

**University & Community College System of Nevada
New Program Proposal Summary**

Date: November 3, 2000

Campus: University of Nevada, Las Vegas

Proposed Program: Surveying Engineering, B.S. degree

Brief Description of Program:

An ABET-accredited baccalaureate (B.S.) degree in Surveying Engineering, and a 2-year Master of Science degree in Geomatics are proposed simultaneously. The M.S. degree in Geomatics is covered in a separate parallel proposal, and is requested to provide a means for attracting graduate students to support faculty research and the proposed B.S. program. The baccalaureate degree will meet state, regional and national needs for licensed surveying engineers, professionals who combine land measurements with geographic information, systems, global positioning and information technologies to analyze and map both constructed facilities and natural resources. The B.S. degree is proposed to fulfill the requirements of Nevada's land surveying practice act, Nevada Revised Statute 625 (NRS 625), passed by the 1999 legislature, which requires a baccalaureate degree for licensing as a surveyor by the year 2010, provided that a suitable academic program is established and operating within the state of Nevada before the year 2006. The baccalaureate degree is intended for high-school graduates and persons with 2-year associate degrees. Articulation with community colleges will permit persons to obtain a 2-year transfer degree and then complete remaining baccalaureate program requirements at UNLV. Several upper-division courses are proposed to be made available via distance education to facilitate state-wide access.

Demonstrated Need for Program (academic, state, regional, national):

National need

Throughout the 20th century, the surveying profession in Europe and the Americas has developed requirements for baccalaureate degrees as the minimum training for licensure as a professional surveyor. In Canada, recognition of the need for formal academic training for land surveyors led to the development of four-year degree programs in the years immediately following World War II. A four-year degree in surveying or a related discipline, or a two-year surveying diploma plus experience are currently required for licensing in the four western Canadian provinces (British Columbia, Alberta, Saskatchewan and Manitoba), (Source: Western Canadian Board of Examiners, <http://www.alsa.ab.ca>). In Mexico, a federal license is issued by the state universities upon graduation, enabling a surveyor (ingeniero topografo) to practice anywhere in the country. The law for the state of Jalisco indicates that a minimum of three years of study is required for any professional title (<http://www.jalisco.gov.mx/plegisla/congreso/legisla/file157.html>). The sample curriculum a four-year surveying engineering degree in Mexico requires approximately 144 semester credits of study (Ingenieria Topografica, #1, June 1996, pp.11-13).

The United States has been slow to develop four-year degree requirements. Land surveyors may currently be licensed without a college degree in most states. In lieu of a degree, a surveyor must demonstrate six to 10 years of appropriate on the job training and professional experience, and also pass a Fundamentals of Land Surveying (F.L.S.) and Principles and Practice of Surveying licensing examinations. It is now generally recognized that global positioning, geographic information systems and computer technologies have increased the complexity and required level of professional services of the surveying profession. Surveyors' accurate assessments of land boundaries and resources have

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significant legal, economic and political consequences. Land developers, natural resource managers and civil engineers need vast amounts of geographic information for land subdivision, natural resource assessment, and facilities design and construction, respectively, and are relying on surveyors to provide the necessary expertise.

The surveying profession in the United States has recognized the need for formal academic training as a prerequisite to employment, and begun to lobby for legislation that will require 4-year degrees as a prerequisite to licensing. Currently, Florida, Iowa, Maryland, Michigan, New Jersey and New Mexico require a 4-year surveying degree for licensure. However, about 20 other states (including Nevada) are moving towards a 4-year degree requirement. This has led to the development of four-year degree programs at American universities to meet the demand. Accreditation of these degree programs is a critical part of the quality control process, and, as of January 2000, 14 bachelor's degree programs in geomatics, surveying, surveying engineering and surveying technology are accredited by the Accreditation Board for Engineering and Technology (ABET) (source: ABET web site, <http://www.abet.org>).

State need

Recognizing the need for improved training in surveying, the Nevada Association of Land Surveyors (NALS) and the Nevada State Board of Professional Engineers and Land Surveyors (NSBPELS) have, in recent years lobbied the Nevada Legislature for revisions to the Nevada Land Surveying Practice Act, Nevada Revised Statute 625 (NRS 625), that would require a baccalaureate degree for licensing as a Professional Land Surveyor (P.L.S.). In 1999, the Nevada Legislature passed revisions to NRS 625 that require a 4-year degree for licensing as a land surveyor in the year 2010 and after, provided that a suitable academic program is established and operating in the state by the year 2006. Currently, there is no 4-year degree program available within Nevada. The closest institutions with accredited 4-year degree programs are California State University, Fresno, and Oregon Institute of Technology. A Nevada program is needed to meet the requirements of NRS 625. The Nevada Association of Land Surveyors and the Nevada State Board of Professional Engineers and Land Surveyors have approached the University of Nevada, Las Vegas with a request to develop a suitable program.

Regional need

At present, there are no 4-year surveying programs in the states of Arizona or Utah. As mentioned above, four-year degrees are offered in California and in Oregon. A four-year degree program is being developed at California Polytechnic State University-Pomona. A two-year degree program is in place and a 4-year program is under development at Idaho State University. If licensing boards in Arizona and Utah move towards requiring 4-year surveying degrees, a four-year program in Nevada could supply some of the demand, and therefore serve both southwestern and intermountain region needs for training of surveying engineers.

Relationship of Program to System, Division, College and Department:

System relationship

There is a statewide need for four-year and advanced-level training for land surveyors. A two-year, terminal Associate of Arts in Applied Science (A.A.S.) degree in surveying is now available through the Building Technology program at the Community College of Southern Nevada (CCSN). There are no other surveying programs offered in the UCCSN. A proposed curriculum for a two-year transfer degree (distinct from the terminal A.A.S. degree) is included herein that could be implemented at

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UCCSN community colleges. It is also envisioned that distance education would be an integral part of a UNLV four-year degree program, with some upper-division surveying courses available at other UCCSN campuses via Web and video means of distribution. In the attached four-year curriculum, courses proposed to be available via distance means are identified with an asterisk (*). Students could complete the two-year transfer degree and the upper-division courses available via distance education, and reduce the time needed in residence at UNLV to two or three semesters.

Division and College relationships

The University of Nevada, Las Vegas (UNLV) was approached by NALS and NSBPPELS with a request to develop four-year and graduate degrees in surveying and geomatics. UNLV's proximity to Nevada's largest and fastest growing metropolitan area is a major factor in the request to locate surveying/geomatics programs at this institution. Rapid population growth has created significant local demand for surveyors as land is developed for residential, commercial and industrial purposes. Pressure on natural, and archaeological resources in southern Nevada has also generated needs for accurate mapping so that these resources may be preserved as development takes place.

The University of Nevada Las Vegas Howard R. Hughes College of Engineering is proposed as the institutional home for the Surveying Engineering B.S. and Geomatics M.S. programs. The College currently offers accredited four-year degrees in civil engineering, computer science, electrical engineering, and mechanical engineering. UNLV's National Supercomputing Center for Energy and the Environment (NSCEE) and the College of Engineering's Transportation Research Center (TRC) and Department of Civil and Environmental Engineering have existing computing and personnel resources that would play a significant role in the development of a modern surveying engineering/geomatics program.

The College of Engineering's expertise in obtaining accreditation for engineering and computer science programs, and the pre-existing skills and knowledge currently available in the College's Department of Civil and Environmental Engineering, combine to make it the most feasible administrative home for a new program in Surveying Engineering and Geomatics.

Departmental relationship

The Department of Civil and Environmental Engineering has some pre-existing expertise in surveying and has developed a relationship with the two-year Surveying Technology program at CCSN. For more than 30 years, the department has taught Elementary Surveying, CEG 121, as a required course for students in the civil engineering baccalaureate program. The department also recently approved a for-credit course in Public Lands Surveying, EGG 323, to be offered through the University's College of Continuing Education. The department has also offered CEG 423, Advanced Surveying, as an upper-division elective in the civil engineering program. The department also offers, CEG 468/668, GIS Applications in Civil Engineering, to civil engineering majors and to natural science majors from across the UNLV campus. These four courses are anticipated to be part of a four-year program in surveying engineering.

The department's surveying equipment inventory is in the process of being combined with equipment donated by NALS to CCSN for their two-year degree program. The combined inventory will be housed on the UNLV campus, and used for field instruction in surveying courses offered by both UNLV and CCSN.

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Department faculty and graduate students provide 100% of the staffing for the College's Transportation Research Center. Two faculty, two professional staff and a half-dozen graduate and undergraduate students are skilled in instruction and applications of Geographic Information Systems (GIS) technology, and two other faculty are skilled in instruction and applications of surveying.

Review of Directly Related Programs within the Institution:

Civil and Environmental Engineering

The ABET-accredited B.S. degree in Engineering, major, Civil Engineering, is the most closely related program at UNLV. Surveying is essential to the civil engineering profession, where engineers use surveying tools and skills to check the alignments, elevations and locations of roadways, utilities, tunnels, bridges and buildings. Civil engineers also use surveying skills to estimate volumes of earth needed for addition or removal to sites, to estimate land slopes and also to estimate changes in elevation that occur over time (land subsidence). Currently, all civil engineering majors at UNLV are required to take one introductory course in land surveying, and they must use this surveying knowledge in advanced courses in hydrology, foundations and geographic information systems. Civil engineers must frequently interact with professional land surveyors, who generate and graphically organize the information that engineers use in their designs. Currently, three courses offered in the Civil Engineering Department, CEG 121, CEG 423 and CEG 468/668, could be cross-listed and incorporated into a Surveying Engineering program.

Other UNLV Academic programs

Other academic units at UNLV have needs for surveying related skills and could provide opportunities for interdisciplinary collaboration and research. The Department of Mechanical and Aerospace Engineering uses accurate digital terrain maps in models that compute the trajectories of winds in the atmosphere. Geosciences has needs for surveying skills to accurately map the locations of geologic resources such as ore bodies and rock formations. Surveying and mapping skills are needed to accurately track dislocations across active faults and inflation and deflation of active and dormant volcanoes. Surveying and mapping of distributions of plants and animal habitats is carried out by the Biological Sciences department, and surveying and mapping of archaeological resources is performed in the department of Anthropology. Health Physics conducts research on the isotopic content of sediment cores, and needs accurate determinations of core positions. Additional resource mapping and analysis needs could emerge in the Environmental Studies Program.

Accreditation considerations: Why call it Surveying Engineering?

The College of Engineering has expertise in obtaining accreditation of its civil, electrical and mechanical engineering degree programs under the Engineering Accreditation Commission (EAC) of ABET. Baccalaureate degrees in surveying may be accredited under any of the three ABET commissions, EAC, RAC (Related Accreditation Commission), or TAC (Technology Accreditation Commission). A proposed Surveying program would have the most equitable relationship with other academic programs within the College if it was to be accredited as a Surveying Engineering program under EAC. A Surveying Engineering program would have undergraduate entry requirements, undergraduate mathematics and science requirements, total program credit requirements and engineering design requirements similar to requirements for the College's other engineering programs, thereby easing advising and administrative burdens on the surveying program's home department.

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Graduate education considerations: Why are we also proposing a graduate degree program (M.S.) in Geomatics?

Tenure-track faculty hired to instruct and perform research in Surveying Engineering and Geomatics will need graduate students who can provide instructional and research support. Surveying engineering faculty will be primarily tenured on the basis of research productivity (grants and publications). Additionally, employment opportunities exist for persons trained at advanced levels in surveying and resource mapping, especially if they desire to advance to leadership positions in the field. The population interested in this kind of training comprises persons with 4-year degrees in surveying, engineering, and natural sciences (predominantly geoscience, and biological sciences) who are interested in mapping of infrastructure and natural resources. The College's current M.S. degree in Engineering generally requires a 4-year degree in engineering for admission. The College's current M.S. degrees in Computer Science and Transportation are targeted at an audiences that have interests and backgrounds different from the audience that would be interested in surveying, GIS and resource mapping. Hence, an M.S. degree in Geomatics, a subject name that is recognized in the profession as associated with land measurement and resource mapping, is proposed to simultaneously provide a means to attract graduate students to support surveying faculty, and also serve as a means of entry into specialized areas of surveying for persons who seek to develop advanced skills in infrastructure and natural resource mapping.

