 2: Site Suitability Tree



Our approach to developing a site criteria scheme is as follows:

- Criteria values were allowed to range between –9 (suitability detracting) and +9 (suitability enhancing), for each land use designation.

- There were three types of criteria:

- *Continuous Range* – Criteria values could take any value on the range –9 to +9. The neighborhood compatibility criteria, shown in the site suitability matrix (Appendix F), is an example of a continuous range criteria.

- *Binary* – Binary criteria were allowed to take two possible values, typically 0 or 1. This type of criteria was ordinarily used with 0 denoting absence and 1 denoting presence of some property. Examples include containment of some feature (e.g. open LUFT), adjacency to some feature (e.g. open LUFT), and intersection with some feature (e.g. flight clear zone). The binary value was then multiplied by the criteria value shown in the site suitability matrix (Appendix F).

  Binary criteria also occurred when the relationship wasn't a simple presence/absence with possible values of 0 or 1. In these cases the criteria could take on values of +1 if true or –1 if false. This allowed us to specify a positive or negative effect on suitability depending on the presence or absence of some condition, rather than a positive (1) or no effect on suitability (0). The zoning criteria within the constraint category of the site suitability matrix (Appendix F) is an example of this type of criteria.

- *Interval* – This criteria type was used to express ranges, ranks, or degree. It was most often used for proximity intervals, where distance ranges were assigned to separate intervals each with separate interval values. Interval values were then multiplied by the value for the criteria. Interval values were allowed to take values between 0 and 3. Criteria values were allowed to take values between –3 and +3. Multiplying criteria values by interval values gives a possible range from –9 to +9. The access and circulation category shown in the site suitability matrix (Appendix F) contains interval criteria.

- We assigned criteria values relative to other criteria within the same category and relative to other land uses considered. Thus, in assigning the criteria values in the site suitability matrix (Appendix F) we considered both the relative importance of a given value with respect to it's horizontal neighbors (within the same criteria) and it's vertical neighbors (within the same land use). Certain criteria can have either a positive or negative effect on suitability depending on the land use under consideration. Criteria values were included in all categories where they have an effect. Where the criterion was considered to have no effect the cell in the site suitability matrix was shaded gray. Such cells were not included in the normalized criteria score.

The following is a detailed discussion of the criteria used and how the criteria values were assigned.

Access and Circulation: We considered three criteria as positive components of access and circulation: proximity to main arterial road, proximity to the central business district and access to public transportation. Two additional criteria, proximity to airport and proximity to highway were considered important but not a factor for the scale of our study area, as there would be no variation between parcels in our study area.

- *Proximity to main arterial road:* Our working definition of a main arterial road was one that supported a daily volume of traffic of over 10,000 vehicles per day. We arrived at this definition by examining the daily traffic volumes of the roads in our project area as published in the Goleta Old Town Final Environmental Impact Report (Santa Barbara County, 1997). There was a clear division between roads carrying over 10,000 vehicles per day and those carrying less. Proximity to a main arterial road was broken into three distance intervals:

    - Interval 1: within an average parcel distance defined by the north-south length of a representative parcel, APN 071-053-024, or 110 feet.

    - Interval II: within an average block distance defined as the north-south length of a representative city block bounded by Gaviota, Hollister, Orange and Magnolia (330 feet).

    - Interval III: greater than one block, but within a comfortable walking distance defined as 330 feet - ¼ mile.

  These intervals were defined from the point of view of pedestrian circulation, thus the distance intervals are relative to the size and characteristics of our project area.

  Note that some parcels may be within a given straight-line geometric distance interval, but this distance does not necessarily reflect the networked road distance which is more appropriate for our project. We did not have a networked road coverage in our GIS to support a network distance retrieval, so instead we found parcels within proximity intervals by using an interactive distance calculation using the linear distance measurement tool in ArcView.

  The proximity intervals carried a value between 1 and 3, and when multiplied by the value of the criteria for each land use (between 1 and 3) gave a range of 1 to 9 for the criteria.

    - Residential: we considered this criterion of medium importance with a value of 2, as roads provide access and circulation (suitability enhancing) but impose safety concerns, and degraded aesthetic characteristics (suitability detracting). The interval values reflect the preference for being near but not

right next to a main arterial road. The interval values are: 3 for Interval II, 2 for Interval I and 1 for Interval III.

- Commercial: we considered this criterion of high importance with a value of 3 as access and circulation (vehicular and pedestrian) are of prime importance to commercial land uses. The interval values are: 3 for Interval I, 2 for Interval II and 1 for Interval III.

- Industrial: we considered this criterion of medium importance with a value of 2, as access and circulation enhance suitability, but are not of prime importance. The interval values are: 3 for Interval I, 2 for Interval II and 1 for Interval III.

- Open Space: proximity to a main arterial road was not considered an important factor for open space.

- *Proximity to Central Business District (CBD):* Proximity was broken into three distance intervals based on how far people are willing to walk. The CBD in Goleta Old Town is identified as the Hollister corridor, between Fairview and SR 217. The intervals are 0 to ¼ mile with a value of 3, ¼ to ½ mile with a value of 2 and over ½ mile with a value of 0.

  - Residential: we considered this of high importance with a value of 3 as it is important for residents to be able to walk to the central business district. This contributes to the mixed-use goals of the County, as well as the Goleta Revitalization Goals of increasing pedestrian use of Hollister businesses and creating a "sense of place".

  - Commercial: we considered this of high importance with a value of 3, as commercial redevelopment will update and upgrade the retail services on the Hollister corridor, thereby enhancing the economic viability of Old Town.

  - Industrial: we considered this of medium importance with a value of 2. Goleta has benefited economically from industrial uses in the recent past, but their proximity to the CBD would not highly enhance suitability.

  - Open Space: we considered this of medium importance with a value of 2.

- *Access to Public Transportation:* we did not have information for the exact location of the bus stops, so we used the roads used by the bus routes as a substitute measure. Proximity was broken into three distance intervals based on how far people are willing to walk. The intervals are the same as the Central Business District proximity intervals.

- Residential: we considered this of high importance with a value of 3 as residents may use public transportation as their primary mode of transport.

- Commercial: we considered this of high importance with a value of 3 as both employees and customers may use public transportation.

- Industrial: we considered this of medium importance with a value of 2 as employees may use public transportation to get to their work.

- Open Space: we considered this of low importance with a value of 1 as people would be more likely to walk to use a local open space rather than use public transportation in a local neighborhood setting.

Aesthetic Value: We considered proximity to any one of the following aesthetically enhancing features to be a positive criterion. The features we considered are riparian corridor, wetland, environmentally sensitive habitat and surface hydrographic features. We decided that proximity to more than one of these features does not have a compounding effect.

- *Proximity to aesthetic feature:* Proximity was broken into four distance intervals based on whether the feature was adjacent to, in the immediate neighborhood or in the "vicinity" of the parcel. The intervals were chosen to reflect our assessment of people's preferences for being near aesthetic features. The distance intervals are 0 to 10 feet with a value of 3, 10-200 feet with a value of 2, 200 to 500 feet with a value of 1 and further than 500 feet with a value of 0.

    - Residential: we considered this of high importance with a value of 3. Aesthetic features enhance the visual quality of a residence via some degree of open, or protected, space as well as a natural feature.

    - Commercial: we considered this of medium importance with a value of 2.

    - Industrial: we considered this of medium importance with a value of 2.

    - Open Space: we considered this of high importance with a value of 3, as riparian corridors, wetlands, and environmentally sensitive habitats benefit from connectivity and proximity to these features.

Chemical Contamination Concern: We considered five criteria as important in considering the negative effects of chemical contamination. Parcels with an open LUFT were removed from the analysis as we considered them unsuitable for redevelopment until the site was closed. Other factors we considered were proximity to an open LUFT site, whether the parcel was a closed LUFT site, or listed under RCRA as a hazardous waste handler or listed under TRI as an emitter of substances to the air, water or soil.

- *Proximity to open LUFT:* We considered an open LUFT site to have a potentially detrimental impact on adjacent parcels (within 50 feet) of the parcel with the open LUFT due to the potential for migration of contaminants. This criterion is binary.

    - Residential: we considered this of high importance with a value of-7, as residential uses of property could include real or perceived exposure to contaminants and this affects the market potential of the property.

    - Commercial: we considered this of medium importance with a value of-4, as commercial uses of property don't necessarily include exposure to contaminants.

    - Industrial: we considered this of low importance with a value of-3.

    - Open Space: we considered this of medium importance with a value of –5, as recreational uses of proximal property could include human and ecological exposure to contaminants.

- *Closed LUFT:* We considered the impact of having a closed LUFT site on the parcel as a detrimental factor. This criterion is binary.

    - Residential: we considered this of high importance with a value of –7, as this could affect the market potential of the property.

    - Commercial: this was considered not a factor for commercial land use.

    - Industrial: this was considered not a factor for industrial land use.

    - Open Space: this was considered not a factor for open space land use.

- *RCRA Hazardous Chemical Handler:* We considered current handling and storage of regulated chemicals on a parcel a negative factor for redevelopment as this could affect the market potential of the property, but does not imply emissions, spill, leaks, or other pathways for exposure. This criterion is binary.

    - Residential: we considered this of medium importance with a value of –4,

    - Commercial: we considered this of low importance with a value of -2.

    - Industrial: we considered this of low importance with a value of -2.

    - Open Space: we considered this of low importance with a value of -3.

- *TRI Hazardous Chemical Emitter:* We considered parcels where there was currently reporting of releases of toxic chemicals into the air, water, or land to the EPA to be a negative factor for redevelopment of that parcel. This criterion is binary.

    - Residential: we considered this to be of high importance with a value of –7, as residential uses of property could include real or perceived exposure to contaminants and this affects market potential of the property.

    - Commercial: we considered this to be of medium importance with a value of –4, as commercial uses of property don't necessarily include exposure to contaminants but this would detract from the redevelopment potential.

    - Industrial: we considered this to be of medium importance with a value of –4, as industrial uses of property don't necessarily include exposure to contaminants but this would detract from the redevelopment potential.

    - Open Space: we considered this to be of medium importance with a value of -6

Compatibility: We considered two criteria: whether the proposed land use was compatible with the current zoning designation, and whether it was compatible with the current land uses of the surrounding parcels (within 50 feet of the parcel of interest.)

- *Zoning compatibility:* The possible values are 1 and -1. If the proposed land use was the same as the current zoning designation then the value was multiplied by 1 to indicate compatibility. If the current zoning was different from the proposed land use then the value was multiplied by -1 to indicate non-compatibility. This is a continuous range criterion.

    - All Land Uses: we gave all land uses a value of 3 for this criterion. Although zoning can be important for individual parcels (incompatible uses would impose permitting difficulties), we did not consider it as important for redevelopment of an area, since rezoning is being considered for many of the sites.

- *Neighborhood compatibility:* For each parcel we calculated a value for neighborhood compatibility based on the current land uses of surrounding parcels within 50 feet of the parcel of interest. The value was calculated by giving a value to each land use in relation to the land use of the parcel of interest and then normalizing over the number of parcels considered. The possible values ranged from -9 to +9, depending on the weights specified in the analysis. Table 4 shows the compatibility weights of surrounding land uses for parcels of a given land use type. The resulting normalized weights range in value between –5 and +9. The

attached script (Appendix G) details the implementation in ArcView. This is a continuous range criterion.

Table 4: Land use compatibility

	SURROUNDING LAND USES			
Parcel of Interest	**Residential**	**Commercial**	**Industrial**	**Open Space**
Residential	9	7	-5	9
Commercial	7	8	7	8
Industrial	2	8	8	8
Open Space	8	8	-5	9

For example, if a parcel is completely surrounded by residential uses, and we are interested in computing the compatibility factor for a target land use of residential, the parcel would get a compatibility score of +9, after normalization. If the same parcel is surrounded by all industrial uses and we are again interested in computing the compatibility factor for a target land use of residential, the parcel would now get a compatibility score of –5, after normalization. A mixture of surrounding land uses will result in a compatibility score somewhere in the range of +9 to –5. These values are based on the Revitalization Plan goals of establishing a "sense of place", and enhancing mixed land use in Goleta Old Town (Santa Barbara County, 1998):

- Residential: compatible with other residential, commercial and open space uses.
- Commercial: compatible with all the other land uses. Surrounding uses of other commercial and open space are seen as having a slightly better compatibility than residential and industrial, although all are acceptable under the mixed land use goals of the revitalization plan.
- Industrial: compatible with other commercial, industrial and open space uses. Proximity to residential uses is less desirable.
- Open Space: compatible with other commercial, residential, open space uses. Industrial locations are less favorable because of reduced aesthetic appeal.

Constraint. We considered constraints to development to be a negative factor. The constraints we considered are; intersection of the parcel with the 100-year flood

plain, the flight clear zone, the flight approach zone; or proximity to a natural feature.

- *Intersects 100-Year flood plain:* We considered intersection of a parcel with the 100-year flood plain to be a detrimental factor. This is a binary criterion.

  - Residential: we considered this of low importance with a value of -3 as flooding can impact residential land use but there are mitigation measures than can limit the effects.

  - Commercial: we considered this of medium importance with a value of –4.

  - Industrial: we considered this of medium importance with a value of –4.

  - Open Space: we considered this of medium importance with a value of 4, as some types of open space can benefit from flooding.

- *Proximity to ecologically sensitive feature:* This was considered a detrimental factor as it might impose restrictions on development. The intervals and features are the same as the proximity to aesthetic feature criterion.

  - Residential: we considered this of low importance with a value of –2, as residential uses might be constrained by protective regulations associated with ecologically sensitive features.

  - Commercial: we considered this of low importance with a value of –2, as commercial uses might be constrained by protective regulations associated with ecologically sensitive features.

  - Industrial: we considered this of low importance with a value of –2, as industrial uses might be constrained by protective regulations associated with ecologically sensitive features.

  - Open Space: we considered this of low importance with a value of 2, as proximity to ecologically sensitive features may enhance open space uses.

- *Within flight clear zone:* The flight clear zone is defined as the area under the approach slope of the primary runway end to the point where the approach slope is 50 feet above ground level. Land uses that result in concentrations of people greater than 25 per acre or hazardous installations are prohibited in the clear zone. There are height limitations on structures within the clear zone (Santa Barbara County, 1997). This is a binary criterion.

- Residential: parcels in the clear zone were blacked out, as residential land uses is effectively prohibited within the clear zone.

- Commercial: we considered this of high importance with a value of -9.

- Industrial: we considered this of high importance with a value of -7. However there are some industrial uses for which this might not be such an important factor so we valued this lower than for commercial land use.

- Open Space: we considered this of low importance but a positive factor as open space is considered one of the few viable options for land in the clear zone.

➢ *Within flight approach zone:* The flight approach zone is an extension of the clear zone. Land use restrictions are less than for the clear zone, however there are restrictions in uses pertaining to high densities of people and potential for fire hazard. This is a binary criterion.

- Residential: we considered this of high importance with a value of -9 as only single family dwellings are permitted in the approach zone.

- Commercial: we considered this of high importance with a value of -7.

- Industrial: we considered this of medium importance with a value of -4.

- Open Space: we considered this of medium importance with a value of 3.

Redevelopment Potential. We considered two factors as important to the ease of redevelopment. Parcels were flagged for having no structure under the assumption that these would be more attractive to developers. The acreage of the parcel is considered as contributing to redevelopment potential.

