APPENDIX B

LOS RIOS TRANSPORTATION CONNECTIONS

Assessment of the Transportation Infrastructure through the Use of GIS

by

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Introduction
Transportation is a geographic issue. The goal is to move a group of people from their respective homes to and from the school. The question is how this is best accomplished. By studying the issue in a Geographic Information System (GIS) we can begin to understand the specific issues involved with the current transportation infrastructure and how this relates to the spatial distribution of the students and others involved with the campus.

A geographic information system is a tool used to store and analyze spatial data. In a GIS, information from a table is linked to a location through a symbol on a map. For example, using a table of addresses of students, we are able to map out their distribution on a map. Behind the scene of the symbology on the map we will still have other demographic information about the students. In this project we have compiled student location with the locations of transportation options, other community features, and proposed solutions. We will be able to understand the spatial aspects of the situation. GIS is the tool that provides this functionality.

Process Overview
The first issue was in collecting GIS-related data that could be used in the analysis. Sources of data are outlined below. Once the data was collected, regions surrounding transportation features (such as light rail and bus stops) as well as the campus were created. These regions surrounding a given feature are referred to as buffers. Student address data was available in tabular format. In order to display those addresses on a map, a process called geocoding is required in which the address is converted to points on a map. When this information was processed, we assessed the number and percentage of students that fell within range of the campus as well as transportation hubs (bus stops, light rail stops, bike routes, etc.) With this spatial analysis as well as the assessment of students that fall outside of accessible alternative transportation, decisions can be made to better serve CRC’s students.

Data Collection
Data that was used is listed below along with the data sources for the information. In most instances, this information was available through local and regional government organizations free of charge. The three leading sources of GIS data for the region are:

- **Sacramento County GIS** found at [http://www.sacgis.org/gis_gisdata.aspx](http://www.sacgis.org/gis_gisdata.aspx)
- **Sacramento Area Council of Governments (SACOG) Mapping Center** found at [http://www.sacog.org/mapping/clearinghouse.cfm](http://www.sacog.org/mapping/clearinghouse.cfm)
• **City of Elk Grove** Mapping and GIS division found at http://www.elkgrovecity.org/gis/

The data used in this project was as follows:

• **CRC Campus** – This polygon GIS layer was extracted from a parcel layer obtained from the County of Sacramento.

• **2006 – 2007 Student Address Data** – This data was provided as a table containing address and demographic information for CRC students from the 2006 – 07 academic school year. This includes both part time and full time students for the fall and spring semester. Students that attended CRC for both semesters where counted only once, however the large number of student addresses used (27,113) in this analysis reflects the high turn around of students attending CRC. That is to say, that when looking at the total number of people who took classes at CRC over the course of the entire year, the number far exceeds the student population typically reported for each semester. I opted to use last year’s data so that a complete year’s worth of data could be used. This information was obtained through the research office on CRC’s campus (http://www.crc.losrios.edu/Faculty_&_Staff/Research_Office.htm). Special note should be added regarding the confidentiality of this data. Obviously, this data is highly sensitive. Although I obtained data where the student identification information had been removed (including names and student ID numbers) the resulting maps are only distributed without the accompanying demographic data.

• **E-Tran Bus Routes and Stops** – This data is not data readily stored on a website, but was obtained by contacting the City of Elk Grove Mapping and GIS department.

• **Sacramento Regional Transit Bus Routes** – This data was obtained from the SACOG website. Bus stops were not available from SACOG. Stop information could potentially be obtained directly from Regional Transit based on coordinates of the stops. Although efforts to obtain that information to date have been unsuccessful, Tom Hixson [THIXSON@sacrt.com] is the contact within Regional transit who can make that data available.

• **Sacramento Regional Transit Light Rail Lines and Stops** – This data was obtained from the SACOG website.

• **Regional Bike Routes** – This data was obtained from the SACOG website.

• **Sacramento County Roadways** – This data was obtained from the County of Sacramento and was used in geocoding student addresses.

• **Base Map Imagery** – This data was obtained from the State of California Spatial Information library (http://casil.calepa.ca.gov/casil/remote_sensing/naip_2005/county_mosaics/Sacramento/) and was used for cartographic and reference material.
Data Analysis
In applying the spatial data obtained, we first set off to geocode the address
information obtained from the research office. We then generated the needed buffers
for the transportation hubs and assessed student proximity to those hubs.