Home Academic Department for Surveying Engineering / Geomatics

Given the Department of Civil and Environmental Engineering's pre-existing expertise in surveying instruction and applications, and GIS technology, it is proposed that Civil and Environmental Engineering be the initial home department for the proposed Surveying Engineering B.S. and Geomatics M.S. degrees.

Estimated Fall Enrollment Headcount:

Computed assuming that, in Fall 2001, 10 students with 1.5 - 2 years of applicable course work would matriculate into the program, representing the graduating class of 2003. In Fall 2002, 20 more students would matriculate into the program, most of them with 1.5 - 2 years of experience, representing the graduating class of 2004. In Fall 2003, 20 more students would matriculate into the program, with half representing the graduating class of 2005, and half representing the graduating class of 2007. In Fall 2003, the program would produce its first graduates. In Fall 2004, 20 more students would matriculate into the program, and 10 students would graduate or leave the program. In Fall 2005, 20 more students would matriculate and 15 students would graduate or leave the program.

1 st year (Fall 2001)	<u>12</u>
2 nd year (Fall 2002)	<u>33</u>
3 rd year (Fall 2003)	<u>51</u>
4 th year (Fall 2004)	<u>60</u>
5 th year (Fall 2005)	<u>66</u>

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Estimated Fall Enrollment Full-time Equivalency (FTE):

Computed assuming that, during the first five years of program operation, 1/3 of each year's fall head-count will be full-time (12 credits) and 2/3 will be half-time (6 credits)

1 st year (Fall 2001)	<u>8</u>
2 nd year (Fall 2002)	<u>22</u>
3 rd year (Fall 2003)	<u>34</u>
4 th year (Fall 2004)	<u>40</u>
5 th year (Fall 2005)	<u>44</u>

Estimate of Resources Needed (personnel, library holdings, facilities, equipment):

Personnel

Summary

The department requests three faculty, a half-time management assistant, one additional full-time instrument technician, and three graduate assistantships for support of the surveying/geomatics B.S. program.

Faculty - According to ABET accreditation guidelines (Section I.C.1.C) a core of three full-time tenured or tenure-track faculty dedicated to the surveying/geomatics program is the absolute minimum that is needed for an accredited program. It is envisioned that several (two or three) part-time faculty drawn from the professional community would also be needed each semester to teach specialized courses or assist with practical training. Faculty searches and hires would take place in the 2000-2001, 2001-2002, and 2002-2003 academic years. The 2000-2001 search would be for a senior faculty who could serve as Surveying/Geomatics program director. The 2001-2002 search, and the 2002-2003 search would be for tenure-track faculty. In 2003-2004, the surveying/geomatics faculty would prepare an accreditation report for an accreditation visit by ABET in the Fall of 2004.

Administrative - A half-time management assistant position is needed to accommodate the expected work load that includes admissions, management of student records, course scheduling, management of program assets, travel, and faculty support. In 1998, the department's construction management graduate program was approved with a half-time management assistant position that has yet to be filled. If the surveying/geomatics program proposal is approved, and the program is staffed to three faculty, then the department would have 19 total faculty. The department currently has two management assistants for 16 faculty. The department requests that the two half-time management assistant positions for construction management and surveying/geomatics be combined into a full-time position, and that this position be authorized to be filled in the 2001-2002 academic year.

Technical - The Civil and Environmental Engineering department currently has one full-time technician to support the teaching and research needs of 16 faculty, 350 students and six degree programs. A second position was included in the department's Civil Engineering Ph.D. program proposal, approved in 1991, but has never been authorized for hire. The current single technician has been stretched thin over all the department's shops and laboratories, and support by only one technician is far less than the support available to other departments in the College of Sciences, where two or three technicians support teaching and research needs of each department. The additional needs for instrument and

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computer maintenance in a surveying/geomatics program would also require the services of a skilled instrument technician, and it is vital that a second technician position be authorized for hire by the department at the start of the surveying program. The department requests that this additional technician position be authorized for the 2000-2001 academic year.

Graduate assistants - The Civil and Environmental Engineering department currently has 12 authorized state-funded graduate assistant positions. These 12 positions currently cover the needs of 16 faculty, 350 students, and six degree programs. Three additional graduate assistantship positions were contained in the M.S. in Construction Management proposal that was approved by the UCCSN in 1999. These positions have yet to be authorized and would bring the department's total to 15, slightly less than one per faculty member. If the surveying/geomatics program is approved, and three additional faculty positions are authorized, the department requests that four more graduate assistantships be authorized, bringing the total number of approved graduate assistant positions to 19. These positions are requested to provide instructional support for the tenured and tenure-track surveying engineering faculty. The assistants would support 4-6 laboratory classes each semester, hold discussion and recitation sessions, and would also provide grading services in large classes.

Library holdings:

A minimum of four journal subscriptions would be required to adequately support the proposed surveying/geomatics program:

1. American Congress on Surveying and Mapping (ACSM) Surveying and Land Information Systems Journal
2. ACSM Cartography and Geographic Information Systems Journal
3. American Society for Photogrammetry and Remote Sensing (ASPRS) Photogrammetric Engineering and Remote Sensing Journal
4. Urban and Regional Information Systems Association (URISA) Journal

Facilities:

Classrooms- The department anticipates the following course offering schedule for classes in surveying engineering:

Fall 2001, Spring 2002 - one full-time faculty teaching two classes each semester, each initially enrolling an average of 10 students - and one part-time faculty teaching one class each semester, each enrolling 10 students, *requires three scheduled 10-seat classroom slots each semester,*

Fall 2002, Spring 2003 - two full-time faculty teaching four classes each semester, each initially enrolling an average of 20 students, and two part-time faculty teaching one class each semester, each enrolling 20 students, *requires five scheduled 20-seat classroom slots each semester,*

Fall 2003, Spring 2004 and subsequent years - three full-time faculty teaching six classes each semester, each initially enrolling an average of 20 students, and two part-time faculty teaching one class each semester, each enrolling an average of 20 students, *requires eight scheduled 20-seat classroom slots each semester,*

By Fall 2003, one classroom would need to be reserved for the entire day, for a minimum of three days per week, to meet the needs of the surveying program.

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Laboratories - The department anticipates needing the following dedicated facilities to support the surveying program

1. A 1000 square-foot computation and mapping laboratory, consisting of seven IBM-compatible personal computers with surveying software, and seven photogrammetric workstations with GPS reduction and image analysis software. This facility does not exist, and would be dedicated to the surveying/geomatics program.
2. An 800 square-foot GIS laboratory consisting of 15 workstations for geographic data analysis and processing. This facility does not exist, and would be shared between the surveying/geomatics and civil engineering programs. It is estimated that six of these workstations would be needed by the surveying/geomatics program.

Office space - The department anticipates the following additional office space needs for the surveying/geomatics program.

1. Three 180 square-foot faculty offices - added at a rate of one office per year for 2001, 2002, 2003.
 2. Two 180 square-foot graduate assistant offices, with each office used for 2 TA's,
 3. One 100 square-foot management assistant space - for desk and filing cabinets,
 4. One 300 square-foot lab/shop technician space - for desk and filing cabinets, workbenches and lockers,
 4. 50 square-feet as a storage area for office supplies,
 5. 50 square-feet of secure space to house program administrative records,
- Ideally, the surveying faculty and graduate assistant office cluster, and the surveying/construction management secretarial desk would be located near the surveying laboratories to provide ease of communications for students, staff and faculty.

Projected budget increases and additional costs to implement new program:

State operating budget increases shown below are based on projected program enrollments listed above, and assume per capita student funding in the state operating budget of about \$200 per student headcount per year for administrative costs. Software licensing costs, also part of the operating budget, are assumed to be supported by external funds.

Equipment budget requests are based on equipment needs reported above, with acquisition of most computer hardware in the first two years of the program, and a three-year replacement cycle for computer hardware thereafter. The equipment budget assumes that state equipment funding will be matched by external funds from grants and gifts. External funding may have to be increased if state equipment funding is unavailable. Operating costs include expected annual renewal fees for CAD, GIS, GPS and surveying software licenses.

	Total operating	Total Equipment
1 st year - 2001-2002	\$5,600	\$49,000
2 nd year - 2002-2003	\$28,800	\$93,500
3 rd year - 2003-2004	\$45,500	\$0
4 th year - 2004-2005	\$49,200	\$10,500
5 th year - 2005-2006	\$50,300	\$16,500

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Source of funds:

	Operating -state	Equipment-state	Oper & Equip - external
1 st year - 2001-2002	\$5,600	\$21,000	\$28,000
2 nd year - 2002-2003	\$4,800	\$55,000	\$62,500
3 rd year - 2003-2004	\$8,000	\$0	\$37,500
4 th year - 2004-2005	\$11,700	\$10,500	\$37,500
5 th year - 2005-2006	\$12,800	\$16,500	\$37,500

Is the new program listed in the campus academic master plan?

The Department of Civil and Environmental Engineering commenced planning for the surveying engineering/geomatics program in the Fall of 1998, and included surveying engineering program development in its Fall 1998 Planning Document. The 1998 College of Engineering Planning Document also included surveying engineering/geomatics as part of its long-range master plan. The Provost's office has indicated strong support for the development of the surveying/geomatics program at UNLV.

Date Approved by Academic Affairs Council: _____

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University & Community College System of Nevada

Program Proposal - Surveying Engineering, B.S.

I. Degree(s) to be awarded upon completion of requirements; or title of department, school, or college to be initiated.

B.S. degree in Surveying Engineering, to be administered by the Department of Civil and Environmental Engineering in UNLV's Howard R. Hughes College of Engineering.

II. Proposed date of implementation.

Program initiation is proposed for Fall 2001, with hire of the first faculty member during the 2000-2001 academic year, and matriculation of the first students in Fall 2001. Additional faculty hires would take place in 2001-2002, and 2002-2003, with an accreditation visit from the Accreditation Board for Engineering and Technology (ABET) during Fall 2004. The first program graduates are expected in 2004-2005.

III. Description of program or instructional unit.

Surveying Engineering / Geomatics

The program name is Surveying Engineering/Geomatics. The program will offer an ABET-accredited B.S. degree in Surveying Engineering and a M.S. degree in Geomatics. The B.S. degree is aimed at high school graduates and persons with two-year degrees who seek licensure as Professional Land Surveyors. A four-year college degree will be required for Nevada licensure in the year 2010 and thereafter, provided that a program is available in the state in the year 2006.

The Department of Civil and Environmental Engineering at UNLV will initially administer the Surveying Engineering/Geomatics program. The program will require three new full-time faculty hires, participation by part-time instructors, and will also take advantage of the department's pre-existing expertise in surveying, global positioning and geographic information systems. The department currently has one faculty with expertise in surveying and global positioning, and two faculty with expertise in geographic information systems. The department's current inventory of surveying and GIS equipment would be augmented to provide adequate instructional support for the proposed Surveying Engineering/Geomatics degrees.

The 4-year surveying programs nearest to Nevada are at California State University Fresno, Oregon Institute of Technology and New Mexico State University. The proposed UNLV Surveying Engineering/Geomatics program is intended to have a regional impact, attracting students from other southwestern and intermountain states, including Arizona and Utah, where no 4-year surveying programs currently exist.

The Surveying Engineering/Geomatics program will be intended to serve:

- a. full-time day students in residence, and
- b. a local and statewide population of part-time students.