➢ *No structures present:* we identified parcels that currently do not have a structure on them as being easier to redevelop, as no demolition is required. We considered this of equal importance for all land use categories with a value of 4. This is a binary criterion.

➢ *Acreage:* we considered larger parcels more attractive for redevelopment. Acreage was divided into 4 intervals as a function of the acreage of the parcel. We devised intervals of: 10 acres and larger with a value of 3, 5-10 acres with a value of 2, 1-5 acres with a value of 1, and less than 1 acre with a value of 0.

- Residential: we considered this of low importance with a value of 1, as residential redevelopment does not necessarily require minimum parcel acreage.

- Commercial: we considered this of medium importance with a value of 2, as some commercial redevelopment might be enhanced by larger parcel size.

- Industrial: we considered this of high importance with a value of 3, as industrial redevelopment might be enhanced by larger parcel acreage.

- Open Space: we considered this of high importance with a value of 3**.**

Noise: We considered noise levels as a function of the noise contours available for the project area. Given the proximity to the airport, roads, and the railroad, the entire area experiences high levels of noise, and we considered this to be a negative criterion. Exposure to noise levels in excess of 65 decibels is considered a concern (Santa Barbara County, 1997).

- *Noisiness:* The decibel scale is logarithmic however we assigned values for 4 intervals as a linear function of the noise contours. The intervals were above 75 decibels with a value of 3; between 70 and 75 decibels with a value of 2.5; between 65 and 70 decibels with a value of 2; and between 60 and 65 decibels with a value of 1.5.

  - Residential: we considered this of high importance with a value of -3.

  - Commercial: we considered this of medium importance with a value of -2.

  - Industrial: we considered this of low importance with a value of -1.

  - Open Space: we considered this of medium importance with a value of -2.

Market Potential: Market potential would describe the marketability of a parcel on the current real estate market. It is important to the overall suitability of a parcel in that it incorporates regional economic and demographic characteristics into the market value, and can reveal the potential for investment. Marketability is a more updated and accurate representation of land value than the Assessor data. These values could be attained from the local real estate industry.

We pursued marketability information about Goleta Old Town from local real estate appraisers. We learned that the method for appraising a commercial or residential property is partially designed by the individual appraiser, and partially guided by professional organization guidelines. We were told that market value of properties incorporate valuations of immediate, local, and regional characteristics and these

valuations change often due to changing market conditions. For example, the approval of a large development nearby, or the anticipated entry of a large firm may increase surrounding land values.

Risk: A critical element in brownfields redevelopment is managing real and perceived risk. The chemical contaminant concern category addresses perceived risk based on current land use practices and currently or previously contaminated sites. It does not take into account quantitative measurements of the risks posed by potential. The results from sampling in our study area did not warrant a risk assessment due to the low concentrations encountered, however if higher concentrations had been encountered results from the risk assessment could be incorporated into the suitability analysis in order to address real risk.

3. Combine criteria values within categories and weight the categories

We created new parcel attribute fields in the GIS to hold intermediate criteria and score results for the four land uses. The criteria values were summed and normalized by the number of criteria considered. We normalized the sum of the criteria scores in order to have a standard way to compare and assign category weights. Normalizing the summed criteria scores by the number of criteria ensured that all category scores would fall within the same range of values. Since category scores were all scaled the same we could assign category weights assuming that each category had a similar initial (unweighted) influence.

We assigned weights to the categories reflecting their contribution to overall suitability. These weights are shown in Table 5. After we ran the first analysis we revised some of the category weights to reflect our interpretation of the initial results. Both chemical contaminant concern and redevelopment potential were given higher weights in the second run to correct deficiencies in the first run.

Table 5: Category Weights

Category	Initial Weight (Run 1)	Revised Weight (Run 2)
Access & Circulation	2.5	2.5
Aesthetic Value	1	1
Chemical Contaminant Concern	3	4
Compatibility	3	3
Constraint	3	3
Redevelopment Potential	2	3
Noise	1	1

4. Combine the weighted categories into an overall suitability score

   We applied the weights to the categories and calculated the overall suitability score for each land use designation as a sum of weighted categories. Appendix H shows the actual calculations used in ArcView to perform the site suitability calculation for a commercial land use.

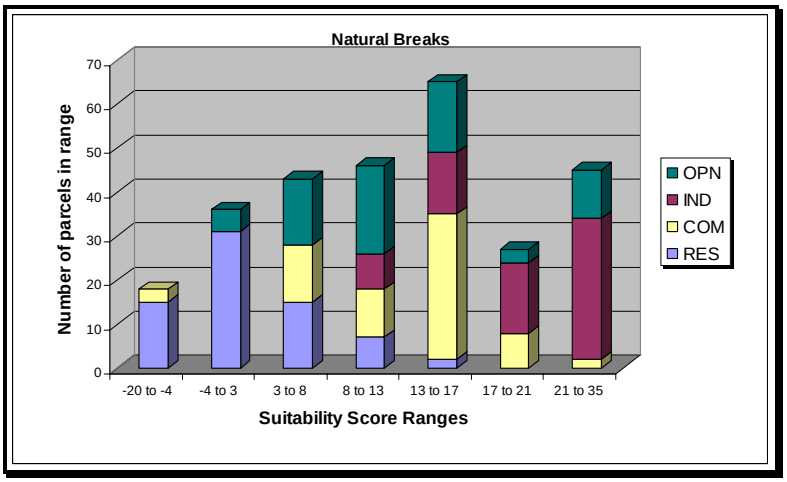
5. Interpret numerical scores in terms of suitability

   Initially we interpreted the overall suitability scores using a "natural breaks" classification, which finds groupings and patterns inherent in the data using Jenk's optimization, a goodness of variance fit technique. Jenk's optimization classifies data into groups that are internally homogeneous while assuring heterogeneity among classes, by using an optimization routine to find class intervals (Dent, 1996). This enabled us to examine each of the land use categories individually, but was not a suitable way to compare suitability between land uses. Natural breaks classification of site suitability are shown for each land use in Table 6, and as a histogram in Figure 3, in order to show the relative distribution of site suitability values between land uses. Note that industrial land use shows the highest suitability scores of all land uses considered. Figure 3 shows the same information in a graphical format.

Table 6: Natural Breaks

Interval Range	Residential	Commercial	Industrial	Open	Total Parcels
-20 to -4	15	3			18
-4 to 3	31			5	36
3 to 8	15	13		15	43
8 to 13	7	11	8	20	46
13 to 17	2	33	14	16	65
17 to 21		8	16	3	27
21 to 35		2	32	11	45

Figure 3: Graph of Final Site Suitability Scores Classified by Natural Breaks



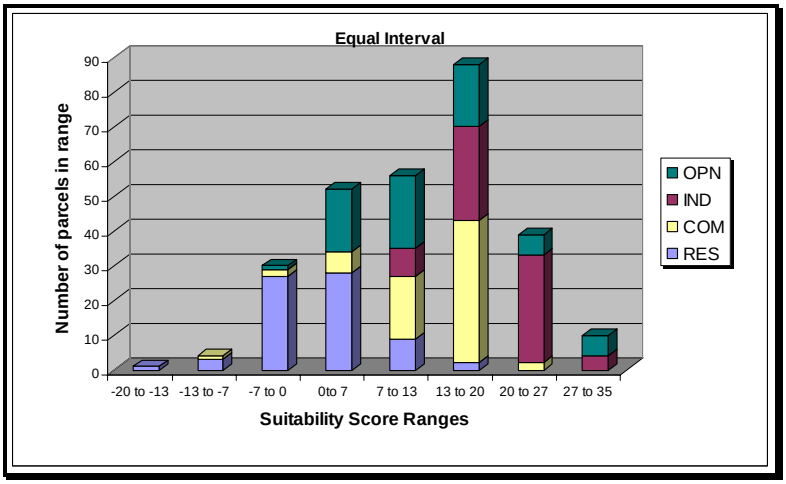
In order to compare site suitability results between land uses we divided the full range of total scores into eight equal interval classes, each spanning a seven-point range. Table 7 shows the interval ranges, the suitability class, and the number of parcels in each interval. Figure 4 shows this information in a histogram. Note that there are three classes of negative suitability and five classes of positive suitability, as there are fewer negative values than positive. Compared to the natural breaks classification, equal interval shows fewer parcels at the high and low ends. The equal interval classification is conceptually cleaner because we draw a distinction between positive and negative suitability scores. The equal interval classification has an interval division at zero identifying the transition between suitability and unsuitability, whereas in the natural breaks classification zero is not necessarily located on an interval boundary.

Note that in both classification techniques residential comes out as having the lowest suitability, commercial and open space have a higher suitability, and industrial land use has the highest suitability score for redevelopment.

Table 7: Equal Interval

Interval Range	Suitability Class	Total Parcels
-20 to -14	Medium Unsuitability	1
-14 to -7	Medium / Low Unsuitability	4
-7 to 0	Low Unsuitability	30
0 to 7	Low Suitability	52
7 to 14	Medium/Low Suitability	56
14 to 21	Medium Suitability	88
21 to 28	Medium/ High Suitability	39
28 to 35	High Suitability	10

Figure 4: Graph of Final Site Suitability Scores Classified by Equal Intervals



6. Evaluate the results and make refinements

We examined the results from the first run and determined adjustments so that results reflect the intended influence of weights and criteria. We identified additional criteria for inclusion and reviewed and modified category weights. We re-

ran the analysis and compared the results. Table 5 shows the changes we made in category weights between runs 1 and 2.

7. Incorporate additional considerations for final recommendations.

   Additional considerations are incorporated into the decision process when using these results to achieve identified goals in making final recommendations for redevelopment. For example the need for affordable housing may prioritize residential land uses over other land uses. In addition less tangible considerations such as "sustainability" principles may play into the decision-making process.

Other Site Suitability Approaches
Ecosystem Management Decision Support Tool (EMDS)

We investigated the use of the Ecosystem Management Decision Support (EMDS) (USDA, Corvallis, OR) system as an additional tool to perform the site suitability analysis for our project. EMDS is designed to analyze problems which may not have well-defined mathematical descriptions, but instead have a mixture of qualitative and quantitative elements. Although originally designed for ecosystem management, the program scales well to many problem sizes and is general enough to be applied to other circumstances (Reynolds, 1999). We investigated EMDS for our project because of the informative analysis it would provide, and for the comparison of site suitability methods that a second methodology would allow. However, our investigation of the EMDS software suggested that adding a second site suitability method was beyond the scope of our project.

EMDS is a separate system that integrates with the ArcView GIS, allowing the user to develop a knowledge-based reasoning scheme which decomposes a problem into a hierarchical network of logical propositions (Reynolds, 1999). It is a single inclusive tool, permitting the analysis to be centrally managed and executed. This feature has the advantage of allowing the user to easily restructure the components of the study, to perform “what if” scenarios by modifying the data inputs, and to query values or states of variables at any place in the networked hierarchy. Performing a GIS site suitability analysis without a central task manager such as EMDS makes it difficult to modify and interact with the components of the analysis. EMDS has two basic modules: Net Weaver and the EMDS program. Net Weaver provides a knowledge-based development environment and EMDS provides the engine to process the knowledge base within a GIS environment.

In EMDS the analysis can be run from within a single environment, and the various levels of the networked decision scheme can be examined separately. Thus, it is easy to observe the behavior of each network and sub-network in the model. This allows the user to examine the influence of the input values and decision criteria on the output results, and make changes if necessary. Another valuable feature is the ability to specify missing information through a placeholder, which allows evaluation of the influence of missing information on the final outcome.

One begins an EMDS analysis by modeling the primary problem factors in Net Weaver. Each factor is then modeled in terms of its dependencies. An example from the user's manual may help to clarify this point. Coho salmon rearing suitability can be modeled as a logical "AND" combination of summer and winter rearing suitability. Summer rearing suitability in turn is a separate node that can be modeled as a logical "AND" combination of summer stream baseflow, summer water quality, and other factors. Dependencies are modeled until they terminate in a data link. Data links are connected to ArcView attribute tables in the GIS. When EMDS runs an "assessment", values are retrieved from the GIS, placed in the data links of the problem scheme and then EMDS solves for the networked dependency output value (Reynolds, 1999). Output values are expressed in terms of a range of logical truth values, where:

A "+1" output evaluates to a proposition truth value of "true".

A "–1" output evaluates to a proposition truth value of "false".

A "0" output evaluates to a proposition truth value of "undetermined".

An output value in the range between +1 and –1 denotes a degree of membership in the "true" and "false" sets. This is called fuzzy set membership. (Reynolds, 1999 Netweaver System)

In terms of a site suitability analysis, such as the one we are interested in, the proposition might be phrased as "this parcel is suitable for redevelopment to a land use of X". Parcels would be ranked in suitability according to the truth value of the output. Parcels with output values close to "+1" would be judged suitable for redevelopment to the land use in question. Parcels with output values close to "-1" would be judged unsuitable for redevelopment to the land use in question. Parcels with output values of "0" or near-"0" would be "undetermined" with respect to suitability potential.

Preliminary investigation of the EMDS software package showed that it was potentially useful for parts of our problem. One positive feature is that EMDS allows different pathways of analysis to be specified depending on the value of the variable at a particular node. For instance, we may use the size of a parcel to determine a threshold for a branch in the analysis. If the parcel is above 2.5 acres in size, the analysis will follow a particular route. If it is less than 2.5 acres, it will follow another route containing a differing set of criteria. Additionally, the use of a "switch" statement, EMDS allows the user to build more complex decision pathways, testing two or more conditions sequentially. The user can test for the most important conditions first, and if these are not met the flow of control will then test for other, less important conditions. For example, in calculating industrial site suitability one might want to query for the size of the parcel. One sequence of analysis can be performed for parcels greater than 10 acres, another sequence for parcels from 5-10 acres, etc. The switch statement allows this to be done with no extra preparation of the GIS database.

After consideration we decided that EMDS was an inappropriate framework for our particular site suitability analysis, given our understanding of its operation. We developed

our site suitability scheme to produce a final suitability index value based on the weighted sums of category inputs. We identified categories that we considered to be important to the redevelopment suitability of parcels and then created a weighting scheme that reflected the relative importance of these factors with respect to each other. This was the central structure to our site suitability analysis. Because EMDS is based on a logical truth-value scheme, relative weighting cannot be put into the analysis. In fact, although the author of the EMDS program originally designed a facility in the program for weighting factors in the analysis, results from weighted analyses were seen as being unpredictable and unreliable. The EMDS authors now suggest that this feature not be used.

Results

The site suitability analysis was run in two stages. The first stage produced scores for each of the separate categories (aesthetic value, access and circulation, etc.). The category scores represent the normalized contribution of the component criteria. For example, the access and circulation category has three criteria: access to public transportation, proximity to the central business district, and proximity to a main arterial road. The second stage of the analysis combined the different category scores according to their weight in contributing to overall site suitability.