Geocode Student Addresses
Geocoding is the process of address data stored as text and generating point locations
on a map. Although the process is somewhat complex, the function is done quite often
using online applications such as Google Maps or MapQuest. In order to geocode
addresses in ArcGIS, you must generate a tool referred to as an address locator.
The general idea of any geocoding is to break apart the text involved in an address,
interpret what each part represents and then reference those address elements against
reference data, typically a road GIS layer. In this process, we created an address
locator using Sacramento roads as the reference data. Many areas around CRC,
specifically, the region of Elk Grove is rapidly growing and finding current road data is
somewhat difficult.
After running the geocoding process on the address information for our students, 85.5%
of the student addresses were matched with a location. The geocoding process was
unable to find the remaining 14.5% for a number of reasons such as the address
provided being a post office box, the road was not yet included on the reference data
used, or the address was outside of the county. We felt that the 85.5% would provide a
clear picture of the overall distribution of student address locations. No further efforts
were made to improve the geocoding results.

Generate Buffers on Key Features
One key issue in generating buffers is in determining appropriate distances. These
distances are used to determine distances that a student might walk or use a bicycle. In
conversations with representatives from SABA, we agreed that a distance of one-half
mile would be an appropriate distance that a student would walk, by choice, to school
or to a transportation hub such as a bus stop or light rail station. We also discussed the
distance of 2 miles as an appropriate distance to use in calculating biking distance.
As noted above in the data sources section, bus stops were not yet available for use
from Regional Transit. Points were generated where the bus lines intersected at major
intersections.
It is also important to note that not all bus stops and routes were used. Only those routes
that have a direct line to campus were used. Transportation options that involve bus
transfers were not used.
All light rail stops were used. Although the light rail station is not yet at CRC, analysis was
run on the light rail in anticipation of that time.

Analyze Student Access to Transportation
With the point locations of students as well as buffers of applicable transportation hubs, comparisons were made. The results with accompanying maps are outlined below.

**Results**

**Overall Student Distribution**

One interesting aspect to the student distribution of CRC students is that there is a pattern. One might anticipate that most of the students would be centered around the campus. On the contrary, CRC students are distributed across the county. Both on campus and district-wide, research has been done to determine this distribution pattern. It is suggested that students pursuing specialized degrees or certificates will travel across town to take classes in their specialty. A map illustrating the student distribution is provided below.

![Map showing student distribution](image)

**Legend**

- Student Addresses

**Walking Proximity**

It was presumed that students that live within one-half mile of campus have the highest likelihood of walking to campus. Of the 27,113 student address locations, 882 were located within the one-half mile buffer of campus. Arbitrarily, 2,354 live within a one mile
radius of campus. Potential campaigns could be run to encourage those additional students (8.6% of the student population) to consider walking. A map highlighting the one-half buffer around CRC is provided below.
Bicycling Proximity

In our analysis, we assumed that students would most likely use a bicycle to travel to and from campus if they lived within 2 miles of campus. 6,331 students were found to live within two miles of campus. As outlined in the SABA report, Highway 99 acts as a barrier to bicycle transportation. As outlined in the map below, many of those students live on the east side of Highway 99.
Proximity to Bus Stops

Bus stops for the E-Tran and Regional Transit bus lines that have a direct line to CRC were assessed. Again, assuming that a student would walk one-half mile, 13,899 (51.3%) students live within that distance to a bus stop. The proximity to bus routes is outlined in the map below.

Assuming that a student might only walk one-quarter of a mile to a bus stop, still 8,870 (32.7%) students live within one-quarter mile of a bus stop that has a direct line to CRC.
Proximity to Light Rail Stops
Assuming that all of the proposed light rail lines and stops will be initiated, 2,651 CRC students live within one-half mile of a rail stop. Although this value is significantly lower than those students near bike routes, the light rail system reaches further out into the county, giving direct access to students who live beyond proximity to bus stops. This distribution is illustrated in the map below.

It is also noteworthy that the development of the light rail station at CRC could potentially draw additional students from outside of the immediate service perimeter.
Overall Service to Students

Based on this analysis, 14,795 (54.6%) students live within one-half mile of campus, bus stops with direct service to campus, or light rail stops. This service area is outlined below.

This map also outlines areas where students live that are not currently served with direct bus or light rail service. These areas include outlying communities such as Galt, North of 47th east of Highway 99, the north portion of Greenhaven/Pocket neighborhood, and areas between Gerber and Calvine East of Highway 99.

Future Applications

It is hoped that this report will serve as a template to other campuses to use in running similar analysis of distribution. There are, of course, other procedures that could be used within a GIS that might provide more accurate results. This could include a cost-distance weight analysis or the application of Network Analyst. These applications take into consideration the road network and use that in considering distance of travel. Availability of current data is a constant issue. Using more current road data in the geocoding process would provide better results. Current student data would provide an assessment of the current conditions.

Running a similar analysis on employees of the college would provide another aspect of transportation. With such information, materials regarding carpooling and alternative transportation options could be delivered directly to those employees involved.