Courses will primarily be offered in afternoons and evenings, and the statewide population will be served by a combination of extension courses for credit, and distance education credit courses, taught via videotape or via the World-Wide Web. To serve the part-time student population, the program is intended to provide articulation with a two-year transfer degree, likely an Associate in Arts (A.A.) in pre-surveying that could be offered by UCCSN community colleges.

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Since the proposed program would be located in southern Nevada and would be the only 4-year program in the state, a significant population in other parts of the Nevada would also need to be served. Some of the upper division courses in the proposed 4-year degree program would be offered through distance education means. When community college transfer degrees are combined with upper division courses available via distance means, residency at UNLV could probably be shortened to one and a half years.

IV. Statement of degree objectives.

The objectives for the B.S. Surveying Engineering degree are:

1. To prepare graduates to enter pre-professional employment in surveying in Nevada, and in any region of the nation or the world.
2. To develop competency in the fundamentals and applications of surveying, and in the developing fields of mapping (geographic information systems) and spatial data, such as global positioning systems.
3. To meet or exceed ABET and University general education requirements, so that graduates have adequate background in humanities, social sciences and the arts, and can function in multicultural and international environments.
4. To prepare graduates to take and pass the Fundamentals of Land Surveying (F.L.S.) examination developed by the National Council of Examiners for Engineering and Surveying (NCEES).
5. To develop background in basic sciences, most commonly geological and biological sciences, that will be used in the mapping of natural resources.
6. To prepare those program graduates who show the required attributes to pursue graduate studies in geomatics or other disciplines.

V. Plan for assessment of degree objectives.

The Civil and Environmental Engineering department has previously conducted a survey of its civil engineering alumni and employers that led to significant enhancements of the civil engineering curriculum. Similar tools would be developed for assessment of the B.S. Surveying Engineering program.

1. Surveying employers will be periodically surveyed on the skills, knowledge and performance of UNLV Surveying Engineering graduates relative to the performance of graduates from other programs.
2. Alumni will be periodically surveyed to determine how their education prepared them for survival in the workplace.
3. Preparation of documents for an ABET accreditation visit in 2004, will provide an opportunity to assess the status of the entire program, including adequacy of curriculum and facilities, and performance of program graduates.
4. A Surveying Engineering Advisory Committee will be developed. The Committee will meet every semester, and will provide feedback on performance of student interns, recent graduates, and adequacy of curriculum and facilities.
5. Student comprehension of surveying knowledge and adequacy of student skills will be assessed using traditional academic performance measures (homework problem sets, term papers, quizzes, and examinations).

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6. Student performance on the nationally administered Fundamentals of Land Surveying (F.L.S.) examination will be used to assess long-term understanding of surveying principles and performance of UNLV graduates relative to the performance of graduates from other institutions and regions. Students will be required to pass the F.L.S examination in order to obtain their degree.

VI. Contribution and relationship of program objectives to:

1. Institutional mission.

In 1996, the University of Nevada, Las Vegas developed a Planning Document with seven major goals. Among the goals were:

Goal #4 - Grow Selectively and Serve the Region. The Surveying Engineering/Geomatics Program is being developed in response to an identified need for higher education in a vital segment of the professional community. Surveyors are seeking to improve their profession through implementation of a requirement for a 4-year degree as a prerequisite to licensure. The University will be serving the region by developing a 4-year degree program that will satisfy this licensing requirement

2. Campus Academic Master Plan.

The campus academic master plan, which incorporated the College master plan, included surveying engineering / geomatics in 1998 when the need for a 4-year surveying program in Nevada was first recognized. The campus plan also emphasizes the increasing importance of research in the University's academic efforts. The proposed M.S. program in Geomatics will provide a mechanism for attracting faculty to the program, as it will provide them with a graduate program that will attract high-quality graduate students who can assist surveying faculty in funded research in surveying, mapping and spatial positioning.

3. Department and College Plan.

At the department level, surveying/geomatics program objectives are very similar to those developed for both civil engineering and construction management. Proposed assessment tools are identical to tools developed for civil engineering and construction management. At the baccalaureate level, civil engineering and construction management students must take the Fundamentals of Engineering (F.E.) and Constructors Qualifying Examination (C.C.E.) - Level I in order to graduate. These requirements are similar to the F.L.S. requirement in the proposed surveying program.

Considerable interaction is expected between surveying students and faculty and the civil engineering and construction management disciplines. Surveying engineering faculty and students will be able to provide expertise in solving practical and research surveying problems that arise in civil engineering. Collaboration is expected between surveying and civil engineering faculty on problems associated with, for example, mapping and spatial positioning of soil and water quality data, soil and rock properties, subsidence and alignment of building foundations, mapping of traffic volumes and accident frequencies, and delineation of watershed boundaries and cones of depression.

At the College level, development of a surveying engineering/geomatics program is expected to enhance the ability of College faculty to attract funded research, a major College and University objective. Surveying engineering/geomatics faculty collaborate with faculty in other departments to attract interdisciplinary research projects. For example, surveying faculty could assist electrical engineering faculty with mapping and risk assessment of electric power transmission infrastructure. Surveying faculty could also develop improved terrain maps for use in complex atmospheric flow models developed by mechanical engineering and computer science faculty.

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Academic program objectives in the College's engineering departments are fairly similar, as the civil, electrical and mechanical engineering programs all seek to prepare graduates to perform competently in entry-level professional engineering positions, to pursue graduate studies in engineering, and to exhibit the characteristics of a broadly educated person.

4. Other Programs in the Institution.

Program objectives for surveying engineering/geomatics should generate opportunities for collaboration with other programs at UNLV. Surveying engineering/geomatics faculty could collaborate with geosciences faculty in the mapping of geologic features such as karst terrain, fault displacement, or inflation/deflation of volcanoes, and in mapping of geological resources such as ore bodies and groundwater. Surveying faculty could collaborate with biological sciences faculty in the mapping of endangered species, and in the determination of the extent of plant communities. Additionally, surveying faculty could assist anthropology faculty in the mapping of archaeological and cultural resources.

5. Other Related Programs in the System.

Currently, the Community College of Southern Nevada offers a two-year Associate of Applied Science degree in Surveying, administered by its Building Technology program. This is the only surveying-related program currently operating in the UCCSN. Other institutions, such as UNR or Truckee Meadows Community College offer one or two introductory surveying courses, but no other degree programs are currently offered or planned in the System.

6. Articulation issues.

It is expected that the surveying engineering/geomatics program will accept graduates of two-year programs from the System's community colleges. As part of this program proposal, a proposed two-year transfer (A.A.) degree curriculum has been developed that will facilitate articulation of the 4-year program with the community colleges. This proposed degree is distinct from the current A.A.S. degree offered by CCSN. To facilitate transfer of a majority of the credits earned at CCSN into the UNLV Surveying Engineering B.S. degree program, the transfer degree contains more general education courses, and no surveying technology (B suffix) courses. Students with the A.A.S. degree could also matriculate into the B.S. Surveying Engineering program, but surveying technology courses (B suffix) completed for the A.A.S. degree would not count towards the UNLV B.S. degree.

In addition to the transfer degree, it is proposed that several upper division courses in the B.S. Surveying Engineering program be made available through distance education, so that place-bound students in northern, western and eastern Nevada can earn some of the upper-division credits towards the UNLV B.S. degree and reduce the time required in residence on the UNLV campus.

VII. Evaluation of need for the program.

1. Intrinsic academic value of program within the discipline.

Baccalaureate-level training in surveying and geomatics is common in Europe, Latin America and Canada. Throughout the 20th century, the surveying profession in Europe and the Americas developed requirements for baccalaureate degrees as the minimum training for licensure as a professional surveyor. In Canada, recognition of the need for formal academic training for land surveyors led to the development of four-year degree programs in the years immediately following

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World War II. A four-year degree in surveying or a related discipline, or a two-year surveying diploma plus experience are currently required for licensing in the four western Canadian provinces (British Columbia, Alberta, Saskatchewan and Manitoba), (Source: Western Canadian Board of Examiners, <http://www.alsa.ab.ca>). In Mexico, a federal license is issued by the state universities upon graduation, enabling a surveyor (ingeniero topografo) to practice anywhere in the country. The law for the state of Jalisco indicates that a minimum of three years of study is required for any professional title (<http://www.jalisco.gov.mx/plegislacongreso/legisla/file157.html>). The sample curriculum a four-year surveying engineering degree in Mexico requires approximately 144 semester credits of study (Ingenieria Topografica, #1, June 1996, pp.11-13).

The United States has been slow to develop four-year degree requirements. Land surveyors may currently be licensed without a college degree. In lieu of a degree, a surveyor must demonstrate six to 10 years of appropriate on the job training and professional experience, and also pass the Fundamentals of Land Surveying and Principles and Practice of Surveying licensing examinations. It is now generally recognized that global positioning, geographic information systems and computer technologies have increased the complexity and required level of professional services of the surveying profession. Surveyors' accurate assessments of land boundaries and resources have significant legal, economic and political consequences. Land developers, natural resource managers and civil engineers need vast amounts of geographic information for land subdivision, natural resource assessment, and facilities design and construction, respectively, and are relying on surveyors to provide the necessary expertise. The surveying profession in the United States has recognized the need for formal academic training as a prerequisite to employment, and begun to lobby for legislation that will require 4-year degrees as a prerequisite to licensing. Currently, Florida, Iowa, Maryland, Michigan, New Jersey and New Mexico require a 4-year surveying degree for licensure. However, about 20 other states (including Nevada) are moving towards a 4-year degree requirement. This has led to the development of four-year degree programs at several American universities to meet the demand. Accreditation of these degree programs is a critical part of the quality control process, and, as of January 2000, 14 bachelor's degree programs in geomatics, surveying, surveying engineering and surveying technology are accredited by the Accreditation Board for Engineering and Technology (ABET) (source: ABET web-site; <http://www.abet.org>).

2. Evidence of existing or projected local, state, regional, national and/or international need for program.

National need

Compared to Europe and other countries in the Americas, the United States has been slow to develop four-year degree requirements. Baccalaureate degrees in surveying have been required in most countries in Europe for many years. A four-year degree in surveying or a related discipline, or a two-year surveying diploma plus experience are currently required for licensing in the four western Canadian provinces (British Columbia, Alberta, Saskatchewan and Manitoba), (Source: Western Canadian Board of Examiners, <http://www.alsa.ab.ca>). A 4-year degree is required in Mexico. In most states in the U.S., land surveyors may currently be licensed without a college degree. In lieu of a degree, a surveyor must demonstrate six to 10 years of appropriate on the job training and professional experience, and also pass Fundamentals of Land Surveying and Principles and Practice of Surveying licensing examinations.

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profession. Surveyors' accurate assessments of land boundaries and resources have significant legal, economic and political consequences. Land developers, natural resource managers and civil engineers need vast amounts of geographic information for land subdivision, natural resource assessment, and facilities design and construction, respectively, and are relying on surveyors to provide the necessary expertise. The surveying profession in the United States has recognized the need for formal academic training as a prerequisite to employment, and begun to lobby for legislation that will require 4-year degrees as a prerequisite to licensing. This has led to the development of four-year degree programs at several dozen American universities to meet the demand. Since 1970, approximately 25 universities in the United States have initiated baccalaureate-level programs, and many of these have also created advanced degree programs. Accreditation of these degree programs is a critical part of the quality control process, and, as of January 2000, 16 bachelor's degree programs in surveying have been accredited by the Accreditation Board for Engineering and Technology (ABET) (ABET web site, <http://www.abet.org>).