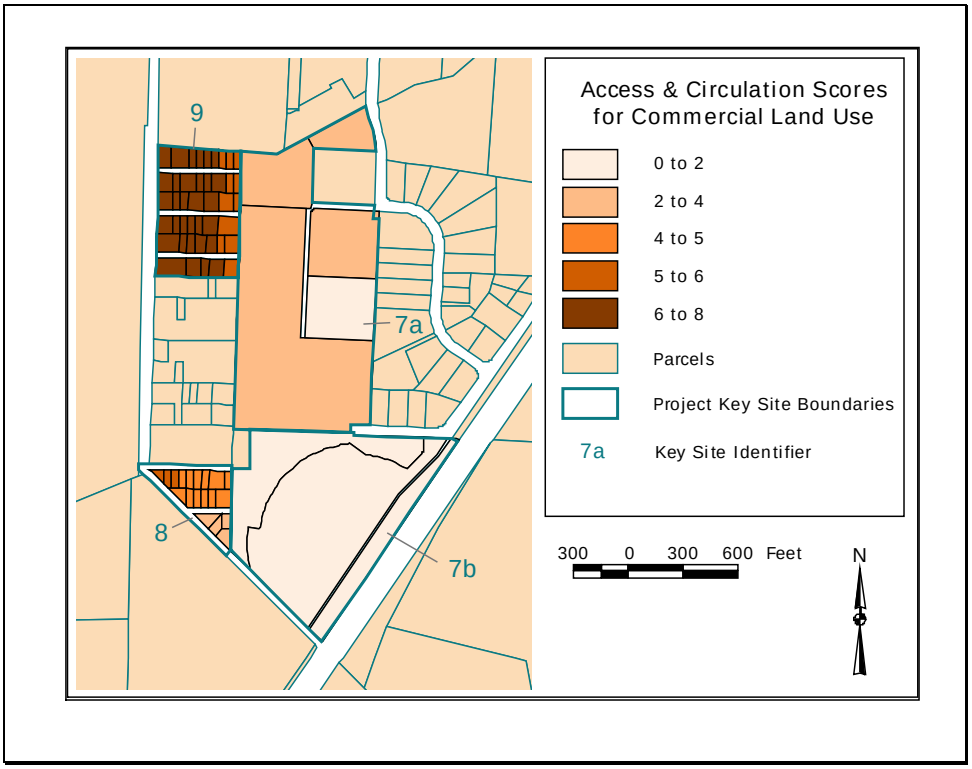
Two scenarios were analyzed: the first used the existing transportation infrastructure; the second incorporated the planned transportation infrastructure improvements of extending Ekwill Street and Fowler Road, designed to increase access and circulation through the southern portion of the area.

Category Scores

Maps 11-17 show the resultant category scores using commercial land use as an example. The data were classified by the "natural breaks" method in ArcView in order to see patterns and groupings in the data. These maps show the un-weighted input of each category to site suitability

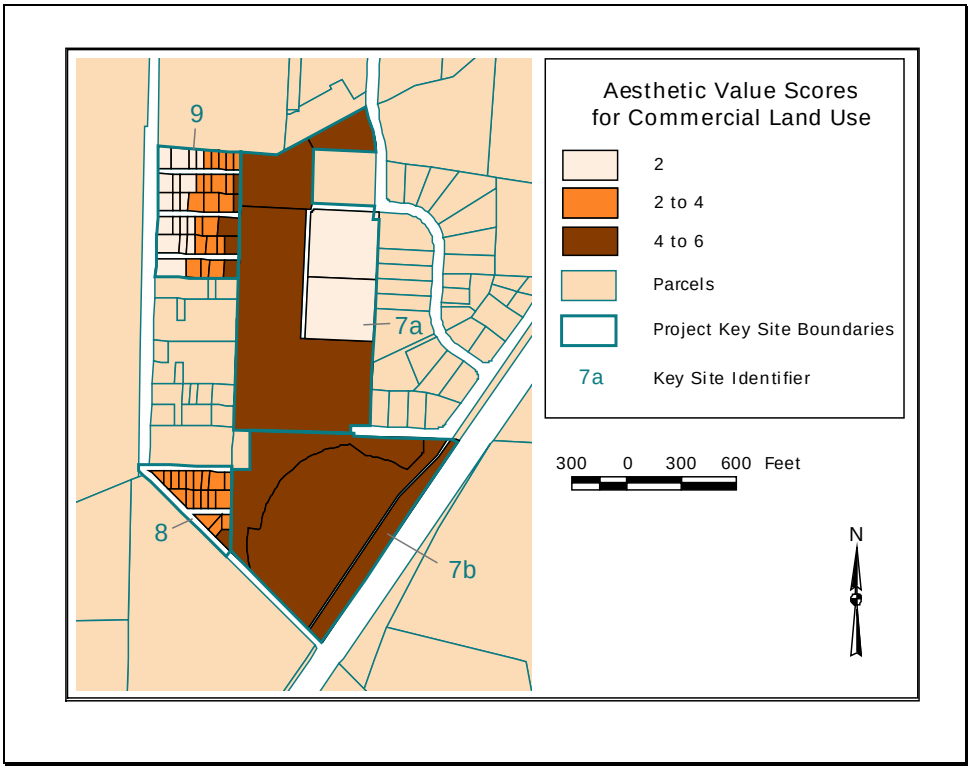
Map 11 shows the result of the access and circulation scores for commercial land use. The higher values seen in Key Sites 8 and 9 are attributed to proximity to Fairview Avenue, immediately to the west of the study site, which is a main arterial road serviced by public transportation. Higher values are seen in Key Site 9 due to the proximity to the central business district located to the north of the study site. Key Sites 7a and 7b exhibit lower values in this category, as they are not currently serviced by a main arterial road or public transportation. Additionally, Key Site 7b is further from the central business district giving it a very low score in this category.

Map 11: Access and Circulation Category Scores: Commercial Land Use



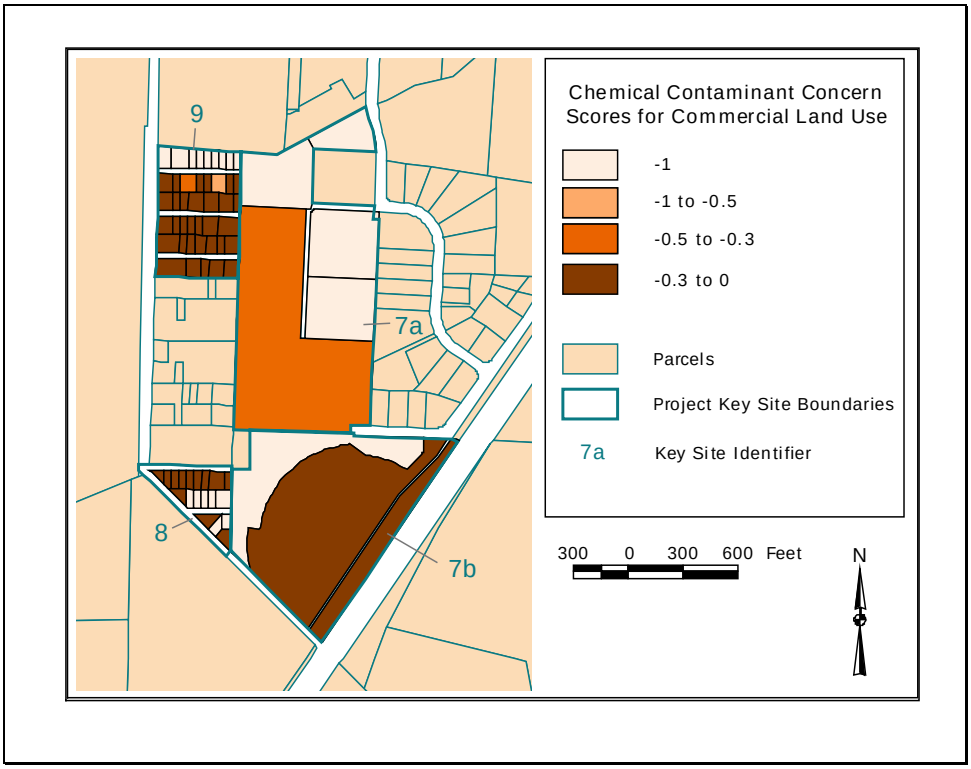
Map 12 shows aesthetic value scores for commercial land use. The parcels with the highest scores are all located immediately adjacent (0-10 feet) or in the immediate neighborhood (10-200 feet) of the features considered aesthetically enhancing. These include the riparian corridor that runs between Key Sites 7a and 9, San Jose Creek that runs between Key Site 7b and SR 217 and the wetland located to the southwest of Key Sites 7b and 8.

Map 12: Aesthetic Value Category Scores: Commercial Land Use



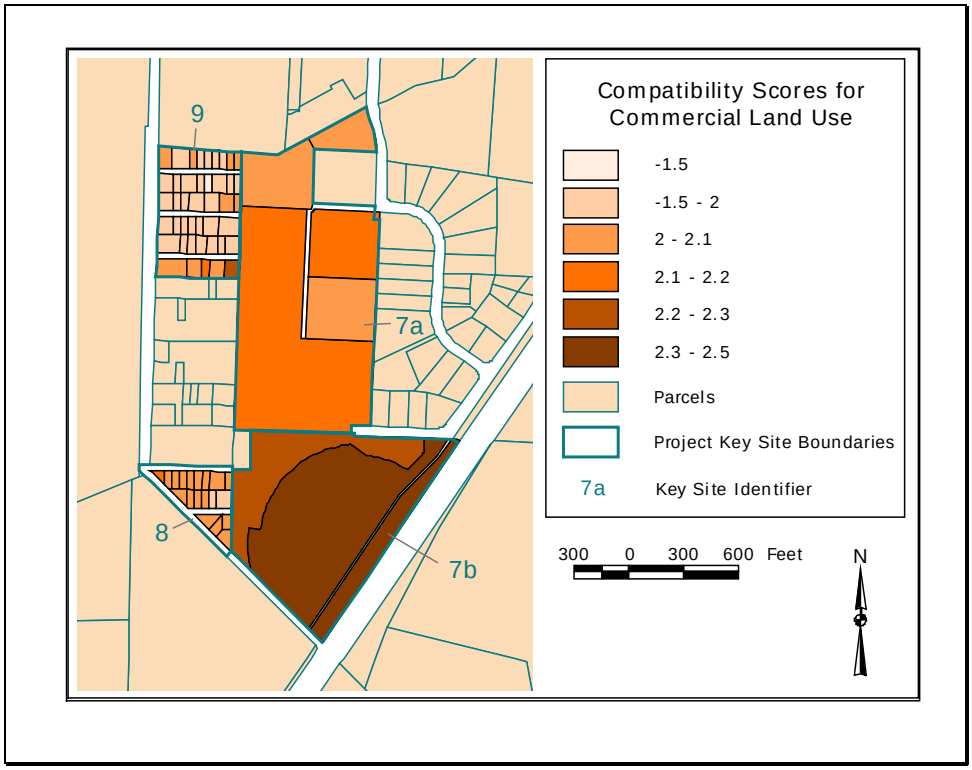
Map 13 shows the chemical contaminant concern scores for commercial land use. As this category is a detracting factor the scores are negative; thus a light color indicates a negative impact on the suitability. For our study area, the light-colored parcels are those adjacent to open LUFT sites where a concern about potential migration of the contamination results in a negative impact on the suitability of those parcels. There are also 2 closed LUFT sites in the area, located in Key Site 9 and the large parcel in Key Site 7a. See Map 5 for locations of regulated sites.

Map 13: Chemical Contaminant Concern Category Scores: Commercial Land Use



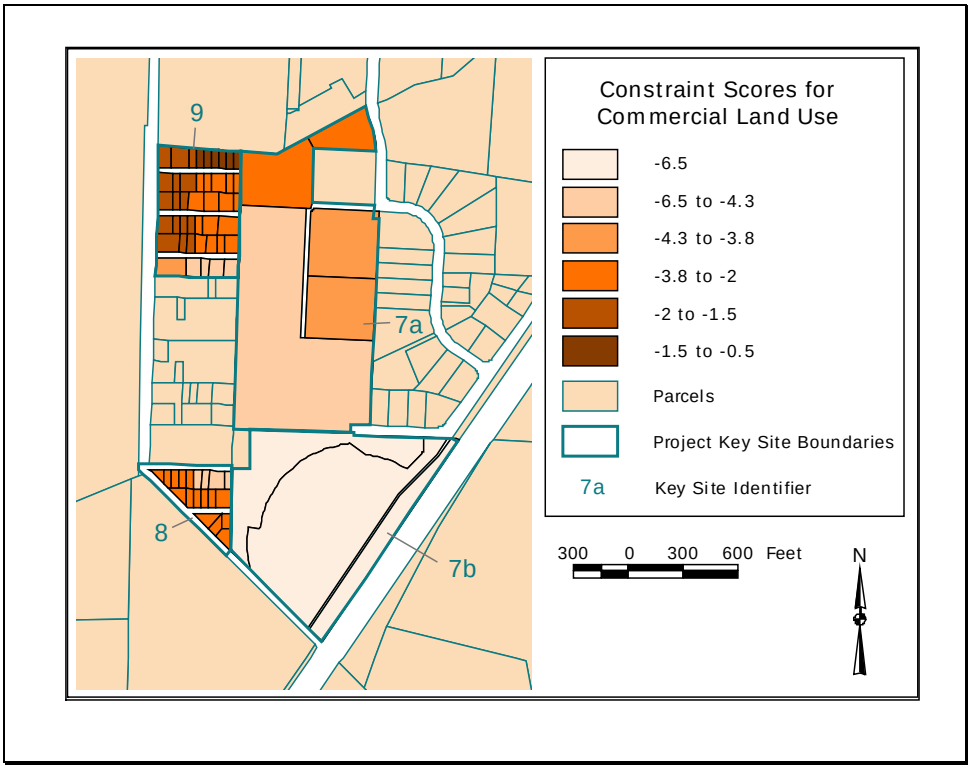
Map 14 shows "compatibility" scores for commercial land use. Compatibility was based on two criteria: current zoning, and current surrounding land uses. A higher score shows that the potential land use fits well with current zoning regulations and land use. At present the land uses are predominately industrial, non-compliant residential and open space, and the entire area is zoned for industrial uses.

Map 14: Compatibility Category Scores: Commercial Land Use



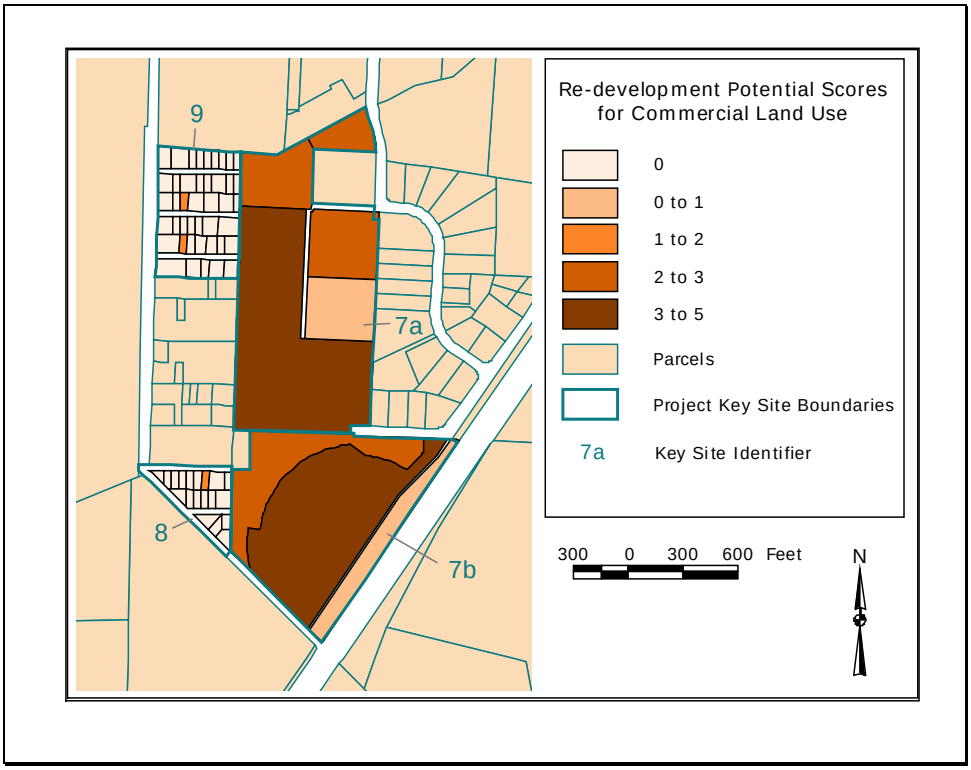
Map 15 shows the constraint scores for commercial land use. Constraints are defined as adjacency or intersection with any feature that serves to impose additional regulations on development for the parcel. Constraint criteria include intersection with the 100-year floodplain, intersection with the flight clear or approach zone and proximity to an ecological feature that would require design or construction modifications. Darker values represent lesser constraints. Parcels in the upper and lower western portion of the study area showed better constraint scores because they are outside of the flight zones. The darkest parcels in the north section of Key Site 9 have the highest scores, as they are situated outside of the 100-year floodplain.