State Need for Program

Recognizing the need for improved training in surveying, the Nevada Association of Land Surveyors (NALS) and the Nevada State Board of Professional Engineers and Land Surveyors (NSBPELS) have, in recent years lobbied the Nevada Legislature for revisions to the Nevada Land Surveying Practice Act, Nevada Revised Statute 625 (NRS 625), that would require a baccalaureate degree for licensing as a Professional Land Surveyor (P.L.S.). In 1999, the Nevada Legislature passed revisions to NRS 625 that require a 4-year degree for licensing as a land surveyor in the year 2010 and after, provided that a suitable academic program is established and operating in the state by the year 2006. Currently, there is no 4-year degree program available within Nevada. The closest institutions with accredited 4-year degree programs are California State University-Fresno, Oregon Institute of Technology and New Mexico State University. A Nevada program is needed to meet the requirements of NRS 625. The Nevada Association of Land Surveyors and the Nevada State Board of Professional Engineers and Land Surveyors have approached the University of Nevada, Las Vegas with a request to develop a suitable program.

Assuming current licensing rates remain constant, statewide licensing rates for professional land surveyors are projected to be about 40 per year in the year 2010. It is anticipated that the proposed surveying engineering/geomatics program could be generating 20 graduates per year by that time, with about 10 others coming from out-of-state programs, and another 10 coming from related bachelor's degrees in engineering, geography and the natural sciences.

Regional need

Currently, there are no 4-year surveying programs in the states of Arizona or Utah. Licensing boards in those states may soon require 4-year surveying degrees. A four-year program in Nevada could therefore serve both southwestern and intermountain region needs for training of surveyors. Memoranda of understanding (MOU's) should be negotiated with the professional groups and licensing boards of neighboring states to facilitate acceptance of a Nevada degree as suitable preparation for licensure. Additionally, in-state or reduced out-of-state tuition rates for students from neighboring states should be established. Most areas of the U.S. have regional university consortia that allow students to cross state lines at in-state rates.

Successful completion of MOU's and implementation of reduced tuition rates would facilitate development of a regional program, and increase the pool of candidates for the UNLV program.

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Local need

The southern Nevada economy is currently exhibiting strong demand for surveyors, largely driven by construction of resorts, commercial centers, housing developments, and related infrastructure such as roads and utilities. Current growth forecasts indicate no slowing of construction activity until the year 2020, when geographic and topographic constraints may limit outward expansion. At CCSN, about 70-80 students per semester are currently enrolled in 4 surveying courses per semester, with a graduation rate of five to eight students per year. It is anticipated that some of these students might also be interested in proceeding to the four-year B.S. Surveying Engineering degree.

3. Evidence of employment opportunities for graduates (state and national).

A recent poll of employers who are members of the Nevada Association of Land Surveyors (NALS), indicated that:

- a. More than three-quarters had difficulty filling positions for qualified land surveyors.
- b. A recent graduate of a 4-year surveying program who has passed the Fundamentals of Land Surveying examination can expect to be offered \$35,000-\$45,000 per year to start as a Land Surveying Intern.
- c. Demand for Professional Land Surveyors is so high that a typical starting salary for a recently licensed P.L.S. (a professional who has met the education and experience requirements, generally, 4 year degree plus 4 years experience as a Land Surveying Intern, and has just passed the Principles and Practice of Land Surveying Examination) is \$50,000-\$60,000 per year, and a P.L.S. with 10 years of experience can expect to earn \$70,000-\$75,000 per year.
- d. There are currently 90 firms with surveying departments in southern Nevada. The number of employers has steadily increased from 15 in 1980 to 90 in 2000. Of these 90 firms, 80 are in metropolitan Las Vegas.
- e. Strong demand for qualified surveyors also exists at public agencies, with needs for surveying and mapping skills at the U.S. EPA, U.S. Geological Survey, U.S. Forest Service, U.S. Bureau of Land Management, U.S. National Park Service, U.S. Natural Resource Conservation Service and other resource management agencies at state and local levels.

The following table gives 5-year averages for surveyor licensing rates in the state of Nevada from 1980 to 1999 (Data provided by Rita Lumos, Vice-Chair, Nevada State Board of Professional Engineers and Land Surveyors, February 2000)

Interval	Number licensed	Number by reciprocity	Number by examination
1980-1984	52	37	15
1985-1989	47	36	11
1990-1994	48	28	20
1995-1999	46	26	20

The average number of surveyors licensed in the state over the last 20 years is 49, with 17, or 35% licensed by examination within the state. Currently, persons seeking formal academic training in surveying must obtain it from outside the state. For planning purposes, statewide licensing rates for professional land surveyors are conservatively projected to be about 40 per year through calendar year 2020. It is anticipated that the proposed surveying engineering/geomatics program could be generating 20 baccalaureate-level graduates per year by 2010, with about 20 other licensees coming from out-of-state programs, either by examination, or by reciprocity.

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4. Student clientele to be served.

The Surveying Engineering/Geomatics program will be intended to serve both:

- a. full-time day students in residence, and
- b. a local and statewide population of part-time students.

It is anticipated that initial demand for the program will be from persons employed in the field who seek to improve their skills, become licensed, and advance in the profession. This population would consist mostly of part-time students. After about five years, with initial demand from employed professionals satisfied, the long-term population to be served would be recent high-school graduates and students recently matriculated into the University who would study for the degree full-time.

To best serve the local part-time student population, courses will be primarily in afternoons and evenings. The afternoon and evening course format would also serve the full-time student population, as an on-the-job internship is expected to be an integral part of the four-year program, and afternoon and evening course times would permit the full-time students to work at their internships and then attend class. The statewide part-time population would be served by a combination of extension courses for credit, and distance education credit courses, taught via videotape or via the World-Wide Web. The program is intended to provide articulation with a two-year transfer degree, likely an Associate in Arts (A.A.) in pre-surveying that could be offered by UCCSN community colleges.

5. Procedures used to arrive at the decision to propose the program.

In the Fall of 1998, the Nevada Association of Land Surveyors (NALS) and the Nevada State Board of Professional Engineers and Land Surveyors approached UNLV with a request to initiate a program in Surveying and Geomatics. Their request was based on:

- a. the requirements of NRS 625, which will require a four-year degree for licensure in the years 2010 and beyond, provided that a four-year program is operating in the state by the year 2006, and
- b. the need to provide training in emerging technologies in the field, including Computer Assisted Design (CAD), Global Positioning (GPS), Geographic Information Systems (GIS), and Remote Sensing.

The request from NALS and the State Board was referred to the College of Engineering for action, and the decision was made to develop the surveying/geomatics program proposal in the Department of Civil and Environmental Engineering, as it had the most appropriate expertise. The Department already offers courses in Elementary Surveying and in Geographic Information Systems every semester, and uses Global Positioning and Geographic Information Systems technologies in its research programs. In Spring 2000, University Provost Douglas Ferraro indicated a strong desire to develop a Surveying/Geomatics program at UNLV, and Associate Provost for Academic Affairs, Barbara Cloud, was also supportive. In Spring 2000, this program proposal had the support of the Dean of the College of Engineering, William R. Wells, and of the Chair of the Department of Civil and Environmental Engineering, David E. James. Leadership changes in summer 2000 have produced a new interim Provost, Ray Alden, and a new Dean of the College of Engineering, Ronald Sack, who need to be informed about the statewide need for the program and the potential for generating research dollars.

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VIII. Detailed curriculum proposal.

1. Representative course of study by year (options, courses to be used with/without modification; new courses to be initiated). * means potential Distance Course

Program of Study by year: B.S. Surveying Engineering

Year 1

Fall Semester

Course		Type	Credits
ENG 101	Composition I	existing	3
HIS/POS	US/Nevada Constitution	existing	4
SEG/CEG 121	Elementary Surveying	existing	3
MAT 181	Elementary Calculus I	existing	4
AAD 101	Cities and Buildings of the World	existing	3
Total			17

Spring Semester

Course		Type	Credits
ENG 102	Composition II	existing	3
CHE 115	General Chemistry I	existing	4
PHY 180	Engineering Physics I and lab	existing	4
EGG 102	Introduction to Engineering Design	existing	3
MAT 182	Calculus II	existing	4
Total			18

Year 2

Fall Semester

Course		Type	Credits
ECO 190	Global Economics	existing	3
PHY 181	Engineering Physics II and Lab	existing	4
MAT 283	Calculus III	existing	3
SEG 201	Field Data Capture and Lab	new	4
CEG 201	AutoCAD & Civil Engr. Applications	existing	3
Total			17

Spring Semester

Course		Type	Credits
	Humanity/soc.science elect - international requirement	existing	3
MAT 253	Linear algebra	existing	3
SEG 202	Computation and Mapping (plane)	new	4
GEY 101	Introductory Geology	existing	4
ENG 404	Technical Writing	existing	3
Total			17

Summer Semester Year 2

SEG 300	Cooperative Work Experience	new	1
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Year 3

Fall Semester

Course	Type	Credits
Humanity/soc. science elect - multicultural requirement	existing	3
Laboratory science elective	existing	3-4
*SEG 301 Geodesy	new	3
*SEG 302 Data Analysis and Adjustment	new	3
SEG 303 Image Mapping and Analysis and Lab	new	4
Total		16-17

Spring Semester

Course	Type	Credits
Humanity/social science elective #1	existing	3
Engineering science elective	existing	3
SEG 304 Geographic Information Science & Lab	new	4
SEG 305 Satellite Positioning	new	3
*SEG 306 Boundary and Cadastral Principles	new	3
Total		16

Summer Semester Year 3

SEG 400 Cooperative Work Experience	new	1
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Year 4

Fall Semester

Course	Type	Credits
Humanity/social science elective #2	existing	3
Law-Business-Management elective #1	existing	3
Law-Business-Management elective #2	existing	3
*SEG 401 Surveying Professional Ethics	new	1
*SEG 402 Public Land Surveying	new	3
SEG 403 Surveying Practice and Lab	new	4
Total		17

Spring Semester

Course	Type	Credits
Law-Business-Management elective #3	existing	3
STA 463 Statistics for Engineers & Scientists	existing	3
SEG 404 Land Development Design and Lab	new	4
SEG 405 Highway Geometr Design & Constr	modif exist	3
SEG 497 Surveying Engineering Design	new	3
Total		16

Total credits for degree: $17 + 18 + 17 + 17 + 1 + 16-17 + 16 + 1 + 17 + 16 = 136-137$

Total new courses to be initiated: 15 courses counting for 45 credits

Total courses to be modified: 1 course counting for 3 credits

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To provide knowledge of natural resources that would be mapped by surveyors, select one laboratory science elective from:

CHE 116	Chemistry II and Lab	4 credits
PHY 182	Engineering Physics III and Lab	4 credits
BIO 190	Biological Science I and Lab	4 credits
BIO 191	Biological Science II and Lab	4 credits
BIO 122	Plants of Southwestern Deserts	3 credits
GEY 135	Earth Resources and Society	4 credits
GEY 220	Mineralogy and Optical Mineralogy	4 credits
GEY 341	Structural Geology	4 credits

To provide knowledge of physical infrastructure that would be mapped, select one engineering science elective from:

EEG 291	Introduction to Electrical Engineering	3 credits
CEG 206	Statics	3 credits

To provide knowledge of legal issues and business practices, select three Law-Business-Management electives from:

EGG 307	Engineering Economics	3 credits
CEG 409	Engineering Project Management	3 credits
BLW 273	Business Law I	3 credits
BLW 331	Real Estate Law	3 credits
BLW 302	Legal Environment	3 credits
BLW 431	Real Estate Law II	3 credits
MGT 301	Principles Of Management and Org. Behav.	3 credits

Humanity / Social science electives:

1. Six credits of humanities and six credits of social science are required.
2. Courses should be selected to meet the UNLV international and multicultural Core requirements.
3. To satisfy ABET requirements, no more than three of the 12 humanity and social science credits may be skills-related. Examples of skills-related courses include Statistics for the Social Sciences, foreign language grammar or composition, speech craft.

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Survey program course descriptions:

All courses are new except SEG 121, *Elementary Surveying*, which is cross-listed with CEG 121, and SEG 405, which is a modification of CEG 466, *Geometric Highway Design*.

Freshman-level courses:

SEG/CEG 121 *Elementary Surveying* (3 credits): basic surveying methods, angle and distances, leveling, traverse closure, topographic mapping, construction layout, applications to engineering projects. Prerequisite: Satisfactory grade (C, 2.0 or better) in high school or college-level plane trigonometry.

Sophomore-level courses:

SEG 201 *Field Data Capture and Lab* (4 credits): electronic distance measurement, optical and electronic theodolites, total stations, digital data recording and transfer, measurement error theory, precise leveling, introduction to the global positioning system, GPS for mapping applications. Prerequisite: CEG 121 or SEG 121.

SEG 202 *Computation and Mapping (plane)* (3 credits): plane coordinate computation, plane coordinate geometry, computer mapping, state plane coordinate systems, universal transverse mercator, map projections, coordinate datum conversions. Prerequisite: High school geometry and CEG 121 or SEG 121.

Junior-level courses:

SEG 300 *Cooperative Work Experience* (1 credit): work experience with cooperating surveying and mapping employers. 300 hours required employment or equivalent with a participating surveying firm. Written report required at 300 hours. Prerequisite: ENG 404 and satisfactory (C, 2.0) or better completion of SEG 121, CEG 201, SEG 201, and SEG 202. Graded Pass/Fail.

*SEG 301 *Geodesy* (3 credits): reference frames, gravity distributions, ellipsoids, geoid determination, computation of geodetic position, earth-centered rectangular, geodetic coordinate conversion. Prerequisite: SEG 202

*SEG 302 *Data Analysis and Adjustment* (3 credits): least squares analysis of redundant survey systems, standard error, weighting, error propagation, adjustment, error theory. Prerequisites: CEG 121, MAT 182

SEG 303 *Image Mapping and Analysis and Lab* (4 credits): aerial photography, flight operations, vertical aerial photos, stereo mapping, aerotriangulation, image mapping, remote sensing, image analysis, image detection and classification, orthophotos, digital terrain models. Prerequisite: PHY 181, SEG 202

SEG 304 *Geographic Information Science and Lab* (4 credits): digital mapping, topology, spatial objects, database design, relational database theory, GIS hardware and software, applications. Prerequisite: SEG 202

SEG 305 *Satellite Positioning* (3 credits): survey-grade GPS hardware, software and procedures, static, real time kinematic, network design, observation, reduction, differential methods. Prerequisite: SEG 201

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*SEG 306 Boundary and Cadastral Principles (3 credits): cadastral systems, boundary law, resolution of deed and ownership issues according to case and statute law, senior rights, adverse possession, evidence, title, legal descriptions, instruments of title. Prerequisite: SEG 202

Senior-level courses:

SEG 400 Cooperative Work Experience (1 credit): work experience with cooperating surveying and mapping employers. 300 hours required employment or equivalent with a participating surveying firm. Written report required at 300 hours. Prerequisite: ENG 404 and satisfactory (C, 2.0) or better completion of at least 16 300-level SEG credits. Graded Pass/Fail.

*SEG 401 Professional Surveying Ethics (web-based) (1 credit): principles of professional ethics, systematic application of ethical rules, test cases.

*SEG 402 Public Land Surveying (3 credits): history of the public land survey system, original surveys, retracement, restoration of corners. Prerequisite: CEG 121 or SEG 121

SEG 403 Surveying Practice and Lab (4 credits): professionalism, regulation of the surveying profession, licensure, project cost estimation, procedures for survey design and execution, standards for survey documentation, liability, negotiations, court room procedures, field evidence methods and evaluation. Prerequisites: SEG 301, 303, and 306.

SEG 404 Land Development Design and Lab (4 credits): subdivision land planning, tract analysis, plan review, lot and street design, platting, paving and drainage plans, development review. Prerequisite: CEG 202.

SEG 405 Highway Geometric Design and Construction (3 credits): plan, profile, and cross section views of a highway project, design controls, AASHTO geometric design standards, project development, right of way. Prerequisite: CEG 201.

SEG 497 Surveying Engineering Design (3 credits): a capstone design experience in surveying engineering. Evaluation and synthesis of solutions for real world design situations requiring the integration of sociological, technical, economic, and ethical issues. Prerequisites: EGG 102, ENG 404, all 300-level SEG courses, SEG 401, SEG 402, and in last semester of study for degree.

2. Program entrance requirements.

1. Matriculation from high school. Entrance requirements for the program are similar to those required for other science and engineering majors at UNLV. A high-school diploma and GPA of 2.50, completion of the minimum number of high-school credits in mathematics, science and english required for majoring in science and engineering, and completion of the ACT or SAT examinations is required.

2. Transfer from another University or another College within UNLV. A minimum 2.0 GPA is required for transfer into the program from another University or UNLV College. Students must complete all program prerequisites with grades of C, 2.00, or better.

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3. Program completion requirements (credit hours, grade point average; subject matter distribution, prerequisites).

A. Credit hours

The B.S. degree requires a minimum of 136-137 applicable credits for completion. This credit requirement is similar to the requirements for the civil, electrical and mechanical engineering majors at UNLV. Students entering the program with deficiencies in english, mathematics or sciences will be required to satisfactorily complete remedial classes, and will need more than the minimum number of credits to graduate.

B. Grade point average

1. A minimum 2.00 overall GPA is required for graduation.
2. Students must complete all required courses in english (ENG), mathematics (MAT), engineering (EGG), civil engineering (CEG), chemistry (CHE), and physics (PHY) with grades of C (2.00) or better.
3. Students must complete all prerequisite (100, 200 and 300 level) courses in SEG with grades of C (2.00) or better.
4. No more than 2 passing grades less than C will be allowed in other upper division terminal (300 and 400 level) courses in SEG. Exception, SEG 497 must be completed with a grade of C (2.00) or better.

C. Other graduation requirements

1. Fundamentals of Land Surveying Examination

Students must take the National Council of Examiners in Engineering and Surveying (NCEES) Fundamentals of Land Surveying (F.L.S.) Examination, administered by the Nevada State Board of Professional Engineers and Land Surveyors, in the 12 months prior to anticipated date of graduation. A passing score on the examination is required for graduation.

2. Cooperative Work Experience

Students must satisfactorily complete 600 hours of cooperative work experience in order to graduate. The 600-hour requirement will be met by two 300-hour summer internships, completed after the sophomore and junior years. Satisfactory completion will be determined by agreement between the program's internship coordinator and the student's on-the-job supervisor. The supervisor will submit written evaluation at the end of each summer. The student will submit a term report at the end of each summer. Satisfactory job evaluations and written reports are required for a passing grade.

D. Subject matter distribution

The proposed curriculum for the Bachelor of Science Surveying Engineering degree has four components.

1. **General Education Core - 31 credits.** This component is intended to simultaneously satisfy University and ABET general education requirements. Courses in humanities, social science, english, fine arts and constitutions will meet the University's international and multicultural requirements, and will provide broadly educated graduates from the program. The mathematics, logic and science requirements in the University general education core are met in the Technical Foundation component of the proposed curriculum. Courses in this component are:

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Communication		
ENG 101	Composition I	3 credits
ENG 102	Composition II	3 credits
ENG 404	Technical Writing	3 credits
Social Sciences and Humanities		
ECO 190	Global Economics	3 credits
Social Science electives		6 credits
Humanities elective courses		6 credits
Constitutions		
U.S. and Nevada Constitutions		4 credits
HIS 100 History or POS 101 Political Science		
Fine Arts		
AAD 101	Cities and Buildings of the World	3 credits

2. Technical Foundation - 55-56 credits. This component provides the development of mathematical, scientific, engineering and business-management skills needed by surveying engineers. Courses in this component are:

Mathematics: Knowledge of algebra, geometry and trigonometry plus the following: (18 credits)

MAT 181	Elementary Calculus I	4 credits
MAT 182	Elementary Calculus II	4 credits
MAT 253	Linear Algebra	3 credits
MAT 283	Intermediate Calculus	4 credits
STA 463	Applied Statistics for Scientists & Engineers	3 credits

Science (23-24 credits)

PHY 180	Engineering Physics I and Lab	4 credits
PHY 181	Engineering Physics II and Lab	4 credits
CHE 115	General Chemistry I and Lab	4 credits
GEY 101	Introductory Geology	4 credits
One additional Laboratory Science Elective		3-4 credits

chosen from:

CHE 116	Chemistry II and Lab,	4 credits
PHY 182	Engineering Physics III and Lab	4 credits
BIO 190	Biological Science I and Lab	4 credits
BIO 191	Biological Science II and Lab	4 credits
BIO 122	Plants of Southwestern Deserts	3 credits
GEY 135	Earth Resources and Society	4 credits
GEY 220	Mineralogy and Optical Mineralogy	4 credits
GEY 341	Structural Geology	4 credits

Engineering Science (9 credits)

EGG 102	Intro. to Engineering Design and Lab	3 credits
CEG 201	AutoCAD for Civil Engineering	3 credits
Engineering Science elective, either one of:		3 credits
EEG 291	Introduction to Electrical Engineering	3 credits
CEG 206	Statics	3 credits

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Law-Business-Management Electives (9 credits) - three courses chosen from:

EGG 307	Engineering Economics	3 credits
CEG 409	Engineering Project Management	3 credits
BLW 273	Business Law I	3 credits
BLW 331	Real Estate Law	3 credits
BLW 302	Legal Environment	3 credits
BLW 431	Real Estate Law II	3 credits
MGT 301	Princ. of Management and Org. Behav.	3 credits

3. Surveying Engineering Core - 27 credits. This component develops the essential skills and knowledge required for successful practice in surveying and geomatics. Courses in this component are:

SEG/CEG 121	Elementary Surveying	3 credits
SEG 201	Field Data Capture and Lab	4 credits
SEG 202	Computation and Mapping	3 credits
SEG 301	Geodesy	3 credits
SEG 302	Data Analysis and Adjustment	3 credits
SEG 303	Image Mapping and Analysis and Lab	4 credits
SEG 304	Geographic Information Science & Lab	4 credits
SEG 305	Satellite Positioning	3 credits

4. Surveying Engineering Design Application Areas - 23 credits. This component develops design ability in the surveying engineer by applying the skills and knowledge acquired in the technical foundation and surveying engineering core parts of the program. This component includes a capstone design course that requires integration skills and knowledge of all areas of the student's program. Courses in this component are:

SEG 300	Cooperative Work Experience	1 credit
SEG 306	Boundary and Cadastral Principles	3 credits
SEG 400	Cooperative Work Experience	1 credit
SEG 401	Prof. Surveying Ethics (web-based)	1 credit
SEG 402	Public Land Survey (distance ed.)	3 credits
SEG 403	Surveying Practice and Lab	4 credits
SEG 404	Land Development Design and Lab	4 credits
SEG 405	Highway Geometric Design and Construction	3 credits
SEG 497	Surveying Engineering Design Project	3 credits

4. Accreditation considerations. Organization (if any) that accredits program. Requirements for accreditation. Plan for attaining accreditation. Include costs, time frame.

It is proposed that the University seek accreditation for the B.S. degree in Surveying Engineering at the earliest possible date, most likely in the Fall of 2004.

A. Accrediting Organization. The Accreditation Board for Engineering and Technology (ABET) will accredit the B.S. Surveying Engineering degree. It is proposed that the University seek accreditation of the B.S. degree as Surveying Engineering under the Engineering Accreditation Commission (EAC) of ABET. The University's other engineering degree programs (civil, mechanical and electrical) are accredited under EAC, and the College has substantial experience in developing

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accreditation materials for these degree programs under this commission. Accreditation as Surveying Engineering will put the degree program on an equal footing with UNLV engineering degrees. This is an important factor in both external and internal perception of the quality and rigor of the degree program.