Map 15: Constraint Category Scores: Commercial Land Use



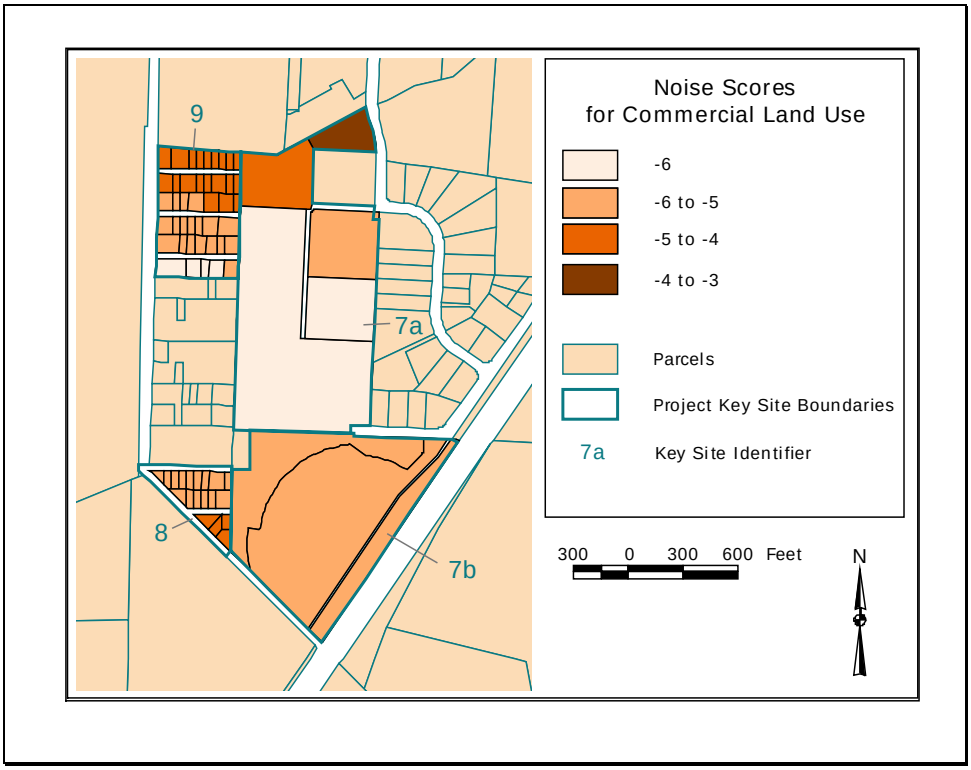
Map 16 shows the redevelopment potential scores for commercial land use. This category captures the ease with which the parcel may be redeveloped. High significance is given to those parcels without structures or that have a sizable acreage. Parcels with high scores in this category were mostly the undeveloped, open parcels in the eastern portion of our study area. The small parcels with higher scores in Key Sites 8 and 9 are those without structures.

Map 16: Redevelopment Potential Category Scores: Commercial Land Use



Map 17 shows the noise constraint scores for commercial land use. On this map high noise levels translate into high negative scores. The map corresponds with the map of noise contour levels. In general the central portions of the study area experiences higher noise levels due to the flight zones, while the parcels to the north and south are outside of the highest noise levels.

Map 17: Noise Category Scores: Commercial Land Use

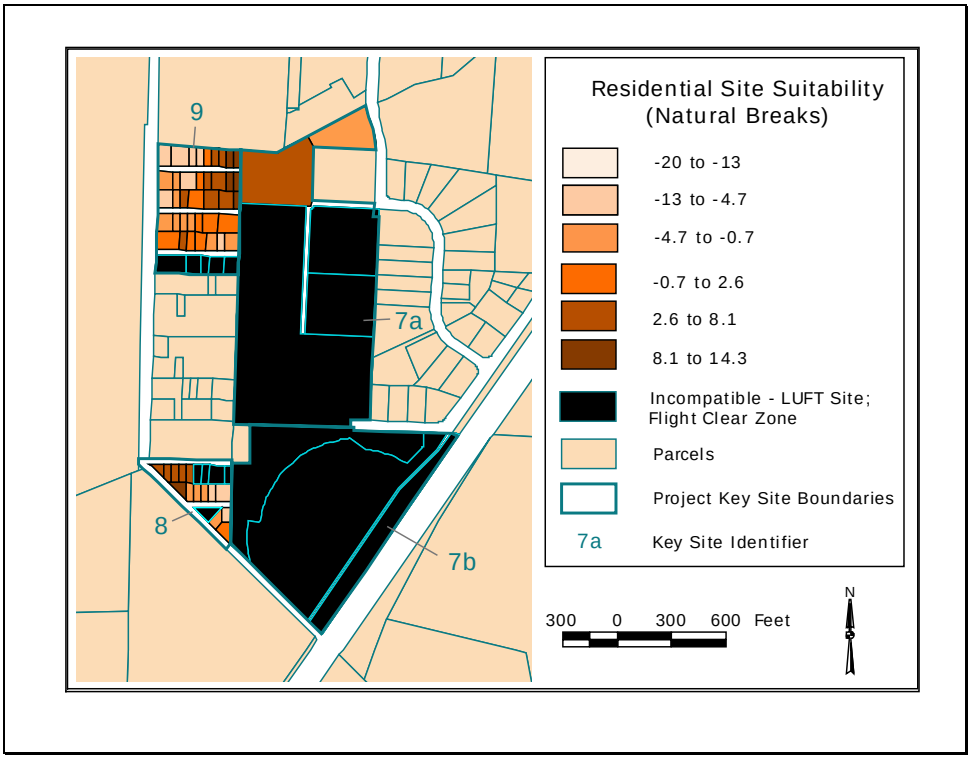


Relative Site Suitability

Site suitability scores reflect the weighted sum of the seven categories. Maps 18 to 21 show the final site suitability results for each potential land use on a relative scale in order to compare the suitability of parcels within a single land use category. These maps are designed to be examined for each land use individually. The data are classified using natural breaks in order to see patterns and groupings in the results.

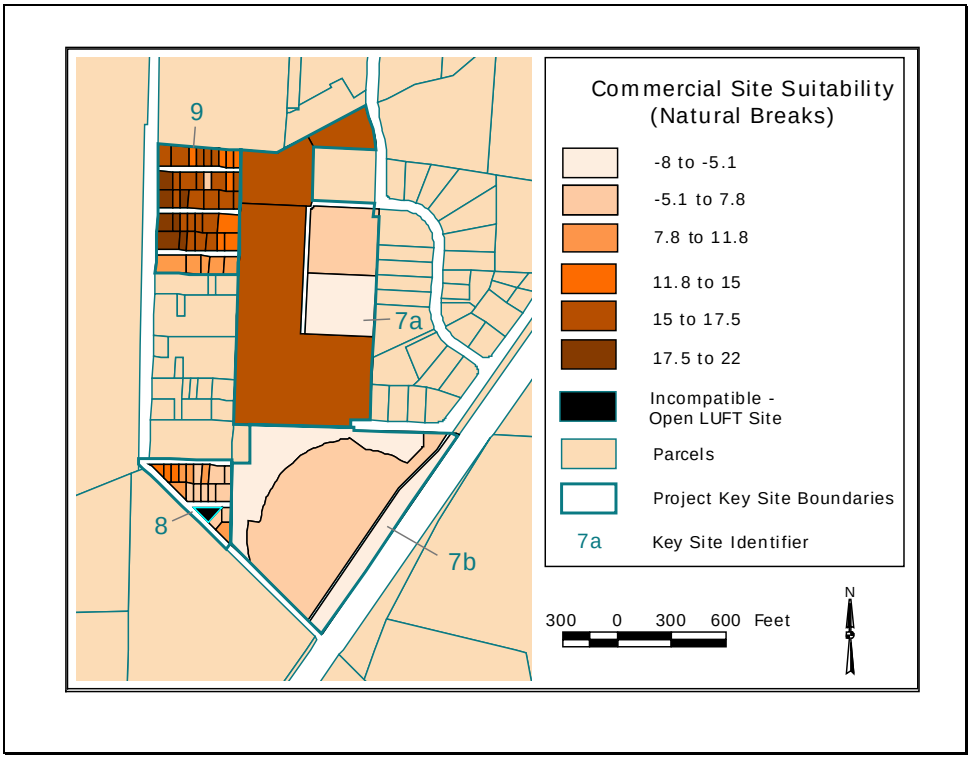
Map 18 shows relative residential site suitability. Residential land uses are best located off the main commercial thoroughfares and close to areas with aesthetic features. Areas shown in black are considered unsuitable for residential use due to either an open LUFT site or as they fall within the flight clear zone, both of which effectively prohibit residential land use.

Map 18: Residential Relative Site Suitability



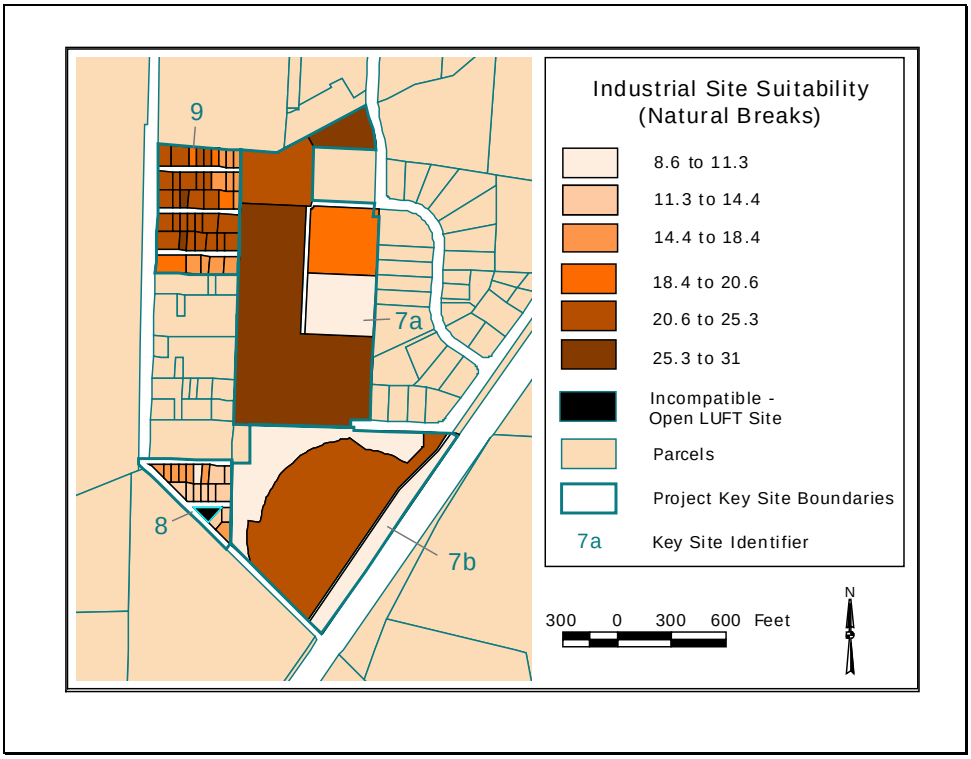
Map 19 shows relative commercial site suitability. Sites in Key Site 9 close to Fairview Avenue on the west of the project area show the highest values in this category. The large parcel in Key Site 7a has a high score relative to the 7b Key Site, showing the influence of access and circulation on this land use. The open LUFT site is indicated in black, as it is incompatible with redevelopment of any type.

Map 19: Commercial Relative Site Suitability



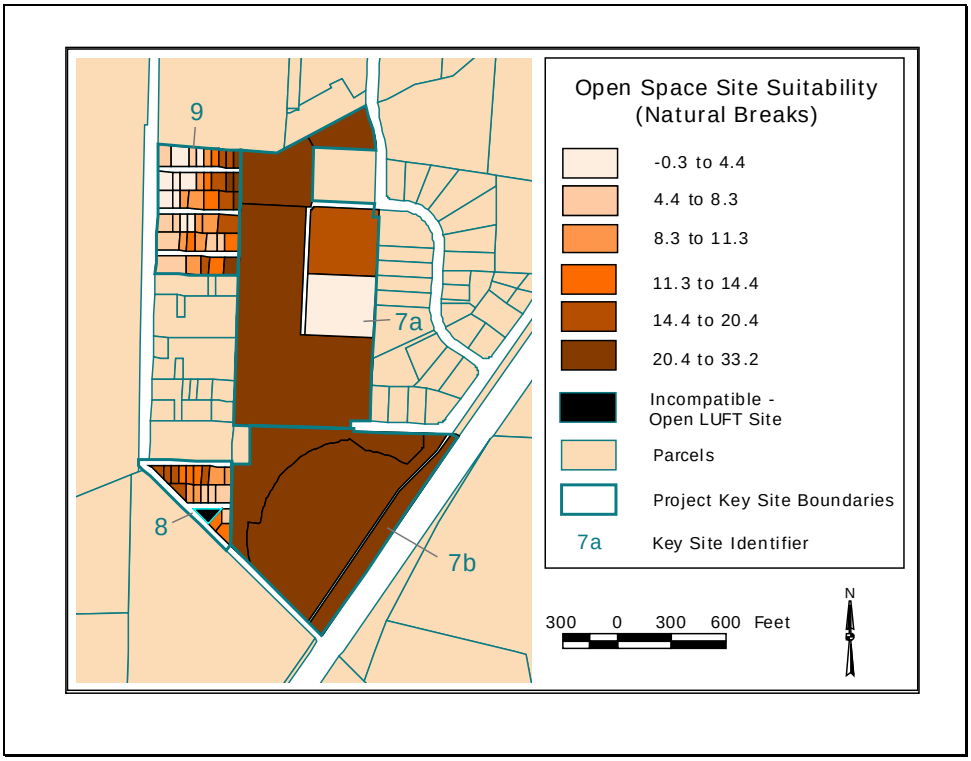
Map 20 shows relative industrial site suitability. The large parcels in Key Sites 7a and 7b show high scores, likely due to the high redevelopment potential for large and currently undeveloped parcels. The scores in this category are high due to compatibility with the current land uses and zoning. The open LUFT site is indicated in black, as it is incompatible with redevelopment of any type.