B. Accreditation requirements. The most recent ABET statement on accreditation of programs in surveying indicates:

1. Minimum of three full-time equivalent faculty should be devoted to the baccalaureate program. The current program proposal provides for staffing by three full-time faculty members after the third year of the program.
2. At least one-half year of topics in the humanities and social sciences, exclusive of English. The proposed program has 22 credits in humanities and social sciences, and 9 credits of English.
3. At least one year of an appropriate combination of mathematics and basic sciences. The current program proposal has 46-47 credits of mathematics and basic sciences.
4. At least one and a half year's coverage of engineering (in this case, surveying) topics. The current program proposal has 50 credits of courses in surveying, divided into 27 credits of surveying engineering core and 23 credits of surveying engineering design application areas.
5. Adequacy of institutional resources (space, equipment, operating funds) to support the program. The current program proposal outlines the needs for space, equipment and operating funds to support the program.

C. Plan for attaining accreditation. The University will seek accreditation four years after program start-up, after successful completion of the third faculty hire in Surveying Engineering and Geomatics. David Gibson, the University's consultant on development of the Surveying Program, has developed a detailed timetable for development of an accredited program. The timetable is attached to this proposal. It is also proposed that an external consultant be retained to make an annual visit to the University to evaluate progress towards accreditation. The proposed timetable is as follows:

1. Fall 2000 - Spring 2001. Conduct search and hire surveying engineering Program Director, with start date of Fall 2001. Receive first consultant visit to evaluate progress.
2. Fall 2001 - Spring 2002. With assistance of Civil Engineering Chair, Surveying Program Director begins development of courses and laboratory/equipment resources. Teach two courses per term. Conduct search and hire second faculty member at tenure-track assistant professor level. Admit first students (community college transfers and recent high school graduates) to program. Receive second consultant visit to evaluate progress.
3. Fall 2002 - Spring 2003. Continue development of courses and resources. Teach four to six courses per term. Conduct search and hire third faculty member at tenure-track assistant professor level. Receive third consultant visit.
4. Fall 2003 - Spring 2004. Complete development of laboratory and equipment resources. Develop accreditation document for submission to ABET in Spring 2004. Teach minimum of eight courses per term. Graduate first students from program. Receive fourth consultant visit.

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5. Fall 2004 - Spring 2005. Receive ABET accreditation visit in Fall 2004. Continue to teach minimum of eight courses per term. Receive and respond to ABET evaluation in Spring 2005. Graduate more students from program.

6. Summer 2005 - receive results of program accreditation. If successful, accreditation of the Surveying Engineering B.S. degree would apply both to program graduates into the near future (time period to be determined by ABET) and retroactively to all program graduates up to the date of accreditation.

7. Fall 2005 - Spring 2006. Continue to teach eight courses per term, and improve program per ABET recommendations.

5. Evidence of approval by appropriate committees of the institution.

At the date of writing of this draft (February 17, 2000), no committee approvals have been obtained. Prior to submission to the System, the draft program proposal will be submitted for review and approval by:

- a. Faculty of the Civil and Environmental Engineering Department;
- b. College of Engineering program and curriculum review committee;
- c. University Curriculum Committee;
- d. University Priority and Program Review Committee;
- e. Review by the Provost and President of UNLV;

The Nevada Association of Land Surveyors and the Nevada State Board of Professional Engineers and Land Surveyors will also be contacted for review and comment on the draft program proposal.

The program proposal will be modified to reflect the inputs of the above reviewers, and this section of the proposal will be modified to report the results those reviews.

IX. Readiness to begin program.

A. Faculty strengths (specializations, teaching, research, and creative accomplishments.

The following Civil and Environmental Engineering department faculty have specializations in teaching and research that are applicable to the proposed Surveying Engineering program.

1. Dr. Barbara Luke, Assistant Professor, has taught CEG 121, Elementary Surveying, and uses Global Positioning System technologies in her research programs. Along with Dr. Shashi Nambisan, P.E., she has received grant funding to use and develop GPS technologies in civil engineering instruction and research.

2. Dr. Shashi Nambisan, PE, Professor, has expertise in use of Geographic Information Systems technology and has received grants totaling over \$1,000,000 in the last five years to conduct applied GIS research on traffic safety, hazardous materials routing, and inventory of publicly owned infrastructure, including utilities and roadways. Dr. Nambisan has also received a grant with Dr. Barbara Luke to acquire state of the art Global Positioning System technology, and apply it to instructional and research problems in civil engineering.

3. Dr. Walter Vodrazka, PE, Professor, and Associate Dean of the College of Engineering, regularly instructs civil engineering courses that would be used in the Surveying Engineering program, including:

- a. EGG 307 - Engineering Economics Law-Business-Management elect
- b. CEG 466/666 - Geometric Design of Highways, similar to
SEG 405 - Highway Geometric Design Required course
- c. CEG 409/609 - Engineering Project Management Law-Business-Management elect

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4. The department has several adjunct faculty who serve as instructors in the following subjects:

a. Elementary Surveying. Mr. Tom Barnes, PLS, and Mr. Byron Johnson, PLS. It is anticipated that Messrs. Barnes and Johnson would provide instruction in SEG/CEG 121 if the Surveying Engineering program proposal is approved.

b. AutoCAD and applications. Mr. Keith Warren, PE. Mr. Warren serves as instructor in CEG 201 - CAD Applications in Civil Engineering.

5. Dr. Mohamed Kaseko, Associate Professor, has regularly taught EGG 307, Engineering Economics, a Law-Business-Management elective in the proposed curriculum.

6. Dr. Gerald Frederick, PE, Professor, has regularly taught, CEG 206, Statics, an engineering science elective in the proposed Surveying Engineering Curriculum.

B. Contribution of new program to department's existing programs (both graduate and undergraduate) and contribution to existing programs throughout the university.

1. Department's existing programs

It is anticipated that the proposed program in Surveying Engineering would have a substantial positive benefit on the department's undergraduate and graduate programs in Civil Engineering. Surveying is essential to the civil engineering profession, where engineers use surveying tools and skills to check the alignments, elevations and locations of roadways, utilities, tunnels, bridges and buildings. Civil engineers also use surveying skills to estimate volumes of earth needed for addition or removal to sites, to estimate land slopes and also to estimate changes in elevation that occur over time (land subsidence).

Currently, all civil engineering majors at UNLV are required to take one introductory course in land surveying, and they must use this surveying knowledge in advanced courses in hydrology, foundations and geographic information systems. Civil engineers must frequently interact with professional land surveyors, who generate and graphically organize the information that engineers use in their designs. Currently, three courses offered in the Civil Engineering Department, CEG 121, CEG 423 and CEG 468/668, could be cross-listed and incorporated into a Surveying Engineering program.

The addition of surveying faculty and equipment to the department would significantly enhance its ability to compete for external research funding in fundamental and applied areas of positioning technology, geographic information systems and remote sensing. Addition of surveying skills would enhance the department's ability to perform quality research in such areas as:

- a. Accurate location of sites for environmental sampling,
- b. Accurate determination of extent of contamination of soil and ground water
- c. Accurate measurement of expansion and subsidence of soils and foundations,
- d. Accurate location of physical infrastructure
- e. Accurate estimation of terrain elevations and ground slopes

The Civil and Environmental Engineering department's inventory of surveying, positioning, and GIS technology would be enhanced by development of instrumentation for the Surveying/Geomatics program as additional total stations, sub-meter resolution GPS systems are acquired for the Surveying Engineering program.

2. Academic programs throughout the University

Several academic programs at UNLV have needs for surveying related skills and could provide opportunities for interdisciplinary collaboration and research. The Department of Mechanical and

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Aerospace Engineering uses accurate digital terrain maps in models that compute the trajectories of winds in the atmosphere. Geosciences has needs for surveying skills to accurately map the locations of geologic resources such as ore bodies and rock formations. Surveying and mapping skills are needed to accurately track dislocations across active faults and inflation and deflation of active and dormant volcanoes. The Biological Sciences department carries out surveying and mapping of distributions of plants and animal habitats, and surveying and mapping of archaeological resources is performed in the department of Anthropology. Health Physics conducts research on the isotopic content of sediment cores, and needs accurate determinations of core positions. Additional resource mapping and analysis needs could emerge in the Environmental Studies Program.

3. Completed prior planning for the development of the program (recent hires, plans for future hires, securing of space, curricular changes, and reallocation of faculty lines.

a. Recent hires - The proposed program has not affected the nature of recent hires. Recent hires, including two in construction engineering and management and one in environmental engineering, were made in response to significant programmatic needs that were developed before the need for surveying engineering became apparent.

b. Plans for future hires - The department seeks faculty lines for Surveying Engineering that are in addition to needs developed for civil engineering. Since the mid 1990's, the department has made it a goal to develop a nucleus of three faculty in each of the following areas of specialization, environmental (2 currently), geotechnical (2 currently), structural (2 currently, with a third position now open and search underway), construction (3 currently), transportation (2½ currently), water resources (2 currently). Given the significant growth needs in southern Nevada and the southwest, and projected growth in student enrollments, the department requests that its priorities for faculty lines within its current specialty areas be retained, and that three surveying engineering positions be developed in addition to the four slots needed for civil engineering.

c. Reallocation of faculty lines - Currently, there are no anticipated faculty departures from the department. With an average of two faculty in each specialty area, and a need for at least two undergraduate and two graduate courses per semester in each specialty area, the department is at minimal strength in each specialty area for adequate delivery of course instruction for its B.S., M.S. and Ph.D. degrees in Civil Engineering. If such departures were to take place, it would be in the best interest of the department to replace departing faculty members with someone in the same specialty area. The department would oppose any reallocation of existing faculty lines from civil engineering to surveying engineering.

d. Securing space - Space in the Tiberti Engineering Complex is not currently adequate to house the Surveying program. For the short-term, until a major addition to the Tiberti Complex can be funded and constructed, space elsewhere on campus is needed for the program. It is anticipated that space could be made available in the Facilities Management Buildings A and B, when they are vacated sometime in the year 2000. If the proposed Surveying Program is given priority, office and laboratory space in FMA and FMB would be sufficient for the initial needs of the Surveying Engineering Program. Plans for program space needs are detailed in Section XI of this proposal.

e. Curricular and equipment changes

Curriculum

The Department of Civil and Environmental Engineering recently approved EGG 323 - Public Lands Surveying, to be taught via a distance education. EGG 323 would later become a SEG course, SEG

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405, in the Surveying Engineering program. The department is also seeking a part-time instructor to offer CEG 423, Advanced Surveying, as a civil engineering elective in Fall 2000.

Equipment

The department's surveying equipment inventory is now in the process of being combined with equipment donated by NALS to CCSN for their two-year degree program. The combined inventory will be housed on the UNLV campus, and used for field instruction in surveying courses offered by both UNLV and CCSN. This combined inventory would also be made available to the Surveying Engineering program.

4. Recommendations from prior program review and/or accreditation review teams.

As of the date of this writing, February 17, 2000, there have not been any prior program review or accreditation reviews of Surveying Engineering/Geomatics program proposals at UNLV. This document is the first program proposal for Surveying Engineering/Geomatics.

It is planned that this program proposal will be reviewed by several external organizations and agencies that have strong interests in the success of the program, including:

- a. The Nevada Association of Land Surveyors
- b. The Nevada State Board of Professional Engineers and Land Surveyors

Comments from these bodies will be incorporated into a revised version of the proposal.

5. Organizational arrangements that must be made within the institution to accommodate the program.

a. Additional faculty lines.

Faculty lines in addition to those planned for civil engineering should be developed for Surveying Engineering/Geomatics. The minimum number of faculty allowed by ABET for a separate engineering discipline is three. Three lines, with one at the senior level, and two at the assistant professor level, represent approximately \$200,000 - \$240,000 per year in faculty salary and benefits.

b. Initial faculty hire.

The first faculty hire in Surveying Engineering should be at a senior level (Associate or Full Professor) with tenure, and this first hire should be designated the Program Director for Surveying, with reduced teaching responsibilities that allow for a major effort in the development of curriculum, contacts, research and facilities.

c. Support staff.

The level of institutional support for administrative and technical positions needs to be improved if the department's programs are to remain viable. It is vital that one additional management assistant and one additional laboratory technician position be authorized for the department if the Surveying Engineering/Geomatics program is approved. If the Surveying Program attracts 60-100 majors and three faculty in the first five years, the department would be faced with trying to manage the needs of 19 faculty and 450 majors in eight degree programs with its current staffing of only two management assistants and one shop technician.

d. Graduate assistantships.

The Department of Civil and Environmental Engineering currently has 12 graduate assistant positions to meet the needs of 16 faculty and 300 undergraduate majors in civil engineering and construction management. The departmental allocation should be increased to at least 19 positions if the Surveying Engineering/Geomatics program is approved. Here are the reasons:

1. The department did not receive any additional assistantships when Construction Management was added to the department's responsibilities. The department has had to allocate assistantships from

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civil engineering to construction management to cover laboratory and grading responsibilities in that program. Three additional computer laboratory courses are being offered each semester in Construction Management. The department should receive three additional GA's to support the Construction Management B.S. and M.S. degree programs, but has currently received none.

2. If the Surveying Engineering/Geomatics program is approved, and three faculty, 60 students and eight classes per semester are added, including four laboratory sessions per semester in Fall (CEG 201, SEG 121, SEG 201, SEG 303), and six laboratory sessions per semester in Spring (CEG 201, SEG 121, SEG 202, SEG 304, SEG 403, SEG 404), the department will not be able to meet programmatic needs with 12 or 15 teaching assistants. A minimum of four additional state-supported graduate assistantships is needed to support Surveying laboratories and grading in Surveying classes.

X. Resource Analysis.

1. Proposed source of funds (enrollment-generated state funds, reallocation of existing funds, grants, other state funds).

a. Enrollment-generated state funds

Assuming 10 credits per head-count in the program, and fees of \$70 per undergraduate credit hour, development of the Surveying Program would provide the following additional student-generated revenue in each of the following planning years:

1 st year (Fall 2001)	<u>12</u>	x 2 semesters x 10 credits x 70 \$/credit = \$16,800
2 nd year (Fall 2002)	<u>33</u>	x 2 semesters x 10 credits x 70 \$/credit = \$46,200
3 rd year (Fall 2003)	<u>51</u>	x 2 semesters x 10 credits x 70 \$/credit = \$71,400
4 th year (Fall 2004)	<u>60</u>	x 2 semesters x 10 credits x 70 \$/credit = \$84,000
5 th year (Fall 2005)	<u>66</u>	x 2 semesters x 10 credits x 70 \$/credit = \$92,400

These figures represent revenue to the state from student in-state tuition, and do not represent funds received by the department to operate the program.

b. Reallocation of existing state funds - The department's 1999-2000 operating budget was \$52,000. The department has not received any state equipment dollars for three years, and has no state funds for faculty or student travel. The operating budget is adequate for office supplies, office help and general office suite software licensing of the Civil Engineering, Transportation, and Construction Management degree programs. It is conceivable that office support expenses for the first year of the Surveying Engineering/Geomatics program could be accommodated by this budget, but beyond year 1, funds in this account would not be sufficient to cover Surveying Engineering/Geomatics expenses.

Annual fees for licensing of the GIS, CAD, GPS and remote sensing software to be used by the Surveying Engineering/Geomatics program are expected to be very high, on the order of \$35,000 - \$40,000 per year, and these expenses would wipe out the department's current operating budget.

c. Gifts - Given historical levels of state funding support for other programs at the University, it is apparent that a significant portion of program funding may have to come from outside support. The

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UNLV Foundation's Director of Development for Engineering and Science, Jack Jenks, has already initiated a fund-raising campaign with the Nevada Association of Land Surveyors, and NALS has indicated a willingness to develop an initial level of external support in the range of \$20,000 to \$30,000 per year for the program, along with donations of equipment. An endowment for a complete scholarship for one student is under discussion.

d. Grants - It is anticipated that significant research funding opportunities exist in Surveying and Geomatics. The rapid development and incorporation of remote sensing technologies from satellites and aircraft, global positioning technologies, Geographic Information Systems technology, and laser-based measurement systems has created significant funding opportunities for incorporating these technologies into traditional surveying and mapping activities. Although the primary efforts of Surveying/Geomatics in the initial years will be focused on curriculum and program development, the surveying program consultant estimated that a minimum level of \$100,000 per year in Surveying/Geomatics research funding should be easily attainable in the first few years of program operation.

2. Each new program approved must be reviewed for adequate full-time equivalent (FTE) to support the program in the fifth year. Estimate the following:

a. full-time equivalent fall enrollment for the first, third, and fifth year.

Computed assuming that, during the first five years of program operation, 1/3 of each year's fall head-count will be full-time (15 credits) and 2/3 will be half-time (9 credits)

1st year (Fall 2001) 8

3rd year (Fall 2003) 34

5th year (Fall 2005) 44

b. total headcount fall enrollment for the first, third, and fifth year.

Computed assuming matriculation of 10 students in year 1, 20 students each in year 2 and thereafter, with graduation rates slowly building from 10 in year 4 to 15 in year 5. These estimates are based on

1. known enrollments in the Surveying Technology 2-year program at CCSN (about 70-80 per semester), assuming that 10 per semester would be interested in continuing to a four-year program at UNLV,

2. a poll of the membership of NALS, indicating interest of about 10 per year from NALS membership,

3. anticipated needs for surveying licensing in the state of Nevada of about 40 per year, with half of the demand being met by graduates from the UNLV surveying engineering program, 10 per year by graduates from out-of-state programs, and 10 per year by persons with other degrees qualifying for licensing as Land Surveyors.

1st year (Fall 2001) 12

3rd year (Fall 2003) 51

5th year (Fall 2005) 66

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3. Budget projections (revenue and expenditures) for each of the first three years, including:

a. revenue and expenditures associated with the program itself,

	Revenue			Expenditures		
	students ¹	gifts	grants	operating	salaries ²	equipmnt ³
1 st year (Fall 2001)	16,800	10,000	0	5,600	100,000	49,000
3 rd year (Fall 2003)	71,400	30,000	50,000	45,500	335,000	0
5 th year (Fall 2005)	92,400	40,000	100,000	50,300	415,000	16,500

¹Tuition revenue does not come back to the program directly

²Salaries include estimated fringe benefits, and assumed one faculty in year 1, two in year 3 plus a half a management assistant, a technician and three GA's, and three faculty in year 5 plus a half a management assistant, a technician and four GA's.

³Equipment costs shown here skip over year 2, where start-up acquisitions require \$93,000 in funds.

b. institutional financial support to be reallocated to accommodate the program,

At the time of writing of this draft (February 17, 2000), no plans for reallocation of institutional support have been made. As previously discussed, the current Civil and Environmental Engineering department operating budget could probably accommodate Surveying Engineering start-up operating costs in year 1, but after that, existing funds are inadequate to support the program.

c. full-time equivalent (FTE) faculty,

Three additional full-time equivalent faculty and two part-time (one course per semester) faculty are needed to provide the minimum level of instructional support needed for an accredited baccalaureate program.

d. classified staff, professional staff, and graduate assistants,

1. Classified staff:

- a. An additional half-time management assistant (which when combined with the half-time position authorized for the construction management program) adds to a full-time position.
- b. An additional full-time laboratory/shop technician - approved with the department's Ph.D. program in 1991 but never authorized, is needed.

2. Professional staff - none

3. Graduate assistants - four additional graduate assistants to support anticipated demand for laboratory and classroom support

e. operating funds,

Expected operating funds needed in the first year of the program are shown below. The bulk of the costs in years 2 through 5 are from annual licensing fees for the remote sensing, global positioning, and GIS software

Year 1	\$5,600
Year 2	\$28,800

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Year 3	\$45,500
Year 4	\$49,200
Year 5	\$50,300

f. library and information resources, and

Library funds will be needed to support subscription costs (print or on-line) for four major journals, shown below:

1. American Congress on Surveying and Mapping (ACSM) Surveying and Land Information Systems Journal
2. ACSM Cartography and Geographic Information Systems Journal
3. American Society for Photogrammetry and Remote Sensing (ASPRS) Photogrammetric Engineering and Remote Sensing Journal
4. Urban and Regional Information System Association (URISA) Journal

Interlibrary loan services should be available for specialized needs, and World-Wide Web / Internet access should be available to surveying faculty and students in their offices and laboratories.

g. other,

Significant start-up equipment costs can be anticipated for first two years of the program. Modest equipment costs can be anticipated in years 4 and 5 as computer systems acquired during years 1 and 2 are replaced on a 3-year cycle. Estimated costs for years 1 through 5 of the program are shown below:

Year 1	\$49,000
Year 2	\$93,500
Year 3	\$0
Year 4	\$10,500
Year 5	\$16,500

4. Estimated budgetary and financial ramifications for the institution.

Anticipated expenditures in year 1 of the program, \$155,600, represent about 0.1% of UNLV's current level of state support. Anticipated expenditures in year 5 of the program, \$482,000, represent about 0.5% of UNLV's current level of state support. The program is expensive in comparison to programs of similar size in other departments because of high anticipated costs to maintain state of the art computers and up-to-date software licenses in the programs instructional laboratories.

Given past levels of state funding, and anticipated slow or no growth in state funding, a major effort in external fund raising will be necessary to develop a viable program.

5. Impact of new program on department's existing resources.

The department

- a. Has adequate surveying equipment to support the lower division and several upper division classes in surveying engineering/geomatics.
- b. Has adequate operating funds to support year 1 of the surveying engineering/geomatics program.
- c. Does not have adequate operating funds to support year 2 or beyond.
- d. Does not currently have the equipment budget to acquire equipment or computers

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needed for photographic analysis, CAD, GIS, Geodesy, or remote sensing analyses.

e. Does not have open faculty lines that can be reallocated to surveying engineering.

f. Does not have adequate classified staff to support the surveying engineering/geomatics program.

g. Does not have adequate space to support the surveying engineering/geomatics program.

h. Does not have adequate numbers of state-funded graduate assistantships to support the proposed surveying engineering/geomatics program.

XI. Facilities and equipment required.

1. Existing facilities: type of space required, number of assignable square feet, space utilization assumptions, special requirements, modifications, effect on present programs.

a. Existing facility:

Equipment storage locker - The department's current storage locker space is anticipated to be adequate for storage of both civil engineering and surveying engineering field equipment. It has about 220 assignable square feet and can be secured with a Marlock key. No modifications are required.

b. Other department space:

Current departmental laboratory and office space is inadequate for the department's existing programs. Four faculty groups, geotechnical, structural, water resources, and transportation, are housed in trailers and buildings external to the Tiberti Engineering Complex, some 300 yards and 500 yards away from the building. Departmental faculty are housed in two separate buildings, and existing structural, fluid mechanics, geotechnical and environmental laboratories must combine teaching and research functions, requiring constant shifting and displacement of instructional apparatus and occasional displacement of research setups to accommodate instructional needs. The Transportation Research Center lacks space for its records and personnel. Civil engineering, construction management and mechanical engineering must share the College's CAD laboratory, and it will be booked for over 50 instructional hours per week in Spring 2000, and this will increase in Fall 2000.

c. Space utilization assumptions:

It is assumed that:

1. Each surveying engineering/geomatics faculty will be assigned their own office, and that, at minimum, three 180 square foot offices will be needed for the three faculty to be hired,
2. One 1000 square-foot laboratory dedicated to photogrammetry, and one 800 square foot laboratory dedicated to GIS instruction will be needed,
3. Two hundred square feet will be needed for a management assistant, files and supply storage,
4. Three hundred square feet will be needed for a shop technician, work benches and lockers,
5. Two 180 square foot shared offices will be needed for graduate assistants.

d. Effect on current programs:

There is no room for Surveying Engineering laboratories to be incorporated into existing departmental or College space.