Map 20: Industrial Relative Site Suitability



Map 21 shows relative open space suitability. Parcels with the highest scores for this land use are those with large acreage, are close to existing ecological features, and are currently undeveloped. The open LUFT site is indicated in black, as it is incompatible with redevelopment of any type.

Map 21: Open Space Relative Site Suitability



Comparison between land uses

Maps 22-25 show the overall site suitability scores in terms of ordinal intervals on a scale ranging from high suitability to medium unsuitability. These classes show the suitability score in terms of the overall suitability relative to other potential land uses. These maps are designed to be examined collectively in order to compare suitability for different land uses for the same parcel. The data was classified based on equal interval classifications with green tones representing suitable scores and red tones representing unsuitable scores. Darker shades represent a greater degree of suitability/unsuitability and black parcels represent areas where the land use is effectively prohibited.

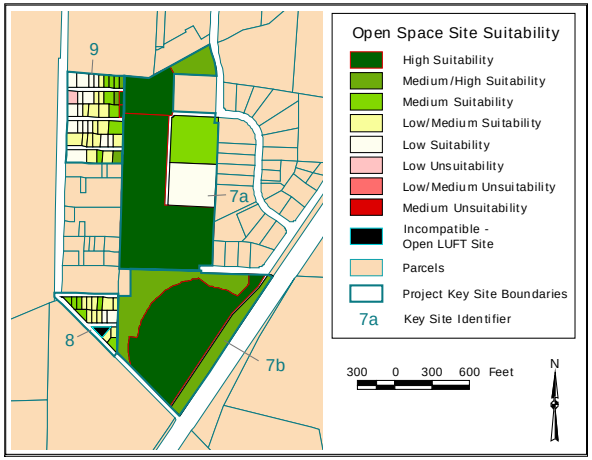
For residential land use we can see that much of the area prohibits residential land uses due to the flight clear zone. The remaining parcels are predominantly unsuitable for residential land uses with only a few parcels in Key Sites 8 and 9 having low to medium suitability.

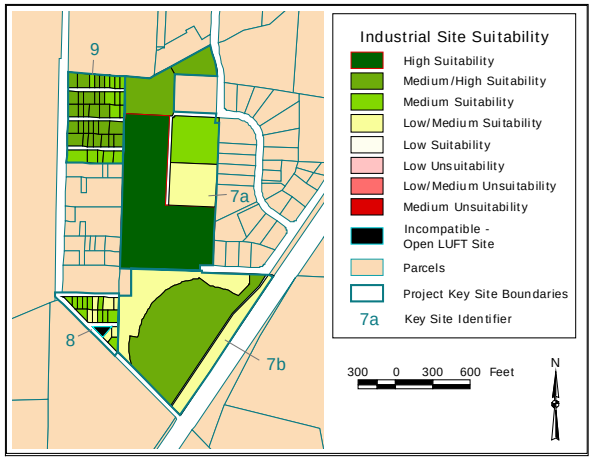
Commercial land use shows a variation in suitability from low unsuitability to medium/high suitability. The parcels in Key Sites 7a and 9 exhibit the more suitable scores whereas the parcels in Key Site 7b are mostly unsuitable, as they are poorly serviced by roads and are furthest from the central business district.

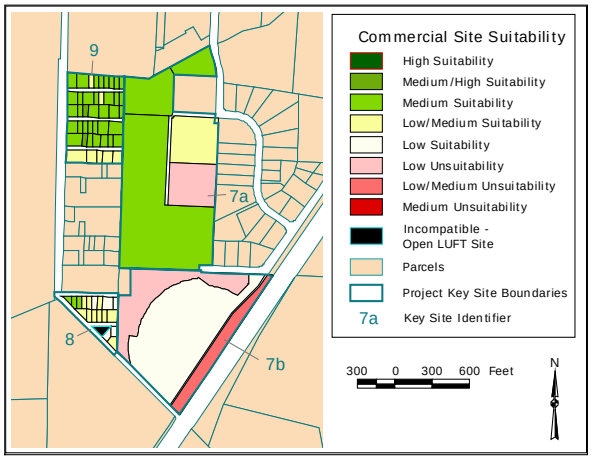
Industrial land use shows the highest suitability scores for the area. All parcels fall into the suitable range. In general, higher suitability is seen for parcels in Key Sites 7a and 9. Key Site 9 contains mostly industrial uses at present, resulting in high scores for compatibility. Key Site 7a contains medium to large size parcels, resulting in high suitability scores as well.

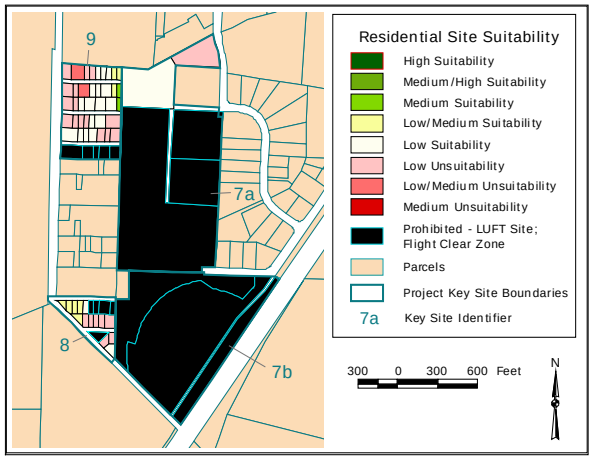
Open space shows predominantly suitable scores with only one parcel in the unsuitable range. Large, undeveloped parcels without any significant structural build-up, such as in Key Sites 7a and 7b, were highly suitable. Proximity to ecological features such as the riparian zone, or wetland area was also a positive factor in the overall suitability score. This can be seen in the parcels that are ranked as medium suitability in Key Site 8; they are close to a wetland area and fare better than similar parcels in Key Site 9, which are further from a wetland area.

Map 22, Map 23, Map 24, Map 25: Final Site Suitability Maps









Transportation Infrastructure improvements

Maps 26-29 show overall suitability for the four land use categories incorporating the planned transportation infrastructure improvements of extending Fowler Road and Ekwill Street to connect Fairview Avenue with SR 217. These maps are displayed with the same classes as Maps 22-25 and are designed to be examined collectively, and compared to Maps 22-25. Ekwill Street would carry a daily volume of 13,300 vehicles per day and Fowler Road would carry 4,300 vehicles per day once extended, and would improve access to SR 217 from within Goleta Old Town (Santa Barbara County, 1998). These extensions have the highest impact on Key Sites 7a and 9. The transportation infrastructure improvements of the Revitalization Plan include improved public transportation circulation, electric shuttles, bikeways and a multi-use trail along the riparian corridor, and parking improvements. We ran the site suitability analysis on a simplified depiction of these improvements, evaluating only the effects of the two road extensions.

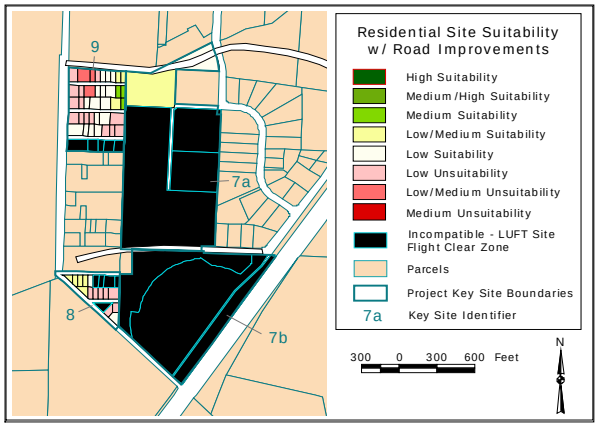
Residential land use shows a marginal increase in suitability scores mainly in the northern portion of the Key Site 7a which would be influenced by Ekwill Street to the north of the study area.

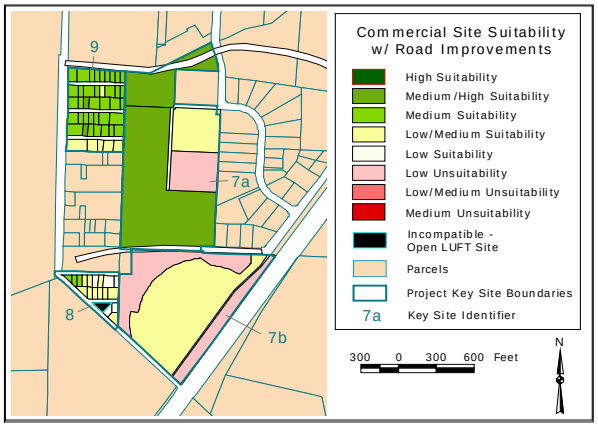
Commercial land use shows an overall increase in suitability scores by one suitability class, with most sites in Key Sites 7a and 9 improving from medium to medium/high suitability. Scores for the large parcel in Key Site 7b also increase from low to low/medium suitability due to connection with SR 217.

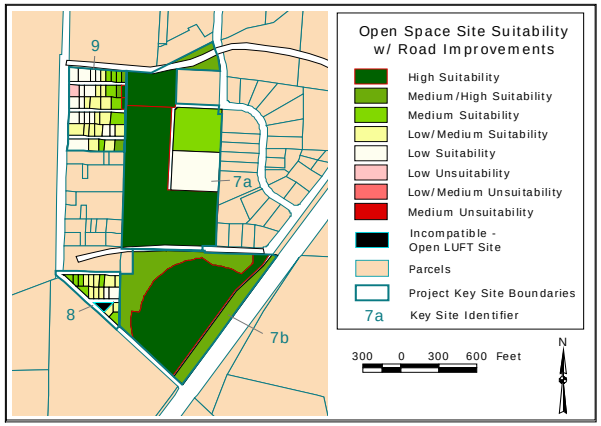
Industrial land use shows some increase in suitability scores in the northern parcels in Key Sites 7a and 9.

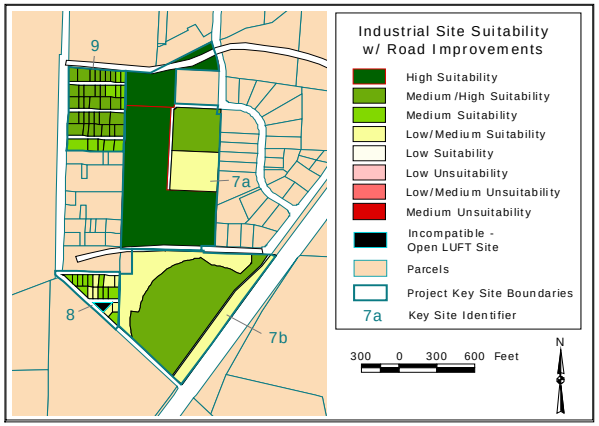
Open space suitability shows little change in scores as access and circulation criteria had low values for this land use.

Map 26, Map 27, Map 28, Map 29: Overall Site Suitability with Transportation Infrastructure Improvements









Discussion

Our discussion is divided into two sections, the first relates to the results obtained for the Goleta Old Town Brownfield Area. The second is an evaluation of the methodology that we developed.

Discussion of Results

The methodology shows what land uses are more suitable and which are less suitable for a particular parcel based on the physical, social, and political characteristics of the area (represented by the criteria used in the analysis). For the four selected Key Sites we examined in Goleta Old Town, the area is best suited to industrial and open space land uses with commercial use slightly less suitable and residential use mostly unsuitable for the area. Given the objective of Santa Barbara County to encourage mixed land uses, a mixture of industrial, commercial and open space would be appropriate for the area (Santa Barbara County, 1998).

- Key Sites 7a has high suitability for both industrial and open space and medium suitability for commercial use. Key Site 7a is unsuitable for residential use as the flight clear zone effectively prohibits residential land uses on this site.

- Key Site 7b has high suitability for open space, medium/high suitability for industrial use, and low suitability for commercial use. Key Site 7b is unsuitable for residential use as the flight clear zone effectively prohibits residential land uses on this site.

- Key Site 8 is best suited to industrial land use, with low/medium and medium suitability for open space, mostly unsuitable for residential use, and mostly low/medium suitability for commercial use.

- Key Site 9 has medium to medium/high suitability for both commercial and industrial land uses, with mostly low and low/medium suitability for open space and mostly low unsuitability and low suitability scores for residential land use.

Incorporating the planned transportation infrastructure improvements into the analysis enables us to see the effect of these improvements on the suitability scores of the sites. The Ekwill Street extension would constitute an additional main arterial road in the area and thus has a suitability enhancing effect on the northern parcels of Key Sites 7a and 9. The Fowler Road extension would provide access to SR 217 for Key Site 7b.

The results from the site suitability analysis support decision-making. There may be additional considerations that need to be taken into account when making final recommendations for redevelopment. Our analysis was performed on a section of Goleta Old Town, which is a cohesive neighborhood. Factors that influence the entire neighborhood such as the need for affordable housing or the entry of a particular keystone

industry may need to be considered. In addition, less tangible considerations such as "sustainability" principles may play into the decision-making process.

One examination of our results is accomplished by comparison with the redevelopment objectives that Santa Barbara County has developed for each of the Key Sites. County decisions are based on local expertise and pre-existing conditions. Our site suitability analysis categories incorporate County objectives and needs, and include additional factors we considered important to the decision. Therefore, we expect some consistency of our results with the Revitalization Plan, as is seen.

The following is a comparison of our suitability results against the Revitalization Plan objectives for our selected Key Sites:

Key Site 7a has parcels of low, medium and high suitability for industrial use. The Revitalization Plan indicates goals of industrial expansion, maintaining aesthetic and landscaping policies consistent with a gateway development, and including a 50-ft. open space easement along Old San Jose Creek and construction of a Multi-Use Trail across the parcel.

Key Site 7b has parcels of low/medium and medium/high suitability for industrial use. The Revitalization Plan indicates goals of industrial expansion, possibly involving filling the site to raise development levels above the floodplain. Landscaping policies, and linkage with the Old San Jose Creek Multi-Use Trail and Bikeway are consistent with a gateway development.

Key Site 8 has parcels of low and medium suitability for industrial use. The Revitalization Plan indicates goals of public infrastructure improvements (street paving, street lights, sidewalks, parking, landscaping and flood control), improved visual appearance, and future businesses as part of a gateway development.

Key Site 9 has parcels of medium and medium/high suitability for industrial use. The Revitalization Plan indicates goals of a wide range of intensive industrial uses, general clean-up, night lighting, landscaping, and other public improvements.

Influence of Categories on Overall Site Suitability Score

In the site suitability scheme our categories were weighted according to their relative importance to each other. In order to better understand our methodology we calculated the range of possible values for each category (Appendix F). It was difficult to anticipate the values that would result from the analysis because these values were dependent on a weighted sum of multiple factors. Factors such as frequency of occurrence of particular variables within the attribute table of the GIS or the heterogeneity or homogeneity of variables across the selected Key Sites made prediction of results complex. In order to better understand the weighted influence of each category on the final site suitability score we decided to step back from the analysis and investigate the behavior of our methodology under more controlled conditions.