1. To avoid displacing existing Civil, Mechanical or Construction Management classes,

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surveying laboratory classes could only be taught on weekends in the existing space.

2. Creating a dedicated surveying engineering photogrammetry lab in existing space would require displacement of some other departmental or college function.

3. Adding surveying engineering faculty to existing office space would require faculty to share offices, with a detrimental effect on the quiet time needed for writing of proposals and publications.

2. Additional facilities required: number of assignable square feet, description of space required, special requirements, time sequence assumed for securing required space.

a. Description of space required and number of assignable square feet

Classroom - The department anticipates the following course offering schedule for classes in surveying engineering:

Fall 2001, Spring 2002 - one full-time faculty teaching two classes each semester, each initially enrolling an average of 10 students - and one part-time faculty teaching one class each semester, each enrolling 10 students, *requires three scheduled 10-seat classroom slots each semester,*

Fall 2002, Spring 2003 - two full-time faculty teaching four classes each semester, each initially enrolling an average of 20 students, and two part-time faculty teaching one class each semester, each enrolling 20 students, *requires five scheduled 20-seat classroom slots each semester*

Fall 2003, Spring 2004 and subsequent years - three full-time faculty teaching six classes each semester, each initially enrolling an average of 20 students, and two part-time faculty teaching one class each semester, each enrolling an average of 20 students, *requires eight scheduled 20-seat classroom slots each semester*

By Fall 2003, one classroom would need to be reserved for the entire day, for a minimum of three days per week, to meet the needs of the surveying program.

Laboratories - The department anticipates needing the following dedicated facilities to support the surveying program

1. A 1000 square-foot computation and mapping laboratory, consisting of seven IBM-compatible personal computers with surveying software, and seven photogrammetric workstations with GPS reduction and image analysis software. This facility does not exist, and would be dedicated to the surveying/geomatics program.

2. An 800 square-foot GIS laboratory consisting of 15 workstations for geographic data analysis and processing. This facility does not exist, and would be shared between the surveying/geomatics and civil engineering programs. It is estimated that the surveying/geomatics program would need six of these workstations.

Office space - The department anticipates the following additional office space needs for the surveying/geomatics program.

1. Three 180 square-foot faculty offices - added at a rate of one office per year for 2001, 2002, 2003.

2. Two 180 square-foot graduate assistant offices, with each office used for 2 TA's,

3. One 100 square-foot management assistant space - for desk and filing cabinets,

4. 50 square-feet as a storage area for office supplies,

5. 50 square-feet of secure space to house program administrative records,

Ideally, the surveying faculty and graduate assistant office cluster, and the surveying/construction management secretarial desk would be located near the surveying

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laboratories to provide ease of communications for students, staff and faculty.

b. Time sequence for securing required space

Classroom - By Year 3 of the program, when all required courses will be taught a classroom will need to be scheduled to surveying engineering/geomatics at least three full days per week

Laboratory - By Year 2 of the program,

1. a laboratory space dedicated to photogrammetric analysis and surveying instruction must be located and set up, and
2. a civil engineering/surveying engineering shared GIS laboratory must be located and set up

Office space

1. Faculty offices, one new faculty office will be needed for the program in each of Years 1, 2 and 3
2. Management assistant office, one new management assistant space needs to be identified for the program by Year 2
3. Shop technician desk space - one new work area and desk for a second shop technician needs to be identified by Year 1 of the program
4. One new graduate assistant office needs to be located for the program in each of Years 2 and 3
5. Office supply and file storage space needs to be identified for the program by Year 2.

c. Special requirements

1. Classroom. Needs minimum number of 20 seats and multimedia capability.
2. Laboratory. Photogrammetry laboratory should be large enough to accommodate Kelsh or similar analog stereoplotter, which is a very large (12 feet long) piece of equipment. All laboratories should have Ethernet/Internet networking
3. Office space. Ethernet/Internet access and faculty/GA/management assistant offices located in close proximity to each other (in a "cluster") would enhance communications and collaboration within the program.
4. File and supply space. Files should in a secure location and in close proximity to the management assistant's desk.

3. Existing and additional equipment required.

a. Field equipment: UNLV's existing surveying field equipment should be adequate for the initial instructional activities. The local profession has loaned CCSN two total station surveying instruments, and these will soon merged with UNLV's more traditional surveying equipment. The program should have the following within the first two years of operation:

- Six or seven "lockers" of full sets of field equipment: optical theodolites, tapes, levels, and level rods. This equipment is currently available.
- Three total station electronic surveying instruments with retro-reflectors with digital data recording capabilities. When combined with NALS equipment loaned to CCSN, two stations are currently available
- Data collection software (TDS or SMI) with each student having a HP48 for field data recording. This capability is not available.

It appears that only data collection hardware and software may be needed at the current time, supplemented by an additional total station instrument package. (estimated additional cost \$10,000)

b. Computational equipment: Once field measurements are taken, a considerable amount of computation and mapping is performed that requires specialized software. The program should have:

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- At least three AutoCAD PC computer stations that are fully accessible by surveying students within the first year of program operation. By the end of the five-year period, there should be from five to seven stations where surveying students have full access. (estimated cost \$2,500 per seat with AutoCAD)
- Each of these PC's should also have a dominant coordinate geometry (COGO) software set such as Softdesk, or Eagle Point. This software should work seamlessly with AutoCAD for survey computation and plotting (estimated cost \$1,500 per seat).

A networked 15-seat laboratory (TBE B367) with CAD software is available, but is heavily scheduled. Surveying software must be acquired. Development of a second CAD/GIS instructional laboratory is strongly recommended.

Photogrammetry instruction will require several specialized sets of hardware or software:

- Seven mirror stereoscopes and precise viewing and measurement of 9x9 air photos. (estimated cost \$2,000 each, total \$14,000).
- One "soft copy" stereo photogrammetric work station hardware and software (estimated cost \$30,000).
- One older analog stereoplotter, Kelsh or similar for demonstration. (no additional cost).
- Image mapping software for image and remote sensing mapping such as ERDAS or similar. (estimated cost \$3,000).

None of this equipment is currently available, however, the vice-president of NALS has secured a verbal agreement with several aerial photo companies to loan their equipment and office space for lab work in the late afternoon and early evening.

Instruction in geodetic surveying and mapping will require global positioning system hardware and reduction software:

- Two geodetic-grade (centimeter resolution) GPS system for static differential and kinematic surveying. (estimated cost \$20,000 each, total \$40,000).
- Two mapping grade (meter resolution) GPS systems. (estimated at \$5,000 each)

One single frequency geodetic grade GPS system with six units is available. A dual frequency geodetic grade GPS two mapping grade GPS systems need to be acquired.

Instruction in geographic information systems will require GIS software. UNLV already has ARC/INFO in its Transportation Research Center. ARC/INFO is the industry leader with a large percent of the GIS market, and this software is recommended. It is not clear whether surveying students would have access to the GIS capabilities of the TRC, but in any case the surveying students should have full access to:

- A networked lab of five PC's running ARC/VIEW. (estimated software costs \$1,500 each)
- At least one seat of "full" ARC/INFO software. (estimated software costs \$12,000)

A networked lab (B367) with GIS ARC/VIEW software exists, but is heavily scheduled. Development of a second computer laboratory with instructional capabilities in GIS and CAD is strongly recommended.

B.S. Surveying Engineering Program Proposal

XII. Student services required.

1. Plans to provide student services to accommodate the program, including its implications for services to the rest of the student body.

A. Advising. Surveying engineering B.S. majors will be advised in a manner similar to advising for Civil Engineering majors:

1. All Surveying engineers will be assigned a faculty advisor. Students are required to meet with their advisor every semester to plan their degree program.
2. An Advanced Standing program requirement will be implemented for Surveying Engineers. Students must complete a defined set of lower division courses in english, mathematics, science, civil engineering, and surveying before they will be allowed to register for junior and senior level classes.
3. Prerequisites for lower division courses will be enforced by computer
4. Student academic records will be maintained in locked file cabinets, with access to each student's file limited to department faculty and staff, and to the student.
5. A comprehensive review of the student's record will take place when the student files their Graduation Application at the start of their planned next-to-last semester of study.

B. Student activities.

1. A student chapter of the Nevada Association of Land Surveyors will be created, with planned participation in the chapter by surveying practitioners as advisors and mentors.

XIII. Consultants (required for university programs only).

1. Names, qualifications and affiliations of consultant(s) used.

David W. Gibson, Geomatics Program Director at the University of Florida, Gainesville, was retained by the College of Engineering to evaluate the feasibility of establishing a four-year surveying program in Nevada.

2. Summary of consultant's comments and recommendations.

Mr. Gibson completed a report in late October 1999, titled "A Five-Year Plan for Development of a Surveying Degree Program at the University of Nevada, Las Vegas".

Recommendations were made for the development of a program with regional impact, including

- recruiting and advertising of the program in neighboring states,
- implementation of in-state tuition rates for residents from neighboring states lacking a 4-year surveying degree, and
- negotiation of memoranda of understanding with professional societies in Nevada and neighboring states on the acceptability of a Nevada degree.

A M.S. degree in Geomatics was proposed to be developed simultaneously with the B.S. degree in Surveying Engineering, so that graduate students could be attracted to support faculty research while receiving advanced training in surveying that would prepare them for leadership positions in the field. A separate program proposal covers the M.S. degree.

B.S. Surveying Engineering Program Proposal

The report laid out a detailed curriculum plan, hiring plan, space plan, and implementation schedule for a program in Surveying Engineering/Geomatics. Curricula were proposed for:

- a. A four-year B.S. degree in Surveying Engineering
- b. A two-year M.S. degree in Geomatics
- c. A two-year A.A. transfer degree from Community College

Existing equipment and laboratories were assessed during a site visit, and a plan presented for acquisition of equipment sufficient to initiate the program, along with a listing of the laboratory facilities needed to house and operate the equipment.

A plan for hiring one faculty a year for three years was presented, and an annual visit from an external consultant was recommended in the years leading up to an accreditation visit from ABET.

3. Summary of proposer's response to consultant.

Only minor adjustments were needed to the first draft of the consultant's report. The department and College requested addition of a capstone senior design course to the curriculum plan. The final draft of the report included the capstone design course, and was accepted by the Department and the College of Engineering in Fall 1999. The consultant's report is viewed as a thorough, comprehensive guide to the development of a Surveying Engineering/Geomatics program at UNLV.

Since acceptance of final draft, the consultant's suggested curriculum has been slightly modified to meet ABET surveying requirements by requiring the geology course (instead of having it as a laboratory science elective). As a result the current proposed curriculum now has only one laboratory science elective, instead of two.

The consultant's proposed 3-credit higher mathematics elective was removed, and replaced with two required 3-credit higher mathematics courses:

- 1) STA 463, Applied Statistics for Engineers, to provide knowledge of data distributions and regression techniques.
- 2) MAT 253, Linear Algebra, to provide the theoretical foundations for understanding matrix-based coordinate transformations on spherical surfaces, used in Photogrammetry.

As a result of these changes, the proposed curriculum is now 136-137 credits, instead of the 133 credits recommended by the consultant.

4. Attachment of consultant's complete report.

Please see attachment of complete report from Mr. Gibson dated 10/26/99. Substantial portions of his report have been incorporated into this program proposal with little modification.

Proposal format revised: 10/22/98