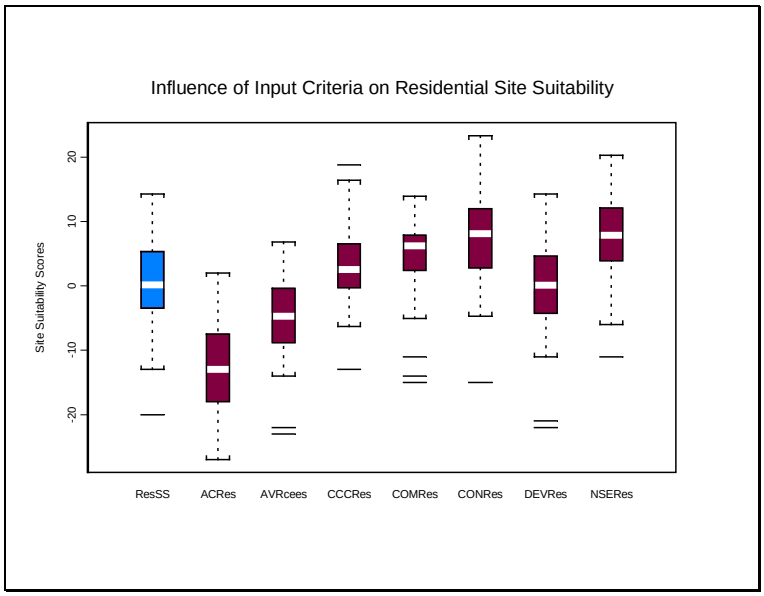
Our approach was to perform a second series of site suitability calculations for each potential land use category. We removed one category at a time from the analysis and recalculated the site suitability score to see the impact that the absence had on the overall site suitability. For example, to see what kind of influence each category had on overall residential site suitability, we recalculated seven new site suitability scores, each excluding one category in the analysis, to show the influence of the missing category. For example, to examine the influence of access and circulation on residential site suitability we calculated a new suitability score using the weighted sum of the six other categories. The difference between this result and the overall residential site suitability gives a measure of how influential access and circulation is in the overall site suitability results.

Results of these influence investigations are shown as boxplots in Figures 5-8. Boxplot diagrams are useful as an exploratory tool for showing range of values in a dataset and as a means to allow comparison between datasets (Krause & Olson, 1997). The first "box" in each of the four boxplot diagrams shows the full site suitability score distribution, highlighted in blue. The seven boxplots that follow are the same data set minus the indicated category. By showing the same dataset absent the criteria of interest we can observe how each individual category element influences the overall site suitability score. From left to right the categories that were removed are: access and circulation, aesthetic value, chemical contaminant concern, compatibility, constraints, and redevelopment potential. Note that the y-axis is scaled differently between land uses.

Categories which have a positive impact on the overall score are: access and circulation, aesthetic value, and redevelopment potential. When these are removed from the site suitability calculation the score decreases. Categories which have a negative impact on the overall score are: chemical contaminant concern, constraints, and noise. When these are removed from the site suitability calculation the score increases. The compatibility score can have either a positive or negative influence depending on the land uses surrounding the parcel of interest.

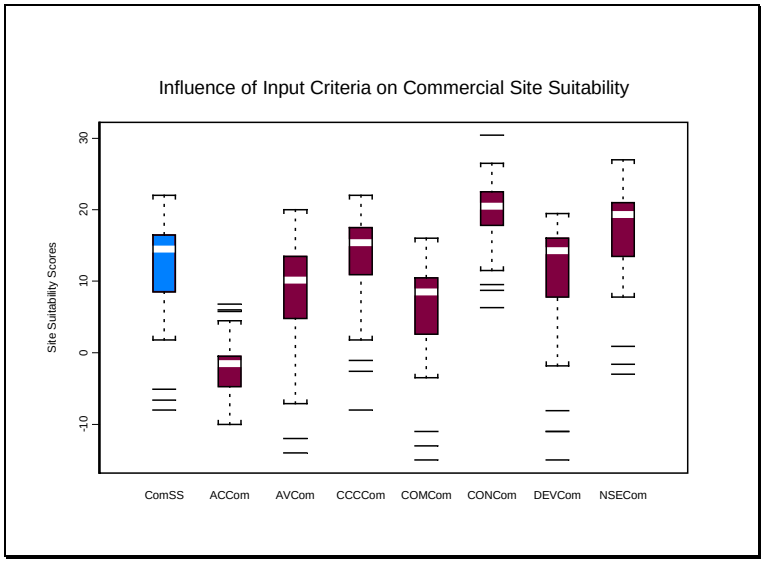
Residential Site Suitability: The first "box" is the full site suitability score distribution and shows a median of zero for the overall residential site suitability dataset, and a fairly even distribution about the median. The site suitability score is affected by the removal of most categories, with the exception of the redevelopment potential category, which shows very little overall change. Site suitability is most affected by removal of the access and circulation category, revealing a large influence for this category. The fact that there is virtually no overlap between the access and circulation and overall site suitability boxes indicates a strong influence for this category. Besides access and circulation, aesthetic value, constraint and noise categories had the greatest influence on residential site suitability.

Figure 5: Influence of Categories on Residential Site Suitability



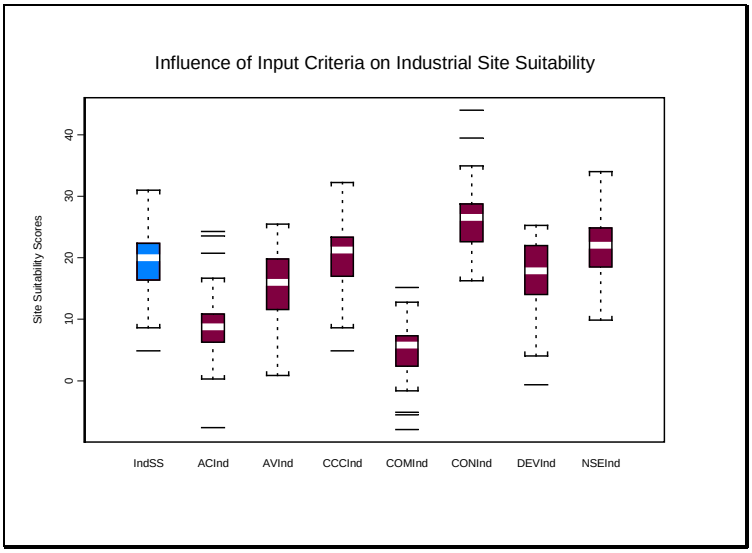
Commercial Site Suitability: The first box for commercial land use shows a median of fifteen and a skewed distribution towards higher values.. The second box shows that access and circulation has an effect on not only the median value, but also on the distribution of values. When access and circulation is removed from the site suitability calculation the range of values decreases dramatically, and the site suitability median drops below zero. The constraint category shows a similar, though lesser, effect on the distribution of output values, and an opposite effect in the direction of change.

Figure 6: Influence of Categories on Commercial Site Suitability



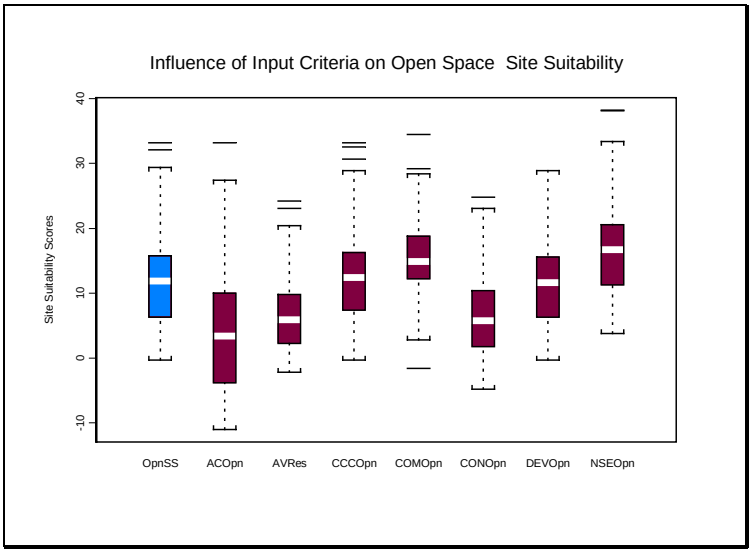
Industrial Site Suitability: The first box for industrial land use shows a median of approximately 20 and a tight distribution around the median. The access and circulation and compatibility categories show the most influence here, each dropping the median score by more than 10 points and tightening the central range of the distribution when they are excluded from the analysis. Chemical contaminant concern and noise categories are not very influential to this land use. Excluding the constraint category increases industrial site suitability scores.

Figure 7: Influence of Categories on Industrial Site Suitability



Open Space Site Suitability: The median score for open space site suitability is around 10 and there is a tight distribution around the median. It is interesting that in this scenario the absence of the constraint category has an opposite effect than in the other site suitability categories. This suggests that constraints are having a negative pull on site suitability for residential, industrial, and commercial and a positive influence on open space suitability. Also, median values are not affected as greatly in this category as they are for the other three, suggesting that open space suitability is less sensitive to category inputs than the other land use scenarios.

Figure 8: Influence of Categories on Open Space Site Suitability



Overall we see that access and circulation, compatibility, and constraint are the categories which have the greatest influence on the final site suitability scores. Examination of the site suitability matrix in Appendix F shows that these are among the most heavily weighted categories in our analysis. Note that although the category chemical contaminant concern had the highest weight of any category it did not display as significant a role in determining the overall site suitability score. This is due to the fact that this category only affects a limited number of parcels and while there may be a large effect on any one parcel the effect on the distribution of scores is minimal. To really understand the influence that each category has on the overall site suitability score it would be necessary to test the methodology on a variety of areas which have a more diverse set of input characteristics.

Discussion of our methodology

GIS Database Assessment

A significant portion of time spent on the project was used in preparing the GIS for the site suitability analysis. This involved cleaning up the data and getting it into a usable format. The GIS data came from a variety of sources, at different scales and levels of accuracy. In using data from different scales, there is a potential for inaccuracies to be introduced. We corrected our data whenever it was required for the site suitability analysis or when it was feasible to do so. Still, the quality of the analysis is constrained by the quality of the data used as input.

Our study focused on 70 parcels within four selected Key Sites. Our site suitability was performed as a sequence of numeric calculations. In order to support these calculations, we had to make several annotations to the database so that the site characteristics of interest were encoded in a numeric format. These additions often involved several operations in the GIS and sometimes involved correction of data. Extending the site suitability methodology to areas outside of our selected Key Sites would have been useful to a critique of the method, but would have required more data resources and detail than were accessible.

As mentioned above, our site suitability analysis required extensive additions to the parcel theme attribute table. Most of the criteria variables had to be encoded explicitly into the database. Intermediate steps were also encoded in the database. As such, changes could not easily be made to the analysis. When changes were made to the analysis the whole sequence of calculations needed to be repeated. A centralized assessment manager such as EMDS would have facilitated this more efficiently.

Subjectivity

Although we have developed and demonstrated a systematic method of decision making in that all parcels are analyzed in same manner, there is subjectivity in all areas. This includes deciding what criteria to include, assigning intervals and values, assigning weights to classes, and interpreting scores into suitability ranks.

Performing the analysis on a small area that we had first hand knowledge of made it difficult to assign values to criteria objectively. In some cases we valued criterion based on knowledge that it might be the most appropriate land use for the area rather than letting the analysis show suitability. For example we valued intersection with the flight approach zone as a positive criterion for open space use. This reflects an assumption that other land uses are restricted in the flight approach zone. Therefore some criteria values need to be adjusted.

In refining the values to reflect the intended influence of the weights and categories it required an evaluation of the results and knowledge of the influence of categories. There is subjectivity in adjusting the method based on evaluation of the results.

There are areas of higher and lower subjectivity however, the openness of the method allows recognition of the factors that influence the results. Demonstration of this methodology on another project area would illustrate the areas of high subjectivity.

Improvements and Further Research

We reviewed the available literature, but were not able to find a complete and detailed description of a site suitability methodology that could be applied to our Brownfield area. We did find some studies that provided general guidelines for performing a site suitability analysis, but they did not give specific details on implementation. After performing two runs with our methodology, we noticed parts of the technique could be improved.

When we calculated a value for the "neighborhood" compatibility criteria we did not take into account the relative size of the parcels. Thus, in our method a small parcel carries the same weight as a large parcel. For example, no distinction is made in this calculation between the small parcels of Key Site 9 and the much larger parcels of Key Site 7a. This became an issue when calculating the "neighborhood" compatibility of the large parcels, which sometimes had as many as 17 neighbors. All neighbor parcels had the same weight in the calculation, so no distinction was made between a neighbor which bordered on 5% of the lot boundary or one that bordered on 30%. Several small, neighboring parcels had a more of an overall influence on the compatibility score than a single large neighbor, even though the large neighbor occupied more space or shared a larger segment of the parcel boundary. The neighborhood compatibility calculation could be improved by incorporating some measure of parcel size into the calculation.

Relative area is also an issue when it comes to some of the binary values used in the study. We were interested in including information about intersection with such physical features as the 100-year floodplain or administrative features such as the flight clear zone. In our study intersection was coded as a simple binary value, either true or false. No distinction was made between a parcel that intersects only 5% of the 100-year floodplain and one that is completely within the floodplain. One would expect a difference in terms of the constraints imposed on these two parcels. In this case using a ratio scale to account for percentage overlap would help reflect the constraints more realistically.

Certain categories identified in the site suitability matrix (Appendix 2) were not included in our analysis due to lack of data or because the category was not a factor for our particular selected area. These are highlighted in gray in the matrix and include such things as: capacity of services, proximity to school, contaminant concentration, and whether the area falls into the Local Coastal Plan or Heritage District administrative zones. A more thorough site suitability analysis would have involved some of these factors.

It would also be instructive to apply the site suitability analysis to areas having different characteristics than our Key Sites. Our selected Key Sites were in a predominantly industrial area, so suitability scoring was only tested under a limited set of conditions. The technique could be applied to areas having more heterogeneous land use or zoning characteristics, or a

different predominant land use, for example a central business district. In addition, our selected area was rather small, containing only 70 parcels. The technique should be further tested on a larger study area.

Given our limited resources, we could not include all factors that we deemed important to a full exploration of environmental decision-making in the Old Town Brownfield area. The following are some ideas on how our work could be improved and extended.

Extensions of our Research

1. While we did include an investigation of the influence of our category factors on the overall site suitability score, we did not pursue a thorough sensitivity analysis of our criteria and category inputs. This type of analysis would give a better understanding of the sensitivity of output values to changes in input values. Criteria values could be varied, noting corresponding changes in output. Intervals specified in the criteria could be changed (e.g. change the definition of Interval I from 0-1/4 mile to 0-1/2 mile). Category weights could be examined by varying weights systematically, then monitoring changes in the output values.

2. Brownfields redevelopment is a multi-faceted issue which includes aspects of liability risk, regulatory uncertainty, financing, economic depression (exhibited by declining property values and local unemployment), and community involvement. Over the past few years, several states have tried different approaches to addressing these issues, learned valuable lessons, and ultimately developed new tools and strategies that are now stimulating redevelopment, housing, and new jobs. These issues are acknowledged by the US EPA Brownfields Redevelopment Initiative, and are elements of the Santa Barbara County Brownfields Pilot. Further research would examine these issues in Goleta Old Town Brownfields and explore integration of them into the site suitability methodology.

3. Examination of the use of this GIS decision support tool for monitoring land use changes and specific projects. One of the functions of a county planning agency is to track land use change, and currently approved and pending development projects. Further research would track the utility of the GIS and evolution of the suitability results with respect to Brownfields redevelopment.

Conclusions

A GIS of parcel-scale land use data allows the decision-maker to compile, organize, and analyze data for brownfields redevelopment. This project demonstrated the use of GIS in evaluating the appropriateness of different land uses. A single system was used to compile, manipulate, and store parcel level information on the physical and non-physical characteristics of the area and used for analysis of the to area and to analyze the impact of planned roadway improvements

A decision support system allows creation and evaluation of different "scenarios" which demonstrate a range of possible decisions, enable comparisons of outcomes, and facilitate incorporation of values or goals in identification of the "best" decision. In the case of Goleta Old Town, scenarios can be built for different regulatory policies, varying economic and demographic growth projections, disturbances, or specific community goals (e.g., "a sense of place").

Using standardized approaches in public decisions can reduce the mystery or uncertainty in public agency decisions, enhance public participation, and encourage innovation. Using a GIS-based decision support tool to formulate decisions allows the decision-making process to be standardized, with results repeatable by others. Model data and assumptions are accessible for viewing by others. Decision-makers can go into the data and model, and see why/how a decision resulted. A formal entity (e.g., a planning agency) can formalize goals, policies, and methods in the GIS and generate repeatable results consistent with its models, even with different operators of the system. This reduces the inconsistencies which occur with incremental decision-making over time.

A GIS enables a brownfields redevelopment model based on relevant site characteristics. With an established data model, data can be systematically collected and analyzed, decision criteria can be established, and decision-making is therefore formalized and consistently implemented.

GIS helps evaluate decision-making methods. The user can view and modify the data model (what criteria are considered) and can view and modify the weighting and ranking of criteria.

GIS helps evaluate results. Viewing intermediary results that contributed to ultimate results prevents the decision process from being a "black box". A GIS allows the methods to be viewed by any user so that decisions and methods can be better evaluated. The user can modify criterion to analyze the effect of that criterion on the decision. In complex scenarios, it may not otherwise be possible for a human to distinguish the subtler effects of specific criterion on the overall decision.

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Appendices

Appendix A: Included Base Layers

Planning:

- Land Use
- Zoning
- Parcel Base Map

Constraints

- Flight Clear / Approach Zones
- Noise Contours
- 100-Year Floodplain
- Design Constraints
- Regulated Sites
  - TRI
  - RCRA
  - LUFT

Demographic:

- Census Data (1990)

Infrastructure:

- Roads
- Proposed Construction / Infrastructure Improvements

Landscape Features:

- Vegetation Cover
- Surface Hydrography
- Riparian Corridor

Environmentally Sensitive Habitat

Wetlands

Site Topography:

Digital Elevation Model (1999)

Elevation Contours

Planimetric:

Building footprints

Vegetation footprints

Aerial Photography:

High Resolution Color Aerial Photography (1995, 1:12,000)

Time-Series Black and White Aerial Photography (1943, 1954, 1967, 1976, 1986, 1997, undetermined scale)

Historical Information:

Historical land ownership (hardcopy maps 1933, 1954)

Appendix B: GIS Layer List

GIS Layers	Available	Acquired	Ready for Use?	Date Received	Format	Provider	Source Projection/Datum	Units	Resolution	Meets FGDC compliance?	Scale/Precision	Topology?	Primary Source	Contact Person	Notes
100-year floodplain	Y	Y	Y	9/27/99	ArcView (.shp)	SBFD	CA SP Zone V NAD27	feet	N		1:24,000	Y	FEMA Flood Insurance Rate Maps	Kristen Zechar	Shapefile created from AutoCAD; check AutoCAD file for original info; conducted from separate coverages, circa early 1990's; Not officially adopted
Digital Orthophoto Quarter Quadrangle (DOQQ)	Y	Y	Y	9/27/99	tif	Aerometrics Digital Library	CA SP Zone V NAD83	feet	(blank)		1:12,000	-	USGS	Greg Janes	
High resolution color aerial photograph	Y	Y	Y	3/12/00	tif	UCSB Map & Imagery Lab	Unity	feet	(blank)	N	1:12,000	-	Pacific Western Aerial Surveys, Inc.		Scanned at 600 dpi. Photo series 550 W frame 62, flown 9/1997.
Aerial photograph background base	Y	Y	Y	9/6/99	tif	UCSB Geography	CA SP Zone V NAD83	feet	N		?	-	UCSB Map & Imagery Lab	Ryan Aubry	Scanned at 300 dpi.
Census data/demographics	Y	Y	Y	9/5/99	ArcView (.shp)	UCSB Geography	CA SP Zone V NAD83	feet	N		1:100,000 (?)	Y	US Census Bureau	Ryan Aubry	Single blockgroup for area south of Hollister, west of Fairview, west of SR 217
Derived Layer - Heritage District			Y	-	ArcView (.shp)	-	CA SP Zone V NAD83	feet	(blank)	N	?	?	GCPRP	Old Town Project	Digitized by DT 1/6/2580
Derived Layer - Key Sites			Y	-	ArcView (.shp)	-	CA SP Zone V NAD83	feet	(blank)	N	?	?	GCPRP	Old Town Project	Digitized by DT 1/6/98
Derived Layer - Site Suitability			Y	-	ArcView (.shp)	-	CA SP Zone V NAD83	feet	(blank)	N	?	?	Old Town Project	Old Town Project	
Digital Elevation Model	Y	Y	Y	10/1/99	ArcInfo (DEM)	Mark de la Garza	CA SP Zone V NAD83	feet	?	?	3 meter grid cell resolution	-	UCSB Dept. of Geological Sciences	Mark de la Garza	Subset from Santa Barbara DEM
Elevation contours	Y	Y	Y	10/27/99	ArcView (.shp)	SBFD	CA SP Zone V NAD83	feet	N		?	N	Santa Barbara County Flood Control	Ryan Aubry	5' contour intervals (?)
EPA Listings	Y	Y	Y	10/1/99	ArcView (.shp)	Mark de la Garza	CA SP Zone V NAD83	feet	?	?	0.0001 decimal degrees	N	US EPA	Mark de la Garza	Updated from US EPA website
Groundwater Basin	Y	Y	N	10/27/99	ArcView (.shp)	SBFD	CA SP Zone V NAD27	feet	N		?	N	SBFD AutoCAD	Kristen Zechar	Shapefile created from AutoCAD; check AutoCAD file for original info; not used for our project but included
Hydrographic features (vertices)	Y	Y	Y	7/2/99	ArcView (.shp)	SBFD	CA SP Zone V NAD83	feet	N		?	N	SBFD AutoCAD	Kristen Zechar	
Land Use	Y	Y	Y	9/5/99	ArcView (.shp)	UCSB Geography	CA SP Zone V NAD83	feet	N		?	?	SBFD	Ryan Aubry	
Land Use Overlay Designations - Various	Y	Y	Y	10/27/99	ArcView (.shp)	SBFD	CA SP Zone V NAD27	feet	N		?	N	SBFD AutoCAD	Kristen Zechar	Shapefile created from AutoCAD; check AutoCAD file for original info
Master Environmental Assessment Parcels	Y	Y	Y	10/27/99	ArcView (.shp)	SBFD	CA SP Zone V NAD27	feet	N		?	N	SBFD AutoCAD	Kristen Zechar	Shapefile created from AutoCAD; check AutoCAD file for original info; Compiled from numerous sources at different scales and accuracies
Parcel base map (land value & improvement value)	Y	Y	Y	09/1998; 7/2/99	Lotg, dwg	UCSB Geography/SBFD	CA SP Zone V NAD83/NAD27	feet	N		?	Y	SB County Assessor's Office	Ryan Aubry/Kristen Zechar	The parcel base from Aubry was from the Assessor's office. The parcel base from Zechar was on a different datum and was an unjoined format
Planimetric (building, vegetation footprints)	Y	Y	Y	9/5/99	ArcView (.shp)	UCSB Geography	CA SP Zone V NAD83	feet	N		?	N	Santa Barbara County Flood Control	Ryan Aubry	
Planned infrastructure improvement - public (Old Town Revitalization Plan)	Y	Y	Y	10/27/99	ArcView (.shp)	SBFD	CA SP Zone V NAD27	feet	N		?	N	SBFD AutoCAD	Kristen Zechar	Shapefile created from AutoCAD; check AutoCAD file for original info; from Old Town Revitalization Plan
Roads	Y	Y	Y	9/5/99	ArcView (.shp)	UCSB Geography	CA SP Zone V NAD83	feet	N		?	N	?	Ryan Aubry	
Soils	N	N	N	-	ArcInfo coverage	USDA NRCS	UTM Zone 10/N1 NAD27	meters	?		1:24,000	?	USDA NRCS	-	Inappropriate scale for our project
Subsurface groundwater	Y	Y	N	3/1/00	text file	Goleta Water District	None	-	N		-	-	Santa Barbara County Project Clean Water	Oscar Figueroa	Unable to use - inconsistent format
Subsurface outlying ag	Y	Y	N	1/2/00	hardcopy	UCSB Map & Imagery Lab	unknown	-	-		1:24,000	-	Dibblee Geological Foundation	-	Hardcopy only, not incorporated in GIS
TIGER Road Layer	Y	Y	Y	9/5/99	ArcView (.shp)	UCSB Geography	CA SP Zone V NAD83	feet	N		1:100,000	-	US Census Bureau	Ryan Aubry	
Zoning	Y	Y	Y	9/5/99	ArcView (.shp)	UCSB Geography	CA SP Zone V NAD83	feet	N		?	?	SBFD	Ryan Aubry	From SBFD, said to their parcel base
Zoning Overlay Designations	Y	Y	Y	10/27/99	ArcView (.shp)	SBFD	CA SP Zone V NAD27	feet	N		?	N	SBFD AutoCAD	Kristen Zechar	Shapefile created from AutoCAD; check AutoCAD file for original info

SBFD: Santa Barbara County Planning & Development Department
USDA NRCS: United States Department of Agriculture Natural Resource Conservation Service
GCPRP: Goleta Old Town Revitalization Plan

Appendix C: Informational Handout

Environmental Decision-Making in Goleta Old Town Brownfields

[illegible], Doug Tallman, [illegible]

April 1999 - April 2000

www.bren.ucsb.edu/OldTown

Environmental Decision-Making in Goleta Old Town Brownfields

As a group thesis for the Master's of Environmental Science and Management at the University of California, Santa Barbara, we will work with local government, community, and other stakeholders to address the research question:

"How can a geographic information system be used to drive the formulation and selection of goals for Brownfields development?"

A Geographic Information System (GIS), based on new and existing parcel-level information, is the core for our analyses. This system and the data will be made available for future input, integration, and analysis upon the completion of this project.

Brownfields Assessment Demonstration Pilot

In 1997, Goleta Old Town, Santa Barbara County was awarded an U.S. EPA Brownfields Assessment Demonstration Pilot. The Pilot area, with a population of roughly 5,000, encompasses about 600 acres with approximately 50 potential brownfields sites with known and suspected environmental contamination. Pilot objectives include restoring Old Town as an economically vital social and cultural focus of the Goleta Valley community, creating effective development partnerships, implementing sustainable land uses, and encouraging diverse commerce and business. Santa Barbara County has also developed a Revitalization Project to physically and economically revitalize this area through joint public-private efforts.

> Our Master's thesis demonstrates the efficacy of GIS in addressing Brownfields, providing a comprehensive view of otherwise fragmented information and a tool for analysis. The GIS will also provide an information baseline for other analyses.

The three components of our project are:

- **Physical site characterization and assessment:** An inventory and assessment of the degree of contamination of impacted parcels, spatial patterns in contamination, and identification of priority sites for remediation, exposure and future land use options, using spatial data as the core information base.
- **Human health risk assessment:** An analysis of human health risk, based on site characterization data, for evaluating options for Goleta Old Town contaminated sites.
- **Physical site suitability methodology and application:** Development of a system for ranking and proposing land use options for redevelopment based on physical and human health characteristics, and revitalization priorities. Application of this methodology to selected Key Sites. Delivery of this methodology in a decision-making framework via a workbook.

Master's of Environmental Science and Management

The Donald Bren School of Environmental Science and Management is a professional school aimed at training graduate students in rigorous, interdisciplinary approaches to environmental problem solving. The Master's Thesis Group Project addresses a current problem in an environmental issue that contains both scientific and management challenges and involves a comprehensive analysis of the issue from a multidisciplinary perspective.

We welcome input and suggestions. For further information, please contact the project members at:

Oldtown@bren.ucsb.edu
4670 Physical Sciences North
Santa Barbara, CA 93106-5131
Phone: (805) 893-7363 FAX: (805) 893-7612

Appendix D: US EPA Brownfields '99 Conference Report

Attended by: Effie Milionis and Linda Zwick

Abstract

Environmental Decision-Making in Goleta Old Town Brownfields is working with local government and other stakeholders to address the research question: 'How can a geographic information system be used to drive the formulation and selection of goals for Brownfields development?'

A Masters of Environmental Science and Management Project at the University of California, Santa Barbara, this will be accomplished by developing a GIS system, based on new and existing information at the parcel-level and using this system as the core for analyses. The three components to the project include site characterization and assessment, risk management and community concerns, and development and application of a site suitability methodology. This system and the data will be made available for future input, integration, and analysis.

What we learned

We presented our work to date in an interactive roundtable discussion in the Marketplace of Ideas session. The overall response to the Goleta Old Town Project was supportive and amenable. We were referred to several projects addressing similar issues as we are, such as the City of Shreveport, Louisiana Brownfields Redevelopment Initiative (http://www.ci.shreveport.la.us/dept/cd/brnfield.htm), the Argonne Laboratory Triage Approach to Land Reuse (http://www.ipd.anl.gov/ipd/portfolio/partner.pdf) and the City of Jacksonville, and Tallahasee, Florida Brownfields projects.

Valuable suggestions were given and questions posed for our methodologies for site characterization, GIS data layer design, and risk assessment components, which we have incorporated where appropriate into our project.

Other Sessions attended

The City of Emeryville Brownfields Pilot Project

This session described the successes of the City of Emeryville's brownfields pilot project that was awarded first prize in the Information Technology in the Environment Category at the Global Bangemann Challenge in Stockholm, Sweden. The city's goal is to develop a city-wide mitigation and risk management plan that will include a water management plan, public education programs, a mitigation fund, and a GIS-based "one stop shop."

Speakers

Lester Feldman (Facilitator)	Geomatrix Consultants
Ignacio Dayrit	City of Emeryville Brownfields Project Manager

The City of Emeryville Project is known as one of the most successful Brownfields redevelopment model in place. They have developed an on-line One-Stop Shop, offering images and search functions to be performed from their GIS on the Internet. This project has addressed many of the issues that we are addressing in Goleta Old Town. Attending this session allowed us to compare

methods and approaches between the 2 GIS databases as well as participate in the discussion with others from different projects in regards to the use and design of such a system. Specifically, the Emeryville GIS includes a Real Estate Layer of available properties, as well as a Risk Registry, which indicates where risk-based solutions were put in place, and a site status layer which labels the site as closed, ongoing, etc. These are all suggestions we are considering in making our database more comprehensive and useful, as well as for suggesting directions for future research.

Another interesting aspect of the Emeryville Project is that the City is assuming groundwater liability, assessment, and clean-up costs at cost to the stakeholders. The City perceives groundwater as the deal-breaker in redevelopment. They have compiled a Regulatory and Stakeholders Task Force, which includes the State Department of Toxic Substances Control and the State Water Resources Control Board. The Project has developed a Groundwater Management Plan, which assures ecological protection of the natural resources affecting the San Francisco Bay. Additionally, the City has taken the role of managing regulatory authority on behalf of the relevant lead State agencies via a Memorandum of Understanding.

Science Simplified: Translating Choices into Assessment and Cleanup Decisions!

This panel session featured a discussion of the environmental decision-making process: from how to incorporate and relay science-based information from risk assessments to stakeholders in the decision-making process. Using a real-life example, participants explored brownfields redevelopment risks and tools for translating complex scientific processes to the layperson.

Speakers

Judith A. Shaw	New Jersey Department of Environmental Protection
James Donovan	Strategic Diagnostics, Inc.
Nigel Fields	TAB Program, U.S. EPA
Renu Khator	University of South Florida
Lisa Szymecko	Michigan State University
Elizabeth T. Timm	Agency for Toxic Substances and Disease Registry

Mirror, Mirror on the Wall... Brownfields in a Crystal Ball

Purpose: This roundtable discussion focused on the future of the brownfields world. The presentation featured a talk with Brownfields experts and practitioners about what has worked to spur cleanup and redevelopment thus far; what challenges lie ahead for communities, businesses, and government; and how to collectively address emerging issues.

Speakers

Don Edwards	Justice and Sustainability Associates
Sven-Erik Kaiser	U.S. EPA
Charles Bartsch	Northeast - Midwest Institute
Linda Breggin	Environmental Law Institute
Patrick H. Ridell	Cherokee Environmental Risk Management
Virginia Aveni	Cuyahoga County Planning Commission
Vernice Miller-Travis	Partnership for Sustainable Brownfields Redevelopment

Jennifer Hernandez	Beveridge and Diamond
Joseph M. Schilling	International City/County Management Association

Using Geographic Information Systems (GIS) in Brownfields Projects

This session discussed potential uses of GIS in brownfields including identification of areas for targeting of redevelopment efforts, identification of sites that may have environmental contamination contributing to their idleness (brownfields) and a marketing and information management tool for sites. The session included a demonstration of a the Idle Property Planning Tool (IPPT) a GIS application developed by RTI to aid in identifying and inventorying idle properties in mid-sized cities. Discussion also focused on creating a Brownfields/GIS working group through a joint venture of ESRI and the National Brownfields Association, which we were invited to participate in and on clarification of terminology used in labeling brownfields properties as idle/abandoned/underused.

Speaker

Bill Wheaton	Research Triangle Institute

Useful Contacts

* Malcolm Bender, LandView & Brimms Specialist, USEPA Region 6, Dallas TX

Ignacio Davrit, City of Emeryville Brownfields Project Manager, Emeryville, CA

* Philip E. Elson Aerostar Environmental Services, Inc. Jacksonville FL

Lester Feldman, Geomatrix Consultants, Oakland, CA

* Jerry Horne, Project Manager, Inland Empire Energy Efficiency Project, San Bernardino Valley College, San Bernardino, CA

* Bobbie Kahan, Brownfields Coordinator Superfund Division, US EPA Region 9, San Francisco, CA

* Tony Nelson, National Account Manager, ARCADIS Geraghty & Miller, Santa Barbara, CA

Sara Moola, Environmental Solutions Manager, ESRI, Redland, CA

* Steve Simanonok, Brownfields Coordinator, US EPA Region 9, San Francisco, CA

* Karyn E. Sper, SAIC, Reston, VA

Bill Wheaton, GIS Program Manager, Research Triangle Institute, Research Triangle Park, NC

* attended our session

Overall Value

Attending the National EPA Brownfields Conference was valuable in enabling us to gauge a national perspective of initiatives, technologies, and approaches in Brownfields Redevelopment. This event allowed us to "reality-check" our project against other past and current efforts, to take advantage of lessons learned, and to ensure we are not duplicating efforts unnecessarily. What we found, to our satisfaction, was that our project has been designed comprehensively and our methodologies incorporate the most recent innovations in land use decision-making. Plenary speakers included the Honorable Ronald Kirk, Mayor of Dallas and Carol Browner, U.S. EPA Administrator, who spoke on

urban problems and on brownfields as a key focus for environmental protection in the 21st century, respectively.

Appendix E: Goleta Community Plan: Land Use Designations and Coastal and Comprehensive Plans

(Reproduced from Goleta Community Plan, October 1995, SB County Planning & Development Department)

Open Land Uses
- Agriculture I
- Agriculture II
- Mountainous Areas
- Existing Public or Private Park/Recreation and/or Open Space
- Proposed Public or Private Park/Recreational Facility Overlay
- Open Lands

Residential
- Rural Residential
- Residential Ranchette
- Single Family
- Multiple
- Planned Development

Commercial
- General Commercial
- Neighborhood Commercial
- Service Commercial
- Highway Commercial
- Office and Professional Commercial

Industrial
- Industrial Park
- Light Industry
- General Industry

Community Facilities
- Educational Facility
- Institution/Government Facility
- Public Utility
- Civic Center
- Cemetery
- Transportation Corridor

Overlay Designations
- Scenic/Buffer Areas

Appendix F: Site Suitability Matrix

Appendix G: ArcView Avenue script for land use compatibility

```
'  COMP_SCRIPT
'  Avenue script to calculate the normalized compatibility index
'  for all land use potentials for a user selected parcel.

'  by Doug Tallman
'  2.15.2000
'  NOTE: Not all of the functionality described below has been implemented.
'  Currently the script only gets to Step 5. It does not write the output
'  to the attribute table. The script takes into account only four land
'  uses: residential, commercial, industrial, and open space
'  uses. The script needs to be modified if other land uses are to be taken
'  into account.

'  PreCondition: The user has selected the parcel of interest.

'  Operation: This program will reference the selected
'  parcel and:

'  (1) Find all the neighboring parcels within a specified distance
'      (50 feet is the default hardcoded value).
'  (2) Query the attribute table for the Land Use Code of the surrounding
'      adjacent parcels.
'  (3) Assign scores to each of the land use types of the surrounding
'      parcels.
'  (4) Sum the weighted scores.
'  (5) Normalize the weighted score by the number of surrounding parcels.
'  (6) Write the normalized score to the RES_COMPAT field of the parcels
'      attribute table.

'  Compatibility factor scores
RESadjComm   = 7
RESadjIndust = -5
RESadjOpen   = 9
RESadjResid  = 9

COMadjComm   = 8
COMadjIndust = 7
COMadjOpen   = 8
COMadjResid  = 7
```

```
INDadjComm   = 8
INDadjIndust = 8
INDadjOpen   = 8
INDadjResid  = 2

OPNadjComm   = 8
OPNadjIndust = -5
OPNadjOpen   = 9
OPNadjResid  = 8

'   compabitibility sums
REScompSum   = 0
INDcompSum   = 0
COMcompSum   = 0
OPNcompSum   = 0

'   compatibility scores
REScompScore = 0
INDcompScore = 0
COMcompScore = 0
OPNcompScore = 0

'   counter for number of adjacent parcels
adjParcelCnt = 0

'  Select the parcels in the immediate vicinity of parcel of interest
'  (ie. within 50 feet)
 myView    = av.GetProject.FindDoc("Old Town Brownfield Project - Base Map View")
 fTheme1   = myView.GetThemes.Get(0).GetFTab
 fTheme2   = myView.GetThemes.Get(0).GetFTab

 for each rec in fTheme1.GetSelection
    thisField = fTheme1.FindField("Project_Us")
    thisLUtype = fTheme1.ReturnValueString(thisField, rec)
 end

 for each rec in fTheme1.GetSelection
    thisFieldAPN = fTheme1.FindField("Apnnum")
    thisAPNnum   = fTheme1.ReturnValueString(thisFieldAPN, rec)
 end

 MsgBox.Info("This LU type is "++thisLUtype
              ++"                                          This APN number is
"++thisAPNnum, "Test Value")
```

```
 fTheme1.SelectByFTab(fTheme2,
                      #FTAB_RELTYPE_ISWITHINDISTANCEOF,
                      50,
                      #VTAB_SELTYPE_NEW)

myField = fTheme2.FindField("Project_Us")

for each rec in fTheme2.GetSelection

   currLUtype = fTheme2.ReturnValueString(myField,rec)
   adjParcelCnt = adjParcelCnt + 1

   if (currLUtype = "Residence") then
     REScompSum = REScompSum + RESadjResid
     COMcompSum = COMcompSum + COMadjResid
     INDcompSum = INDcompSum + INDadjResid
     OPNcompSum = OPNcompSum + OPNadjResid
   elseif (currLUtype = "Industrial") then
     REScompSum = REScompSum + RESadjIndust
     COMcompSum = COMcompSum + COMadjIndust
     INDcompSum = INDcompSum + INDadjIndust
     OPNcompSum = OPNcompSum + OPNadjIndust
   elseif (currLUtype = "Commercial") then
     REScompSum = REScompSum + RESadjComm
     COMcompSum = COMcompSum + COMadjComm
     INDcompSum = INDcompSum + INDadjComm
     OPNcompSum = OPNcompSum + OPNadjComm
   elseif (currLUtype = "Open Space") then
     REScompSum = REScompSum + RESadjOpen
     COMcompSum = COMcompSum + COMadjOpen
     INDcompSum = INDcompSum + INDadjOpen
     OPNcompSum = OPNcompSum + OPNadjOpen
   end

 end

'   if statements to subtract parcel of interest weight from count
if (thisLUtype = "Residence") then
  REScompSum = REScompSum - RESadjResid
  INDcompSum = INDcompSum - INDadjResid
  COMcompSum = COMcompSum - COMadjResid
  OPNcompSum = OPNcompSum - OPNadjResid
elseif (thisLUtype = "Industrial") then
```

```
  REScompSum = REScompSum - RESadjIndust
  INDcompSum = INDcompSum - INDadjIndust
  COMcompSum = COMcompSum - COMadjIndust
  OPNcompSum = OPNcompSum - OPNadjIndust
elseif (thisLUtype = "Commercial") then
  REScompSum = REScompSum - RESadjComm
  COMcompSum = COMcompSum - COMadjComm
  INDcompSum = INDcompSum - INDadjComm
  OPNcompSum = OPNcompSum - OPNadjComm
elseif (thisLUtype = "Open Space") then
  REScompSum = REScompSum - RESadjOpen
  COMcompSum = COMcompSum - COMadjOpen
  INDcompSum = INDcompSum - INDadjOpen
  OPNcompSum = OPNcompSum - OPNadjOpen
end

'   remove parcel of interest from parcel count
adjParcelCnt = adjParcelCnt - 1

REScompScore = REScompSum / adjParcelCnt
COMcompScore = COMcompSum / adjParcelCnt
INDcompScore = INDcompSum / adjParcelCnt
OPNcompScore = OPNcompSum / adjParcelCnt

REScompScore.SetFormat("dd.d")
COMcompScore.SetFormat("dd.d")
INDcompScore.SetFormat("dd.d")
OPNcompScore.SetFormat("dd.d")

MsgBox.Info("Residential Compatibility Score = "++REScompScore.AsString
              ++"    Commercial Compatibility Score = "++COMcompScore.AsString
              ++"       Industrial Compatibility Score = "++INDcompScore.AsString
              ++"                    Open Compatibility Score =
"++OPNcompScore.AsString, "Compatibility")

av.ShowMsg("Normalized compatibility calculation complete")
```

Appendix H: Example Site Suitability Calculation

Our study considered four potential land use scenarios in the site suitability weighted scoring scheme. What follows is an example calculation for commercial site suitability for the current Key Site configuration (i.e. no road improvements).

The final site suitability score was a weighted sum of seven category scores. Each category was further decomposed into sub-criteria which were normalized on a range of –9 to +9, constraining the overall category score to a –9 to +9 range. The following shows the relative weight of each category score, the name of the commercial (COM) categories as they appeared in the GIS, and a description of the category.

```
2.5 COM A&C CatScr – Category Score for Circulation & Access
1   COM AV  CatScr - Category Score for Aesthetic Value
4   COM CCC CatScr - Category Score for Chemical Contamination
    Concern
3   COM COM CatScr - Category Score for Compatibility
3   COM CON CatScr - Category Score for Constraint
3   COM DEV CatScr - Category Score for Redevelopment
1   COM NSE CatScr - Category Score for Noise
```

Appendix F shows the entire weighting scheme for the site suitability method. The four columns of land uses show the relative weights of criteria within each category. Thus, the Access and Circulation Category Score (A&C) for a Commercial Land Use option is calculated by multiplying each criteria by a weight of three and then normalizing, by dividing this sum by the number of criteria (three). This was entered in the ArcView "Field Calculator" dialog box as follows:

```
COM A&C CatScr =
    (((3*[TRANS Prox])+(3*[PROX to CBD])+(3*[COM Prox Class I]))/3)
```

The Aesthetic Value (AV) category for commercial land use has a single criteria with a weight of two. In this case there was a single criteria so normalization was not required. This was entered in the ArcView field calculator as follows:

```
COM AV CatScr  =
    (2*[PROX to Aesthetic])
```

The Chemical Contaminant of Concern (CCC) category was comprised of four influencing criteria. The other "LUFT open" criteria acts as a placeholder to flag a parcel as unsuitable and does not contribute to the weight of this category score. The CCC category score for commercial land use was calculated with the ArcView field calculator as follows:

```
COM CCC CatScr =
    (((-4*[PROX to Contam])+(-1*[Bin Luft closed])+(-2*[Bin
    RCRA])+(-4*[Bin TRI]))/4)
```

The Compatibility category consisted of two criteria: neighborhood compatibility and zoning compatibility. Neighborhood compatibility had a relative criteria weight of one, while zoning compatibility had a relative weight of three. The parcel of interest received a positive multiplier (i.e. +1) if it was zoned for the land use under consideration – in this case

commercial land use. This value was then multiplied by the criteria weight of three. If the current zoning was different than the land use under consideration, the parcel of interest received a negative multiplier (i.e. –1). This was also multiplied by the criteria weight of three. The "- 2" operation is an artifact from our attribute table in ArcView. We were not able to enter negative values in this column of the attribute table so we entered value of three and one, and in the calculation subtracted an offset of two to give the desired alternatives of +1 and –1. The sum of the criteria values was then divided by two to normalize the final score. This was entered in the field calculator as follows:

```
COM COM CatScr =
    (([NORM COM Compat]+(([COMM Zoning]-2)*3))/2)
```

The constraint category had four criteria weighted as shown below for a commercial land use consideration. This sum was normalized by dividing by four. This was entered in ArcView as follows:

```
COM CON CatScr =
    (((-4*[inter_fplain])+(-2*[PROX to Aesthetic])+(-
    7*[int_flappzone])+(-9*[int_flclrzone]))/4)
```

The redevelopment potential category consisted of two criteria: whether or not there was a structure on site and a score for parcel acreage. The sum was normalized over the number of categories (two) and was entered into ArcView as follows:

```
COM DEV CatScr =
    ((( 4*[No Structure Flag] )+(2*[Acreage Cat]))/2)
```

The final category score was noise, which had a single criterion with a weight of negative two for a commercial land use option. Because there was only a single criteria this value did not need to be normalized. This was entered into the ArcView field calculator as follows:

```
COM NSE CatScr =
    (-2*[Noise Levels])
```

After the individual category scores were calculated we obtained the final site suitability score by multiplying category scores by the weights for each category. This calculation was performed with the ArcView field calculator as follows:

```
FINAL SITE SUITABILITY (ComSS)=

    ((2.5*[COM A&C CatScr])+([COM AV CatScr])+(4*[COM CCC
    CatScr])+(3*[COM COM CatScr])+(3*[COM CON CatScr])+(3*[COM DEV
    CatScr])+([COM NSE CatScr]))
```